JURNAL EDUSCIENCE (JES)
p-ISSN : 2303 - 355X | e-ISSN : 2685 - 2217
PUBLISHED BY : LPPM of UNIVERSITAS LABUHANBATU

Deep Digital Learning (DDL) Model Effect on Higher Education Critical Thinking and Problem-Solving Skills: A Quasi-Experimental Study

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ARTICLE INFO

Keywords:
Critical Thinking
Deep Digital Learning
Higher Education
Problem Solving
Instructional Design

ABSTRACT

Purpose – This study investigates the effectiveness of the Deep Digital Learning (DDL) model to address the failure of conventional digital learning to foster Higher-Order Thinking Skills (HOTS). Unlike prior fragmented approaches, the model proposes a novel conceptual synthesis of personalization, collaboration, authentic problem-based learning, and data-driven feedback to enhance critical thinking and problem-solving.

Methodology – This quasi-experimental design employed 70 students from the Educational Technology study program. The experimental group (n = 35) used the DDL intervention via the SIDIA Learning Management System (LMS). In contrast, the control group (n = 35) used Conventional Digital Learning (CDL) as a non-equivalent control for seven weeks. Data were collected using validated rubrics for Critical Thinking (CT) and Problem-Solving (PS) skills tests, which were analyzed using Analysis of Variance (ANOVA).

Findings – The ANOVA results statistically showed that the DDL group achieved significantly higher post-test scores for both Critical Thinking skills ($F(1, 68) = 169.30$, $p < 0.001$) and Problem-Solving skills ($F(1, 68) = 140.65$, $p < 0.001$). The mean difference confirmed the superiority of the experimental class in both skills (3.35 points for CT and 3.37 points for PS). This confirms DDL is more effective than CDL in enhancing students' HOTS.

Contribution – Beyond statistical significance, this study positions DDL as a strategic instructional blueprint in advancing HOTS. It provides Higher Education with a proven framework to strengthen digital transformation, ensuring the achievement of Outcome-Based Education (OBE) and 21st-century skills.

Received 13 November 2025; Received in revised form 23 November 2025; Accepted 12 February2026
Jurnal Eduscience (JES) Volume 13 No. 1 (2026)
Available online 28 February 2026

INTRODUCTION

The swift evolution of higher education necessitates adapting instructional methods to meet the requirements of the 21st century. Central to these objectives is the effective development of Critical Thinking (CT) and Problem-Solving (PS) abilities, which are essential for professional achievement and align with the tenets of Outcome-Based Education (OBE) and international needs (Lock & Duggleby, 2018). Digital learning platforms have become pivotal to this transition, providing unparalleled access to a variety of educational resources and facilitating adaptable learning environments (Bygstad et al., 2022; Decuypere et al., 2021). These changes necessitate not only a command of core knowledge but also the development of crucial abilities, such as critical thinking and problem-solving, which are vital for success in both academic and professional environments (Almufarreh & Arshad, 2023).

The emergence of digital technology has brought about a fundamental shift in the ways knowledge is accessed, constructed, and applied in educational settings (Martín-Lucas & García del Dujo, 2023). Digital learning has been acknowledged for its ability to revolutionize educational methodologies, broaden accessibility, improve engagement, and foster independent learning competencies. Moreover, extensive research supports the incorporation of technology to enhance interactive and collaborative learning processes, advancing education beyond mere passive information consumption (Daniela, 2021; Garivaldis et al., 2022; Harju et al., 2019). Numerous studies emphasize the significance of digital platforms in these scenarios, including the incorporation of chatbots to boost motivation (Yin et al., 2021) and mobile-based settings to improve self-efficacy (Meyer & White, 2022). This scenario clearly underscores the need for robust instructional frameworks that connect technological implementation with measurable skill improvement (Daniela, 2021; Kirkwood & Price, 2014; Wang, 2022).

