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Blended FORCE Model: Advancing Collaborative, Cloud-Based Learning in System Design Courses

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This study introduced the FORCE Learning Model, a blended learning approach for a 'System Analysis and Design' course at a Thai university in 2022, using cloud-based collaborative learning to enhance engagement and outcomes. Employing a mixed-methods research design, the study utilized semi-structured interviews, surveys, and skill assessments, achieving inter-rater reliability of 0.79 and test reliability of 0.74. Data analysis included mean, standard deviations (SD), and t-tests. The results revealed three key findings: (1) identification of six major challenges in course management, including issues with content delivery, student engagement, and assessment methods; (2) development of the FORCE model with five distinct steps—Face-to-face, Online, Rotation activities, Collaborative learning, and Evaluation—demonstrating high process and outcome efficiencies above 81%; and (3) statistically significant improvements in students' team learning skills and academic performance, with gains observed at a 0.01 significance level. These findings emphasize the model’s potential in addressing educational challenges and fostering academic success.

Keywords: blended learning, collaborative learning, system analysis, system design, undergraduate students, Thailand

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INTRODUCTION

The 21st century is marked by the emergence of a knowledge-driven society, encouraging the integration of Information Communications Technology (ICT) within traditional teaching methods. This shift has led to innovative pedagogies like Blended Learning (BL), which optimizes the learning experience by strategically combining traditional and technological approaches. According to Hrastinski (2019), BL leverages online technology alongside classroom instruction, enabling an effective and efficient knowledge transfer to learners. Siripongdee et al. (2021) further support this by highlighting how BL offers a comprehensive learning experience that surpasses traditional lectures alone by combining face-to-face teaching with online resources and smartphones.

Another indispensable advancement in modern educational environments is cloud computing (CC). Cloud computing has redefined how educational institutions manage and deliver learning experiences. As Marinescu (2022) noted, CC platforms offer a structured and flexible foundation for various academic activities. Additionally, research by Saxena and Singh (2024) illustrates how CC integrates machine learning with cloud infrastructure, enabling sustainable resource management in educational institutions. This combination of cloud computing and blended learning significantly improves operational efficiency, as evidenced by Badawy Fathelbab Mohammed (2023), who explored cloud-based technologies' impact on student engagement and resource allocation.

Complementing BL and CC, computational thinking (CT) has emerged as a vital framework for modern education. CT introduces systematic problem-solving methodologies like decomposition, abstraction, and pattern recognition, which are essential in developing 21st-century skills (Brennan & Resnick, 2012). Wing (2006) first proposed CT as a universal skill comparable to reading and writing, emphasizing its applicability beyond computer science. CT provides a foundation for learners to interact meaningfully with digital tools, enhancing their adaptability in technology-rich environments (Sun et al., 2024). In the context of BL, CT fosters a structured approach to learning, enabling students to conceptualize complex problems and design solutions collaboratively.

Artificial intelligence (AI) further amplifies the capabilities of BL and CC. AI's ability to personalize learning pathways, automate assessments, and provide real-time analytics has redefined education. Luckin (2017) suggests that AI-powered systems enable adaptive learning by tailoring content to individual learner profiles. Moreover, Zawacki-Richter et al. (2019) found that AI integration in BL environments enhances collaboration and resource accessibility, particularly in resource-constrained regions. These tools offer dynamic feedback mechanisms and advanced analytical capabilities, promoting active learning and self-regulation.

However, adopting CT and AI in BL frameworks introduces challenges. Ethical concerns, such as data privacy and algorithmic bias, pose significant barriers (Selwyn, 2019). Additionally, the digital divide and limited technical proficiency among educators hinder widespread adoption. Addressing these issues requires targeted interventions, including teacher training and the development of open-source AI tools to ensure inclusivity (Williamson et al., 2020).

Collaborative learning (CL) within BL and CC environments further transforms educational approaches. CL emphasizes constructing knowledge through teamwork, encouraging students to explore their interests collaboratively (Lenkauskaitė et al., 2020). Sidgi (2022) demonstrates that collaborative activities promote interaction, critical discussion, and co-creation, enriching the learning process. Jirasatjanukul et al. (2023) underscore that this method fosters a culture of acceptance where learners value diverse perspectives.

