Blended Learning Platform Using Design Thinking Method for Reinforcing Students' Information, Media, and Technology Skills

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***Abstract*—This study presents the development and evaluation of a blended learning platform guided by the design thinking methodology to enhance undergraduate students' Information, Media, and Technology (IMT) skills. A quasi-experimental design was employed involving 60 participants, divided into an experimental group receiving instruction via the platform and a control group receiving conventional instruction. The platform was developed using a five-stage design thinking process, integrating empathic learning design with digital tools and interactive components. Data collection included pre-and post-tests of IMT competencies and academic achievement, expert evaluations, and student satisfaction surveys. Statistical analyses—Multivariate Analysis of Variance (MANOVA), Cohen's d, and partial eta squared (η^2)—revealed that students in the experimental group showed significantly higher gains in both IMT skills and academic performance compared to the control group ($p < 0.01$). The platform also received high ratings for instructional quality and learner engagement. Findings indicate that a blended learning environment, when structured through design thinking, can effectively support the development of 21st-century competencies. This model holds potential for broader application in higher education contexts, promoting critical thinking, learner autonomy, and digital literacy.**

***Keywords*—blended learning platform, design thinking, information, media and technology skills, Thailand**

I. Introduction

In the current global educational landscape, there is a growing emphasis on equipping learners with 21st-century skills to meet the demands of a rapidly evolving society [1]. In alignment with this international movement, Thailand's National Education [2] has been formulated as a strategic framework designed to enhance the national education system comprehensively and effectively. The plan underscores the importance of cultivating students' essential competencies—including critical thinking, creativity, communication, and collaboration—alongside developing desirable values and lifelong learning skills consistent with international educational standards [3]. Communication skills and information and media literacy are among the essential competencies for 21st-century education. They are critical for preparing learners to navigate and thrive in a knowledge-based, digitally interconnected society. This is to develop students' skills in a direct way whether to develop individual student to be ready for education or to develop high-level skills for occupations. Information, Media, And Technology (IMT) skills are among the core competencies essential for 21st-century education. These skills align with the broader educational focus on life and career competencies, learning and innovation capabilities, and digital literacy frameworks [4–9]. In a digital learning environment, IMT skills are increasingly indispensable for students. They support learners in navigating everyday digital interactions and enhance the effectiveness of computer-assisted instruction. By fostering students' digital fluency, such competencies play a crucial role in developing 21st-century skills, reassuring their importance in education. These competencies also serve as foundational guidelines for designing effective pedagogy and producing graduates equipped to meet the demands of Thai society in an increasingly digital and information-driven world. As information literacy becomes essential for everyday functioning and future professional success, governments must ensure that students are adequately prepared with these 21st-century skills. In response to this national priority, the Thai Qualifications Framework for Higher Education (TQF: HEd) [10] was established to articulate clear learning outcome standards for graduates. The framework provides a structured basis for curriculum planning, instructional innovation, and assessment reform—ensuring that higher education institutions align graduate attributes with national and global expectations, thereby highlighting the significant role of their work in shaping the future.

Blended learning is a learning model that combines face-to-face learning with online learning [11–19]. Blended learning can be applied in learning at all levels to encourage learners' interaction with lessons very well. It can be guidelines for teachers who are interested in teaching with various methods with support of current technology. The blended learning platform, which integrates design thinking, is an effective method for developing students' skills and a powerful tool that can significantly enhance their learning experience. It is essential to acknowledge that while it presents certain limitations, these can be addressed. Moreover, it supports the situation of the 2019 novel coronavirus pandemic, where face-to-face classroom learning must be adapted. Blended learning remains a relevant and effective tool, with a strong focus on enabling students to gain skills with learning achievement or competencies following requirements of the 21st-century skills and Thai Qualification Framework for Higher Education (TQF: HEd). Blended Learning (BL) enhances education by combining face-to-face and online instruction, improving flexibility and student engagement, and placing the student at the center of the learning process.

Research shows BL supports diverse learning needs and promotes active learning strategies. Its adoption has

expanded, especially post-COVID-19, emphasizing its role in modern education. Further studies continue to refine BL models for optimal effectiveness.

Regarding the design thinking method, many educators apply the design thinking method in research [19–22]. These educators found that the design thinking method focuses on various methods in science, intellectual process, and collaborative work process. The design thinking method can be used with multiple quality thinking processes, integrated well into learning management and innovation in information, media, and technology, and used to change current situations or environments as expected in the future. The design thinking method consists of 5 steps: Empathize, Define, Ideate, Prototype, and Test. Among these five steps, Step 1 and Step 2 (Empathize and Define) are the steps for making understanding and deeply interpreting problems while Step 3 (Ideate) is a step to use creative thinking and various perspectives to create ideas. Step 4 and Step 5 (Prototype and Test) are the steps to test the concept and develop a prototype in order to obtain guidelines or innovation to solve the problem and situations. According to Refs. [23–26], the design thinking method is a model for helping students learn novel things, engage in creative thinking, and apply this thinking in various fields of study. In addition, this method conforms to 21st-century skills.

According to the background and problems mentioned above, the researcher thinks that developing a blended learning platform using the design thinking method to enhance information, media, and technology skills for the students in the computer education program at Rajabhat University can be a model for managing teaching/learning for students in their future teaching occupations [27]. Conformingly, Aumgri and Petsangsri [8], Aumgri [9], Phaupan *et al*. [28], and E. Avdiu *et al*. [29] mention that teachers need to possess skills and be able to manage teaching/learning well and suitable for the 21st-century skills and Education 4.0. They need to be equipped with basic information and communication technology necessary for education in order to enhance their learning effectiveness. This plan, in line with the National Digital Economy and Society Development Plan and Policy, is a master plan for the 20-year country development of digitality for economy and society B.E. 2561–2580 (2018–2037). It outlines sustainable directions for driving the country's development through digital technology. The emphasis is on simultaneously upgrading students, teachers, classrooms, learning media, and schools in the system, promising long-term benefits. The National Digital Economy and Society Development Plan and Policy B.E. (2018–2037); Regional Education Office. Moreover, the TQF: HEd effectively promotes graduates to have expertise in their professions in the future. The framework consists of skills and competencies important for teaching profession in relation to information technology for supporting abilities to use information skills for developing innovative media used in professions. These skills are not just skills but life and work skills, learning and innovative skills, and information, media, and technology skills [4–7, 9]. Therefore, students' skills in using information technology are not just necessary but increasingly crucial at present and in the future. UNESCO [5] and Ministry of Education [30] state that within a decade, 90% of the world's population will need to access the internet to drive the world society to connect with the internet of everything or internet of things, for helping students gain specialized skills congruent with the skills in the future, and for helping computer teachers in the future more flexible in managing teaching/learning. Computer teachers must enhance knowledge, skills, and competencies that are important for professions in transferring knowledge and managing learning about information, media, and technology skills more accurately and completely. This can also result in better learning achievement and help respond well to the world's future demand for skills [27].

Traditional learning methods in Thailand often result in low student engagement and inadequate skill development. BL enhances student participation by integrating face-to-face and online learning, promoting active engagement and self-directed learning. Design Thinking (DT) fosters creativity, problem-solving, and collaboration, making learning more interactive [31]. Implementing BL and DT in Thai education can bridge learning gaps, improve digital literacy, and better prepare students for 21st-century challenges [32]. These strategies offer a modern approach to education, enhancing student outcomes and engagement.

II. Literature Review

A. Blended Learning Platform

In a blended learning platform, learners creatively build knowledge on their own through project assignment, process of work presentation, and learning process under the concept of flipped classroom. Panic [33] explains the learning process by using this concept. 1) On the first lesson, the teacher should explain usefulness of this learning management and its positive effects, make understanding, and make agreement between the teacher and students by explaining importance of learning with blended learning. And 2) the teacher teaches students how to see the blended learning platform as follows.