Despite the widespread adoption of digital platforms, the effectiveness of digital learning is frequently criticized for emphasizing the delivery of content over the development of deep understanding (Hrastinski, 2023). Digital learning practices often remain limited to surface-level learning activities, consequently lacking the ability to foster higher-order thinking skills (Dolmans et al., 2016). Students frequently struggle to focus, get distracted, and find it challenging to apply their knowledge in real-world settings. This highlights a crucial pedagogical gap: while digital tools provide access, they often lack a sufficient framework to support the active engagement, critical reflection, and knowledge construction inherent in the concept of deep learning. While individual strategies such as adaptive or problem-based learning have shown promise, they are predominantly applied in isolation. This fragmentation creates a specific void: the absence of a unified digital ecosystem that synergizes these fragmented strategies. Therefore, the specific problem addressed in this study is the insufficiency of fragmented digital instructional models to foster Higher-Order Thinking Skills (HOTS) effectively in higher education contexts.

Previous studies consistently indicate that although digital learning enhances accessibility and student engagement, it frequently fails to cultivate deep comprehension and Higher-Order Thinking Skills (HOTS) (Almufarreh & Arshad, 2023; Daniela, 2021). Individually, various deep learning methodologies have demonstrated efficacy in cognitive advancement: Personalized and adaptive learning fosters self-regulation and profound reflection (Plass & Pawar, 2020); Collaborative digital environments facilitate critical argumentation and the assessment of diverse perspectives (Huri et al., 2024); Authentic problem-based learning improves analytical application in real-world scenarios (Angelo, 2022; Timperley & Schick, 2024); and Data-driven feedback expedites iterative cognitive enhancement (DeSantis et al., 2023; Reinhold et al., 2024). However, studies that comprehensively integrate and empirically substantiate the synergistic impact of all these fundamental deep learning principles within a singular, integrated digital instructional design framework are markedly limited. Thus, the Deep Digital Learning (DDL) paradigm aims to effectively bridge this gap by leveraging established methodologies to significantly enhance Critical Thinking and Problem-Solving skills (Wu, 2024).

To address the limitations of conventional approaches and distinct from existing fragmented digital models, this study introduces the concept of Deep Digital Learning (DDL). Unlike prior approaches that often utilize deep learning strategies in isolation (Kovač et al., 2025; Dolmans et al., 2016; Matsushita, 2018), DDL conceptually integrates four core principles—personalized learning, interactive collaboration, authentic problem-based learning, and data-driven feedback—into a cohesive instructional framework (DeSantis et al., 2023). This theoretical model is operationalized using the SIDIA Learning Management System (LMS), which was explicitly designed to facilitate these deep cognitive interactions. Empirically, this model moves beyond surface-level engagement or merely facilitating content delivery, as often reported in digital learning studies, by validating the synergistic effect of these principles in fostering complex cognitive outcomes, specifically Critical Thinking and Problem-Solving skills (Wu, 2024).

This research aims to test the effectiveness of the novel DDL model empirically. Specifically, this study addresses the following research questions, which form the core contribution of this manuscript: (1) to what extent can the deep digital learning model enhance critical thinking skills compared to conventional digital learning in higher education? (2) to what extent can the deep digital learning model enhance problem-solving skills compared to conventional digital learning in higher education?

By confirming the efficacy of DDL, this study offers a dual contribution of theoretical and practical significance. Theoretically, it advances the discourse on digital deep learning by providing empirical validation for a unified framework that synthesizes personalization, collaboration, and feedback—moving beyond the fragmented applications often seen in prior literature. In practice, this study offers Higher Education Institutions and administrators a strategic blueprint for aligning digital transformation with Outcome-Based Education (OBE), ensuring that investments in digital infrastructure directly translate into mastery of essential 21st-century competencies.

METHODOLOGY

Research Design

This study utilized a quasi-experimental design. This specific design, involving the non-randomized assignment of pre-existing groups (classes), was chosen because the research was conducted in an authentic educational setting where randomizing individual students was not feasible due to academic and administrative policies. The design involved two groups: an experimental group and a control group. The purpose of this design was to compare the effectiveness of the Deep Digital Learning (DDL) model (intervention) with that of the Conventional Digital Learning (CDL) model in enhancing students' critical thinking and problem-solving skills in higher education settings.

