THE DEVELOPMENT OF INSTRUCTIONAL MEDIA IN BOARD GAME TO ENHANCE THE CAPABILITY OF CRITICAL AND COLLABORATIVE SKILLS IN IT STUDENTS OF SOUTHEAST BANGKOK UNIVERSITY

Thitikorn Suthiapa[1], Verathian Khianmeesuk[2], Nantarat Klinhom[3] and Chariya Sricharoon[4]

Department of Multimedia and e-Sports,
Faculty of Digital Technology and Innovation, Southeast Bangkok University [1,3]
Skywalker Club Company, Chachoengsao, Thailand [2]
Department of Business Administration Program in Digital Marketing,
Faculty of Account and Management Science, Southeast Bangkok University [4]
Corresponding author email: : thitikorn@sbu.southeast.ac.th [1]*, v.khianmeesuk@hotmail.com [2],
nantarat@sbu.southeast.ac.th [3], chariya@sbu.southeast.ac.th [4]

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Abstract

The rapid advancement of technology necessitates innovative educational approaches, especially in IT education. This study has the following objectives: 1) to design and develop an instructional board game aligning with Thai IT undergraduate curriculum and learning outcomes; 2) to assess its effectiveness in enhancing critical thinking, problem-solving, and collaborative skills; and 3) to evaluate both student and educator perceptions of board games as a practical, engaging tool in IT learning. The board game simulates real-world IT project management scenarios grounded in constructivist learning theory to foster problem-solving, strategic planning, collaboration, and decision-making skills. The population comprised Thai IT undergraduate students, with a sample of 159 participants selected through random sampling. The research tools included the developed board game, as well as pre-game and post-game surveys that assessed critical skills. Statistical analysis and participant feedback were used to evaluate the game's effectiveness. Results indicated significant improvements in critical thinking, problem-solving, and collaboration skills, aligning with the research objectives. The study concludes that board games are effective instructional media for enhancing essential skills in IT education and recommends their integration into curricula to prepare students for industry challenges.

Keywords: Game-Based Learning, IT Education, Board Games, Thai Undergraduate Students, Critical Thinking, Problem-Solving, Collaborative Learning.

Introduction

The fourth industrial revolution has accelerated the convergence of cloud computing, artificial intelligence, and ubiquitous connectivity, fundamentally reshaping how information is produced, shared, and applied in the workplace. Contemporary Information Technology (IT) graduates are therefore expected to enter the labour market with a robust mix of hard skills—coding, systems integration, data analytics—and an equally important repertoire of soft skills, including critical thinking, problem-solving, collaboration, and strategic decision-making. Traditional lecture-centric instruction frequently struggles to nurture these higher-order competencies because students remain passive recipients of content rather than active constructors of knowledge [1]. In response, educators worldwide have started to embed elements of game-based learning (GBL) into their courses, harnessing the motivational power of play to deepen engagement and improve learning outcomes [2]–[4].

GBL differs from simple "edutainment" in that it integrates specific learning objectives with game mechanics that reward inquiry, experimentation, and reflection. Meta-analytic evidence shows that well-designed games promote sustained attention, encourage iterative trial-and-error, and stimulate the kinds of cognitive conflict that lead to conceptual change [5]. However, merely adding points or badges to existing lessons (i.e., surface-level gamification) is insufficient; the game environment must support meaningful decisions, provide timely feedback, and align with curricular standards to be educationally effective [6], [7].

Among the wide spectrum of serious games, analogue board games occupy a distinctive niche. Their physical components—cards, tokens, boards—invite tactile manipulation and face-to-face negotiation, fostering social presence and collective sense-making in ways that purely digital games sometimes overlook [8], [9]. Research across STEM and business disciplines demonstrates that board games can improve retention of complex content, stimulate higher-order thinking, and cultivate teamwork by obliging players to explain strategies, bargain for resources, and cope with uncertainty [10], [11].

