IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 4, July 2026
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Gamified Digital Worksheets with AI Feedback Support for Active Learning in Elementary Civic Education

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DOI: https://doi.org/10.46245/ijorer.v7i4.1512

Sections Info

Article history:
Submitted: May 25, 2026
Final Revised: Juny 29, 2026
Accepted: July 21, 2026
Published: July 27, 2026

***Keywords*:**
Active Learning; AI Feedback Support; Civic Education; Digital Worksheet; Gamification

ABSTRACT

Objective: This study aims to develop and test the feasibility of gamified digital worksheets with AI feedback support to promote active learning in elementary Civic Education (PKn). **Method:** The study employed a research and development design using the 4D model consisting of define, design, develop, and disseminate stages. The participants were fourth-grade elementary students, and the evaluation involved expert validation, a limited trial, and a broader trial. Two expert raters validated the draft across six aspects: civic education content, digital media, gamification, active learning, AI feedback support, and language. Content validity was analyzed using Aiken's V, while inter-rater reliability was calculated using percentage agreement, Cohen's kappa, and the intraclass correlation coefficient (ICC). Teacher and student responses were converted into percentages and categorized as Very Good, Good, Fair, or Poor. **Results**: The average Aiken's V was 0.90, with a range of 0.67-1.00, indicating that the product was highly valid. Inter-rater reliability showed 83.33% exact agreement, Cohen's kappa of 0.61, and ICC of 0.61. Teacher responses increased from 93.33% in the limited trial to 100.00% in the broader trial, while student responses increased from 97.46% to 99.15%. **Novelty**: The study offers a gamified worksheet model in which AI serves as a feedback and reflection support tool, while gamification and active learning remain the main pedagogical structure for strengthening civic understanding, participation, and responsibility in elementary learning.

INTRODUCTION

Civic Education in elementary schools has a strategic position in developing students' civic knowledge, civic skills, civic dispositions, and responsible participation. Contemporary civic learning is expected to move beyond memorizing concepts toward activities that help students analyze everyday civic problems, communicate arguments, make ethical decisions, and reflect on rights and responsibilities (Halverson et al., 2024; Schmitt et al., 2024). However, elementary Civic Education is still frequently constrained by teacher-centered instruction, limited interactive resources, and learning tasks that do not fully encourage students to participate actively.

Active learning provides a relevant pedagogical foundation because students are positioned as participants who investigate problems, discuss alternatives, and construct meaning from contextual cases. In Civic Education, this orientation is particularly important because civic values are not only understood cognitively but also practiced through deliberation, cooperation, responsibility, and reflection. Therefore, digital learning resources for elementary students should combine clear civic content, age-appropriate activities, collaborative tasks, and opportunities for feedback.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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Gamification can strengthen this active learning orientation by embedding missions, points, rewards, levels, challenges, and reflection tasks into worksheet activities. When game elements are aligned with academic objectives, they can increase students' cognitive, emotional, and behavioral engagement without reducing the seriousness of civic learning (Najjar & Salhab, 2022; Ruiz et al., 2024). In this study, gamification is not used merely as entertainment; it is structured to guide students through civic cases, decision-making activities, peer discussion, and value reflection.

More specifically, the worksheet design maps each gaming component onto the three civic competency domains. Mission-based activities and short civic cases are aligned with civic knowledge because they guide students to identify rules, rights, obligations, and norms in school and community life. Challenges and collaborative quests are aligned with civic skills because they require students to discuss alternatives, communicate reasons, make decisions, and solve civic problems with peers. Points, levels, and progress indicators function as feedback on task completion and participation rather than as prizes alone, while rewards, badges, and reflection checkpoints are used to reinforce civic dispositions such as responsibility, fairness, cooperation, respect for different opinions, and willingness to improve choices. This mapping helps ensure that gamification supports Civic Education objectives instead of becoming a separate motivational layer (Halverson et al., 2024; Schmitt et al., 2024).

