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AI-enhanced flipped classroom design thinking to improve self-efficacy in open distance learning

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Abstract. Self-efficacy is a critical determinant of learner success in Open and Distance Learning (ODL), where limited interaction and tutor-centred instruction may weaken confidence and autonomy. This study examines how progressively scaffolded learning designs improve self-efficacy by comparing a Conventional Tutorial, a Flipped Classroom with Design Thinking (FCDT), and an AI-enhanced FCDT-AI model. Using a within-subjects repeated-measures design, 26 undergraduate ODL students recruited through purposive sampling experienced all three conditions in a counterbalanced sequence. Self-efficacy was measured with a validated 34-item scale, complemented by reflection logs. Quantitative analysis (Greenhouse–Geisser–adjusted repeated-measures ANOVA) showed a significant, monotonic increase in self-efficacy from the Conventional Tutorial to FCDT and FCDT-AI ($p < .001$). Mean scores rose from 77.79 to 80.99 and 85.05, respectively, with decreasing coefficients of variation indicating more stable confidence under higher scaffolding. Qualitative findings reinforced this progression: students described tutor dependence and uncertainty under the Conventional Tutorial, greater autonomy and structured mastery under FCDT, and the strongest, most consistent confidence under FCDT-AI due to AI-supported guidance. These results demonstrate that structured flipped design-thinking models, strengthened by generative AI scaffolding, can substantially enhance self-efficacy in ODL contexts. Future studies should investigate long-term effects across larger and more diverse learner populations.

Introduction

Open and Distance Learning (ODL) systems are designed to promote equitable access, learner autonomy, and flexible study pathways, enabling geographically dispersed learners to progress independently at their own pace. Ideally, students in ODL environments are expected to possess strong self-regulated learning skills, technological readiness, and high levels of self-efficacy attributes that support effective engagement in asynchronous tasks, sustained motivation, and mastery of increasingly complex academic content. In practice, however, many ODL learners struggle to maintain confidence when navigating digital platforms, managing independent study demands, and engaging with course materials without continuous tutor presence. Recent research shows that challenges related to cognitive load, limited interaction, and reduced scaffolding frequently undermine ODL students' self-efficacy, which is a central psychological determinant of persistence and achievement (Ahmed et al., 2022; Azevedo et al., 2022; Zimmerman, 2000;

Puspaningsih, 2020; Purnadewi & Widana, 2023). These discrepancies between the ideal and actual conditions underscore the need for structured, interactive, and autonomy-supportive instructional designs that can stabilise and strengthen self-efficacy in ODL systems.

Although flipped classroom models and design-thinking pedagogies have demonstrated the capacity to enhance engagement, cognitive processing, and perceived competence, existing studies have been conducted predominantly in campus-based or blended settings, where tutor presence and peer interaction differ significantly from the constraints of fully asynchronous ODL (Algarni, 2023; Latorre-Cosculluela, 2022). Likewise, empirical work on design thinking has highlighted its value in developing problem-solving skills and a sense of mastery, yet its application in large-scale ODL environments remains limited and typically confined to small or in-person initiatives (Breen et al., 2023; J. Li et al., 2024). At the same time, emerging research suggests that generative AI tools can support autonomy, reduce uncertainty, and enhance learning self-efficacy, but empirical evaluations of AI-supported pedagogies, particularly those integrating flipped learning and design-thinking cycles, remain scarce, short-term, and lacking in ecological validity (Laupichler et al., 2022; Saritepeci & Yildiz Durak, 2024; Zhou & Peng, 2025; Putra, 2021). Furthermore, very few studies systematically compare tutor-centred ODL tutorials with progressively scaffolded flipped and AI-enhanced designs within the same learner population, leaving unanswered questions about how these models differentially influence self-efficacy trajectories over consecutive learning cycles.

These gaps are important because the variables embedded in advanced ODL instructional designs, such as self-efficacy, flipped learning, design thinking, and AI-supported scaffolding, represent interdependent components of a pedagogical ecosystem aimed at strengthening learner capability. Self-efficacy, central to Bandura's framework, shapes learners' beliefs about their ability to complete academic tasks, regulate behaviour, and persist through challenges. Flipped learning structures shift cognitive processing to pre-class activities and encourage active problem-solving during tutorial sessions, thereby facilitating mastery experiences crucial for self-efficacy development. Design thinking introduces iterative cycles of ideation, prototyping, testing, and reflection, which further reinforce autonomy and structured mastery. When integrated with generative AI support, these models may enable real-time scaffolding that reduces uncertainty and enhances learners' ability to manage academic demands independently.

Taken together, the limited evidence base and the inconsistencies across contexts highlight a clear research gap: there is insufficient empirical understanding of how self-efficacy evolves when ODL learners experience a sequence of instructional models that progressively increase structural scaffolding from Conventional Tutorials to Flipped Classroom Design Thinking (FCDT) and to an AI-supported FCDT-AI model.

To address this gap, the present study investigates how students' self-efficacy changes across these three instructional conditions using a repeated-measures design that isolates intra-individual variation. Specifically, the study aims to (1) compare self-efficacy levels under each instructional condition, (2) examine whether progressively scaffolded designs produce systematic improvements in self-efficacy, and (3) explore learners' perceptions of their capability across the three models. Grounded in the theoretical expectation that mastery experiences and structured autonomy enhance self-efficacy, the study hypothesises that: (1) Self-efficacy will increase from the Conventional Tutorial to the FCDT condition; and (2) Self-efficacy will be highest in the FCDT-AI condition.