B. Comparison Between Traditional Learning and Blended Learning

Traditional learning, as we know it, involves a teacher delivering a lecture on the main content in the classroom while students listen, take notes, and answer questions. On the other hand, blended learning is a flexible model that combines online and offline lessons. It empowers students to take classes through online media and participate in classroom activities, providing a more adaptable learning experience.

In conclusion, traditional learning and blended learning have their own strengths and weaknesses. Traditional learning in a normal classroom focuses on prompt interaction and communication while blended learning is more flexible and use technology to increase learning effectiveness.

C. Benefits of Blended Learning

For teachers, blended learning is beneficial in 1) increasing teaching effectiveness, 2) reducing workload, 3) promoting interaction with students, and 4) developing teachers' technology skills. For students, blended learning is beneficial in 1) increasing learning flexibility, 2) enhancing self-study, 3) increasing interaction between teachers and students, 3) developing learning skills and technology skills, and 4)

effectively increasing students' learning motivation.

D. Design Thinking

Design thinking focuses on creation of innovation by placing importance in making users to really understand before actual practice i.e., observation, inquiry, and test of prototype to find solutions to problems which meet students' need [21].

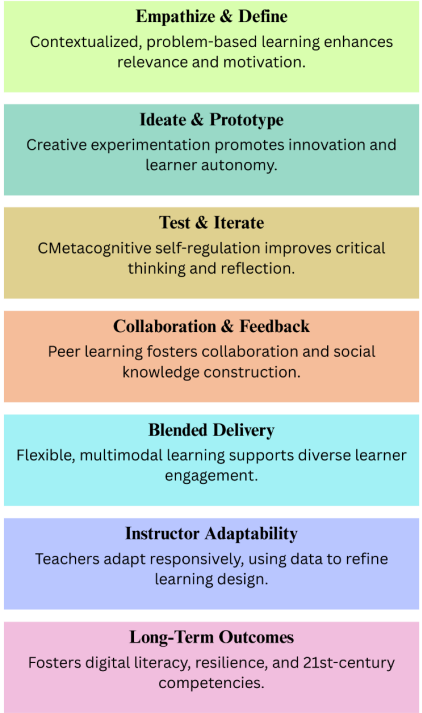

Fig. 1. Pedagogical mechanisms supporting design thinking in a blended learning context.

E. Pedagogical Mechanisms Supporting Design Thinking in a Blended Learning Context

Fig. 1 illustrates the pedagogical mechanisms that support the integration of design thinking within a blended learning context, encompassing seven essential components. The first component, Empathize & Define, emphasizes contextualized, problem-centered learning that enhances learners' sense of relevance and motivation. The Ideate & Prototype stage encourages creative experimentation, which fosters innovation and promotes learner autonomy. Test & Iterate involves metacognitive self-regulation that strengthens critical thinking and reflective learning processes. Through Collaboration & Feedback, peer learning is facilitated, which encourages teamwork and the social construction of knowledge. The Blended Delivery model provides flexible, multimodal instruction that accommodates diverse learner needs and enhances student engagement. Additionally, Instructor Adaptability ensures that teachers respond dynamically to students' learning needs by using real-time data to improve instructional design. Ultimately, these mechanisms contribute to Long-Term Outcomes by promoting digital literacy, resilience, and the development of core 21st-century competencies.

As shown in Fig. 1, integrating design thinking into blended learning environments requires pedagogical strategies that foster creativity, metacognitive reflection, collaboration, and adaptive use of technology. These components collectively support the development of essential student competencies for long-term academic and professional success.

F. Information, Media and Technology Skills

In this study, the researcher conceptualized the model structure based on the core components of IMT skills, as outlined in Ref. [34]. The framework encompasses five key indicators: (1) foundational knowledge of information, (2) information access, (3) information utilization, (4) creative media production, and (5) information management and evaluation.

III. Research Objectives

To achieve these objectives, the research is structured around two primary goals. The first emphasizes the development of a blended learning platform grounded in the design thinking methodology. The second objective focuses on empirically validating the platform's effectiveness by comparing students' academic performance before and after using the platform.

1) Using the innovative design thinking method, we aim to develop a blended learning platform that stands out. This approach will be instrumental in reinforcing students' information, media, and technology skills.
2) Using the design thinking method, our project aims to compare learning achievement before and after the lessons of the students who studied with a blended learning platform. This method is designed to reinforce students' information, media, and technology skills, which are crucial in today's digital age.

IV. Materials and Methods

A. Population and Sample Group

1) Evaluation of platform suitability

A panel of experts, each with a wealth of professional experience in instructional design and educational technology, meticulously assessed the platform's appropriateness.

2) Comparison of IMT skills and academic achievement

The study comprehensively compared students' IMT skill levels and academic achievement between those who engaged with the developed platform and those who received conventional instruction, ensuring the validity of the results.

3) Satisfaction with the platform

Evaluating learner satisfaction was a comprehensive process involving Nakhon Pathom Rajabhat University undergraduate students. Participants were selected using a multi-stage random sampling technique and assigned to either the experimental or control group to ensure a balanced representation across both conditions. This study, conducted on a significant scale, adopted a quasi-experimental design to investigate the effectiveness of a blended learning platform developed through the design thinking methodology in enhancing students' IMT skills. The target population comprised 450 undergraduate students enrolled in a 21st-century skills course. A total of 60 participants were selected using a multi-stage random sampling process, ensuring the fairness and representativeness of the study. This

emphasis on fairness and representativeness underscores the integrity and trustworthiness of the research. The rigorous and fair design of this study further enhances its credibility and reliability [35]. Initially, the Computer Education program was identified through cluster sampling, followed by random assignment of students into experimental and control groups based on student identification numbers.

To ensure the results could be generalized, participants were selected based on balanced demographic characteristics such as age (18–22), gender, and academic performance. Students were required to have some experience using digital tools, while those who had previously participated in blended learning programs were excluded to avoid any potential bias in their responses. The sample size was verified using G*Power analysis, and random assignment was performed using R software.

The research utilized five main instruments: (1) a platform evaluation rubric validated by nine experts using Item-Objective Congruence (IOC); (2) a tool to assess the instructional quality of lesson plans and Learning Management System (LMS) content; (3) a 30-item academic achievement test with strong reliability ($\alpha = 0.78$) and verified Content Validity (CVI); (4) a rubric to evaluate students' IMT skills based on five levels of performance; and (5) a 20-item satisfaction survey using a 5-point Likert scale, with internal consistency ($\alpha = 0.86$) and construct validity confirmed via exploratory factor analysis.

The experimental intervention lasted for nine weeks, totaling 15 instructional hours, combining live sessions, digital self-learning materials, and interactive learning activities. Pre- and post-tests were administered to both groups, and satisfaction was measured at the end of the intervention.

Data were analyzed with thoroughness using advanced statistical methods, including descriptive statistics (mean, standard deviation), Multivariate Analysis of Variance (MANOVA) to compare group differences and effect size measures (Cohen's d, partial eta squared), including 95% Confidence Intervals (CI) to assess the precision of the results. This rigorous approach ensures the scientific validity of the study and provides confidence in the reliability of the findings.

V. Research Tools

A. Platform Evaluation Instrument

A team of seasoned professionals developed an evaluation form to assess the suitability of the blended learning platform designed using the design thinking method. The instrument consisted of three sections: Section 1: Content Alignment. This section critically evaluated the platform's alignment with design thinking principles, a key factor in supporting the development of students' IMT skills at the undergraduate level. Section 2: Platform Appropriateness. This section assessed the platform's overall appropriateness in terms of instructional design, usability, and pedagogical relevance for enhancing IMT skills. Section 3: Expert Recommendations. This section gathered expert suggestions and qualitative feedback, highlighting the potential for further platform development and improvement to support IMT skill acquisition.

B. Evaluation of Lesson Plans and Online Course Materials

A panel of experts assessed the quality of lesson plans and online instructional content developed within the blended learning platform, which was structured using the design thinking approach. The evaluation, which was thorough and meticulous, focused on content validity and technical design to ensure the platform's effectiveness in fostering undergraduate students' IMT skills. Two evaluation instruments were utilized [36, 37]:

Copy 1: Content Evaluation Form. This instrument examined the course content's relevance, clarity, and alignment with the targeted IMT competencies. Expert judgment was based on a 3-point rating scale, where a higher score indicates a more substantial alignment with the IMT competencies. Copy 2: Technical Design Evaluation Form. This form assessed the platform's instructional design features, user interface, interactivity, and media integration using a 3-level rating scale.

