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The Impact of Multimedia-enhanced Web-based Learning on Knowledge Acquisition and Motivation in Generative AI Education

Konkanok Srilasopha[1] & Patcharin Panjaburee[1,2*]

Faculty of Education, Khon Kaen University, Thailand[1], Digital Education and Learning Engineering Association, Thailand[2*]

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Abstract

The increasing significance of Generative AI education requires more effective teaching approaches beyond traditional PowerPoint-based instruction, which often limits student engagement and accessibility, thereby hindering knowledge acquisition. Multimedia-enhanced web-based learning offers several advantages, including interactivity, flexibility, content simplification, and dynamic learning experiences accessible anytime and anywhere. Therefore, this study developed a multimedia-enhanced web-based learning approach designed to facilitate primary school students' acquisition of Generative AI concepts. A quasi-experimental study was conducted with 47 fourth-grade students from two classes. Using random allocation, one class with 22 students was assigned to the experimental group, which received instruction through the multimedia-enhanced web-based learning approach, while the other class with 25 students formed the control group, receiving traditional PowerPoint-based instruction. Data were analyzed using t-tests on pre- and post-achievement tests and motivation questionnaires, resulting in three key findings. First, the experimental group demonstrated significantly higher knowledge comprehension than the control group. Second, an analysis of knowledge progression indicated that the experimental group exhibited significantly greater improvement in understanding. Finally, the motivation assessment revealed that the experimental group achieved significantly higher scores across all dimensions, including attention, relevance, confidence, and satisfaction, compared to the control group. These findings suggest the effectiveness of multimedia-enhanced web-based learning in both knowledge construction and motivation in Generative AI education, highlighting its potential as an innovative approach to modern educational practices.

Keywords: Web-based learning, artificial intelligence, educational innovation, educational technology, knowledge construction

*Corresponding author
Email address: patchapan@kku.ac.th

■ Introduction

In the era of digital transformation, Artificial Intelligence (AI) has become a significant force shaping various sectors, including education (Rabhi, Beheshti, & Gill, 2025). Among the rapidly emerging AI technologies, Generative AI stands out due to its ability to create content, generate data, and produce new forms of media based on existing information (Wu & Ren, 2025). This advancement has not only revolutionized industries but has also profoundly impacted learning processes and the skill development of 21st-century students (Amanawa, 2025). As AI continues to evolve, educational systems must adapt and equip students with the necessary knowledge and skills to understand and utilize Generative AI effectively (Varghese, Jose, & Cleetus, 2025). One of the key challenges in the digital era is the growing digital divide, which may exacerbate educational inequalities and undermine future opportunities for children from underprivileged backgrounds (Van Dijk, 2021). While children in well-equipped areas have greater access to technology and the internet, those in rural or disadvantaged communities often lack such resources, putting them at a considerable disadvantage in developing skills for future employment and education (United Nations, 2019). To address this gap, equipping children with Artificial Intelligence (AI) literacy from an early age is a crucial step toward mitigating inequality and strengthening their ability to navigate a technology-intensive future (Luckin et al., 2016). Providing all children with the knowledge and skills to use AI responsibly and effectively is imperative to empower them to become active contributors in a rapidly changing world.

However, AI in education has been growing. Teaching such complex technologies to young learners, in particular at the elementary level, posed a significant challenge (Holmes et al., 2019). Traditional teaching methods that focus primarily on basic computing skills and conventional programming may not align with the evolving needs of the modern workforce (Joshi, 2025). Moreover, many schools still rely on lecture-based instruction and static teaching materials, which may fail to stimulate creativity, critical thinking, and hands-on application (Subhan Gill, 2025). As a result, students may miss opportunities to develop essential competencies such as analytical reasoning, problem-solving, and creative thinking—skills that are increasingly vital in today's AI-driven world (Ajiye & Omokhabi, 2025).