Method

Research Design

This study employed a within-subjects repeated-measures design to examine the effects of three instructional conditions: Conventional Tutorial, Flipped Classroom Design Thinking (FCDT), and an AI-enhanced FCDT-AI model on students' self-efficacy. The repeated-measures structure enabled all participants to experience each condition, thereby controlling for inter-individual variability, increasing statistical power, and reducing error variance (Creswell & Clark, 2018). A mixed-methods approach integrated quantitative data from a self-efficacy questionnaire with qualitative insights from reflection logs, allowing for a comprehensive interpretation of changes in perceived capability across the three learning environments (Creswell & Clark, 2018). Quantitative data were analysed using repeated-measures ANOVA, while qualitative data were subjected to reflexive thematic analysis (Braun & Clarke, 2006).

Participants and Sampling Technique

Participants were 26 undergraduate students enrolled in the *Academic Writing Techniques* course at Universitas Terbuka (UT) Denpasar. These students reflect the demographic profile typical of Indonesian ODL learners, who often balance full-time employment, family responsibilities, and geographically dispersed study commitments. A purposive sampling technique was used, requiring participants to (1) be officially enrolled in the course, (2) have access to UT's TUWEB learning management system, and (3) provide informed consent. Participation was voluntary.

Research Setting and Timeline

The study was conducted through TUWEB, Universitas Terbuka's institutional learning management system, which supports synchronous tutorials and asynchronous learning activities. This process was carried out from 18 April to 8 June 2025. The research unfolded over three consecutive tutorial cycles, each lasting two weeks. Every cycle corresponded to one instructional condition (CT, FCDT, or FCDT-AI). At the end of each cycle, participants completed the self-efficacy questionnaire and submitted a written reflection log. A counterbalanced sequencing procedure was implemented to minimise potential order effects arising from the study's repeated-measures structure. The FCDT-AI model extended this structure by integrating AI-based scaffolding in key design-thinking phases, including ideation, prototyping, and evaluation, following and refining the framework proposed by (Suwardika et al., 2024).

Research Procedures

Across the three instructional conditions, students first experienced the Conventional Tutorial (CT), delivered through Universitas Terbuka's standard tutor-centred approach in which learners followed synchronous explanations and completed tasks individually with minimal scaffolding. They then engaged in the Flipped Classroom Design Thinking (FCDT) model, which required interaction with structured pre-class materials such as readings and mind-mapping tasks and participation in tutorial activities organised around design-thinking phases of empathy, ideation, prototyping, and testing, supported by Learning Activity Sheets to foster autonomy. The third condition, FCDT-AI, retained the FCDT structure but incorporated generative AI tools that scaffolded ideation, prototyping, and evaluation, providing assistance in conceptual elaboration, content structuring, error checking, and reflective feedback in accordance with the established FCDT-AI framework. At the end of each cycle, participants independently completed the self-efficacy questionnaire and submitted a 150–250-word reflection log detailing their learning experiences.

Data Collection Techniques and Instruments

Self-efficacy was measured using a 34-item Likert-scale questionnaire comprising six theoretically grounded dimensions: task performance confidence, regulatory self-efficacy, technological self-efficacy, cognitive processing confidence, social-academic self-efficacy, and adaptability and persistence (Bandura, 1997). Validity was established using Confirmatory Factor Analysis, while Rasch modelling verified item-person fit, unidimensionality, and measurement invariance across the three instructional conditions. Reliability indices for persons and items were high, indicating strong measurement robustness. Instrument validity and reliability tests have been published by (Gede Suwardika et al. 2024). Reflection logs (150–250 words) were collected after each condition, prompting students to describe their self-efficacy, learning experiences, and challenges encountered in TUWEB-based activities.

Data Analysis Techniques and Criteria

The study unfolded over three consecutive tutorial cycles lasting two weeks each. Participants completed the self-efficacy questionnaire and submitted reflection logs at the end of each cycle, ensuring independent measurement for each instructional condition. Quantitative analyses followed established procedures for repeated-measures designs (Goss-Sampson, 2022). Assumption testing included Q-Q plots for normality and Mauchly's test of sphericity; where the sphericity assumption was violated, the Greenhouse–Geisser correction was applied. Post-hoc comparisons employed Holm adjustments, and raincloud plots illustrated distributions and individual trajectories. Qualitative data were analysed inductively following Braun and Clarke (2006) six-phase framework, supported by reflexive memoing to ensure analytic transparency and methodological rigour.

Results and Discussion

Quantitative Findings

Descriptive statistics for students' self-efficacy across the three instructional conditions are presented in Table 1.

Table 1. Descriptive Statistics for the Three Instructional Conditions (Conventional Tutorial, FCDT, and FCDT-AI)

RM Factor 1	N	Mean	SD	SE	Coefficient of variation
Conventional Tutorial	26	77.788	12.659	2.483	0.163
FCDT	26	80.986	11.689	2.292	0.144
FCDT-AI	26	85.048	10.913	2.140	0.128

Note. N = 26 for each condition. CT = Conventional Tutorial; FCDT = Flipped Classroom Design Thinking; FCDT-AI = Flipped Classroom Design Thinking with AI scaffolding.

Self-efficacy was lowest in the Conventional Tutorial (M = 77.79, SD = 12.66), increased in the FCDT condition (M = 80.99, SD = 11.69), and reached the highest level in the FCDT-AI condition (M = 85.05, SD = 10.91). The progressive decline in the coefficients of variation (0.163 → 0.144 → 0.128) suggests not only rising levels of self-efficacy but also increasingly stable responses as students engaged with more structured, technology-enhanced learning designs. The distributional patterns visualised in the raincloud plot (Image 1) highlight an upward shift across conditions and predominantly ascending individual trajectories, indicating consistent self-efficacy gains for most participants.