Historically, education was limited to face-to-face settings, where direct interactions occurred between students and teachers. However, the advent of distance learning extended education beyond physical boundaries, laying the groundwork for blended learning. Al-Qatawneh et al. (2020) argue that this evolution allowed learners to gain knowledge without needing direct interaction, setting the stage for the strategic fusion of in-person and online instruction. This transition and Web 2.0 developments enabled BL to become a dynamic and flexible educational model (Bizami et al., 2023; Cao, 2023; Yu et al., 2022). Bonk and Graham (2012) suggest that this fusion of modalities supports personalized educational experiences, effectively reducing in-class time and increasing opportunities for active learning beyond the traditional classroom.

Blended learning also emphasizes personalized learning opportunities through online platforms, allowing educators to present course material, conduct assessments (Aroonsiwagool, 2024), and foster interactive learning environments. Siripongdee et al. (2021) found that this integration increases student engagement and improves learning outcomes. Numerous studies, such as those by McCutcheon et al. (2018) and Hill et al. (2017), further highlight BL's effectiveness in enhancing students' attitudes, satisfaction, and motivation. Such findings establish BL as a key driver in fostering student achievement across various disciplines.

Despite its many advantages, BL's effectiveness can vary based on instructional design and contextual factors. For instance, Berga et al. (2021) and Chang et al. (2014) noted conflicting evidence about BL's impact, suggesting variations in instructional strategies and learner autonomy may influence results. Olitsky and Cosgrove (2014) highlighted that specific blends of online and offline activities must align with learners' needs for optimal results. Nevertheless, BL consistently outperforms traditional teaching in fostering academic achievements and supporting skill development, particularly in communication, critical thinking, and reasoning (Monteiro & Morrison, 2014; Shorey et al., 2018).

In conclusion, the strategic integration of computational thinking and artificial intelligence within blended learning models—supported by cloud computing—represents a paradigm shift in education (Govea et al., 2023; Qiu, 2024). These advancements collectively foster a scalable, inclusive, and personalized learning environment, equipping students with the skills needed for lifelong learning. As evidenced by the gaps identified during Phases 1 and 2 in students' preparedness for the 'System Analysis and Design' course, an integrated approach incorporating CT, BL and future AI applications (Mutawa & Sruthi, 2025), can effectively address challenges like limited teamwork and analytical problem-solving skills.

The blended learning model developed in this study incorporates collaborative learning facilitated by cloud computing, offering a flexible and scalable solution for undergraduate business administration students at Rajabhat Rajanagarindra University. This model supports continuous knowledge acquisition, collaboration, and sustainable, lifelong learning by leveraging modern learning technologies. Therefore, the authors propose the following research objectives (ROs) and research hypotheses (RH):

RO1: To develop an effective blended learning model based on collaborative learning through cloud computing.

RO2: To study the effects of using the blended learning model through collaborative learning via cloud computing.

RH1: Students' team learning skills and academic performance in '*System Analysis and Design'* will be significantly higher after using the FORCE Learning Model compared to before.

METHOD

This study employed a mixed-methods research approach, integrating qualitative and quantitative paradigms to comprehensively investigate the effectiveness of the FORCE Learning Model. By combining qualitative insights with quantitative measurements, the research aimed to provide both depth and breadth in understanding the learning model's impact.

Stage 1: Exploration and Development

Step 1: Study of Current Learning Management Conditions/Problems

Participants

The study involved three instructors with at least three years of experience teaching the 'System Analysis and Design' course and 30 undergraduate students who had completed the course. Participants were drawn from the Faculty of Management Science at Rajabhat Rajanagarindra University in the 2022 academic year.

Data Collection

Semi-structured interviews and student opinion surveys were used to gather qualitative data on the current state and challenges of learning management. These methods provided in-depth insights into participants' experiences and identified critical issues.

Data Analysis

Qualitative data were analyzed using content analysis and synthesis techniques, focusing on recurring themes and significant issues.

Step 2: Development and Quality Evaluation

Participants

Seven experts, purposively selected, contributed to this phase, including specialists in educational technology, curriculum development, and assessment.

Data Collection

A 5-point Likert scale tool with 30 items across five aspects (learning objectives, content, processes, media, and evaluation) was used for expert evaluation. The Index of Congruency (IOC) for items ranged from 0.60 to 1.00. Feedback was collected during a focus group discussion via Zoom and analyzed for mean ($\bar{X}$) and standard deviation (SD).