One promising approach to addressing this educational challenge is Web-Based Learning (WBL). WBL utilizes internet-based platforms to deliver instructional content in a flexible, accessible, and interactive manner (Pajo, 2025). Previous research has highlighted the effectiveness of WBL in enhancing student engagement, motivation, and knowledge retention by incorporating multimedia elements such as infographics, videos, and interactive exercises (Bishnoi & Pomeroy, 2025). Unlike traditional classroom settings, WBL enables learners to progress at their own pace, access a wide range of resources, and engage in interactive learning experiences that foster creativity and independent problem-solving (Gafiatullin & Mukhanova, 2025).

Studies have demonstrated that integrating AI technology into learning environments can enhance students' cognitive abilities, including critical thinking and creativity. For instance, (Holmes et al. 2019) found that AI-assisted learning can effectively support students in developing problem-solving skills and innovative thinking. Additionally, given these insights, this study aims to investigate the impact of Web-Based Learning on teaching Generative AI to elementary school students. Specifically, it seeks to compare WBL with traditional lecture-based instruction in terms of students' understanding, creativity, and learning motivation. By examining the effectiveness of WBL in delivering AI-related content, this research will provide valuable insights into innovative teaching strategies that align with modern technological advancements.

Furthermore, this study contributes to the growing body of knowledge on AI education at the elementary level by bridging the existing research gap in the field. The findings will offer practical implications for curriculum development, instructional design, and policy-making in AI-related education. Ultimately, the research aims to support educators in preparing students to harness the potential of Generative AI, ensuring they develop the necessary skills to thrive in an AI-driven society. Therefore, this study has been framed by the following research questions:

RQ1: Do students learning through traditional instruction and those learning through web-based learning have different levels of understanding in using Generative AI?

RQ2: Do students learning through traditional instruction and those learning through web-based learning have different levels of motivation in learning and using Generative AI?

■ Literature Review and Related Research

Web-Based Learning (WBL)

Web-Based Learning (WBL) is an instructional approach that leverages web technology for content delivery, learner-instructor interaction, and outcome assessment, offering flexibility and accessibility to accommodate diverse learning needs (Garrison & Anderson, 2003), while also serving as a key component of distance education by enabling student-teacher communication through emails, discussion forums, and interactive platforms (Moore & Kearsley, 2005); additionally, multimedia integration in WBL, including videos, animations, and interactive content, enhances student engagement, knowledge retention, and motivation, with its adaptability to real-time content updates making it particularly effective for dynamic subjects like Artificial Intelligence (AI) (Clark & Mayer, 2011); further empirical evidence supports WBL's impact on student engagement and academic performance, as demonstrated in a study on primary school students in the UAE, which highlights the benefits of web-based technology in increasing accessibility and interaction in ICT courses, reinforcing the role of WBL in advancing modern education systems (Shana, Naser, & Zeitoun, 2024). That is to say, web-Based Learning (WBL) offers a flexible, interactive, and accessible instructional model that enhances learner engagement and achievement. Its integration of multimedia tools and adaptability across contexts makes it particularly effective for teaching complex and evolving subjects.

Generative AI in Education

Generative AI refers to AI systems that autonomously generate content such as text, images, videos, and data through advanced neural networks and deep learning, with Generative Adversarial Networks (GANs) introduced by Goodfellow et al. (2014). It uses a generator and a discriminator to produce high-quality synthetic data, paving the way for AI-driven content creation, while large-scale language models like GPT-3. As defined by Brown et al. (2020), generative AI applications generate coherent and context-aware text applicable to writing and answering questions. Moreover, AI-assisted tutoring and its broad applications across art, media, and education, as highlighted by Bommasani et al. (2021), underscore its potential to enhance creativity, automate content generation, and personalize learning experiences.

That is, generative AI represents a transformative technology utilizing advanced neural networks and deep learning architectures to autonomously create diverse content formats, from text and images to personalized educational materials, thereby offering unprecedented opportunities for enhancing creativity, automating content generation, and delivering individualized learning experiences across multiple domains.