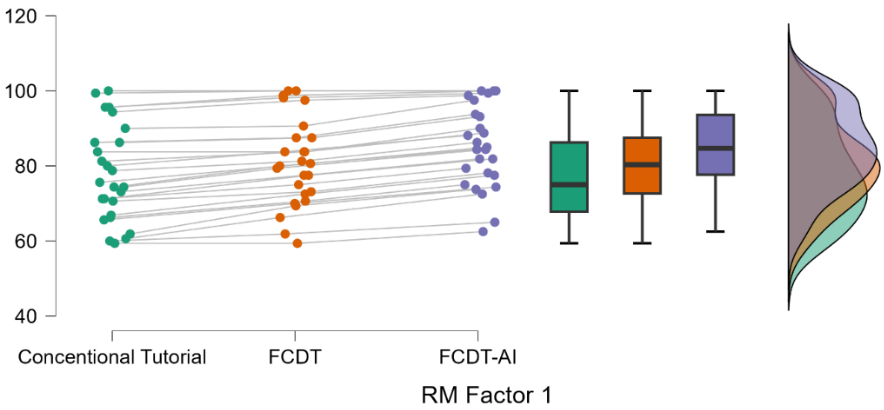

Image 1. Raincloud Plot Displaying the Distribution, Boxplots, and Individual Trajectories Across the Three Instructional Conditions

Assumption testing was conducted prior to the main analysis. The Q-Q plot of standardised residuals (Image 2) showed that the points aligned closely with the diagonal reference line, with only minor deviations in the upper tail. This pattern supports the conclusion that the residuals were approximately normal, satisfying the normality assumption for repeated-measures ANOVA.

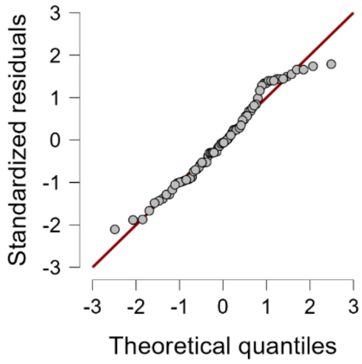

Image 2. Q–Q Plot of Standardised Residuals for Assessing Normality in the Repeated-Measures ANOVA Model

Mauchly's test of sphericity (Table 2) indicated that the assumption of sphericity was violated, W = 0.580, $\chi^2(2) = 13.079$, p = .001. Hence, Greenhouse–Geisser corrections were applied (ε = 0.704).

Table 2. Mauchly's Test of Sphericity

	Mauchly's W	Approx. X^2	df	p-value	Greenhouse-Geisser ε	Huynh-Feldt ε	Lower Bound ε
RM Factor 1	0.580	13.079	2	0.001	0.704	0.734	0.500

The Greenhouse–Geisser–adjusted repeated-measures ANOVA (Table 3) demonstrated a significant effect of Condition on self-efficacy, F(1.408, 35.208) = 116.621, p < .001, indicating substantial differences in self-efficacy levels across the three instructional modes.

Table 3. The Greenhouse–Geisser–adjusted repeated-measures ANOVA

Cases	Sphericity Correction	Sum of Squares	df	Mean Square	F	p
RM Factor 1	Greenhouse-Geisser	688.371	1.408	488.788	116.621	< .001
Residuals	Greenhouse-Geisser	147.566	35.208	4.191		

Note. Type III Sum of Squares
[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated (p < .05).

Holm-adjusted post-hoc comparisons confirmed that each pairwise contrast was statistically significant (Table 4). Self-efficacy was higher in the FCDT condition than in the Conventional Tutorial (Mean Difference = 3.197, SE = 0.415, t(25) = –7.703, p < .001). A stronger improvement was observed between the Conventional Tutorial and FCDT-AI (Mean Difference = 7.260, SE = 0.610, t(25) = –11.892, p < .001). Additionally, self-efficacy was significantly higher in the FCDT-AI condition compared with FCDT (Mean Difference = 4.063, SE = 0.369, t(25) = –11.011, p < .001). Collectively, these findings indicate a clear, systematic, and robust enhancement of self-efficacy from Conventional Tutorial → FCDT → FCDT-AI, with the AI-augmented flipped classroom producing the strongest and most consistent psychological gains among students.

Table 4. Holm-Adjusted Pairwise Comparisons Between Instructional Conditions

		Mean Difference	SE	df	t	p_{holm}
Conventional Tutorial	FCDT	-3.197	0.415	25	-7.703	< .001
	FCDT-AI	-7.260	0.610	25	-11.892	< .001
FCDT	FCDT-AI	-4.063	0.369	25	-11.011	< .001

Note. P-value adjusted for comparing a family of 3 estimates.

Qualitative Findings

Self-Efficacy After the Conventional Tutorial

Students generally reported moderate to high self-efficacy, although their confidence was often mixed with uncertainty, difficulty understanding the content, or dependence on tutor explanations. Several students expressed confidence because they "*understand for receiving and processing information*" (R5-CT), felt "*confident in myself*" (R10-CT), or were "*quite sure, around 80%*" because the material was "*interesting but sometimes difficult*" (R27-CT).

However, many students also conveyed a conditional or fragile sense of efficacy, often tied to inconsistent understanding, distractions, or lack of mastery. For example, one student noted, "*I am 70% because I am less able to understand what the tutor said*" (R17-CT), while another admitted, "*60% because I lack self-confidence and fear making mistakes*" (R21-CT). Some students relied heavily on tutor guidance: "*50% because I always just listen to the tutor explaining*" (R12-CT). The Conventional Tutorial produced moderate but unstable self-efficacy, with many students still unsure about their learning capability and expressing dependence on external guidance.

Self-Efficacy After the FCDT Tutorial

Self-efficacy increased noticeably after students experienced the Flipped Classroom Design Thinking (FCDT) tutorial. Students reported higher confidence because the activities required autonomy, evaluation, and creative engagement with digital sources.

Many students expressed clear growth in their belief in their capability:

> "*I am confident 85%… the material is clear, structured, and easy to follow*" (R4-FCDT).
> "*I am 87%… it triggered my creative thinking and problem-solving*" (R15-FCDT).
> "*I am quite confident, around 85%… I am used to the online learning platform*" (R13-FCDT).