C. Validity-Driven Assessment of IMT Competencies and Learning Outcomes

The assessment of students' IMT skills was conducted using a performance-based evaluation rubric comprising five proficiency levels, adapted from the frameworks of Refs. [38, 39]. In addition, a comprehensive assessment approach was adopted, which included a multiple-choice objective test to measure students' academic achievement. This test played a significant role in providing a holistic view of students' performance. To ensure the validity of the IMT skills assessment, nine subject-matter experts reviewed the instrument. Content and construct validity were verified using the Index of Item-Objective Congruence (IOC) based on a three-point rating.

D. Assessing Suitability, Quality, and Impact of a Design Thinking-Based Blended Learning Platform: A Comparative Study

The researcher 1) evaluated the suitability of the platform using a focus group with nine experts, selected by the purposive sampling method, of the blended learning platform using the design thinking method for reinforcing students' information, media, and technology skills of the undergraduate students; 2) checked the quality evaluation of the contents and technique of the blended learning platform using design thinking method for reinforcing students' information, media, and technology skills of the undergraduate students; 3) compared the skill and achievement of information, media, and technology skills of the sample groups: 45 students in the experimental group who studied with the blended learning platform using design thinking method and 45 students in the control group who studied with a standard learning platform, and 4) assessed the satisfaction with the platform: the control group was 45 students who studied with the blended learning platform using design thinking method.

E. Experimental Procedure and Data Analysis

The data were analyzed by mean, standard deviation, and Interrater Reliability (IR).

The lesson plan, academic test, information, media, and technology skills test (practical test), and online courses were

developed based on the 21st-century skills for life and career subject to explore the efficiency of the blended learning platform using the innovative design thinking method for reinforcing the information, media, and technology skills of undergraduate students. The study included 15 hours of instruction, comprising 2 hours per week for 9 weeks, including pre-test and post-test sessions. The experiment was conducted in semester 1 of the academic year 2024. Details of the instructional components are presented in Table 1 and Table 2.

Table 1. Comparative analysis of traditional and blended learning methods

Aspect of Comparison	Traditional Learning	Blended Learning
Teaching Methods	Traditional teaching mostly takes place in classroom. The teacher gives lectures or demonstrates contents while students receive information through listening, taking notes, and groups activities in the classroom.	Blended teaching combines classroom lessons with online lessons. Students learn through online platforms such as videos, online media, and online activities through the internet.
Use of Technology	Technology used in traditional classroom is basic such as whiteboard, slides, projector, and textbooks.	More technology is used such as online learning platforms, educational software programs, learning application, and communication via video conference.
Flexibility	Students must attend class at specific time so it is less flexible.	Students can learn through online media in convenient time, and they can access lessons everywhere and every time. Therefore, it is more flexible.
Student Participation	Student participation takes place in classroom through discussion, group activities, and direct questions.	Students can participate lessons through online discussion, online test, and assignment submission through digital platform.
Evaluation	Evaluation is implemented through classroom tests, exercises, project assessment, and observation of classroom behaviors.	Evaluation can be done through online test, activities and exercise on online platforms, and monitor of progress through the digital system.
Support and Advice	The teacher can give advices and answer questions promptly in the classroom.	Students receive advices through online channels such as email, chat, and video conference. However, responses may take longer time than direct responses in the classroom.

Table 2. Mapping pedagogical strategies to design thinking phases in learning platform design

Design Thinking Phase	Design Thinking Phase
Empathize (Understanding Learner Needs)	A needs assessment was conducted through semi-structured interviews, focus groups, and surveys to identify key challenges related to student engagement, cognitive load, and digital literacy. Thematic analysis was performed to synthesize findings into actionable insights.
Define (Identifying Core Learning Challenges)	Data from the Empathize phase informed the articulation of problem statements, focusing on: (1) Cognitive overload in digital learning environments, (2) Lack of interactive and adaptive content, and (3) Barriers to self-regulated learning. These challenges guided the instructional design framework.
Ideate (Developing Instructional Solutions)	Based on the defined challenges, multiple pedagogical and technological interventions were explored. Key solutions included: (1) Adaptive learning pathways, (2) Gamification elements, and (3) Collaborative learning tools. Solutions were evaluated based on pedagogical effectiveness, scalability, and technological feasibility.
Prototype (Developing Learning Platform Mode	A low-fidelity prototype was developed using instructional design software, followed by iterative refinements based on expert reviews and usability testing. Key features included multimedia learning resources, interactive discussion forums, and personalized feedback mechanisms.
Test (Evaluation and Iteration)	The prototype was subjected to pilot testing with a subset of students, with feedback collected through usability metrics, engagement analytics, and post-intervention surveys. The results were analyzed to refine platform features before full-scale implementation.

To examine the effectiveness of the blended learning platform—developed using the design thinking approach—in enhancing undergraduate students' IMT skills, several instructional materials and assessment tools were utilized. These included lesson plans, an academic achievement test, a performance-based IMT skills assessment, and a set of online course modules within the 21st-century skills for life and career course [40]. This research is particularly relevant to educators, instructional designers, and scholars engaged in technology-enhanced learning and competency development.

The intervention spanned 9 weeks during the first semester of the 2024 academic year, comprising a total of 15 instructional hours (2 hours per week), including both pre-test and post-test sessions. Details of the instructional sequence and activity structure are presented in Table 1 and Table 2.

Table 3 presents the management process of a blended learning platform designed using the design thinking method to enhance students' IMT skills. The process includes five key stages: development of blended learning activities through live lectures, self-study, collaboration, assessment, and teacher facilitation; platform design focusing on online and offline learning, user engagement, and supporting technology; implementation through pretest, learning tasks, and practice-based assessment; comparison of pretest and posttest results to evaluate learning gains; and student satisfaction evaluation using structured questionnaires. Each stage is aligned with specific evaluation tools to ensure the platform's effectiveness.

Table 3. Management of the blended learning platform by using the design thinking method

Research Steps	Research Procedures	Instruments for Evaluation
1	The development of the blended learning process was analyzed through the lens of the design thinking methodology, with a focus on enhancing students' Information, Media, And Technology (IMT) skills across five key dimensions: 1. synchronous instruction via live lectures,	Lesson plan, content assessment, technical assessment, and satisfaction questionnaire

Research Steps	Research Procedures	Instruments for Evaluation
	2. self-directed learning supported by supplementary instructional materials, 3. collaborative learning through peer interaction and group tasks, 4. formative and summative assessment, and 5. the teacher's role as a learning facilitator.	
2	The management design of the blended learning system, grounded in the design thinking approach, was structured to enhance students' IMT skills across four critical dimensions: 1. online learning, focusing on flexible access to digital content and interactive resources; 2. offline learning, emphasizing experiential and contextual activities; 3. user engagement, including both learners and instructors as active participants in the learning process and 4. Technological infrastructure encompassing tools, platforms, and digital environments that support effective implementation.	Blended learning platform by using the design thinking method to reinforce information skills
3	In five steps, use the design thinking method to reinforce information skills to determine the effectiveness of the blended learning platform. 1) Students took pretest through Google Form. 2) Students used online lessons and did assignments from worksheets to design workpieces. The teacher taught both online and onsite. 3) Students and group members assessed data in groups to further develop the group's concept in making and testing workpieces by using their existing knowledge about basic information, ability to access information, ability to apply information, ability to create information creatively, ability to manage and evaluate information. These knowledge and abilities were measured and evaluated through practice.	Pretest, posttest, worksheets during lessons
4	Compare students' learning achievement and information, media and technology skills after studying with the blended learning platform by using the design thinking methods in the following steps: 1) Students took pretest and reviewed online and onsite lessons. And 2) Students took posttest to measure learning achievement.	Pretest and posttest
5	Assess students' satisfaction after studying with the blended learning platform by using the design thinking method. In this step, the students complete the assessment form on their satisfaction to the learning model.	Satisfaction questionnaire