■ Web-based Learning and Firefly AI Tool

Web-based Learning Environment

The Web-Based Learning (WBL) platform introduced in this study is designed to facilitate knowledge acquisition and motivation in Generative AI education by providing an interactive, multimedia-rich environment that integrates various educational resources, real-time support systems, and assessment tools to enhance learning experiences. The platform incorporates a content access and review system, allowing learners to navigate structured lessons on Generative AI, including topics such as “What is AI?”, “Lesson 1: ChatGPT,” and “Lesson 2: AI-Generated Images,” with integrated infographics, interactive content, and downloadable supplementary materials to support comprehension. A learning resource repository further supplements this environment by offering video demonstrations of Generative AI applications, step-by-step guides for AI tools, and additional materials such as external links and educational games to reinforce AI concepts. To enhance collaboration, the interactive and communication system features a real time chat function enabling 24/7 interaction between students and instructors, along with discussion forums for knowledge sharing and AI-related discourse (Figure 1).

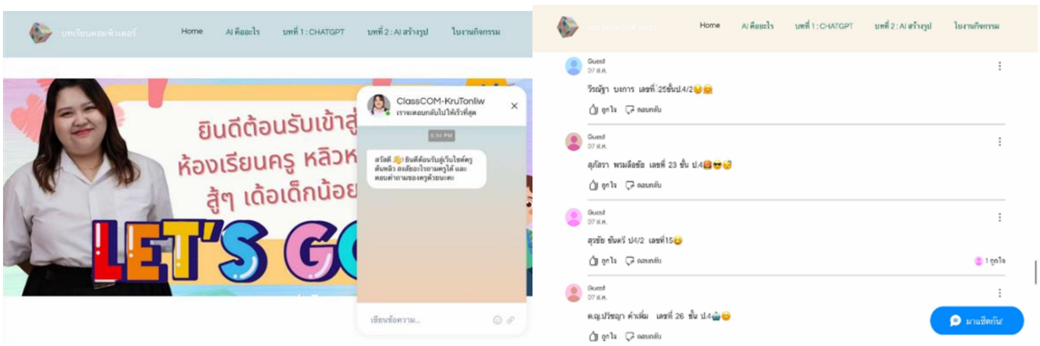

Figure *1*. Chat and Discussion Forums Enhance Collaboration and Peer Learning

Additionally, the task and activity management system provides a dedicated space for student project submissions and assignments, complemented by a gallery showcasing AI-generated student work (Figure 2). Finally, the assessment and motivation evaluation module incorporates pre- and post-learning assessments to measure knowledge improvement, along with motivation evaluation tools to analyze student engagement and interest in Generative AI learning.

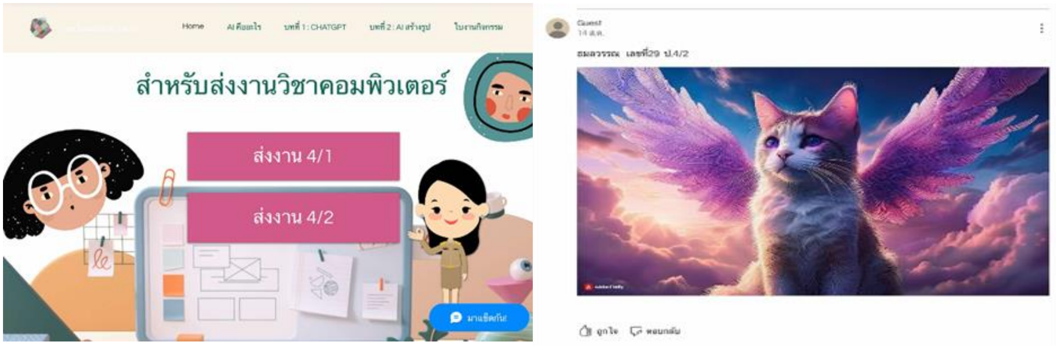

Figure *2*. Students Submit AI-Generated Projects and Engage In Creative Tasks

Firefly Generative AI Tool

Adobe Firefly is an AI-powered generative tool designed to create digital content, including images, text effects, and other multimedia elements. It enables users to generate high-quality visuals based on simple text prompts, making it an accessible and engaging tool for creative expression. In this study, Firefly was integrated into AI-assisted learning to enhance students' creativity through guided AI prompting (Figure 3). To simplify the process for primary students, a structured four-question framework was introduced: What – What is the creature you want to create? Where – Where is your creature located? When – When does the creature appear? How – What is your creature doing?