Students who previously relied on tutor direction now demonstrated greater independence, noting improvements in managing tasks, navigating digital platforms, and completing assignments. One student stated, "*80%… materials are clear, and I follow the instructions well*" (R11-FCDT). However, some still reported barriers such as time management or understanding complex material ("*still need to improve time management*", R13-FCDT), indicating that self-efficacy was improving but not yet optimal. The FCDT condition strengthened self-efficacy by providing clear structure, autonomy, and iterative practice, resulting in more confident, self-directed learners.

Self-Efficacy After the FCDT-AI Tutorial
Self-efficacy reached its highest and most stable level when students engaged in the AI-supported Flipped Classroom (FCDT-AI). Learners described strong confidence stemming from clearer guidance, AI-mediated scaffolding, improved understanding, and increased mastery in content creation and digital tasks. Several students reported exceptionally high self-efficacy:

> "*I am confident around 90–95%*" because the material was clear and tasks were completed independently (R18-AI).
> "*I am confident around 90%… the learning flow is structured, and I know where to find help*" (R7-AI).
> "*I am 85–90% because I understand, follow the tasks, and finish assignments well*" (R1-AI).

Others emphasised their ability to solve problems creatively, navigate digital content, and manage learning independently, such as:

> "*I have 85% confidence… I can follow instructions step-by-step accurately*" (R16-AI).
> "*I feel 80% confident because I have read all materials and completed tasks properly*" (R3-AI).

Students who initially lacked confidence under the Conventional Tutorial reported substantial improvement by the FCDT-AI stage. For example, a student who earlier felt unsure stated, "*I am 80%… because I can access and evaluate digital information effectively*" (R10-AI). The FCDT-AI condition produced the strongest self-efficacy, characterised by higher confidence, autonomy, technological mastery, and readiness to complete academic tasks independently.

Restatement of Purpose and Summary of Key Findings
The purpose of this study was to examine how students' self-efficacy developed as they experienced three progressively scaffolded instructional conditions: Conventional Tutorial (CT), Flipped Classroom Design Thinking (FCDT), and AI-enhanced Flipped Classroom Design Thinking (FCDT-AI) within an open and distance learning (ODL) environment. The repeated-measures design enabled the systematic observation of within-participant changes in self-efficacy, a methodological approach well aligned with prior work investigating self-efficacy dynamics in flipped and design-thinking-informed distance learning contexts (Bingen et al., 2020; Lin et al., 2023; Widana & Ratnaya, 2021).

Quantitative analyses revealed a significant main effect of instructional Condition on self-efficacy, with scores increasing monotonically across CT, FCDT, and FCDT-AI. This pattern demonstrates that as the instructional model incorporated more structured scaffolding, learner autonomy, and technology-enhanced support, students' perceived capability improved in a consistent upward trajectory, mirroring the staged developmental patterns reported in earlier studies of flipped and hybridised learning environments (Goria & Konstantinidis, 2023; Suwardika, Sopandi, Indrawan, et al., 2024). The effect size associated with the Condition factor was large, indicating that the observed differences hold substantial practical significance and reflect the degree to which progressively scaffolded and AI-augmented pedagogies can enhance learners' sense of competence in digitally mediated settings (Cha & Kim, 2020). Pairwise comparisons showed statistically significant differences between each instructional condition, CT versus FCDT, CT versus FCDT-AI, and FCDT versus FCDT-AI, highlighting a stepwise enhancement of self-efficacy as students progressed through increasingly autonomous and support-rich learning environments, a finding consistent with studies demonstrating incremental gains in self-efficacy through structured and technology-enhanced pedagogical designs (Yildiz Durak, 2022; Citrawan et al., 2024).

The qualitative findings triangulated and reinforced the quantitative trajectory. Students initially reported fragile or conditional confidence during the CT condition, emphasising uncertainty, dependency on tutor explanations, and inconsistent understanding. Upon transitioning to the FCDT condition, their narratives reflected growing autonomy, clearer task structure, and improved self-regulation. By the FCDT-AI condition, students consistently described high levels of confidence, stable mastery, and strengthened digital competence. This observed progression aligns with broader research demonstrating that mastery experiences, autonomy-supportive learning structures, and AI-based scaffolding are influential mechanisms for strengthening self-efficacy in ODL settings (Berg, 2020; Mathew & Chung, 2021; Mohd Amin et al., 2025; Santoso et al., 2022).

The convergence of quantitative and qualitative findings provides compelling evidence that the instructional progression from CT to FCDT to FCDT-AI fosters increasingly higher levels of self-efficacy. This coherent developmental pattern aligns with theoretical expectations derived from (Bandura, 1997) self-efficacy framework and is consistent with empirical studies showing that structured flipped learning, design-thinking pedagogies, and AI-supported guidance collectively enhance learners' perceived competence, autonomy, and control within distance learning contexts.

Interpretation of Findings in Relation to the Instructional Designs

The finding that self-efficacy was lowest and most unstable in the Conventional Tutorial (CT) condition is consistent with the characteristics of a tutor-centred, largely transmissive mode of instruction that affords learners limited autonomy and few authentic mastery experiences in open and distance learning (ODL) contexts. In this study, participants' reflections under CT frequently emphasised reliance on tutor explanations, difficulty sustaining understanding, and a tendency to "just listen" rather than actively construct knowledge, a pattern known to constrain the development of robust self-efficacy beliefs in remote environments. Such dependence on instructor-led delivery mirrors ODL research showing that passive modes of engagement heighten perceived cognitive load, restrict agency, and undermine confidence, especially when students' opportunities to regulate learning and test their own understanding are limited (Aldossary, 2021; Herrera & Vílchez, 2021; Olney et al., 2021; To & Liu, 2021). From a social cognitive perspective, this pattern is also compatible with Bandura's emphasis on mastery experiences and agentic involvement as primary drivers of self-efficacy; when learners cannot independently scaffold or verify their understanding, confidence tends to fluctuate in parallel with the availability and clarity of tutor input (Herrera & Vílchez, 2021; Laupichler et al., 2022).