Table 4. Model of the blended learning management

Time	Teaching/Learning Management
Week 1–2	1. The research introduced lessons and teaching/learning methods, and created an online group for the students in the computer education program at Nakhon Pathom Rajabhat University by using Learning Management System-Nakhon Pathom Rajabhat University (LMS-NPRU) in Unit 1 learning and innovation skills. 2. Students took pretest for 60 minutes. 3. The teacher taught classroom lessons and assign each student to study additional contents at home, review the lesson, and study the next lesson in advance on learning and innovation skills from online lesson that the teacher had shared in the LMS-NPRU group created by the teacher. Or students may additionally study from YouTube by searching relevant topics from textbooks or other reliable sources. In addition, students did exercises about learning and innovation skills. 4. Students were required to submit exercises before the next class session in order to have time for doing more classroom activities.
Week 3	1. The researcher asked students about online lessons that the teachers had created. The teacher asked to assess what the students learned and understood. 2. The researcher and students summarized the lesson learning and innovation skills which had been assigned in advance from online lesson and workpiece of learning and innovation skills in the classroom.
Week 4	The researcher addtionally taught about using Google Sheet, made an activity sheet about use of Sheet, distributed a manul sheet of use of Sheet concerning calculation of mean, standard deviation, maximum, minimum, and commission which the researcher had created and shared in the LMS-NPRU group for additonal study outside class.
Week 5	1. The researcher created an online group for students by using LMS-NPRU in Unit 2 introduction to artificial intelligence. 2. The researcher assigned each student to study contents in advance about introduction to artificial intelligence from online lessons that the researcher had shared in the LMS-NPRU group, and to do exercises in Unit 2 introduction to artificial intelligence.
Week 6	1. The researcher asked students about online lessons that the teachers had created in the group. The teacher asked to assess what the students learned and understood. 2. The students summarized together the lesson on learning and innovation skills which had been assigned in advance from Unit 2 introduction to artificial intelligence. 3. The researcher assigned each student to study contents about creation of online website in Google Site in advance at home from video clip that the teacher had shared in the LMS-NPRU group. The students did assignment in the activity sheet about creation of online website in Google Site. 4. The students were required to submit workpieces from the activity sheet about creation of online website in Google Site before the next class session in order to have time for doing more classroom activities.
Week 7	1. The researcher reviewed lesson on creation of online website from LMS-NPRU, assigned students to make workpieces, and gave chance for students to ask questions. 2. The researcher assigned each student to study lesson in Unit 3 creation of AI media for teaching and learning management with Canva in advance at home from online lesson that the teacher had shared in the Unit in the LMS-NPRU group, and did assignment in the activity sheet. 3. The students were required to submit assignment from the activity sheet of Unit 3 creation of AI media for teaching and learning management with Canva before the next class session.
Week 8	1. The researcher reviewed lesson of Unit 3 creation of AI media for teaching and learning management with Canva, assigned students to make workpieces, and gave chance for students to ask questions. 2. The researcher introduced lesson of Unit 4 use of applications, Chat, GPT, and Bing; and assigned each student to create workpieces that they were interested to use for teaching students at the primary education level.
Week 9	1. The researcher reviewed lesson of Unit 4 use of applications, Chat, GPT, and Bing, and gave chance for students to ask questions. 2. The students took posttest for 60 minutes.

Table 4 presents the instructional model of the blended learning platform based on the design thinking method, implemented over nine weeks. The teaching and learning management combined classroom instruction with online learning using the LMS-Nakhon Pathom Rajabhat University system. During weeks 1–2, students were introduced to the platform, took a pretest, and began studying Unit 1 on learning and innovation skills. In weeks 3–4, students

reviewed online content, completed exercises, and received additional instruction on using Google Sheets. Weeks 5–6 focused on Unit 2—an introduction to artificial intelligence—and students created online websites using Google Sites. weeks 7–8 covered Unit 3 on AI media development using Canva and introduced Unit 4 on applying tools like ChatGPT and Bing for educational purposes. Finally, in week 9, the lesson concluded with a review and posttest to measure learning outcomes.

Table 5. Use of classroom time

Lesson Type	Activity Description	Time (min)
Onsite Lesson	Introduction	5
	Review of assignment	10
	Practice and lecture of new contents	15
	Students did classroom activities as assigned by the teacher.	30
Online Lesson	Introduction	5
	Online teaching media	15
	Summary of contents	5
	Students did activities inside and outside classroom as assigned by the teacher.	30

Table 5 outlines the blended learning model's time allocation for onsite and online lessons. Each format includes key instructional components such as introduction, content delivery, activity-based learning, and summary. Onsite sessions emphasize in-class practice and review, while online sessions focus on digital media, flexible learning activities, and content reinforcement—each with a balanced total of 60 minutes to support comprehensive engagement and skill development.

F. Analysis of Learner Perception on Blended Learning for IMT Competencies

A five-point Likert scale satisfaction survey was employed to evaluate students' perceptions of the blended learning platform developed through the design thinking methodology [41]. The platform aimed to enhance undergraduate students' competencies in IMT. The survey, a comprehensive two-section document, was designed to understand the students' experiences thoroughly. Section 1) collected respondents' demographic information using a checklist format. Section 2) evaluated satisfaction with the platform across four core dimensions: instructional content, educational media, learning activities, and assessment practices.

Table 6. Assessment components and corresponding reliability and validity indicators

Assessment Component	Description	Scoring Criteria	Reliability & Validity Measures	References
Learning Achievement Test	A 30-item multiple-choice assessment, structured according to Bloom's Taxonomy's cognitive levels, was developed to evaluate students' knowledge retention, problem-solving skills, and conceptual understanding.	- 1 point per correct response - Categorized performance levels: Excellent (85–100%) Satisfactory (70–84%) Needs Improvement (<70%)	- Cronbach's Alpha = 0.78 (Acceptable internal consistency) - Content Validity Index (CVI) = 0.85, reviewed by subject-matter experts	[42, 43]
Student Satisfaction Survey	A 20-item Likert-scale instrument evaluating students' learning engagement, usability perception, and instructional effectiveness in the blended learning platform.	A five-point Likert scale was employed, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), to assess student satisfaction. The mean scores obtained from the survey were interpreted based on predefined criteria as follows: • 4.51–5.00 = Very High Satisfaction • 3.51–4.50 = High Satisfaction • 2.51–3.50 = Moderate Satisfaction • 1.51–2.50 = Low Satisfaction • 1.00–1.50 = Very Low Satisfaction - Mean scores interpreted for satisfaction levels	- The instrument demonstrated high internal consistency, with a Cronbach's alpha coefficient of 0.86. Construct validity was confirmed through Exploratory Factor Analysis (EFA), yielding a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.82 and a statistically significant result from Bartlett's Test of Sphericity (p <0.05).	[41, 44]
Suitability Evaluation (Expert Review)	A standardized rubric assessing the accuracy, instructional alignment, and usability of the blended learning model.	- 5-point rating scale evaluating key instructional design aspects	- Reviewed by a panel of instructional design experts - CVI = 0.85, ensuring strong expert agreement	[45]
Suitability Evaluation (Expert Review)	A standardized rubric assessing the accuracy, instructional alignment, and usability of the blended learning model.	- 5-point rating scale evaluating key instructional design aspects	- Reviewed by a panel of instructional design experts - CVI = 0.85, ensuring strong expert agreement	[45]
Validity Testing	Content validity verified through expert evaluation and construct validity assessed via factor analysis.	- CVI ≥0.85 for expert-reviewed content - EFA verifying latent constructs	- The KMO measure of the sampling adequacy was at 0.82, indicating a meritorious level of factorability. In addition, Bartlett's Test of Sphericity was statistically significant (p <0.05), confirming the suitability of the dataset for factor analysis.	[44, 46]

Table 6 summarizes the key assessment components used to evaluate the effectiveness of the blended learning platform. It includes tools for measuring academic achievement, student satisfaction, and instructional suitability, each supported by rigorous reliability and validity indicators. The learning achievement test is based on Bloom's Taxonomy and demonstrated acceptable internal consistency (Cronbach's α = 0.78). At the same time, the satisfaction

survey yielded high reliability ($\alpha = 0.86$) and strong construct validity through Exploratory Factor Analysis (EFA) (KMO = 0.82). Expert reviews confirmed the platform's instructional alignment, with a Content Validity Index (CVI) of 0.85 across evaluation instruments, ensuring the robustness of the assessment framework.