To illustrate how Firefly was used in practice, students were engaged in a creative activity based on the prompt "Create an imaginary animal." Using the four-question framework (What, Where, When, How), they crafted vivid descriptions and generated AI visuals accordingly, as shown in Figure 4.

Representative student-generated examples are as follows:

(1) A rabbit (What) on the moon (Where) in a pink-purple space setting (When) that is eating food (How).

(2) A fish (What) swimming underwater (Where) in a bright blue morning (When) with feet, walking and eating (How).

These activities encouraged the students to engage in abstract and imaginative thinking while translating language into visual forms using AI, a process that deepened their conceptual understanding of how generative models work.

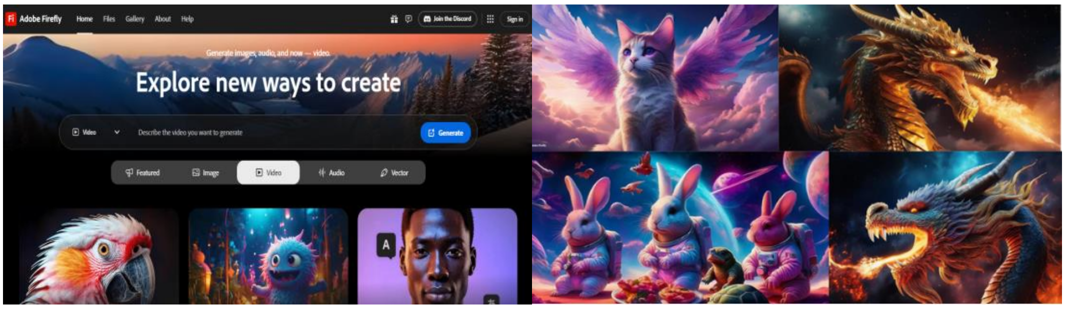

Figure 3. Student-Created Artwork on the Firefly Platform


Figure 4. Student-Generated Images Created from Prompts Using the Firefly Platform

■ Research Methodology

Participant

The participants were fourth-grade students from a single school in the Northeastern part of Thailand during the first semester of the 2024 academic year. Purposive sampling was used to select 47 students, divided into the experimental group (22 students) receiving instruction via Web-based Learning and the Control group (25 students) following traditional lecture-based instruction. The same teacher taught both groups to ensure consistency, with the only variation being the instructional.

Measuring Tools and Data Analysis

To address the research questions, this study employed both knowledge acquisition and motivation assessments. A 15-item multiple-choice test was administered as a pre- and post-test to evaluate students' understanding of Generative AI, ensuring validity through a Cronbach's Alpha of 0.80 and a discrimination index between 0.3 and 0.54. Motivation was assessed using a 15-item Likert-scale questionnaire based on Keller's ARCS model (Attention, Relevance, Confidence, Satisfaction), which was modified from Hao and Lee's (2019) study and demonstrated high reliability (Cronbach's Alpha = 0.903).

For data analysis, Independent Samples T-tests were conducted to compare post-test scores and motivation levels between the experimental and control groups. These analyses provided insights into the differences in learning outcomes and motivation between students learning through traditional instruction and multimedia-enhanced web-based learning.