The qualitative narratives observed in CT, which foregrounded dependence on tutor explanations, limited opportunities for autonomous decision-making, and variable comprehension, resonate strongly with studies highlighting how external dependence and constrained self-regulation suppress self-efficacy in ODL and flipped-learning environments (Doo & Bonk, 2020; Kant et al., 2021). In particular, learners' reports of only partial understanding and fear of making mistakes under CT reflect the broader literature's identification of autonomy-supportive and scaffolded designs as critical for promoting stable efficacy beliefs; where such structures are absent, learners' confidence often remains conditional and situation-dependent (Kara, 2022; Zhou & Peng, 2025). More generally, the CT condition exemplifies the well-documented challenge of passive delivery in ODL, where lecture-like approaches and limited interactivity are associated with lower engagement, constrained cognitive elaboration, and reduced persistence, all of which contribute to diminished and unstable self-efficacy (Olney et al., 2021; Zhu & Chikwa, 2021; Widana et al., 2023).

By contrast, the moderate increase in self-efficacy observed in the Flipped Classroom with Design Thinking (FCDT) condition can be interpreted as the result of clearer instructional structure, increased learner agency, iterative problem-solving, and creative engagement built into the design-thinking workflow. In this study, FCDT introduced a series of scaffolded activities such as mind mapping, empathy exploration, ideation, and prototyping that required students to engage actively with course materials, articulate their own solutions, and refine outputs over time, thereby providing repeated opportunities for successful task completion and reflection. This design aligns closely with theoretical accounts that structured, agency-enhancing tasks cultivate mastery experiences and deep cognitive engagement, which in turn bolster self-efficacy and persistence (Yang & Hsu, 2020; Zhao, 2021). Empirical research on design thinking in higher education similarly demonstrates that student-led inquiry anchored in authentic problems supports gains in self-efficacy, particularly in problem-solving and creative performance domains (Berg, 2020; Després et al., 2022).

Design-thinking tasks embedded in FCDT, especially the cycles of ideation, testing, feedback, and prototyping, directly support mastery experiences, typically regarded as the most influential source of self-efficacy in Bandura's framework (Herrera & Vílchez, 2021; Laupichler et al., 2022). As learners successfully complete mind-mapping tasks, generate and refine ideas, and develop prototype lesson plans, they accumulate tangible evidence of competence, which helps transform conditional confidence into more stable efficacy beliefs (H. Li, 2023). Moreover, the scaffolded nature of these activities, including explicit steps and iterative feedback, supports regulatory efficacy (beliefs about managing one's study behaviour) and cognitive processing (planning, monitoring, and evaluating one's learning), mechanisms that have been shown to mediate the impact of design-thinking interventions on self-efficacy (Akhmetzadina et al., 2023; Berg, 2020; Ho, 2025). In this way, the moderate but consistent gains in self-efficacy under FCDT are consistent with the broader literature on design-thinking scaffolds and iterative cycles as drivers of enhanced mastery and self-regulation (Després et al., 2022; Herrera & Vílchez, 2021).

The strongest self-efficacy scores and lowest variability in the AI-supported Flipped Design Thinking (FCDT-AI) condition can be understood as a function of additional, AI-mediated scaffolding that operates during ideation, prototyping, and reflective phases of learning. In this condition, AI tools helped students expand idea fluency, structure lesson plans, visualise concepts, and analyse feedback, thereby reducing uncertainty and enabling learners to progress more independently through complex tasks. This pattern accords with studies indicating that AI-assisted guidance can enhance self-regulated learning by providing timely scaffolds, adaptive feedback, and cognitive reinforcement, which collectively foster mastery experiences and autonomous performance (Shi et al., 2025; Xiao et al., 2024). The reduction in variability in self-efficacy scores is also consistent with findings that AI-mediated environments can homogenise access to high-quality support, ensuring that a broader range of learners experience successful performance and reflective consolidation (Aydın et al., 2021).

Qualitative evidence from the FCDT-AI condition highlighting improved understanding, independent task completion, and elevated technological confidence further aligns with emerging research on AI-supported learning environments that emphasise autonomous exploration, feedback-rich cycles, and metacognitive regulation as key pathways to enhanced self-efficacy (Aydın et al., 2021; Xiao et al., 2024). Students' reports of feeling more capable of following step-by-step instructions, identifying and correcting errors, and navigating digital tools converge with studies showing that AI-enabled tools can strengthen learners' perceived capability to manage both task demands and their own learning processes (Shi et al., 2025). Importantly, the AI feedback and scaffolding structures in FCDT-AI map closely onto the recognised drivers of self-efficacy: mastery experiences (e.g., iterative success on AI-supported tasks), reduced uncertainty (predictable, on-demand guidance), cognitive reinforcement (specific, actionable feedback), and autonomy support (learner-controlled pacing and exploration) (Herrera & Vílchez, 2021; Laupichler et al., 2022). This alignment helps to explain why FCDT-AI not only yielded the highest mean self-efficacy but also the greatest stability in learners' confidence, consistent with work linking AI-mediated scaffolding to repeated mastery opportunities and heightened autonomy (H. Li, 2023).