Participants

The research was conducted at the Department of Educational Technology, Universitas Negeri Surabaya, in 2025. The participants were students enrolled in the Learning Design and Strategy course of the Educational Technology study programme. The sampling technique used was purposive sampling. The total sample size was 70 students:

Table 1. Sample and Grouping

Group	N	Class	Treatment	Male	Female	Age Average (Y)
Experimental	35	2023B	Deep Digital Learning	7	28	20.5
Control	35	2023A	Conventional Deep Learning	8	27	20.8

Resources and Materials

The course utilized for the intervention was Learning Design and Strategy, a new course under the Bachelor of Educational Technology study programme. Both groups followed an OBE-based semester learning plan.

The core resource for the experimental group's intervention was the SIDIA Learning Management System (LMS). SIDIA served as the digital pedagogical infrastructure that enabled the four principles of DDL:

personalization, collaboration, authentic problem-based learning, and data-based reflection. The main features of this platform are: Project Submission, which facilitates authentic, problem-based learning and enables student collaboration; ANSIA Quiz, which provides real-time, data-driven feedback to help students reflect on their understanding; and an Interactive Discussion Forum that supports personalization and interactive learning. These features ensure that SIDIA is not just a place to upload materials (CDL), but an active environment that fosters critical thinking and problem-solving skills. The control group used a conventional digital learning model. The same instructor taught both classes.

Data Collection

The intervention period lasted for seven weeks. Both the experimental and control groups followed the learning activities, which were held once a week for 100 minutes per class. The data collection procedure was executed in three sequential phases over seven weeks. Initially (Weeks 1-2), both the experimental and control groups were introduced to the fundamental concepts of the Learning Design and Strategy course to establish a common baseline. Subsequently, the intervention phase ran from Weeks 3 to 6, during which the experimental group engaged with the Deep Digital Learning (DDL) model facilitated by the SIDIA platform, while the control group followed the conventional digital learning model. Finally, the study concluded in Week 7 with a comprehensive post-test administered to both groups to assess and compare the resultant improvements in critical thinking and problem-solving skills.

Instrument

The instrument used to measure the outcome variables—Critical Thinking (CT) and Problem-Solving (PS) skills—was a written assessment administered according to a rubric. This rubric was modified from existing works on CT (Apianti & Hermanto, 2020; Daryanes et al., 2023) and PS (George et al., 2021; Manassis, 2012). The specific indicators measured are explained in Table 2.

Table 2. Instrument of Data Collection Indicators

Variable	Indicators and Sources
Critical Thinking	simple explanation, advanced clarification, tactics and strategies, and inference (Apianti & Hermanto, 2020; Daryanes et al., 2023)
Problem-Solving	understanding the problem, planning alternative solutions, compiling solution steps, and evaluating the solution (George et al., 2021; Manassis, 2012)

Prior to implementation, the modified rubrics underwent a rigorous validation process to ensure data integrity. First, content validity was established through expert judgment involving three specialists in educational technology and evaluation. The validation results indicated a high level of consensus, with an Aiken's V coefficient of 0.73 confirming that the items accurately represented the constructs of Critical Thinking and Problem-Solving. Second, to ensure consistency, a reliability test was conducted on a pilot group of 15 students who were not part of the main sample. The assessment yielded inter-rater reliability coefficients of 0.81 for Critical Thinking and 0.76 for Problem-Solving, indicating that the instruments were highly reliable and suitable for the study.