Stage 2: Implementation and Evaluation

Participants

Thirty undergraduate students enrolled in the 'System Analysis and Design' course in 2022 were selected using cluster random sampling.

Team Learning Skills Assessment

A rubric-based tool with nine criteria, scored on a 4-point scale, was used to evaluate team learning skills. The tool achieved an IOC of 0.60 to 1.00 and an inter-rater reliability score of 0.79.

Learning Achievement Test

A 30-item multiple-choice test was developed, aligning with Bloom's revised taxonomy. The test covered recall, understanding, and application, with reliability (KR-20) at 0.74.

Data Collection

The FORCE Learning Model was implemented over six weeks, with 180-minute sessions weekly. Pre- and post-intervention measurements of team learning skills and academic achievement were conducted.

Data Analysis

Quantitative data were analyzed using t-tests for dependent samples to evaluate changes in learning outcomes. This provided a positivistic perspective, complementing the interpretative depth from qualitative methods.

Integration of Methods

The qualitative findings informed the model's design, while quantitative data validated its effectiveness. This mixed-methods approach ensured a holistic understanding of the FORCE Learning Model's impact.

FINDINGS

The study revealed critical insights into learning management conditions and problems, integrating both qualitative and quantitative data to ensure a comprehensive understanding.

Learning Management Conditions and Problems

Qualitative Insights

Through semi-structured interviews with instructors and surveys of students, the research identified several challenges:

- **Course Content**: While systematic teaching frameworks were in place, the extensive lesson content limited classroom activities, reducing engagement.
- **Student Engagement**: Observations and participant feedback highlighted issues such as distractions from social media and insufficient preparation for lessons.
- **Instructor Support**: Interviews revealed that while instructors provided substantial guidance, they often lacked sufficient time for detailed student consultations.
- **Learning Environment**: Infrastructure challenges, including inadequate WiFi and crowded classrooms, hindered effective learning.

These qualitative findings provided depth in understanding the specific issues faced by students and instructors, forming the basis for developing the FORCE Learning Model.

Quantitative Results

The quantitative phase of the study involved pre- and post-intervention assessments using t-tests for dependent samples, confirming statistically significant improvements in learning outcomes:

- **Learning Outcomes Measurement**: The overall mean score of 3.74 indicated favorable perceptions of the learning management system. The highest-rated areas, such as student engagement (mean = 3.81), highlighted critical areas needing improvement.
- **Model Efficiency**: The E1 (process efficiency) and E2 (outcome efficiency) scores exceeded 80%, demonstrating the FORCE Learning Model’s effectiveness.

FORCE Learning Model Effectiveness Results

Quantitative analysis further validated the model’s success, showing significant gains in teamwork skills and academic performance. Post-intervention, students' scores in team learning skills increased from a mean of 17.60 to 24.76 ($p < .01$), while academic performance improved from a mean of 14.26 to 24.43 ($p < .01$). These results underline the blended model's potential to address educational challenges effectively.

The FORCE Learning Model Development and Efficiency Results

The FORCE Learning Model was designed around five steps. These included Face-to-face learning (F), Online content learning (O), Rotation activities (R), Collaborative learning (C), and Evaluation (E) (Figure 1). Table 1 details the FORCE Learning Model's five-step activities.

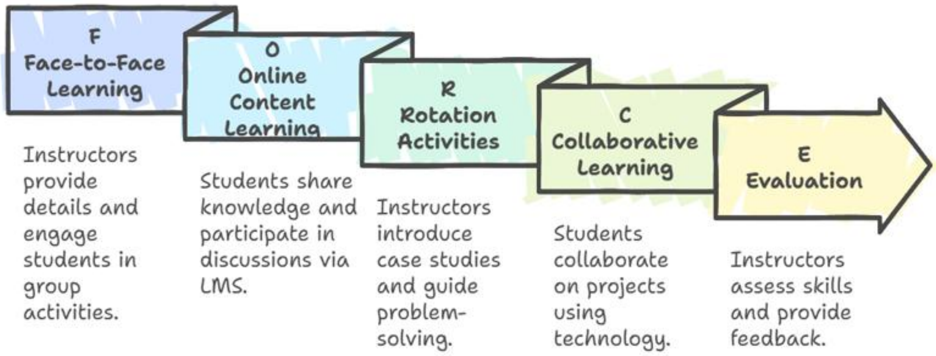

Figure 1
FORCE learning model sequence
Source: The authors.