Alignment with Theory and Previous Research

The findings align with Bandura's (1997) conceptualisation of self-efficacy, particularly the central role of mastery experiences and self-regulatory support. CT offered minimal opportunities for mastery and thus produced inconsistent confidence; FCDT generated more stable efficacy through iterative tasks and autonomy; FCDT-AI maximised mastery by providing continuous, adaptive scaffolding. The progression observed here mirrors patterns reported in studies where structured, active, and technology-enhanced instruction increased learners' adaptive beliefs and academic performance in digital learning environments (Cho et al., 2021; Indrawan et al., 2025; Laupichler et al., 2022; Suwardika, Sopandi, Indrawan, et al., 2024).

Novelty and Contribution

This study offers three contributions to the literature. First, it provides rare within-subject empirical evidence comparing CT, FCDT, and FCDT-AI in an authentic ODL environment, allowing precise observation of intra-individual changes. Second, it expands existing research by demonstrating that design-thinking pedagogy can be effectively operationalised in a distance-learning system rather than in face-to-face or blended settings where it is usually studied. Third, it contributes to emerging scholarship on human–AI collaboration in education by demonstrating how generative AI can enhance scaffolding in design-based flipped-learning models.

Limitations

Despite its strengths, this study has several limitations that should be considered. The relatively small sample size (N = 26) reduces the generalisability of the results and may limit the statistical power to detect subtle effects. The short duration of data collection, spanning only three instructional cycles, restricts the ability to assess the long-term stability of self-efficacy changes. Furthermore, learners' perceptions may have been influenced by novelty effects associated with AI tools, potentially inflating self-efficacy ratings. Finally, although reflection logs provided valuable qualitative data, their prescribed 150–250-word range may have constrained the depth and nuance of participants' responses.

Conclusion

This study examined how learners' self-efficacy developed as they progressed through three increasingly scaffolded instructional conditions: Conventional Tutorial, Flipped Classroom Design Thinking (FCDT), and AI-supported FCDT-AI within an open and distance learning environment. The findings demonstrate a clear and consistent increase in self-efficacy across these conditions, with the strongest and most stable confidence emerging when generative AI scaffolding was integrated into the design-thinking–based flipped model. Qualitative reflections further revealed that learners initially relied heavily on tutor explanations but gained structure, autonomy, and, eventually, greater independence as the instructional design became more interactive and technologically enhanced. These results indicate that combining flipped learning, design-thinking cycles, and AI-mediated scaffolding can meaningfully strengthen learner capability in ODL contexts by creating richer mastery experiences and reducing uncertainty. Practically, the study suggests that ODL institutions should consider embedding structured, design-oriented, and AI-supported learning models to enhance learner readiness and self-regulated performance. Future research may explore long-term effects, larger and more diverse populations, and the differential impact of specific AI scaffolds to inform more personalised and sustainable ODL innovations.

Bibliography

Ahmed, Md. M., Rahman, A., Hossain, Md. K., & Tambi, F. B. (2022). Ensuring learner-centred pedagogy in an open and distance learning environment by applying scaffolding and positive reinforcement. *Asian Association of Open Universities Journal*, *17*(3), 289–304. https://doi.org/10.1108/AAOUJ-05-2022-0064

Akbulut, Y., Saykılı, A., Öztürk, A., & Bozkurt, A. (2023). What if it's all an illusion? To what extent can we rely on self-reported data in open, online, and distance education systems? *The International Review of Research in Open and Distributed Learning*, *24*(3), 1–17. https://doi.org/10.19173/irrodl.v24i3.7321

Akhmetzadina, Z. R., Mukhtarullina, A. R., Starodubtseva, E. A., Kozlova, M. N., & Pluzhnikova, Y. A. (2023). Review of effective methods of teaching a foreign language to university students in the framework of online distance learning: international experience. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1125458

Aldossary, K. (2021). Online distance learning for translation subjects: Tertiary level instructors' and students' perceptions in saudi arabia. *Turkish Online Journal of Distance Education*, 96–109. https://doi.org/10.17718/tojde.961821

Algarni, B. (2023). An evaluation of the impact of flipped-classroom teaching on mathematics proficiency and self-efficacy in Saudi Arabia. *British Journal of Educational Technology*, *54*(1), 414–435. https://doi.org/10.1111/bjet.13250

Altunçekiç, A., & Birbudak, T. S. (2023). The determination of history teacher candidates' distance education self-efficacy belief levels according to different variables. *Participatory Educational Research*, *10*(6), 266–281. https://doi.org/10.17275/per.23.100.10.6

Awi, A., Naufal, M. A., Sutamrin, S., & Huda, M. (2024). Enhancing geometry achievement in pre-service mathematics teachers: The impact of a scaffolded flipped classroom using a learning management system. *Journal of Ecohumanism*, *3*(6), 637–645. https://doi.org/10.62754/joe.v3i6.4035

Aydın, Z., Öztürk, Z., & Çiçek, Z. (2021). Turkish sentiment analysis for open and distance education systems. *Turkish Online Journal of Distance Education*, 124–138. https://doi.org/10.17718/tojde.961825

Azevedo, R., Bouchet, F., Duffy, M., Harley, J., Taub, M., Trevors, G., Cloude, E., Dever, D., Wiedbusch, M., Wortha, F., & Cerezo, R. (2022). Lessons learned and future directions of metatutor: leveraging multichannel data to scaffold self-regulated learning with an intelligent tutoring system. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.813632

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.