Data Analysis

The post-test data were analyzed using a one-way analysis of Variance (ANOVA) with post hoc tests. Prior to the primary analysis, statistical assumption tests were conducted to ensure the validity of the ANOVA results. First, the normality of the data distribution was assessed using the Shapiro-Wilk test, which indicated that both the experimental and control group data were normally distributed ($p > 0.05$). Second, homogeneity of variance was verified using Levene's Test, which confirmed that variances across groups were equal ($p > 0.05$). Finally, the assumption of independence was met through the randomized cluster sampling design and independent completion of assessments. This statistical method was employed to assess the significance of the

Deep Digital Learning model's impact on enhancing students' critical thinking and problem-solving skills compared to the conventional digital learning model. The level of significance was set at $p < 0.05$.

FINDINGS

The Deep Digital Learning (DDL) model was implemented over 7 weeks, and its effectiveness was compared with that of the Conventional Digital Learning (CDL) model. The data analysis focused on post-test results for both Critical Thinking (CT) and Problem-Solving (PS) skills, using a one-way ANOVA.

Critical Thinking Skills Achievement

The descriptive statistics show a notable difference in the achievement of critical thinking skills between the two groups.

Table 1. Statistical Results of Critical Thinking Skills

Skill	Model	N	Mean	Std. Deviation	Std. Error Mean
Critical thinking	Deep-digital learning	35	14.0857	0.61220	0.10348
	Digital learning	35	10.7429	1.54049	0.26039

The mean score for the experimental group (DDL) was 14.0857, which is significantly higher than the mean score of the control group (CDL) at 10.7429. The mean difference of 3.35 points indicates that students in the experimental class achieved higher levels of critical thinking skills. The study highlights a significant disparity in critical thinking skills between the experimental group, which uses the DDL framework, and the control group, which uses the CDL model. The DDL group achieved a mean score of 14.09. To contextualize this achievement, the scores were converted into percentage effectiveness using the formula: (Mean Score/Maximum Score) x 100. Based on the standard academic evaluation criteria (e.g., Purwanto, 2018), scores exceeding 80% are categorized as 'Very High' mastery. Consequently, the DDL score (88.06%) indicates a high level of mastery in complex cognitive processes. In contrast, the CDL group scored 10.74, translating to 67.13%, which falls into the 'Moderate' category, reflecting a lower development of critical thinking abilities. The substantial 20.93 percentage-point difference in achievement levels demonstrates that DDL successfully scaffolds students from foundational digital engagement to near mastery in critical thinking. The one-way ANOVA test confirmed this observation, revealing a statistically significant difference between the two groups. The analysis yielded a significant F statistic: $F(1, 68) = 169.295$. The significance value was $p < 0.000$, confirming that the DDL intervention had a highly significant positive effect on critical thinking skills compared to the CDL intervention.

Table 2. One-way ANOVA Result of Critical Thinking Skills

		Sum of Squares	df	Mean Square	F	Sig.
Critical Thinking	Between Groups	205.714	1	205.714	169.295	0.000
	Within Groups	82.629	68	1.215		
	Total	288.343	69			

A deeper inspection of the critical thinking achievement reveals that the DDL intervention provided superior support across all four measured indicators. Specifically, the DDL group demonstrated a marked advantage in both the foundational and advanced cognitive components. For the core skill of Simple Explanation (identifying the problem), the DDL mean score was consistently high, suggesting robust initial problem framing. Crucially, the most significant gap was observed in the advanced indicators of Inference and Tactics and Strategies, where DDL students consistently outperformed their CDL counterparts. The DDL group's higher scores in Inference indicate a stronger ability to draw logical conclusions from given information. At the same time, the advantage in Tactics and Strategies confirms that the DDL environment successfully cultivated the skills needed to select and execute the appropriate methods to address challenges. This collective superiority across all indicators confirms that the DDL model, with its emphasis on active cognitive processing, systematically addresses the holistic development of critical thinking.

