

Original Article

DIGITAL-BASED LEARNING MODEL INNOVATION TO ENHANCE UNIVERSITY STUDENTS' CRITICAL THINKING SKILLS: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Background. The rapid advancement of digital technology has transformed higher education worldwide, requiring innovative instructional approaches that foster higher-order thinking skills. Despite extensive integration of digital technologies in universities, evidence regarding effective digital learning models specifically designed to strengthen students' critical thinking remains limited.

Research purpose. This study aimed to develop and evaluate the effectiveness of an innovative digital-based learning model in enhancing university students' critical thinking skills.

Research method. A quasi-experimental study employing a pretest-posttest control group design was conducted among 60 undergraduate students enrolled at a higher education. The intervention group (n=30) received instruction through an innovative digital-based learning model integrating collaborative online learning, interactive multimedia, problem-based activities, and reflective discussion. The control group (n=30) received conventional classroom instruction. Critical thinking skills were measured using a validated critical thinking questionnaire and observational assessment sheets. Data were analyzed using descriptive statistics, paired t-tests, and independent t-tests with a significance level of $p < 0.05$.

Findings. The significant improvement in critical thinking scores among students exposed to the digital-based learning model (pretest mean = 64.23 ± 8.14 ; posttest mean = 81.57 ± 7.26 ; $p < 0.001$). The control group also demonstrated improvement, although the increase was substantially lower (pretest mean = 63.80 ± 7.91 ; posttest mean = 69.43 ± 8.02 ; $p = 0.041$). Post-intervention comparisons indicated significant differences between groups ($p < 0.001$).

Conclusion. The innovative digital-based learning model effectively enhanced university students' critical thinking skills by integrating digital technologies with active and collaborative pedagogical strategies.

Keywords: Digital Learning, Critical Thinking, Educational Innovation, Higher Education, Quasi-Experimental Study.

BACKGROUND

The digital transformation occurring across educational sectors has fundamentally altered the landscape of higher education. Universities are increasingly expected to prepare

graduates who possess not only disciplinary knowledge but also higher-order cognitive competencies, including critical thinking, problem-solving, creativity, and digital literacy. Among these competencies, critical thinking has emerged as a core attribute required for academic achievement, professional practice, and lifelong learning [1].

Critical thinking refers to the ability to analyze information systematically, evaluate evidence, formulate reasoned judgments, and solve complex problems through reflective and logical processes [2]. In contemporary educational settings, students are continuously exposed to vast amounts of information through digital environments. Consequently, the ability to critically evaluate and synthesize information has become increasingly important.

The integration of digital technology into teaching and learning has expanded significantly during the last decade [3]. Digital learning environments provide opportunities for personalized instruction, interactive engagement, collaborative knowledge construction, and flexible access to educational resources. Previous studies have demonstrated that digital learning can improve student motivation, engagement, and academic outcomes [1,4]. However, merely adopting digital technologies does not automatically lead to improved critical thinking skills.

Several educational institutions continue to utilize digital platforms primarily as repositories for learning materials rather than as interactive environments that stimulate higher-order thinking. This practice creates a gap between technological adoption and meaningful pedagogical innovation. Existing literature suggests that digital learning environments must be intentionally designed to incorporate active learning, problem-based activities, collaborative discussions, and reflective practices to foster critical thinking [3].

Previous research has demonstrated positive associations between digital learning environments and critical thinking development. Smith reported that interactive online learning platforms significantly increased students' engagement and analytical skills [5]. Similarly, Garrison emphasized that meaningful online learning requires cognitive presence, social presence, and teaching presence to stimulate critical inquiry [3].

However, effective digital learning requires more than technological infrastructure. Instructional design principles emphasizing collaboration, reflection, and authentic learning tasks are essential for maximizing learning outcomes. This study proposes a digital-based learning model integrating four major components: 1) interactive multimedia learning; 2) collaborative online discussion; 3) problem-based learning activities; and 4) reflective digital assessment.

Research indicates that digital learning environments promote flexibility, learner autonomy, and increased engagement. Interactive multimedia, virtual collaboration, and synchronous and asynchronous communication tools provide opportunities for deeper learning experiences [4]. Although numerous studies have examined online learning and technology-enhanced instruction, empirical evidence regarding comprehensive digital-based learning models specifically aimed at strengthening students' critical thinking remains insufficient, particularly within developing countries. Therefore, this study sought to develop and evaluate an innovative digital-based learning model designed to enhance university students' critical thinking skills. This study aimed to develop and evaluate the effectiveness of an innovative digital-based learning model in enhancing university students' critical thinking skills.

RESEARCH METHOD

This study employed a quasi-experimental design with a pretest-posttest control group approach. The study was conducted at a private higher education institution in government university in Indonesia during the 2025 academic year. A total of 60 undergraduate students participated in the study. Participants were selected using purposive sampling and subsequently assigned into intervention group ($n = 30$) and control group ($n = 30$). Eligibility criteria included active enrollment in undergraduate programs, willingness to participate, and attendance in at least 80% of learning sessions.