Artificial intelligence (AI) can complement gamified worksheets by offering prompt-based feedback, guiding reflection, and helping students revisit their answers. Recent studies indicate that AI in education can support personalization, intelligent tutoring, learning analytics, and adaptive feedback (Dimitriadou & Lanitis, 2023; Kerimbayev et al., 2025; Lin et al., 2023; Zhai, Chu, Chai, Siu, et al., 2021). Nevertheless, AI should be used carefully in elementary education. It must not replace teachers' pedagogical judgment; instead, it should operate as a support tool under teacher supervision, with attention to transparency, fairness, privacy, and age-appropriate use (Adams et al., 2023; Miao & Holmes, 2023).

The integration of gamification and AI feedback support is therefore promising for elementary Civic Education. Gamification can organize students' learning flow and motivation, while AI feedback can help students refine answers and reflect on civic choices. This synergy enables digital worksheets to become more interactive, contextual, and reflective than conventional printed worksheets. At the same time, teacher facilitation remains essential to ensure that feedback is interpreted critically and that civic values are discussed in relation to students' real lives.

Despite the growing literature on gamification and AI in education, there is still limited research that develops digital worksheets specifically for elementary Civic Education by combining gamified active learning activities with AI feedback support. Based on this gap, the present study aims to develop and test the feasibility of gamified digital worksheets with AI feedback support for active learning in elementary Civic Education.

RESEARCH METHOD

Research Design

This research used a research and development (R&D) method with the 4D model adapted from Thiagarajan (1976), which consists of define, design, develop, and disseminate stages. The define stage included analysis of learning needs, fourth-grade

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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student characteristics, Civic Education learning outcomes, digital media requirements, and classroom constraints. The design stage produced the worksheet structure, learning flow, gamification scenario, mission-based activities, reflection prompts, evaluation items, and AI feedback support features. The develop stage included product construction, expert validation, revision, a limited trial, a broader trial, and final product refinement. The disseminate stage was conducted through limited dissemination to elementary teachers and the school learning community by sharing the revised product file, user guide, implementation procedure, and evaluation sheet. A short implementation briefing was also provided so that teachers could replicate the worksheet use, operate the gamification features, supervise AI-assisted feedback, and provide suggestions for further classroom adaptation.

The limited dissemination stage was conducted for two weeks after the final product refinement. It involved the two teacher participants from the limited and broader trial stages as formal teacher respondents (n = 2) and was shared through the school learning community for implementation-readiness feedback. In the first week, the revised worksheet file, user guide, implementation procedure, and evaluation sheet were distributed, followed by a 90-minute briefing on worksheet navigation, gamification procedures, student assistance, and supervised AI feedback use. In the second week, teachers reviewed the product, planned short classroom adaptations, and submitted suggestions related to readability, technical clarity, ethical AI guidance, and classroom replication. Accordingly, dissemination in this study was limited to product sharing and implementation-readiness review, not to an additional effectiveness test.

Research subjects and instruments

The trial subjects were fourth-grade elementary school students. The limited trial involved 10 students and one teacher, while the broader trial involved 30 students and one teacher. The product draft was validated by two expert raters with expertise in Civic Education learning and digital learning media. The instruments consisted of expert validation sheets and teacher and student response questionnaires. The assessed aspects were Civic Education content, digital media, gamification, active learning, AI feedback support, and language. Each item was scored on a 1-4 scale, in which 1 indicated poor quality and 4 indicated very good quality.

Data analysis techniques

Content validity was calculated using Aiken's V with the formula $V = \Sigma s/[n(c-1)]$, where $s = r - lo$, r is the score given by the rater, lo is the lowest score, n is the number of raters, and c is the highest score. This formula estimates the content validity coefficient based on expert judgments regarding item relevance (Aiken, 1985). In this study, $n = 2$, $lo = 1$, and $c = 4$. Inter-rater reliability was calculated using percentage agreement, Cohen's kappa, and the intraclass correlation coefficient (ICC). Cohen's kappa was used to assess agreement after accounting for chance agreement (Mchugh, 2012), while ICC was used to assess the consistency of rating data across raters (Koo & Li, 2015). Teacher and student responses were converted into percentages using the empirical score divided by the maximum score and multiplied by 100%. The percentages were categorized as Very Good, Good, Fair, or Poor.

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RESULTS AND DISCUSSION

Results

Expert validation results

Expert validation was conducted by two raters across six assessment aspects. Overall, the average expert validation score was 3.70 out of a maximum score of 4, equivalent to 92.50%. The average Aiken's V was 0.90, with a range of 0.67-1.00. Referring to Aiken's (1985) content validity coefficient, these results indicate that the draft gamified digital worksheets with AI feedback support have strong content suitability with the development objectives, including Civic Education material accuracy, digital media quality, gamification design, active learning orientation, AI feedback support, and language clarity.