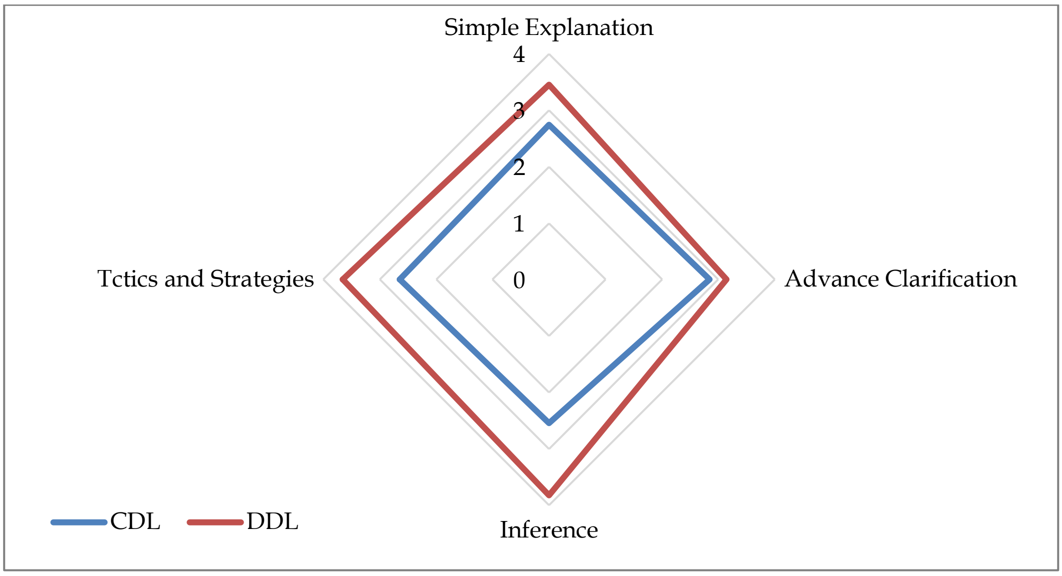

Figure 1. Map of the Score Distribution of Critical Thinking Skill Indicators

Problem-Solving Skills Achievement

Similar to the results of the critical thinking analysis, the descriptive statistics for problem-solving skills also showed the DDL group's superiority.

Table 3. Statistical Results of Problem-Solving Skills

Skill	Model	N	Mean	Std. Deviation	Std. Error Mean
Problem solving	Deep-digital learning	35	13.0000	0.97014	0.16398
	Digital learning	35	9.6286	1.37382	0.23222

The experimental group's mean problem-solving score was 13.00, while the control group's mean was 9.6286. This analysis highlights a mean difference of 3.37 points in problem-solving skills between the two educational approaches. The DDL experimental group achieved a mean score of 13.00 (Standard Deviation = 0.970), representing 86.67% of the maximum score of 15 and demonstrating high proficiency in the problem-solving cycle, from understanding to evaluating solutions. In contrast, the control group operating under CDL scored a mean of 9.63 (Standard Deviation = 1.374), which is about 64.20% of the possible score, indicating significant challenges in performing later stages of problem-solving. The 22.47 percentage-point difference underscores that the collaborative and structured DDL model effectively fostered the strategic thinking necessary for adept problem-solving, a feat that CDL struggled to achieve. The one-way ANOVA test for problem-solving skills further confirmed a statistically significant difference. The ANOVA result showed $F(1, 68) = 140.646$. With a p-value of < 0.000, it is evident that applying DDL significantly improved students' problem-solving skills compared to conventional digital learning.

Table 4. One-way ANOVA Result of Problem-Solving Skills

		Sum of Squares	df	Mean Square	F	Sig.
Problem Solving	Between Groups	198.914	1	198.914	140.646	.000
	Within Groups	96.171	68	1.414		
	Total	295.086	69			

The analysis of problem-solving skills, which involves a sequential cognitive process, shows that DDL's strength lies in facilitating the later, more strategic stages of the cycle. While both groups showed comparable initial capacity in Understanding the Problem (Students write down information they know and the inquiries.), the DDL group displayed clear superiority in Planning Alternative Solutions and Compiling Solution Steps. This suggests that the authentic problem-based learning component within DDL effectively trained students to move beyond simple comprehension to complex planning and solution synthesis. Furthermore, DDL students scored significantly higher on the final indicator, Evaluating the Solution (to check, evaluate, or improve the answers). This final advantage is a direct reflection of the DDL model's built-in data-driven feedback and reflection principle, which encourages students to critically assess the outcomes of their strategies and refine their work, a stage often neglected in conventional digital learning models.