Results and Discussion

Learning Achievement Results

The analysis of pre-test scores showed no significant difference ($t = 0.689$, $p > .05$) in prior knowledge of Generative AI between the experimental group ($M = 6.41$, $SD = 2.61$, $N = 22$) and the control group ($M = 5.92$, $SD = 2.25$, $N = 25$). In contrast, post-test results revealed that the experimental group ($M = 11.05$, $SD = 2.73$) significantly outperformed the control group ($M = 6.72$, $SD = 3.14$) ($t = 5.001$, $p < .05$), indicating that Web-Based Learning (WBL) was more effective than traditional lecture-based instruction in enhancing students' understanding of Generative AI as shown in Table 1.

Table 1.

Comparison of Pre-test and Post-test Scores for the Experimental and Control Groups

Test	Group	Mean ± SD	*T*
Pre-test	Experimental	6.41 ± 2.61	0.689
	Control	5.92 ± 2.25	
Post-test	Experimental	11.05 ± 2.73	5.001*
	Control	6.72 ± 3.14	

** p < .05*

The experimental group showed statistically significant improvement in learning achievement ($p < .05$), while the control group did not. Findings align with Al-Azawei et al. (2016), supporting that e-learning enhances knowledge retention through interactive learning environments.

Leaning Motivation Results

As shown in Table 2, the independent Samples T-test revealed that students in the Web-Based Learning (WBL) group demonstrated significantly higher motivation levels across all four ARCS dimensions, Attention, Relevance, Confidence, and Satisfaction, compared to the control group. The WBL group's interactive and self-paced learning approach enhanced engagement ($t = 4.661$, $p < .05$), content relevance ($t = 4.174$, $p < .05$), confidence in AI learning ($t = 5.308$, $p < .05$), and overall satisfaction ($t = 2.522$, $p < .05$).

Table 2.

Comparison of Learning Motivation Scores between Experimental and Control Groups.

Dimension	Group	Mean ± SD	t-value
Attention	Experimental	4.70 ± 0.42	4.661*

	Control	3.81 ± 0.43	
Relevance	Experimental	4.54 ± 0.42	4.174*
	Control	3.87 ± 0.44	
Confidence	Experimental	4.65 ± 0.43	5.308*
	Control	3.73 ± 0.39	
Satisfaction	Experimental	4.46 ± 0.45	2.522*
	Control	4.02 ± 0.47	

* $p < .05$

These findings align with Keller's ARCS model, reinforcing WBL as an effective method for sustaining motivation and improving learning outcomes in AI education.

■ Conclusions

The findings of this study highlight Web-Based Learning (WBL) as an effective approach for enhancing students' understanding of Generative AI and learning motivation. Compared to traditional lecture-based instruction, students engaged in WBL demonstrated significantly higher learning achievement, benefiting from greater accessibility, flexible content review, and self-paced learning. The web-based environment enabled students to explore additional information independently and engage with multimedia instructional materials, which facilitated deeper comprehension. Furthermore, WBL fostered higher learning motivation, as students actively participated in interactive activities and hands-on experimentation with Generative AI, allowing them to recognize the value of the subject matter and its practical applications.

These findings suggest potential avenues for further development of personalized learning platforms, incorporating AI-driven adaptive learning to tailor content to individual student needs, as well as designing hybrid learning models that integrate WBL with traditional classroom instruction for enhanced effectiveness. Additionally, this research provides valuable insights for advancing digital instructional materials across various disciplines, particularly in technology and artificial intelligence education, ensuring that the integration of these technologies progresses in a way that maximizes student learning outcomes and long-term educational benefits.

■ Recommendations

Based on these findings, several recommendations emerge for educational practice and policy. The web-based learning model demonstrates strong potential for cross-curricular implementation, extending beyond Generative AI education to subjects including science, mathematics, English, and social studies. Its inherent flexibility makes it adaptable across diverse educational contexts, from primary through higher education levels. Most significantly, the widespread adoption of this multimedia-enhanced approach could advance educational equity by providing consistent, high-quality learning experiences regardless of geographical or socioeconomic constraints. By democratizing access to interactive, technology-enhanced instruction, this model prepares all learners to thrive in an increasingly digital society while ensuring that technological advancement serves to bridge rather than widen educational disparities.

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