Berg, G. Van Den. (2020). Context matters: Student experiences of interaction in open distance learning. *Turkish Online Journal of Distance Education*, 223–236. https://doi.org/10.17718/tojde.803411

Bingen, H. M., Steindal, S. A., Krumsvik, R. J., & Tveit, B. (2020). Studying physiology within a flipped classroom: The importance of on-campus activities for nursing students'

experiences of mastery. *Journal of Clinical Nursing*, *29*(15–16), 2907–2917. https://doi.org/10.1111/jocn.15308
Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
Breen, K., Asturias, G., Pena, D., Dotson, M. E., Springate, H., Alvarez, V., Madonna, M., & Ramanujam, N. (2023). Community-centered design thinking as a scalable STEM Learning Intervention. *Advances in Enginering Education*, *11*(2). https://doi.org/10.18260/3-1-1153-36042
Cha, J., & Kim, J. (2020). Effects of flipped learning on the critical thinking disposition, academic achievement and academic self-efficacy of nursing students: A mixed methods study. *Journal of Korean Academic Society of Nursing Education*, *26*(1), 25–35. https://doi.org/10.5977/jkasne.2020.26.1.25
Citrawan, I. W., Widana, I. W., Sumandya, I. W., Widana, I. N. S., Mukminin, A., Arief, H., Razak, R. A., Hadiana, D., & Meter, W. (2024). Special education teachers' ability in literacy and numeracy assessments based on local wisdom. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, *8*(1), 145-157. https://doi.org/10.22437/jiituj.v8i1.32608
Creswell, J. W., & Clark, V. L. P. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.
Després, J.-P., Julien-Gauthier, F., Jourdan-Ionescu, C., & Bédard-Bruyère, F. (2022). The extra-ordinary music camp: An informal online distance learning approach for children with intellectual and physical disabilities and learning disorders. *Frontiers in Education*, *7*. https://doi.org/10.3389/feduc.2022.913390
Doo, M. Y., & Bonk, C. J. (2020). The effects of self-efficacy, <scp>self-regulation</scp> and social presence on learning engagement in a large university class using flipped Learning. *Journal of Computer Assisted Learning*, *36*(6), 997–1010. https://doi.org/10.1111/jcal.12455
Gede Suwardika, Agus Tatang Sopandi, & Indrawan, P. O. (2024). Delopment and validation of a self-efficacy scale for distance learning. *Journal of Education Research and Evaluation*, *8*(4), 584–592. https://doi.org/10.23887/jere.v8i4.84044
Goria, C., & Konstantinidis, A. (2023). A participatory pedagogical model for online distance learning: Ideation and implementation. *Turkish Online Journal of Distance Education*, *24*(1), 145–161. https://doi.org/10.17718/tojde.1082978
Goss-Sampson, M. A. (2022). *Statistical Analysis in JASP a Gude for Students* (Vol. 16). University of Greenwich.
Herrera, J. P., & Vílchez, A. S. (2021). Students' perception and academic performance in a flipped classroom model within early childhood education degree. *Heliyon*, *7*(4), e06702. https://doi.org/10.1016/j.heliyon.2021.e06702
Ho, T. E. (2025). Outcomes of an integrated STEM with design thinking module on preschoolers' science process skills. *Journal of Early Childhood Research*, *23*(3), 353–368. https://doi.org/10.1177/1476718X251325675
Kant, N., Prasad, K. D., & Anjali, K. (2021). Selecting an appropriate learning management system in open and distance learning: a strategic approach. *Asian Association of Open Universities Journal*, *16*(1), 79–97. https://doi.org/10.1108/AAOUJ-09-2020-0075
Kara, M. (2022). Open and distance learning vision of higher education institutions in turkey: implications for leadership. *Open Praxis*, *14*(1), 14–26. https://doi.org/10.55982/openpraxis.14.1.480
Latorre-Cosculluela, C., Suárez, C., Quiroga, S., Anzano-Oto, S., Lira-Rodríguez, E., & Salamanca-Villate, A. (2022). Facilitating self-efficacy in university students: an interactive approach with flipped classroom. *Higher Education Research & Development*, *41*(5), 1603–1617. https://doi.org/10.1080/07294360.2021.1937067
Laupichler, M. C., Hadizadeh, D. R., Wintergerst, M. W. M., von der Emde, L., Paech, D., Dick, E. A., & Raupach, T. (2022). Effect of a flipped classroom course to foster medical

students' AI literacy with a focus on medical imaging: a single group pre-and post-test study. *BMC Medical Education*, *22*(1), 803. https://doi.org/10.1186/s12909-022-03866-x

Li, H. (2023). Effects of a ChatGPT-based flipped learning guiding approach on learners' courseware project performances and perceptions. *Australasian Journal of Educational Technology*, *39*(5), 40–58. https://doi.org/10.14742/ajet.8923

Li, J., Goei, S., & Huang, R. (2024). Unveiling maker mindsets: A journey of formation and transformation through design thinking-making pedagogy within a lesson study context. *Frontiers in Education*, *9*. https://doi.org/10.3389/feduc.2024.1343492

Lin, H., Hwang, G., Chou, K., & Tsai, C. (2023). Fostering complex professional skills with interactive simulation technology: A virtual reality-based flipped learning approach. *British Journal of Educational Technology*, *54*(2), 622–641. https://doi.org/10.1111/bjet.13268

Mathew, V., & Chung, E. (2021). University students' perspectives on open and distance learning (odl) implementation amidst COVID-19. *Asian Journal of University Education*, *16*(4), 152. https://doi.org/10.24191/ajue.v16i4.11964

Mohd Amin, M. R., Ismail, I., & Sivakumaran, V. M. (2025). Revolutionizing education with artificial intelligence (ai)? challenges, and implications for open and distance learning (ODL). *Social Sciences & Humanities Open*, *11*, 101308. https://doi.org/10.1016/j.ssaho.2025.101308

Olney, T., Li, C., & Luo, J. (2021). Enhancing the quality of open and distance learning in China through the identification and development of learning design skills and competencies. *Asian Association of Open Universities Journal*, *16*(1), 61–78. https://doi.org/10.1108/AAOUJ-11-2020-0097

Ozaydin Ozkara, B., & Ibili, E. (2021). Analysis of students' e-learning styles and their attitudes and self-efficacy perceptions towards distance education. *International Journal of Technology in Education and Science*, *5*(4), 550–570. https://doi.org/10.46328/ijtes.200