Table 1
FORCE learning model activities

F - Face to Face (50 minutes)
Instructors provide details and learning steps.
Instructors encourage students to engage in group activities.
Learners study lesson materials from different learning sources.
Learners explore additional lesson-related resources.
Leaners explain and compare information gathered through research.
O - Online Content (50 minutes)
Instructors conduct activities to motivate students through essential lesson content.
Instructors allow students to share and exchange previous knowledge with classmates.
Instructors engage in discussions via an LMS (Learning Management System).
Learners participate in reviewing and reinforcing understanding.
Learners participate in stimulating collaborative learning activities.
R - Rotation (50 minutes)
Instructors introduce problems using case studies.
Instructors set discussion points based on the presented questions or problems.
Instructors involve students in summarizing through rotational activities.
Instructors provide consultation and guidance on solving the problem.
Learners divide into groups and assign roles.
Learners design project plans based on research findings.
C - Collaboration (50 minutes)
Instructors set evaluation criteria for group work.
Instructors form groups of 5-10 students and assign topics based on questions.
Instructors promote the use of technology in communication and collaboration.
Learners exchange ideas and summarize discussion points.
Learners apply acquired knowledge to plan and execute projects.
E - Evaluation (40 minutes)
Instructors assess students’ skills in presenting their work.
Instructors address gaps and provide feedback for improvement.
Learners participate in post-learning achievement tests.

The FORCE Model Effectiveness Results

The data presented in Tables 2 and 3 underscore the effectiveness of the blended learning model that incorporates collaborative learning through cloud processing. After participating in this instructional approach, the results demonstrate a statistically significant improvement in students' teamwork skills and academic performance in system analysis and design.

The efficiency of the blended FORCE Learning Model was assessed using the E1/E2 framework, a systematic approach prevalent in Thai educational research. E1 (Process Efficiency) evaluates engagement and performance during the learning phase, while E2 (Outcome Efficiency) measures improvements post-instruction (Leekhot et al., 2024). Both metrics exceeded the 80% benchmark, highlighting the model's success in fostering active participation and measurable academic gains (Pipattanasuk & Songsriwittaya, 2020). This underscores the significance of data-driven instructional methods in achieving modern educational objectives, particularly in enhancing teamwork and collaboration skills vital for students' professional futures.

The average scores increased from 16.46 (82.33% using a total score of 20) during the learning phase to 24.43 (81.43% using a total score of 30) after the course, reflecting a positive student learning outcome trend (Tamrongkunanan & Tanitteerapan, 2020). The significance of these findings ($p < .01$) indicates that the collaborative cloud-based learning method fosters improved individual academic achievement and enhances essential skills like teamwork, which are crucial in modern educational and professional contexts.

This study contributes to the ongoing discourse on innovative teaching methods, highlighting the role of technology in facilitating effective learning experiences. Demonstrating measurable advancements in students' capabilities reinforces the relevance of integrating blended learning strategies in contemporary curricula, ultimately preparing students for the collaborative demands of their future careers.

Table 2
The efficiency of the blended FORCE Learning Model using collaborative cloud-based learning

Activity	Students (n=30)		Percentage	Criteria
	Full Score	Average		
During Learning	20	16.46	82.33 (E1)	80 (E1)
After Learning	30	24.43	81.43 (E2)	80 (E2)

Table 3 shows how students exhibited enhanced teamwork skills and academic performance in analyzing and designing systems after learning through the blended model, showing significant statistical improvement compared to before learning at the .01 level.

Table 3
Comparison of team learning skills and academic achievement of students before and after learning and studying with the FORCE Learning Model

Team Learning Skills	Students	Full Score	Mean	SD	t-test	Sig.
Before FORCE course	30	30	17.60	1.52	-20.14**	.00
After FORCE course			24.76	1.88		
Academic Achievement						
Before FORCE course		30	14.26	4.76	-15.80**	.00
After FORCE course			24.43	2.09		

Note: **Sig.<.01

DISCUSSION

Multifaceted challenges across six domains characterize the current learning management environment. These include course content, student engagement, instructor effectiveness, support systems, learning environments, and assessment practices. Students have expressed significant concerns about the overall management of their learning experiences, rating it at a high level. This highlights an urgent need for educators and institutions to critically evaluate and reform their approaches to enhance student satisfaction and learning outcomes.