Thailand’s fast-growing digital economy adds further impetus to adopt innovative pedagogies. National foresight reports anticipate an acute demand for graduates who can collaborate across disciplines, innovate under time pressure, and communicate findings to diverse stakeholders [12]. Yet, employer surveys routinely note skill gaps in critical thinking and creative problem-solving among new entrants to the Thai IT sector. The Ministry of Digital Economy and Society, therefore, urges universities to complement technical syllabi with experiential activities that mirror industry practice.

Schrader emphasises that serious games create safe spaces for risk-taking, allowing learners to test hypotheses and witness the consequences without real-world penalties [13]. Girard et al. further report moderate-to-large effect sizes for serious games on analytical reasoning across STEM fields, provided that debriefing sessions explicitly connect game events to theoretical principles [14]. Adipat and colleagues extend these findings to South-East Asian contexts, highlighting that culturally contextualised games heighten relevance and motivation among Thai undergraduates [15]. Meanwhile, Tsekleves et al.

outline design guidelines—including iterative prototyping, stakeholder co-creation, and alignment with accreditation criteria—that inform the present study's methodology [16].

Hebert notes that board-game challenges calibrated at the "zone of proximal development" optimise cognitive load, keeping learners productively stretched but not overwhelmed [17]. Nakano corroborates this in IT classrooms, showing that scenarios requiring resource prioritisation, bug-fixing, and sprint planning significantly elevate students' critical-thinking scores compared with problem sets alone [18]. Parallel Thai studies document positive shifts in digital literacy, creativity, and learner satisfaction when board games supplement lecture content [19], [20]. Specifically, Buranasinvattanakul's work on Thai-language textbook development and Prommas's and Damprasit's studies in grammar instruction confirm that tabletop games can be adapted to diverse domains while preserving academic rigour [20]–[22].

Building on these insights, the present research sets out to design and evaluate an instructional board game that simulates real-world IT project management. The game challenges participants to allocate resources, negotiate milestones, and mitigate emergent risks while tracking budget and stakeholder satisfaction.

Research objectives

1. To design and develop a board game as instructional media that aligns with Thai IT undergraduate students' curriculum and learning outcomes.

2. To assess the effectiveness of the board game in enhancing students' critical thinking, problem-solving abilities, and collaboration skills.

3. To evaluate the perceptions of both students and educators on using board games as a practical and engaging tool for improving learning experiences in IT education.

Methodology

1. Research Instruments

This study employed two primary instruments. First, an instructional board game was created through an iterative design process—prototyping, playtesting, and continuous refinement—following guidelines from Fullerton [11] and Brathwaite and Schreiber [10]. The game's mechanics simulate real-world IT project management, targeting strategic planning, resource management, problem-solving, and teamwork under time and budget constraints. Second, a comprehensive survey captured participant perceptions at three intervals (pre-game, during-game, post-game). The survey combined a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) with open-ended questions, allowing both quantitative assessment of confidence, engagement, and satisfaction and qualitative insights into user experience. All questionnaires were administered electronically via Google Forms to ensure efficient distribution and data integrity.

2. Population and Sample

The target population comprised Thai undergraduate students majoring in Information Technology. Employing simple random sampling, 159 participants were selected to ensure representativeness. Demographic data (age, gender) and prior board-game experience were collected in the pre-game section, establishing a baseline for subsequent analyses of skill development. This sample size balances statistical power for inferential tests with practical feasibility for hands-on game sessions.

3. Research Procedure

The study proceeded through five interrelated stages to ensure rigorous development and validation of the instructional board game:

3.1 Conceptual Design and Prototype Development

Building on constructivist theory and industry-informed learning outcomes, an initial game blueprint was drafted, detailing core mechanics (resource allocation, sprint negotiation, risk mitigation) and component specifications (cards, tokens, board layout). Low-fidelity prototypes were fabricated using cardboard and laser-cut acrylic to permit rapid modification. Each design iteration incorporated feedback from the research team and aligned with learning objectives in strategic planning, problem-solving, and teamwork.

3.2 Structured Playtesting Phases

Three sequential playtesting rounds provided progressively deeper validation:

Phase I (Student Review): Five randomly selected IT undergraduates engaged in think-aloud sessions while playing the alpha prototype; observers recorded usability issues, rule ambiguities, and engagement metrics.

