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A Study on the Impact of Using Educational Board Games to Learn AI Literacy on Self-Efficacy and Critical Thinking: An Example of Upper Elementary School Students

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Abstract: This study aims to explore whether the use of educational board games for AI literacy can foster and enhance students' abilities. A quantitative analysis using pre- and post-test measures was adopted, with data collected from 20 elementary school students who participated in a dedicated camp. The results demonstrated that "Collaborative AI Literacy" increased from a pre-test score of 3.98 to a post-test score of 4.40 following the introduction of the AI literacy board games and related curriculum. Furthermore, reliability analysis of the pre- and post-tests yielded Cronbach's Alpha values of 0.93 and 0.99, confirming the high reliability of the instruments. The data further indicated that students exhibited a high level of Technology Acceptance toward this integrated learning model, with scores for both Perceived Usefulness and Perceived Ease of Use exceeding 4.45. The study concludes that this educational board game can effectively lower the barrier to AI technology while enhancing critical thinking and self-efficacy through collaboration.

Keywords: AI Literacy, Collaborative AI Literacy, Technology Acceptance, Technology Barrier

1. Introduction

With AI's rapid growth, AI literacy has become a core competency, yet its abstract principles and ethics often render traditional instruction ineffective. Consequently, utilizing interactive tools is vital for literacy education. This study employs a game-based model via a self-developed "AI Literacy Educational Board Game" to transform complex concepts into engaging challenges. Beyond acquiring knowledge, students engage in critical thinking while learning within a virtual-physical environment facilitated by tablet-scanned AR cards.

2. Literature Review

Contemporary AI education is increasingly inclined toward deep-seated literacy cultivation. Ng et al. (2023) noted that the current framework for AI literacy should encompass both technical cognition and critical thinking capabilities. Regarding instructional media, the research by Su and Yang (2024) confirms that game-based learning can effectively reduce the cognitive load and technology barrier students face when dealing with abstract topics, while simultaneously enhancing their learning motivation. In terms of learning effectiveness, Zhai et al. (2023) emphasized that collaborative learning environments can enhance students' self-efficacy and engagement, a finding that aligns with the post-test results observed in this study. Finally, Lee and Ali (2025) argued that AI education should employ multidimensional measurement tools to validate literacy growth across various dimensions; the scale utilized in this study precisely aligns with this emerging assessment trend.

3. Methodology

This study adopts a quasi-experimental design aimed at evaluating the impact of the AI Literacy Educational Board Game combined with curriculum instruction on students. The participants consisted of 20 elementary school students (with a male-to-female ratio of 4:1) who registered for a dedicated camp. During the research period, the AI Literacy Educational Board Game was integrated into teaching activities to observe students' learning performance and transitions. The research procedure first involved a 2-hour interactive AI course to establish fundamental concepts, followed by game-based learning through board games and collaborative tasks (including interactions such as scanning AR cards with tablets) conducted in pairs. Through this approach, the study sought to cultivate AI literacy and interest.The research instruments include the self-developed AI Literacy Educational Board Game and relevant scales validated in the literature with high reliability. This board game transforms the six dimensions of AI literacy (foundational skills, technical skills, critical thinking, ethical literacy, mindset of use, and social impact) into specific game levels. It reifies the process of prompt engineering through physical cards representing role-playing, emotional tone, and speaking styles. Students analyze the level descriptions to select appropriate cards for interacting with their self-designed AI robots, followed by scoring and feedback based on the alignment between the dialogue process and the level requirements. Self-efficacy was developed based on the corresponding theory; technology acceptance referred to the Technology Acceptance Model (TAM); collaborative learning adopted the specific perspective; and AI literacy and critical thinking were based on the established framework. The pre-test encompassed five dimensions: individual self-efficacy, collective self-efficacy, collaborative learning tendency, AI critical thinking, and collaborative AI literacy. The post-test additionally included the technology acceptance dimension to evaluate students' acceptance of the board game as a learning medium. To ensure a strong correlation between the collected data and the experimental design, the pre-test was administered prior to the start of the lectures and activities, while the post-test was conducted only after the entire program was completed. Data analysis was performed using SPSS statistical software to further explore the correlations and differences between background variables and learning effectiveness.

4. Results

Research findings indicate that the board-game-based AI literacy curriculum represents a "chain effect" triggered by shifting learning modalities rather than mere score improvements. Through collaboration, students gained confidence in speaking and experimenting, enhancing self-efficacy for both individual and team tasks (Table 1). By embedding AI concepts into game rules, the activities required discussion and proposal under constraints, transforming critical thinking from rote memorization into active decision-making. Positive growth across dimensions suggests the curriculum addressed both cognitive understanding and social interaction, lowering AI entry barriers while advancing learning from "operation" to "judgment and reflection." Furthermore, TAM results show students perceived the board game as an accessible, valuable tool (Table 2), highlighting its potential for general classroom scalability beyond short-term camps.

Table1. Comparison of Pre-test and Post-test Scores(*N* = 20)

Dimension	Pre-Mean	Pre-SD	Post-Mean	Post-SD
Individual Self-Efficacy	3.93	1.15	4.47	0.81
Collective Self-Efficacy	3.78	1.12	4.46	0.83
Collaborative Learning Tendency	3.90	1.11	4.44	0.83
AI Critical Thinking	4.23	0.78	4.43	0.84

Collaborative AI Literacy	3.98	0.80	4.40	0.82

Table2. Technology Acceptance Model(TAM) Results for AI Board Game

TAM Dimension	*M*	*SD*
Perceived Usefulness	4.47	0.81
Perceived Ease of Use	4.45	0.83

5. Discussion and Conclusion

Using board games as a vehicle for AI literacy effectively transforms abstract concepts into learning experiences characterized by discussion, collaboration, and reflection, while simultaneously fostering self-efficacy and critical thinking. Consequently, students move beyond merely "knowing what AI is" to becoming capable of identifying issues within a context, proposing viewpoints, and making responsible judgments through peer collaboration. For future implementation, it is recommended to integrate long-term, modular board game activities into formal curricula (e.g., weekly units paired with worksheets or task feedback). Additionally, incorporating qualitative data—such as observation records, discussion content, and artifact analysis—could better capture how students form judgments and collaborative strategies. From a research perspective, expanding the sample size to include different grade levels and diverse learning backgrounds, while employing control groups or longitudinal tests, would help verify the stability and persistence of these effects. Regarding instructional design, enhancing game levels with "real-world cases" and "ethical dilemmas" could facilitate the transfer of critical thinking from the game to daily AI usage. Providing teacher guidelines and classroom management suggestions would further enhance the feasibility and replicability of this model in school settings.

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