VI. Result and Discussion

Results from the research on development of the blended learning platform by using the design thinking method to reinforce information, media and technology skills are presented below:

A. The Blended Learning Platform by using the Design Thinking Method to Reinforce Information, Media and Technology Skills

The platform is structured around five key instructional components:

1) synchronous instruction via live lectures,
2) self-directed learning through supplemental materials,
3) collaborative learning activities,
4) formative and summative assessment, and
5) facilitation by the instructor as a learning coach.

This instructional model was synthesized based on the design thinking framework and supported by the literature [47–49], as illustrated in Fig. 2.

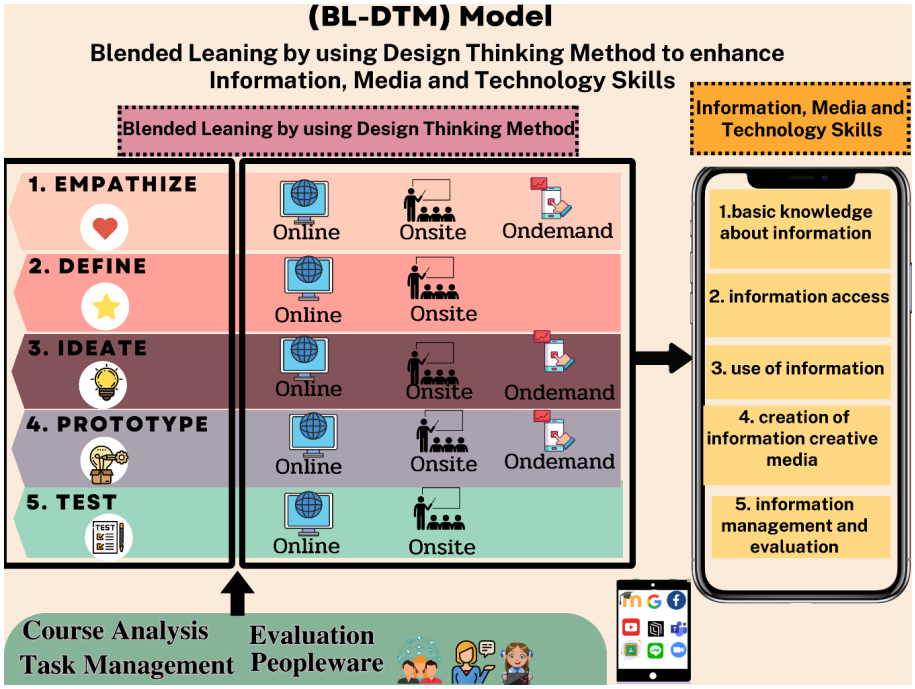

Fig. 2. Process of the blended learning platform by using the design thinking method to reinforce information, media and technology skills technology skills for the students in the computer education program.

B. Expert Evaluation of Platform Suitability

The results of the expert-validated evaluation regarding the suitability of the blended learning platform—developed through the design thinking approach to enhance IMT skills—are presented in Table 7.

Suitability evaluation results of the design thinking–based blended learning platform for enhancing undergraduate IMT skills.

Table 7 presents the results of the suitability evaluation, indicating that the overall appropriateness of the IMT skills component was rated at the highest level ($\bar{x}$ = 4.72, SD = 0.20). The suitability of the blended learning platform, which reinforces these skills through the practical application of the design thinking method, is also at the highest level ($\bar{x}$ = 4.64, SD = 0.49). Lastly, the lesson plan is at the highest level ($\bar{x}$ = 4.61, SD = 0.35).

Table 8 presents the results of the expert-based evaluation of the LMS lesson quality within the blended learning platform, which was developed using the design thinking approach to enhance undergraduate students' IMT skills. The evaluation focused explicitly on the quality of content delivered through the platform.

Table 7. Suitability evaluation results of the design thinking-based blended learning platform for enhancing undergrade IMT skills

Instructional Assessment Instruments.	The experts (n = 9)		Level of Suitability
	$\bar{x}$	SD	
Teaching and learning framework	4.61	0.35	Very High
An instructional model integrating blended learning with design thinking to foster IMT skill development among undergraduate learners.	4.64	0.49	Very High
IMT skills	4.72	0.20	Very High
Total	4.66	0.42	Very High

Table 8. Content and technical quality assessment of LMS lessons in a design thinking–based blended learning platform for IMT skill development

Assessment	$\bar{x}$	SD	Level of Appropriateness
Content quality	3.97	0.59	High
The technical quality of media development	4.08	0.62	High
Overall	4.03	0.61	High

According to Table 8, the quality assessment of the blended learning platform was conducted in two key dimensions: (1) content quality and (2) the technical quality of media development. It's important to note that the overall quality is consistently high ($\bar{x}$= 4.03, SD = 0.61), ensuring a

secure investment in the platform.

C. Descriptive Statistics of IMT Skills and Academic Achievement

The results of data analysis using basic statistics to show mean score ($\bar{x}$) and Standard Deviation (SD) of IMT skills and academic achievement (Table 9).

Fig. 3 This box plot compares the IMT skills and academic achievement of students in the experimental and control groups. It displays the median, interquartile range, and overall score distribution. The experimental group consistently exhibits higher performance across both variables, consistent with the inferential statistical results reported in the analysis.

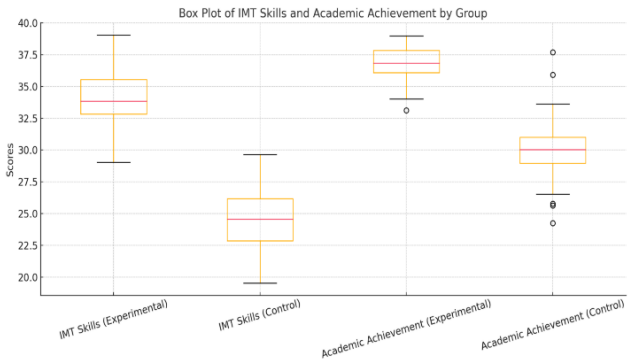

Fig. 3. Box plot of IMT skills and academic achievement by group.

Table 9. Descriptive statistics of IMT skills and academic achievement: mean scores and standard deviations

Group	n	Full score	IMT skills		Full score	Academic achievement	
			$\bar{x}$	SD		$\bar{x}$	SD
Control	30	40	24.73	2.65	40	30.13	3.07
Experiment	30	40	34.53	2.87	40	36.80	1.40

Table 9 presents the results of our data analysis, using basic statistics to illustrate the mean score ($\bar{x}$) and SD of IMT skills and academic achievement. The data showed that the IMT skills of the experimental group students were higher than those in the control group, a significant finding. The mean score of IMT skills of students in the experimental group ($\bar{x}$= 34.53, *SD* = 2.65) was higher than that of the students in the control group ($\bar{x}$ = 24.73, *SD* = 2.65). Furthermore, the academic achievement score after learning with the platform ($\bar{x}$= 36.80, *SD* = 1.40) was higher than that of the students who studied with standard learning methods ($\bar{x}$= 30.13, *SD* = 3.07).

The results of the data analysis provided empirical support for the research hypothesis, thereby reinforcing the overall validity and trustworthiness of the findings. Before performing the MANOVA, the researcher conducted assumption testing to ensure the appropriateness of the data for multivariate procedures. The outcomes of these preliminary tests are summarized in Table 10.