Table 1. Expert validation results based on Aiken's V.

Validation aspects	Average score	Percentage (%)	Mean Aiken's V	Range V	Categories
PKn Material	3.65	91.25	0.88	0.67-1.00	High/Highly Valid
Digital Media	3.75	93.75	0.92	0.67-1.00	High/Highly Valid
Gamification	3.70	92.50	0.90	0.67-1.00	High/Highly Valid
Active Learning	3.70	92.50	0.90	0.67-1.00	High/Highly Valid
AI Feedback Support	3.50	87.50	0.83	0.67-1.00	High/Highly Valid
Language	3.90	97.50	0.97	0.83-1.00	High/Highly Valid

Inter-rater reliability

Inter-rater reliability was calculated to assess the consistency of the judgments provided by expert 1 and expert 2. Of the 60 validation items, exact agreement between raters reached 83.33%. Cohen's kappa was 0.61, and the ICC was 0.61. Based on the interpretation of inter-rater reliability by Mchugh (2012) and ICC reporting guidelines by Koo & Li (2015), these results indicate an adequate level of agreement and consistency. Thus, the validation decision was supported not only by high feasibility scores but also by acceptable agreement between the two experts.

Table 2. Summary of inter-rater reliability

Components	Results
Number of items	60
Number of raters	2
Exact agreement percentage	83.33%
Cohen's kappa	0.61
ICC(2,1)	0.61
Interpretation	Adequate; usable as a basis for product revision and feasibility decisions

The results of teachers' responses to the limited trial and the wider trial

Teacher responses indicated that the product was in the very good category in both trial stages. In the limited trial, the total teacher score was 224 out of 240, or 93.33%. In the broader trial, the score increased to 240 out of 240, or 100.00%. The increase suggests that revisions after validation and the limited trial improved the product's usability, technical consistency, navigation, relevance of civic cases, and alignment with classroom learning needs.

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p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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Table 3. Teachers' responses in the limited and broader trials

Aspects	Limited trial (%)	Categories	Broader trial (%)	Categories
PKn Material	92.50	Excellent	100.00	Excellent
Digital Media	92.50	Excellent	100.00	Excellent
Gamification	95.00	Excellent	100.00	Excellent
Active Learning	95.00	Excellent	100.00	Excellent
AI Feedback Support	87.50	Excellent	100.00	Excellent
Language	97.50	Excellent	100.00	Excellent
Overall average	93.33	Excellent	100.00	Excellent

The results of student responses to the limited trial and wider trials

Student responses also showed very good results. In the limited trial, the total student score was 2339 out of 2400, or 97.46%. In the broader trial, the score increased to 7139 out of 7200, or 99.15%. These results indicate that the product was well accepted by students across the aspects of Civic Education material, digital media, gamification, active learning, AI feedback support, and language. The AI feedback support aspect obtained the lowest relative score among the aspects, although it remained in the very good category. This indicates that the feature was perceived as useful but still required clearer guidance, teacher supervision, and more explicit directions on how students should use AI feedback ethically and critically.

Table 4. Student responses in the limited and broader trials

Aspects	Limited trial (%)	Categories	Broader trial (%)	Categories
PKn Material	98.25	Excellent	99.42	Excellent
Digital Media	98.75	Excellent	99.58	Excellent
Gamification	97.00	Excellent	99.00	Excellent
Active Learning	97.25	Excellent	99.08	Excellent
AI Feedback Support	95.50	Excellent	98.50	Excellent
Language	98.00	Excellent	99.33	Excellent
Overall average	97.46	Excellent	99.15	Excellent

The final product of development

Figure 1. Main interface of the gamified digital worksheet with an AI feedback entry button.

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p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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The final product is a gamified digital worksheet with AI feedback support for fourth-grade Civic Education. The product contains onboarding sections, learning outcomes, learning objectives, concise materials, missions or challenges, collaborative activities, contextual cases, reflection spaces, evaluations, a points or reward system, and AI-supported feedback. Product revisions were conducted in the areas of case relevance, critical-thinking reinforcement, navigation, technical feasibility, learning motivation, teacher supervision, and clarity of AI use. Figure 1 shows the main worksheet interface, while Figure 2 presents the onboarding and AI feedback support screens that guide students through learning missions and reflective feedback.