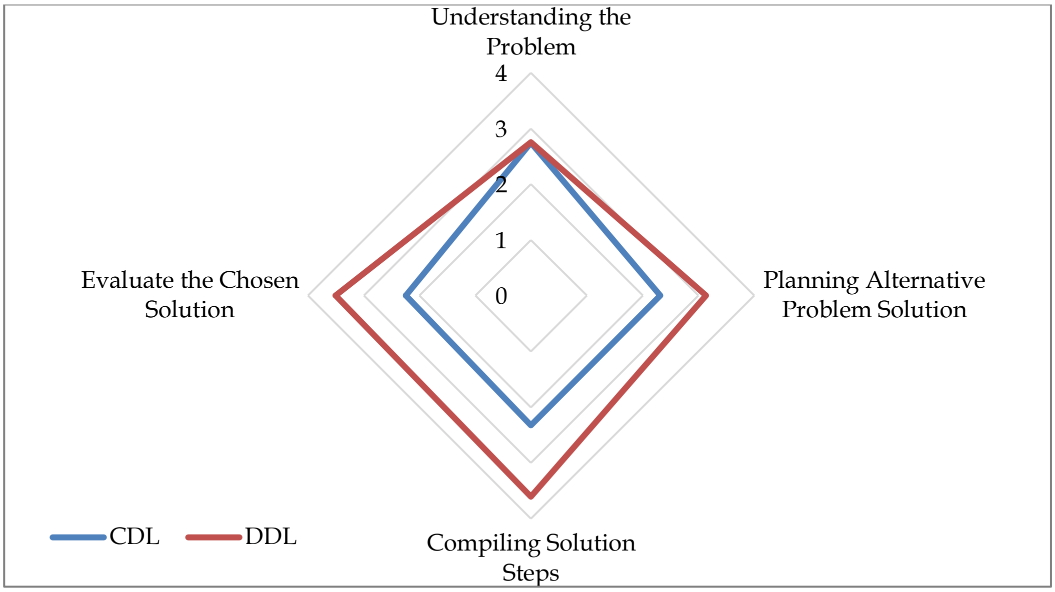

Figure 2. Map of the Score Distribution of Problem-Solving Skill Indicators

In conclusion, this study demonstrates that applying Deep Digital Learning (DDL) significantly improves students' critical thinking and problem-solving skills compared to conventional digital learning. The structure of DDL, particularly the integration of data-driven feedback and authentic problem-based learning, appears instrumental in consistently elevating the students' performance far beyond what the conventional digital environment could achieve. This finding reinforces the notion that the DDL model not only makes a difference (as confirmed by ANOVA) but also yields a substantial, practically significant impact on the core 21st-century skill of critical thinking and problem-solving. The quantitative superiority of the DDL model in addressing a challenging high-order skill further validates its use as a potent instructional design solution.

DISCUSSION

The primary objective of this study, to compare the efficacy of the Deep Digital Learning (DDL) model against the Conventional Digital Learning (CDL) model, was definitively confirmed. The ANOVA results showed that the DDL experimental group achieved statistically significant superiority in both Critical Thinking ($F = 169.30$; $p < 0.001$) and Problem-Solving skills ($F = 140.65$; $p < 0.001$). With substantially higher mean scores (14.09 vs. 10.74 for CT, and 13.00 vs. 9.63 for PS), these findings provide conclusive empirical evidence regarding DDL's effectiveness in a higher education context. Furthermore, the calculated effect size (partial), ranging from 0.71 to 0.73, indicates a large and practically significant impact of the DDL intervention. In the context of real-world higher education, this magnitude offers a compelling justification for curriculum redesign. Practically, it implies that the high 'front-loaded' workload required from lecturers to design DDL environments—such as creating authentic scenarios and configuring the LMS for personalized feedback—yields a disproportionately high return on learning outcomes (Alirezabeigi & Decuypere, 2025). For curriculum designers, this large effect size suggests that DDL is a scalable solution for achieving Outcome-Based Education (OBE) targets. It demonstrates that when digital infrastructure is used to scaffold deep cognition rather than just deliver content, it can more effectively bridge the competency gap than traditional methods. Investing in such robust instructional designs is highly efficient for mass education.