Table 10. Results of assumption testing for Multivariate Analysis of Variance (MANOVA)

Statistic	Assumption	Data analysis	Test results
Bartlett's Test confirmed adequate correlations among variables	Sig < ∝	0.00*	The dependent variables showed no multicollinearity, as indicated by acceptable correlation levels.
Box's M Test indicated equality of variance-covariance matrices	Sig > ∝	0.05	Equality of variance-covariance matrices was confirmed.
Data distribution by Shapiro-Wilk	Sig > ∝	0.06	The data are normally distributed and divided into 2 groups.

* p <0.05.

From Table 10, the overall result of the basic assumption test of MANOVA was examined. Firstly, the test of coefficient correlation using Bartlett's Test found that Sig < α, indicating that the variables do not exhibit multicollinearity. Secondly, the variance-covariance matrix was tested using Box's M Test, showing Sig > α, which supports the homogeneity assumption. However, the Shapiro-Wilk normality test found that Sig < α, suggesting that the data do not follow a normal distribution. This underscores the need for caution in interpreting the results and the importance of your role in the research process. Alternative methods, such as non-parametric tests, should be considered in future studies.

Table 11. Summary of intervention effect – group comparison, effect size, and confidence intervals

Outcome and Statistical Metric	Measure	Value	95% Confidence Interval (CI)	Effect Size Interpretation
IMT skills	Cohen's d	−3.55	[2.74, 4.36]	Very Large Effect [50]
	Partial Eta Squared (η^2)	0.138	[0.065, 0.138]	
	F (1, 58)	9.27	p <0.01	Large Effect [51]
Academic achievement	Cohen's d	2.80	[2.08, 3.51]	
	Partial Eta Squared (η^2)	0.178	[0.065, 0.178]	Statistically Significant
	F (1, 58)	12.54	p <0.01	

Table 11 summarizes the intervention's effectiveness by comparing the experimental and control groups. The analysis demonstrates statistically significant improvements in IMT skills and academic achievement among students in the experimental group.

Statistical analysis revealed that implementing the blended learning platform, integrated with the design thinking approach, had a statistically significant and practically meaningful effect on students' IMT skills and academic achievement. This study, conducted through the collaboration of educators, researchers, and educational technology stakeholders, demonstrated a substantial enhancement in students' IMT skills. The effect was statistically and practically significant, with a large effect size (Cohen's d = −3.55, 95% CI [2.74, 4.36]) and a corresponding partial eta squared (η^2 = 0.138), indicating that 13.8% of the variance in IMT skill development could be attributed to the intervention. Likewise, academic achievement showed a statistically significant improvement, with a large effect size (Cohen's d = 2.80, 95% CI [2.08, 3.51]) and η^2 = 0.178, reflecting the strong explanatory power of the study's conclusions. The results from the MANOVA further confirmed that both effects were statistically significant (F (1, 58) = 9.27 and 12.54, p <0.01). These findings provide strong empirical evidence of the intervention's educational significance,

supporting its application in technology-enhanced learning environments and underscoring the importance of the research. This collaborative effort underscores the value and respect we have for the field of educational technology and learning outcomes, and the importance of our collective work in advancing the field.

Table 12 summarizes the findings from the one-way MANOVA conducted to assess differences between the experimental and control groups.

Table 12. Comparative outcomes in IMT skills and academic achievement: blended learning vs. control group

Source of Variance	Statistical Test	Value	F	Sig.
GROUP	Pillai's Trace	0.166	142.465	0.000
	Wilks' Lambda	0.074	789.380	0.000
	Hotelling's Trace	4.998	142.465	0.000
	Roy's Largest Root	4.998	142.465	0.000

Table 12 reports a statistically significant difference ($p < 0.05$) in academic achievement and computational IMT skills between the experimental and control groups. This highlights the notable influence of the instructional approach on both dependent variables.

Table 13 presents the results of a post-intervention comparative analysis between the experimental and control groups for academic achievement and IMT skills.

Table 13 The analysis revealed a statistically significant difference ($p < 0.05$), showing that students in the experimental group outperformed those in the standard platform group in academic achievement and IMT skills. As the groups were independent, a paired test was not applicable. These findings indicate the experimental group's superior development of IMT competencies. The enhanced academic performance observed in the experimental group can be attributed to several pedagogical factors supported by established learning theories. BL, when integrated with DT, becomes a catalyst for active engagement, problem-solving, and iterative learning are essential components of constructivist pedagogy [52]. This underscores the potential of BL in the educational landscape.

Table 13. Post-intervention comparative analysis of academic achievement and IMT Skills: experimental vs. control group

Source	Dependent Variable	SS	df	F	Sig.	Partial Eta Squared
Corrected Model	Academic achievement	666.67	1	0	0	0.669
	IMT Skill	1440.6	1	0	0	0.765
Intercept	Academic achievement	666.67	1	117.08	0	0.669
	IMT Skill	1440.6	1	188.47	0	0.765
GROUP	Academic achievement	666.67	1	117.08	0	0.669
	IMT Skill	1440.6	1	188.47	0	0.765
Error	Academic achievement	330.27	58	-	-	0.5
	IMT Skill	443.33	58	-	-	0.5
Total	Academic achievement	996.93	59	-	-	1
	IMT Skill	1883.93	59	-	-	1
Corrected Total	Academic achievement	996.93	59	-	-	1
	IMT Skill	1883.93	59	-	-	1

R Squared = 0.668 (Adjusted R Squared = 0.668)
R Squared = 0.764 (Adjusted R Squared = 0.764)

One of the primary advantages of BL is its self-directed nature. This unique feature empowers students to review instructional materials at their own pace, thereby reducing cognitive overload and enhancing comprehension [53].

Peer interaction and iterative feedback, fundamental to DT, also contribute to higher engagement and deeper knowledge retention [54]. Empirical research demonstrates that structured problem-based learning enhances critical thinking, creativity, and knowledge application, aligning with this study's objectives.

Table 13 summarizes the results of student satisfaction with the blended learning platform, which was developed through the design thinking approach to enhance IMT skills.

Table 14 presents the student satisfaction survey results regarding the blended learning platform developed using the design thinking method to enhance IMT skills.

Table 14. Student satisfaction with the blended learning platform designed to enhance IMT skills through the design thinking method

Aspects	Students (n = 30)		Level of Satisfaction
	$\bar{x}$	S	
Learning management model	4.75	0.43	Highest
Instructional activities	4.88	0.33	Highest
Digital learning tools and content sources	4.75	0.43	Highest
Measurement and evaluation	4.88	0.33	Highest
Overall	4.82	0.38	Highest

The analysis revealed that students reported a very high level of overall satisfaction with the blended learning platform developed using the design thinking approach to enhance IMT skills ($\bar{x}$ = 4.82, SD = 0.38). The highest satisfaction was expressed in the areas of instructional activities ($\bar{x}$ = 4.88, SD = 0.33) and measurement and evaluation, followed by the instructional model and the use of digital learning tools and content sources ($\bar{x}$ = 4.75, SD = 0.43). These results indicate that the platform effectively addressed learner needs and expectations, particularly in terms of engagement and instructional design.

VII. Discussion

Evaluating the effectiveness and quality of a blended learning platform based on design thinking for the development of IMT skills in computer education.

A. Evaluation of Platform Effectiveness

The expert panel consistently provided high evaluations across all platform dimensions. The overall instructional quality achieved a mean score of 4.66 (SD = 0.42), with strong performance in content clarity (M = 4.68) and technical robustness (M = 4.54). These findings reflect the platform's pedagogical soundness and technical reliability, which are essential for maintaining learner engagement in blended settings.

B. Quality of LMS Content

The LMS-delivered instructional materials were perceived as effective, yielding a mean rating of 4.03 (SD = 0.61). Content relevance and technical usability met expert expectations, suggesting that the materials were appropriately structured to facilitate autonomous and guided learning processes.