In response to these challenges, the FORCE Learning Model has emerged as an innovative framework for blended learning, comprising five key components: face-to-face interactions, online content delivery, rotational learning activities, collaborative engagements, and thorough evaluations. This model has demonstrated high effectiveness, with process efficiency (E1) and outcome efficiency (E2) scores of 82.16 and 81.11, respectively, indicating its adherence to established benchmarks. As highlighted by Zitha et al. (2023), collaborative learning strategies significantly enhance student engagement and performance, particularly in diverse and heterogeneous educational contexts. Their findings emphasized that implementing collaborative approaches—such as group projects, role-playing, and peer feedback—can significantly improve mastery of critical concepts and foster an engaging learning environment. These insights align well with the core elements of the FORCE Learning Model.

Statistical analyses reveal that students exhibit a marked improvement in team-based learning skills and academic performance in system analysis and design following the implementation of the FORCE Learning Model. These improvements are significant at the .01 level, reinforcing the effectiveness of collaborative blended learning approaches in fostering student success. Such methodologies facilitate knowledge acquisition and promote an engaging and interactive learning atmosphere. McKinsey & Company (2022) found that higher-education institutions can increase engagement by utilizing technologies that promote community building and collaboration, such as virtual study groups and discussion platforms. Al-Samarraie and Seed (2018) and Nantha et al. (2024) supported this and reported that online collaborative learning activities significantly support cloud computing processes. This underscores the FORCE Learning Model's approach, which combines collaborative engagements with technological tools to create a more interactive and supportive learning experience.

The structured learning process of the FORCE Learning Model begins with face-to-face instruction, establishing a foundational understanding before transitioning to more complex learning experiences. This initial phase prepares students for subsequent online learning and collaborative activities, facilitating a seamless educational journey. Spencer (2022) confirmed the value of self-paced, student-centered learning environments in boosting motivation and achievement in middle school mathematics. The self-paced component in the FORCE Learning Model caters to diverse learning preferences and enhances knowledge retention, making it adaptable to different educational levels and contexts.

Incorporating rotational learning further diversifies instructional methods, accommodating various learning styles within a rich and varied curriculum. The collaborative phase encourages students to develop critical thinking skills and actively participate in discussions, strengthening their understanding of the material and fostering a community of inquiry. McKinsey's (2022) study showed that technologies supporting group work and real-time interaction saw the highest uptake and positive impacts on learning. This aligns with the rotational and collaborative components of the FORCE Learning Model, which emphasizes varied, tech-enabled engagements to foster deeper learning.

The evaluation component of the FORCE Learning Model ensures continuous feedback and assessment, guiding students toward ongoing improvement in their learning processes. Mekonen and Fitiavana (2021) argued for a shift from traditional, judgmental assessment approaches to more authentic assessment methods prioritizing continuous feedback and learning enhancement. The FORCE Learning Model embraces this paradigm shift, providing ongoing evaluations to ensure student progress and development.

Integrating the FORCE Learning Model into the educational framework provides a dynamic and practical approach to learning. Zitha et al. (2023) also highlighted that innovative designs promoting collaboration and using individual talents improve participation and communication skills, which are integral to the FORCE Learning Model. By combining online and face-to-face components, the model enriches the learning environment, enhances student engagement, and facilitates deeper learning experiences.

CONCLUSION

In conclusion, the current learning management issues span six critical areas: course content, student dynamics, instructor effectiveness, support systems, learning environments, and assessment methods. Students' perceptions indicate significant concerns about these areas, necessitating a comprehensive review of pedagogical practices.

The FORCE Learning Model has effectively addressed these challenges and achieved high process and outcome efficiency levels. Its structured approach significantly enhances students' teamwork abilities and academic performance, particularly in system analysis and design, demonstrating its effectiveness in facilitating improved educational outcomes.

As educational institutions move through modern learning environments and complexities, adopting innovative frameworks like the FORCE Learning Model will foster student success and prepare them for future challenges.

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