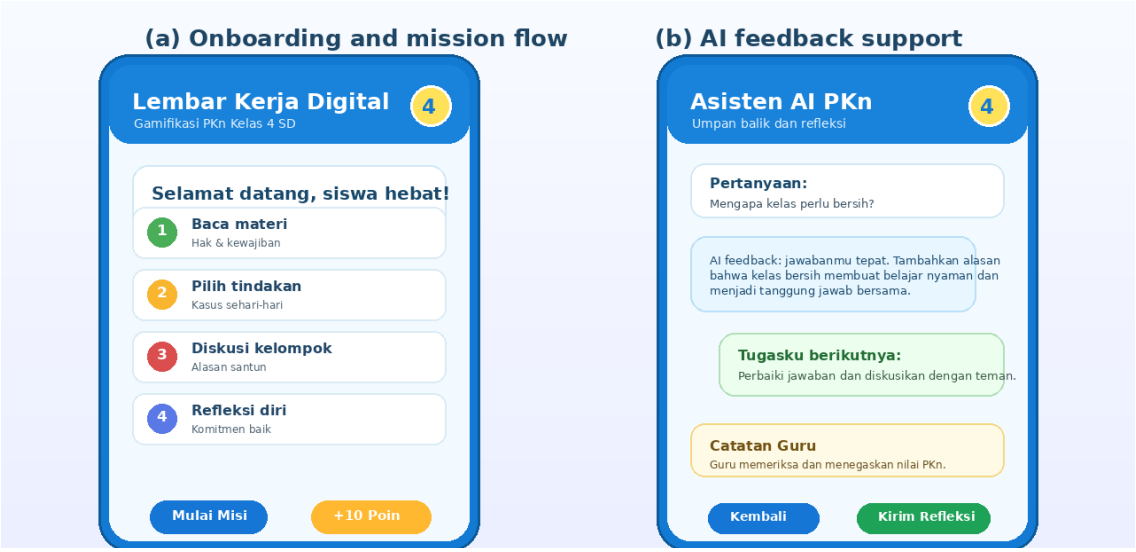

Figure 2. Onboarding and AI feedback support interface of the gamified digital worksheet.

Discussion

The validation results show that the product has strong content validity because the worksheet structure, learning activities, gamification components, AI feedback support, and language are aligned with fourth-grade Civic Education learning needs. The systematic use of the 4D model also helped ensure that the product was not developed only as a digital display, but as a learning resource that passed through needs analysis, instructional design, expert judgment, revision, classroom trial, and limited dissemination.

The pedagogical strength of the product lies in the synergy between gamification and active learning. Gamification provides a learning path through missions, challenges, points, rewards, and levels, while active learning ensures that each game element is connected to meaningful civic tasks. Students are encouraged to read short materials, analyze contextual cases, discuss choices, justify answers, and reflect on rights and obligations. In this way, gamification does not merely increase excitement; it structures participation and directs motivation toward civic understanding and responsible action.

AI feedback support adds another layer to this learning process by helping students evaluate and improve their responses. The AI feature is positioned as a feedback assistant that provides prompts, suggestions, and reflective questions after students complete tasks. This role is consistent with the view that AI can support personalization and adaptive learning (Kerimbayev et al., 2025; Lin et al., 2023; Zhai, Chu, Chai, Jong, et al., 2021). However, the product deliberately maintains a human-centered orientation:

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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teachers remain responsible for explaining concepts, validating AI feedback, guiding discussion, and ensuring that students interpret feedback critically.

The AI feedback support aspect received the lowest relative score among students, even though it remained in the very good category. This finding is pedagogically important. It suggests that elementary students can appreciate AI-based support, but they still need explicit instructions on what AI can and cannot do, how to ask questions, how to revise answers based on feedback, and when to consult the teacher. The lower relative score also indicates that AI literacy, ethical use, data privacy, and teacher supervision should be integrated into classroom implementation rather than treated as optional technical explanations.