C. Learning Outcomes Comparison

Quantitative analysis of post-test scores indicated

statistically significant gains in IMT skills and academic achievement among students who engaged with the blended learning platform designed using design thinking principles. The experimental group demonstrated higher average scores in IMT skills (34.53 vs. 24.73) and academic performance (36.80 vs. 30.13) compared to their peers, with results reaching statistical significance ($p < 0.01$). These findings reflect the platform's effectiveness in enhancing student learning outcomes.

D. Effect Size Interpretation

The analysis revealed large effect sizes corresponding to the observed improvements. For IMT skills, the intervention produced a Cohen's d of −3.55 with a 95% CI [2.74, 4.36] and a partial eta squared (η^2) of 0.138. Academic achievement showed similarly strong effects, with a Cohen's d of 2.80, 95% CI [2.08, 3.51], and $\eta^2 = 0.178$. These values indicate robust and educationally meaningful impacts of the blended learning platform on student outcomes.

E. Verification of Statistical Assumptions

Preliminary assumption testing confirmed the appropriateness of applying MANOVA. Bartlett's Test of Sphericity indicated sufficient inter-variable correlation ($p < 0.05$), while Box's M Test supported the equality of covariance matrices ($p > 0.05$). Although Shapiro-Wilk tests revealed minor deviations from normality, the robustness of MANOVA in moderately non-normal conditions [44] validated its use.

F. Learner Satisfaction Analysis

Student feedback demonstrated high satisfaction levels with the platform, with an average score of 4.82 ($SD = 0.38$). The most highly rated aspects included the interactive nature of the learning activities and the clarity and structure of assessment components, key factors in perceived learning quality.

G. Pedagogical and Practical Implications

The findings offer compelling evidence that integrating design thinking into blended learning environments significantly supports the development of core 21st-century competencies, particularly critical thinking, problem-solving, and collaboration. This pedagogical approach is consistent with current educational frameworks emphasizing active, student-centered learning. Recent research has also highlighted the role of design thinking in increasing student engagement and cultivating higher-order cognitive skills in tertiary education settings [55]. Applying blended learning strategies has also improved academic performance and learner satisfaction [56]. Moreover, combining challenge-based learning with design thinking has effectively promoted problem-solving skills and interdisciplinary collaboration among students [57]. These insights suggest that the model offers flexibility and adaptability, making it transferable across various educational contexts and scalable for broader implementation.

VIII. Conclusion

BL and DT are innovative teaching methods that improve student engagement, problem-solving, and critical thinking skills. Research shows that using DT in teacher education enhances teaching effectiveness in digital learning. In science education, DT helps students think more flexibly and engage deeply with learning. Additionally, combining DT with challenge-based learning fosters creativity and real-world problem-solving skills. BL and DT are increasingly integrated into educational practices to enhance student engagement and innovation. Research indicates that combining BL with DT fosters creativity and practical experience among teacher students, promoting their development as innovators. Additionally, the adoption of digital learning, which merges digital technology with student learning, is gaining popularity, offering more flexible and effective educational experiences. These trends highlight a shift towards more interactive and technology-enhanced learning environments.

BL and DT help students develop problem-solving and creativity skills. Research shows that these methods improve learning outcomes, especially in engineering and teacher training BL and DT also make learning more engaging and adaptable to real-world challenges. By integrating these approaches into educational policies, schools can enhance teaching quality and better prepare students for the future.

The improved academic performance in the experimental group can be attributed to the integration of blended learning and design thinking, which supports active engagement, collaborative problem-solving, and iterative reflection. These principles are not just innovative but also aligned with constructivist and experiential learning theories, instilling confidence in the effectiveness of this approach. It encourages students to take ownership of their learning through real-world tasks, continuous feedback, and meaningful interaction, resulting in deeper understanding and enhanced skill development. The self-paced and flexible structure of blended learning supports self-regulated learning and reduces cognitive overload. Furthermore, the collaborative and feedback-rich nature of design thinking strengthens motivation, knowledge retention, and higher-order thinking. These findings align with previous studies emphasizing the effectiveness of problem-based learning in enhancing critical thinking and creativity.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

CA and KA contributed significantly and equally to this research. CA conceptualized and designed the research framework, developed the blended learning platform based on the design thinking approach, conducted the experiments, performed detailed statistical analyses, coordinated the research process, prepared the manuscript for submission to the journal, and submitted the research article until it was published; KA collected data, conducted the experiments, performed statistical analyses, and systematically interpreted the research results; The two authors worked closely together by reviewing relevant literature, co-writing the initial manuscript, and editing the academic content to ensure that it was comprehensive and of high academic quality; all authors had approved the final version.

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REFERENCES

[1] Office of the Education Council, *The National Scheme of Education B.E. (2017–2036)*, Ministry of Education, Thailand, 2017.

[2] V. Panich, *Creating a 21st Century Learning Skills*, 3rd ed., Bangkok: The Siam Commercial Foundation, 2016.

[3] B. Thornhill-Miller, A. Camarda, M. Mercier, J.-M. Burkhardt, T. Morisseau, S. Bourgeois-Bougrine, F. Vinchon, S. Hayek, M. Augereau-Landais, F. Mourey, C. Feybesse, D. Sundquist, and T. Lubart, "Creativity, critical thinking, communication, and collaboration: Assessment, certification, and promotion of 21st century skills for the future of work and education," *Journal of Intelligence*, vol. 11, no. 3, 54. doi: https://doi.org/10.3390/jintelligence11030054

[4] Partnership for 21st Century Skills. (2009). *P21 Framework Definitions*. [Online]. Available: https://files.eric.ed.gov

[5] UNESCO. (2008). Towards information literacy indicators: Conceptual framework paper. [Online]. Available: http://www.uis.unesco.org/Library/Documents/wp08_InfoLit_en.pdf

[6] Ministry of Education. (2016). Prime Minister meets teacher friend "Happy to the teacher. Teacher happy to students. *From Policy to Practice. Challenger Hall 1, IMPACT Muang Thong Thani: Office of Educational Development*. [Online]. Available: https://rukkroo.com/5214/

[7] Ministry of Education, *Learning Standards and Indicators for Mathematics and Science Learning Strands and Geography in Social Studies*, 2017.

[8] C. Aumgri and S. Petsangsri, "Computational thinking for preservice teachers in Thailand: A confirmatory factor analysis," *J. Educ. Espacios*, vol. 40, no. 29, pp. 12–25, 2019.

[9] C. Aumgri, "The effectiveness of an online learning platform in collaboration with virtual technology using a digital ecosystem to develop information, media and technology skills of undergraduate students," *Int. J. Innov. Creat. Change*, vol. 13, no. 12, pp. 880–895, 2020.

[10] Office of the Higher Education Commission. (May 2015). Current Thai education policies and reform. *APEC Education Network Meeting, Boracay, the Philippines*. [Online]. Available: https://mddb.apec.org/Documents/2015/HRDWG/EDNET/15_hrdwg_ednet_043.pdf

[11] C. Thummanon, "The effects of blended learning on the engagement levels of undergraduate students," *J. Educ., Naresuan Univ.*, vol. 23, no. 2, pp. 140–151, 2021.

[12] R. Phetsaengsri, "Review article: Blended learning and its applications," *J. Ind. Educ.*, vol. 11, no. 1, pp. 1–5, 2012.

[13] P. Wannapirun, "Blended learning: From concept to practice," *J. Voc. Tech. Educ.*, vol. 1, no. 2, pp. 43–49, 2011.

[14] R. Rattanawongsa and P. Koraneekij, "A development of blended information literacy learning web for Thai high school students," *Procedia - Social and Behavioral Sciences*, vol. 174, pp. 2693–2699, 2015. doi: 10.1016/j.sbspro.2015.01.954

[15] P. Suwannatthachote and A. Theeraroungchaisri, *Blended Learning: Strategies for a Connected and Active Classroom (Handout)*, Bangkok: Chulalongkorn Univ., 2018. (in Thai)

[16] E. Allen and J. Seaman. (2005). Growing by degrees, online education in the United States, 2005. *The Sloan Consortium*. [Online]. Available: http://sloanconsortium.org/publications/survey/growing_by_degrees_2005

[17] C. Latchem and I. Jung, *Distance and Blended Learning*, New York: Routledge, 2010.