The superiority of DDL is particularly evident in advanced cognitive processes, as indicated by the analysis. The most significant gains were observed in Inference and Tactics and Strategies for Critical Thinking, as well as Planning Alternative Solutions and Evaluating Solutions for Problem-Solving. This achievement is directly attributable to the integrated educational design of the DDL model. The mandatory Authentic Problem-Based Learning component, facilitated through the SIDIA LMS, requires students to apply their knowledge in complex scenarios, aligning with Timperley and Schick's (2024) view that authentic assessment enhances pedagogical outcomes. This finding is further corroborated by recent scholarship emphasizing the role of realism in digital tasks. For instance, Wakefield et al. (2024) argue that authentic assessment does not merely test knowledge but develops 'capabilities for life,' bridging the gap between academic tasks and professional requirements. Similarly, Hidayatullah and Setiawan (2024) found that utilizing Problem-Based Learning (PBL) in online settings is critical for sustaining collaborative skills. By anchoring the DDL intervention in authentic scenarios, this study addresses the isolation often felt in digital learning, creating a context in which feedback becomes meaningful and actionable (McLachlan & Tippett, 2024).

Crucially, the DDL model's strength lies in its Data-Driven Feedback mechanism. This feature provided rapid, customized feedback, assisting students in self-reflection and revision, which are essential for improved cognitive performance, a finding congruent with the cognitive process framework established by Reinhold et al. (2024). The efficacy of the DDL model also highlights the importance of leveraging Learning Analytics (LA) rather than relying on passive content delivery. Caspari-Sadeghi (2023) posits that in the age of big data, assessment must evolve from summative testing to continuous data-driven monitoring. This study empirically demonstrates Nguyen's (2024) assertion that LMS-based integrated assessment significantly fosters learning motivation and performance.

In contrast, conventional digital learning often treats the LMS merely as a repository, a practice that Nasim et al. (2024) warn can lead to pedagogical stagnation. DDL circumvents this by using the SIDIA platform to facilitate active, data-informed cycles of improvement. This continuous feedback loop enabled DDL students to excel in the final stage of problem-solving (evaluation), a stage that CDL often poorly addresses. In essence, DDL effectively leverages technology to facilitate deep cognitive thinking, transcending conventional content dissemination.

Theoretically, this research introduces the Deep Digital Learning (DDL) model as a new, empirically validated instructional design framework. The model directly addresses the limitations of conventional digital practices, which often lead to surface learning (Dolmans et al., 2016; Hrastinski, 2023). DDL's innovation resides in its comprehensive integration and empirical substantiation of four fundamental deep learning principles (personalization, collaboration, authentic project-based learning, and data-driven feedback) into a cohesive digital intervention (DeSantis et al., 2023). Empirically, the study fills a critical gap in the literature by providing robust quasi-experimental evidence that the synergistic effect of these four principles within DDL delivers a significantly greater impact on HOTS development than any single element or conventional digital approach. The implications of these findings are substantial for higher education institutions committed to Outcome-Based Education (OBE). DDL offers a concrete, tested instructional solution to ensure that graduate learning outcomes (CT and PS) are genuinely achieved in digital environments (Alenezi et al., 2023). In practice, this suggests that investment in digital ecosystems should prioritize educational design that stimulates deep interaction and cognitive reflection, rather than focusing solely on administrative or content management efficiency.