Purnadewi, G. A. A., & Widana, I. W. (2023). Improving students' science numeration capability through the implementation of the PBL model based on local wisdom. *Indonesian Journal of Educational Development (IJED), 4*(3), 307-317. https://doi.org/10.59672/ijed.v4i3.3252

Puspaningsih, A. R. (2020). Penerapan biology interactive notebooks dalam flipped classroom untuk meningkatkan hasil belajar biologi (Implementation of biology interactive notebooks in flipped classroom to improve biology learning outcomes). *Indonesian Journal of Educational Development*, *1*(3), 401-409. https://doi.org/10.5281/zenodo.4284509

Putra, I. M. Y. T. (2021). Implementasi pembelajaran flipped classroom berbasis strategi diferensiasi untuk meningkatkan keterampilan berpikir kritis peserta didik (Implementation of flipped classroom learning based on differentiation strategies to improve students' critical thinking skills). *Indonesian Journal of Educational Development*, *2*(3), 461-471. https://doi.org/10.5281/zenodo.5681318

Santoso, H. B., Riyanti, R. D., Prastati, T., S., FA. T. H., Susanty, A., & Yang, M. (2022). Learners' online self-regulated learning skills in indonesia open university: implications for policies and practice. *Education Sciences*, *12*(7), 469. https://doi.org/10.3390/educsci12070469

Saritepeci, M., & Yildiz Durak, H. (2024). Effectiveness of artificial intelligence integration in design-based learning on design thinking mindset, creative and reflective thinking skills: An experimental study. *Education and Information Technologies*, *29*(18), 25175–25209. https://doi.org/10.1007/s10639-024-12829-2

Shi, J., Liu, W., & Hu, K. (2025). Exploring how ai literacy and self-regulated learning relate to student writing performance and well-being in generative ai-supported higher education. *Behavioral Sciences*, *15*(5), 705. https://doi.org/10.3390/bs15050705

Suwardika, G., Sopandi, A. T., & Indrawan, I. P. O. (2024). *Model flippped classroom design thinking terdiferensiasi berbantuan Artificial Intelligence (AI): Untuk mengembangkan literasi digital, keterampilan berpikir kreatif, dan efikasi diri*. Nilacakra. https://books.google.co.id/books?id=Za8tEQAAQBAJ

Suwardika, G., Sopandi, A. T., Indrawan, I. P. O., & Masakazu, K. (2024). A flipped classroom with whiteboard animation and modules to enhance students' self-regulation, critical thinking and communication skills: a conceptual framework and its implementation. *Asian Association of Open Universities Journal*, *19*(2), 135–152. https://doi.org/10.1108/AAOUJ-10-2023-0115

To, S., & Liu, X. (2021). Outcomes of community-based youth empowerment programs adopting design thinking: A quasi-experimental study. *Research on Social Work Practice*, *31*(7), 728–741. https://doi.org/10.1177/10497315211001442

Widana, I. W. & Ratnaya, I. G. (2021). Relationship between divergent thinking and digital literacy on teacher ability to develop HOTS assessment. *Journal of Educational Research and Evaluation, 5*(4), 516-524. https://doi.org/10.23887/jere.v5i4.35128

Widana, I. W., Sumandya, I. W., Citrawan, I. W. (2023). The special education teachers' ability to develop an integrated learning evaluation of Pancasila student profiles based on local wisdom for special needs students in Indonesia. *Kasetsart Journal of Social Sciences, 44*(2), 527–536. https://doi.org/10.34044/j.kjss.2023.44.2.23

Wolcott, M. D., Castleberry, A. N., Johnson, C., Pick, A. M., & Persky, A. M. (2023). Lessons from using design thinking to develop the 2021 aacp teachers' seminar. *American Journal of Pharmaceutical Education*, *87*(2), ajpe8990. https://doi.org/10.5688/ajpe8990

Xiao, J., Alibakhshi, G., Zamanpour, A., Zarei, M. A., Sherafat, S., & Behzadpoor, S.-F. (2024). How ai literacy affects students' educational attainment in online learning: Testing a structural equation model in higher education context. *The International Review of Research in Open and Distributed Learning*, *25*(3), 179–198. https://doi.org/10.19173/irrodl.v25i3.7720

Yang, C.-M., & Hsu, T.-F. (2020). Integrating design thinking into a packaging design course to improve students' creative self-efficacy and flow experience. *Sustainability*, *12*(15), 5929. https://doi.org/10.3390/su12155929

Yavuzalp, N., & Bahçivan, E. (2020). The online learning self-efficacy scale: Its adaptation into turkish and interpretation according to various variables. *Turkish Online Journal of Distance Education*, 31–44. https://doi.org/10.17718/tojde.674388

Yildiz Durak, H. (2022). Flipped classroom model applications in computing courses: Peer-assisted groups, collaborative group and individual learning. *Computer Applications in Engineering Education*, *30*(3), 803–820. https://doi.org/10.1002/cae.22487

Zhao, L. (2021). The differentiate effect of self-efficacy, motivation, and satisfaction on pre-service teacher students' learning achievement in a flipped classroom: A case of a modern educational technology course. *Sustainability (Switzerland)*, *13*(5), 1–15. https://doi.org/10.3390/su13052888

Zhou, M., & Peng, S. (2025). The usage of ai in teaching and students' creativity: The mediating role of learning engagement and the moderating role of ai literacy. *Behavioral Sciences*, *15*(5), 587. https://doi.org/10.3390/bs15050587

Zhu, X., & Chikwa, G. (2021). An exploration of China-Africa cooperation in higher education: Apportunities and challenges in open distance learning. *Open Praxis*, *13*(1), 7. https://doi.org/10.5944/openpraxis.13.1.1154

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, *25*(1), 82–91. https://doi.org/10.1006/ceps.1999.1016