[18] K. Thorne, *Blended Learning: How to Integrate Online and Traditional Learning*, London: Kogan, 2003.

[19] A. P. Sari, F. Y. Siregar, and D. A. Harahap, "Extrinsic motivation of nursing students during blended learning method." *J. Keperawatan Priority*, vol. 6, no. 2, pp. 128–134, 2023.

[20] H. Plattner. (2019). An introduction to design thinking: Process guide. [Online]. Available: https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf

[21] Hasso Plattner Institute of Design at Stanford. (2018). The bootcamp bootleg. [Online]. Available: https://dschool.sfo3.digitaloceanspaces.com/documents/dschool_bootleg_deck_2018_final_sm2-6.pdf

[22] N. Losomboon, T. Ruangsuwan, P. Sangsawang, and K. Boonyamanee, "A systematic literature review on design thinking processes in education systems towards innovation in art teaching," *J. Educ. Stud., Burapha Univ.*, vol. 31, no. 2, pp. 1–11, 2020.

[23] K. Kwansakun, "Integrating learning management with design thinking process to develop media innovation for the 'otop nawatwithi' community tourism project in ban wang yao," *J. Educ., Prince of Songkla Univ. Pattani Campus*, vol. 32, no. 1, pp. 164–184, 2020.

[24] UK Design Council. (2017). Designers across disciplines share strikingly similar approaches to the creative process, which we've mapped out as 'the Double Diamond'. [Online]. Available: http://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond

[25] W. Banjong, "Little designers: Promoting creativity through creative art experiences with the design thinking process," *J. Educ.*, Chulalongkorn Univ., vol. 46, no. 2, pp. 330–347, 2018.

[26] S. Wongphairin and B. Chaisuwan, "Design thinking process through video content using storytelling techniques of the Facebook fan page minutevideos Thailand," *J. Commun. Arts*, vol. 2, no. 37, pp. 86–99, 2018.

[27] K. Apirating and C. Aumgri, "The development of blended learning by using the design thinking method," *Turk. J. Comput. Math. Educ.*, vol. 13, no. 2, 12530, 2022.

[28] P. Phaupan, C. Viriyavejakul, and P. Pimdee, "Digital literacy skills of students in public higher education institutes," in *Proc. The Asian Conf. on Technology in the Classroom*, 2015.

[29] E. Avdiu, E. Bekteshi, and B. Gollopeni, "Learning skills for the future—implementing the 21st-century learning," *Multidisciplinary Science Journal*, vol. 7, no.1, e2025011, 2024.

[30] Office of the Education Council, *Guidelines for the Development of Learners' Competency for Learners at the Basic Education Level*, 1st ed., Bangkok: OEC, 2020, pp. 1–57.

[31] W. Trilek, P. Piriyasurawong, and N. Jeerungsuwan, "Collaborative project–based learning via augmented reality on m-learning model to enhance basic ASEAN community skills for Thai and the Lao PDR students," *International Journal of Information and Education Technology*, vol. 6, no. 10, pp. 813–816, 2016.

[32] N. Wannapiroon and P. Pimdee, "STEAM creative thinking and innovation skill development," *Educ. Inf. Technol.*, vol. 27, pp. 5689–5716, 2022.

[33] V. Panic, *Ways to Foster Learning for Students in the 21st Century*, Bangkok: Sodsri-Saritwong Foundation, 2012.

[34] C. Aumgri and K. Apirating, "Digital storytelling media online via gamification model to promote digital literacy skills," *Turk. J. Comput. Math. Educ.*, vol. 13, no. 2, pp. 143–150, 2022.

[35] Y. Geng, P.-S. Huang, and Y.-M. Huang, "Crowdsourcing in nursing education," *Sustainability*, vol. 13, no. 6, 3413, 2021.

[36] B. Chauveau, C. Auclair, A. Legrand, R. Mangione, L. Gerbaud, F. Vendittelli, L. Boyer, and D. Lémery, "Is the conventional ultrasound speed of 1540 m/s appropriate for examinations of obese patients? The POWUS study of pregnant women," *Ultrasound Obstet. Gynecol.*, vol. 48, pp. 36–37, 2016.

[37] K. Harandian, S. Bacon, I. Archambault, L. Correale, L. Pagani, S. El Hayek, M. Augereau-Landais, and F. Mourey, "Early socio-emotional difficulty as a childhood barrier to the expected benefits of active play: Associated risks for school engagement in adolescence," *Int. J. Environ. Res. Public Health*, vol. 21, no. 10, 1353, 2024. doi: https://doi.org/10.3390/ijerph21101353

[38] P. Somsak, *Principles of Educational Measurement and Evaluation*, Chulalongkorn Univ. Press, 2001. (in Thai)

[39] A. J. Nitko, *Educational Assessment of Students*, 4th ed., Pearson, 2004.

[40] R. Chen, "Effects of deliberate practice on blended learning sustainability," *Sustainability*, vol. 14, no. 3, 1785, 2022.

[41] R. Likert, "The method of constructing and attitude scale," *Attitude Theory and Measurement*, Wiley, 1967, pp. 90–95.

[42] L. W. Anderson and D. R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing*, New York: Longman, 2001.

[43] D. F. Polit and C. T. Beck, *Essentials of Nursing Research*, 6th ed., Philadelphia, PA: Lippincott Williams & Wilkins, 2006.

[44] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, *Multivariate Data Analysis*, 8th ed., U.K.: Cengage Learning, 2018.

[45] A. Morrison, L.-I. Rigney, R. Hattam, and A. Diplock, *Toward an Australian Culturally Responsive Pedagogy*, Univ. South Australia, 2019.
[46] D. F. Polit and C. T. Beck, *Essentials of Nursing Research*, 6th ed., Lippincott Williams & Wilkins, 2006.
[47] M. J. Finlay, A. B. Smith, and C. D. Johnson, *Understanding Modern Trends in Education*, Academic Press, 2022.
[48] C. Muller and T. Mildenberger, "Facilitating flexible learning by replacing classroom time with an online learning environment," *Educ. Res. Rev*., vol. 34, 100394, 2021.
[49] F. Raharjo, T. J. Raharjo, and I. M. S. W. Sudana, "Blended learning and its impact on learning performance," *Turk. J. Comput. Math. Educ*., vol. 12, no. 6, pp. 4287–4292, 2021.
[50] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed., USA: Lawrence Erlbaum Associates, 1988.
[51] J. T. E. Richardson, "Eta squared and partial eta squared as measures of effect size," *Educ. Res. Rev*., vol. 6, no. 2, pp. 135–147, 2011.
[52] D. H. Jonassen, "Designing constructivist learning environments," in *Instructional Design Theories and Models: A New Paradigm of Instructional Theory*, C. M. Reigeluth (Ed.), vol. 2, Lawrence Erlbaum Associates, 1999, pp. 215–239.
[53] D. R. Garrison and N. D. Vaughan, *Blended Learning in Higher Education*, Jossey-Bass, 2008.
[54] C. E. Hmelo-Silver, "Problem-based learning: What and how do students learn?" *Educ. Psychol. Rev*., vol. 16, no. 3, pp. 235–266, 2004.
[55] I. J. Fitriyah, S. Saputro, and Sajidan, "Research trends in design thinking education," *Eur. J. Educ. Res*., vol. 14, no. 2, pp. 381–391, 2025.
[56] X. M. Vo, C. Do-Hong, T. H. L. Do, T. M. T. Ha, and C. T. Vu, "An examination of blended learning in higher education," *Eur. J. Educ. Res*., vol. 13, no. 4, pp. 1821–1840, 2024.
[57] M. P. Gomez, R. P. Lopez, and L. C. Martinez, "Challenge-based learning and design thinking in higher education," *Innov. Educ. Teach. Int*., vol. 61, no. 3, pp. 317–328, 2024.

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