A crucial distinguishing finding of this study is the observed significant gain asymmetry between the DDL and CDL groups in the highly complex, sequential stages of problem-solving—specifically, in Planning Alternative Solutions and Evaluating the Solution. While other studies might report general score increases, our data confirms that DDL did not merely increase motivation; it fundamentally restructured the cognitive process (Chen & Singh, 2024; Gordon & Debus, 2010; Wu, 2024). The superiority lay not in understanding the problem (where initial differences were minor), but in the deliberate, reflective stages in which students synthesize knowledge and judge its efficacy. This advantage can be attributed to the 'scaffolding effect' inherent in the DDL design, as Lu (2025) notes, active moderation and guidance in synchronous environments are positively correlated with students' depth of critical thinking. Furthermore, Lin and Hwang (2025) demonstrated that procedural scaffolding—similar to the structured steps in our DDL model—is essential for promoting higher-order performance. It is also worth noting that the collaborative nature of DDL may have provided 'affective scaffolding' (Steinert et al., 2025), helping students manage the emotional complexity of solving complex problems, thereby enabling them to persist through the challenging evaluation phase. This unique outcome highlights that DDL's integrated framework is not just an instructional technology, but a cognitive intervention that successfully internalizes the reflective loop required for authentic deep learning, which is a key gap identified in extant digital learning literature (Gee, 2009; Pereira & Wahi, 2019; Kovač et al., 2025).

While the superiority of DDL is statistically evident, it is crucial to interpret these results within the study's contextual constraints critically. The decision to use the same instructor for both groups was intended to control for variability in teaching style and content delivery. However, this design element introduces a potential limitation related to experimenter bias, as the instructor’s familiarity and enthusiasm for the novel DDL model might have subtly influenced classroom dynamics. Furthermore, although cluster random sampling was employed to minimize selection bias, unmeasured variables, such as students' prior digital literacy levels or intrinsic motivation, may have contributed to the performance gap. Thus, the success of DDL should be viewed as a result of the integrated system (technology and pedagogy), but its implementation requires careful attention to these human factors.

Despite the robust findings, this study has several limitations. First, the intervention period was limited to 7 weeks, which may be insufficient to fully assess the long-term retention or transferability of the acquired CT and PS skills. Second, the study was conducted within a single discipline (Educational Technology) at one university, potentially limiting the generalizability of the results across different academic fields. For future research, it is recommended to conduct longitudinal studies to monitor the retention and transfer of CT and PS skills in the DDL group over an extended period and to perform replication studies across diverse disciplines (e.g., Medicine, Engineering) to test the external validity of the DDL model. Incorporating qualitative analysis to explore students' perceptions, motivational factors, and instructors' experiences that contribute to the observed effectiveness of DDL is also beneficial.

The evidence presented suggests that the Deep Digital Learning (DDL) model represents a substantial shift in educational approaches, rather than merely enhancing traditional methods. It has been shown to significantly improve Critical Thinking and Problem-Solving skills, providing educational leaders with a robust, empirically supported framework for pedagogical transformation. This study advocates for the prompt implementation of the DDL framework to prioritize deep learning over mere technological advancements, ultimately equipping graduates with the advanced cognitive skills required in today’s global knowledge economy and fulfilling the objectives of Outcome-Based Education.

CONCLUSION

This study provides empirical evidence that the Deep Digital Learning (DDL) model significantly enhances Critical Thinking and Problem-Solving skills in higher education students compared to conventional digital methods. The observed superiority in advanced cognitive stages—specifically in inference and solution evaluation—is attributed to the synergistic integration of personalization, collaboration, authentic problem-based learning, and data-driven feedback facilitated by the LMS. These findings contribute a validated instructional framework for institutions aiming to align digital learning environments with Outcome-Based Education (OBE) standards. However, given the study's focus on a single discipline over seven weeks, future research should prioritize longitudinal and cross-disciplinary replications to confirm the model's long-term retention and transferability across diverse academic contexts.

ACKNOWLEDGMENT

Universitas Negeri Surabaya supported this work through a regular grant in 2025. This research received no specific grant from other funding agency in the public, commercial, or not-for-profit sectors.

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