Students in the intervention group participated in an eight-week digital-based learning program delivered through a learning management system (LMS). The model incorporated of interactive multimedia modules, online collaborative discussions, problem-based learning scenarios, digital reflective journals, and peer feedback activities. The control group received conventional lecture-based instruction using face-to-face classroom methods.

Two instruments were utilized Critical Thinking Questionnaire [2]. The questionnaire consisted of 30 items measuring five dimensions: 1) analysis; 2) interpretation; 3) evaluation; 4) inference; and 5) self-regulation. Responses were measured using a five-point Likert scale. The instrument demonstrated satisfactory internal consistency (Cronbach's $\alpha = 0.89$). An observational checklist assessed students' participation, collaboration, and problem-solving behaviors during learning activities.

Data analysis was performed using IBM SPSS version 26. Descriptive statistics summarized participant characteristics and outcome variables. Paired t-tests examined within-group differences, while independent t-tests compared post-intervention outcomes between groups. Statistical significance was established at $p < 0.05$. Ethical approval was obtained from the institutional ethics committee by number 312/ERB/2025. All participants provided written informed consent before participation. Confidentiality and anonymity were maintained throughout the study.

FINDINGS

Table 1 presents the demographic characteristics of participants. Between intervention group and control group the mean of age is similar (intervention group= 20.8; control group= 20.6). The gender normal distribution between two group and almost of participants were in second-year students. But no significant differences were identified between groups at baseline ($p > 0.05$).

Table 1. Demographic Characteristics of Participants

Characteristics	Intervention (n=30)	Control (n=30)
Mean age (years)	20.8 $\pm$ 1.4	20.6 $\pm$ 1.2
Female, n (%)	18 (60.0)	17 (56.7)
Male, n (%)	12 (40.0)	13 (43.3)
Second-year students, n (%)	19 (63.3)	20 (66.7)

Table 2. Changes in Critical Thinking Scores

Group	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	p-value
Intervention	64.23 $\pm$ 8.14	81.57 $\pm$ 7.26	<0.001
Control	63.80 $\pm$ 7.91	69.43 $\pm$ 8.02	0.041

Students exposed to the digital-based learning model demonstrated substantial improvements in critical thinking skills. Independent t-test analysis revealed significant differences in posttest scores between groups ($t = 5.87$, $p < 0.001$). Observation findings further indicated increased participation, collaborative engagement, and reflective learning behaviors among students in the intervention group.

DISCUSSION

This study showed that increasing mean from pre-test mean = 64.23 ± 8.14 ; post-test mean = 81.57 ± 7.26 ; $p < 0.001$, it means that the innovative digital-based learning model significantly improved students' critical thinking skills compared with conventional instruction. The substantial increase observed among students in the intervention group suggests that well-designed digital learning environments can effectively support higher-order cognitive development.

The findings align with previous studies indicating that technology-enhanced learning environments promote active engagement and deeper learning [1]. Interactive multimedia and collaborative online discussions may have facilitated knowledge construction by encouraging students to analyze, evaluate, and synthesize information.

Digital learning refers to educational practices that utilize digital technologies to facilitate teaching, learning, interaction, and assessment processes. Contemporary digital learning encompasses various approaches, including online learning, blended learning, mobile learning, and technology-enhanced learning environments [1,3]. The incorporation of problem-based learning activities likely contributed significantly to critical thinking development. Problem-based approaches expose students to authentic scenarios requiring evidence-based decision-making and collaborative reasoning. Such experiences stimulate analytical thinking and reflective judgment. Furthermore, reflective digital journals encouraged metacognitive processes, enabling students to evaluate their own understanding and learning strategies. Metacognition has been identified as a critical determinant of critical thinking development in higher education settings.

These findings support constructivist learning theory, which emphasizes learner-centered environments, social interaction, and active knowledge construction. Digital technologies, when pedagogically integrated, can create meaningful learning experiences that extend beyond passive content delivery. Critical thinking is recognized as a fundamental educational outcome in higher education. According to Facione, critical thinking comprises interpretation, analysis, inference, evaluation, explanation, and self-regulation [2]. Educational strategies that encourage inquiry, reflection, and collaborative problem-solving have been shown to support critical thinking development [6,7]. Constructivist learning theory posits that knowledge is actively constructed through interaction, experience, and

reflection. Therefore, learning environments that encourage active participation and authentic problem-solving are more likely to cultivate critical thinking skills.

Nevertheless, this study has several limitations. The relatively small sample size and single-institution setting may limit generalizability. Future studies should include larger multicenter samples and longitudinal designs to evaluate the sustainability of learning outcomes.

CONCLUSION

The innovative digital-based learning model significantly enhanced university students' critical thinking skills. Integrating interactive multimedia, collaborative online learning, problem-based activities, and reflective practices provides an effective pedagogical approach for promoting higher-order thinking in higher education. Higher education institutions should consider adopting and adapting digitally enhanced instructional models to prepare students for increasingly complex academic and professional environments.

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Conflict of Interest

The authors declare no conflict of interest.

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