Viewed through cognitive load theory in digital learning, the lower relative score for AI feedback support may also reflect the additional extraneous demands experienced by fourth-grade students when they were required to understand civic content, navigate a digital worksheet interface, formulate prompts, read AI-generated feedback, and decide how to revise their answers simultaneously (Skulmowski & Xu, 2022). This interpretation is also consistent with research on AI-enriched digital learning tools, which shows that interface complexity, feedback features, and usability challenges may influence learners' cognitive load during technology-supported learning (Koć-Januchta et al., 2022).

For young learners, movement between mission screens, answer spaces, AI entry buttons, and feedback messages can create extraneous load if the interface is not supported by clear visual cues, worked examples, and teacher modeling. Thus, the lower relative score should not be interpreted only as weaker acceptance of AI, but also as evidence that AI-supported civic learning requires scaffolding that reduces interface-navigation burden and separates the learning steps into manageable actions. Practical revisions should include clearer prompt examples, a short navigation rehearsal, icons that signal when students may request AI feedback, teacher-led demonstration before independent use, and group reflection so that students focus on civic reasoning rather than merely managing the tool.

The improvement in teacher and student responses from the limited trial to the broader trial indicates that product revision had practical value. Teacher feedback helped refine navigation, simplify instructions, strengthen the relevance of civic cases, and clarify the AI feedback procedure. The addition of interface illustrations also supports replication because teachers can more easily understand the learning flow, from onboarding and mission selection to AI-assisted feedback and reflection.

These findings are consistent with studies showing that gamification can improve engagement when game elements are meaningfully connected to academic activities (Najjar & Salhab, 2022; Ruiz et al., 2024). They also support studies on AI in education that emphasize the potential of AI for individualized learning assistance and feedback (Dimitriadou & Lanitis, 2023; Lee & Kwon, 2024; Ng et al., 2024). The novelty of this study is the integration of these two approaches in an elementary Civic Education worksheet, where gamification organizes active civic tasks and AI supports reflection without replacing teacher facilitation.

The contribution of this study is both theoretical and practical. Theoretically, it offers a product model that links Civic Education, gamification, active learning, and AI feedback support. Practically, it provides teachers with an alternative worksheet format that can make civic learning more contextual, interactive, and reflective. Nevertheless, the findings should be interpreted as feasibility evidence, not as proof of effectiveness.

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
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Future implementation needs to include ethical AI guidelines, teacher training, and experimental testing to measure learning outcomes, critical thinking, participation, and civic attitudes.

CONCLUSION

Findings: This study found that gamified digital worksheets with AI feedback support are feasible for promoting active learning in fourth-grade Civic Education. Expert validation, inter-rater reliability, teacher responses, and student responses indicate that the product is valid, usable, and well received after revision. The main finding is that the product works best when gamification becomes the learning structure for civic missions, challenges, collaboration, and reflection, while AI functions as a supervised feedback assistant rather than a substitute for teacher guidance. **Implications:** The results imply that elementary Civic Education teachers can use gamified digital worksheets to make civic learning more interactive, contextual, and reflective. The competency mapping between game components and civic knowledge, civic skills, and civic dispositions also shows that gamification should be designed as a pedagogical structure, not merely as a reward system. AI feedback may support student reflection when teachers provide explicit ethical guidance, technical modeling, and opportunities to discuss the feedback critically. **Limitations:** This study remains limited to feasibility testing with fourth-grade students, two expert raters, and a limited dissemination stage involving teacher respondents from the trial process. It has not yet measured the product's effectiveness on learning outcomes, critical thinking, participation, civic dispositions, or long-term responsible digital behavior. The lower relative student response to AI feedback also indicates that interface navigation, prompt formulation, and cognitive load were not examined through direct observational or experimental measures. **Future Work:** Future studies should test the product through experimental or quasi-experimental designs with broader and more diverse samples. Further development should include stronger ethical AI guidelines, data protection procedures, teacher training, and age-appropriate scaffolds that reduce cognitive load during AI-assisted feedback. Subsequent research should also examine how specific gamification components influence civic knowledge, civic skills, civic dispositions, and active participation in elementary classrooms.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to Universitas Islam Sultan Agung for the financial support that enabled this research to be conducted. This support contributed to the planning, implementation, data collection, analysis, product refinement, and preparation of this manuscript.

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