Phase II (Faculty Evaluation): IT instructors mapped game scenarios to curriculum learning outcomes, assessing content accuracy and pedagogical alignment.

Phase III (Expert Appraisal): Three professional game designers assessed the near-final version for balance, replay value, and user experience.

Each phase generated detailed reports on mechanics, clarity, and educational relevance, driving iterative refinements.

3.3 Pilot Study Implementation

A pilot deployment with a subset of 30 participants tested the refined game under authentic classroom conditions. Researchers conducted systematic observations—using interaction logs and video recordings—to evaluate collaborative behaviors and problem-solving interactions, while pilot survey results were examined for item reliability and clarity.

3.4 Main Data Collection

Following pilot adjustments, the full study engaged 1 5 9 participants. Surveys were administered at three points: pre-game (demographics, baseline self-efficacy), during-game (complexity, rule clarity, engagement, collaboration), and post-game (satisfaction, perceived skill gains). Pre- and post-surveys

were delivered via Google Forms; in-game feedback was captured on paper immediately after each session. All data collection complied with PDPA requirements.

3.5 Data Integration and Validation

Quantitative and qualitative data streams were merged using joint displays, allowing side-by-side comparison of statistical trends with thematic insights. Data cleaning included anonymization, and consistency checks before inferential analyses, ensuring robust triangulation of findings.

4. Statistical Techniques

Quantitative data were analyzed using:

- Descriptive Statistics: Summarized demographics and mean ratings for each survey item.
- Inferential Statistics:

1) ANOVA was used to test for differences in satisfaction and skill gains across levels of prior board-game experience.

2) Chi-square examined associations between gender and satisfaction.

3. Pearson correlation assessed the relationship between perceived game complexity and reported improvements in critical thinking and problem-solving.

- Qualitative Data Analysis: Thematic analysis of open-ended responses identified recurring themes (e.g., tactile engagement, communication enhancement) that enriched and contextualized the numerical results.

Results

1. Design and Baseline Alignment

A total of 159 Thai IT undergraduates participated, confirming the target demographic for which the game was intended.

Table 1 Demographic Overview

Demographic Category	Sub-Category	Percentage (%)
Gender	Male	Pass (82%)
	Female	Pass (18%)
Age	18-24	98.0%
	Above 24	2.0%
Board Game Experience	Less than 1 year	67.3%
	1-3 years	22.6%
	More than 3 years	10.1%

Table 1 presents the demographic profile of the 159 Thai IT undergraduates who participated in this study. The gender distribution skews male (82.0%) relative to female (18.0%), while the age ranges cluster overwhelmingly between 18 and 24 years (98.0%), with only 2.0% being older than 24. Prior exposure to board games varied: 67.3% of respondents reported having less than one year of experience, 22.6% had engaged in board gaming for between one and three years, and 10.1% had exceeded three years. These figures establish that the cohort consists primarily of young, novice players, thereby reducing potential confounding from advanced gaming expertise and ensuring that subsequent skill gains can be attributed to the instructional intervention. Moreover, the representativeness of this sample relative to typical IT undergraduate populations supports the external validity and generalizability of our findings, confirming the game's alignment with its intended curricular context.

2. Effectiveness in Enhancing Critical Thinking, Problem-Solving, and Collaboration

Participants' self-efficacy, engagement, and perceived learning gains were measured before, during, and after gameplay.

Table 2 Pre-Game Feedback

Pre-Game Expectation Category	Question	Mean Rating (1-5)
Confidence in Critical Thinking	"How confident are you in your critical thinking skills?"	3.2
Confidence in Problem-Solving	"How confident are you in solving IT-related problems?"	3.5
Confidence in Collaboration	"How confident are you in working collaboratively with a team?"	3.7
Expectation of Game Complexity	"What level of complexity do you expect from the game?"	3.8

Table 2 indicates moderate baseline confidence in critical thinking (3.2) and higher confidence in collaboration (3.7), with participants anticipating a balanced level of complexity (3.8). These pre-game metrics guided calibration of game scenarios to challenge cognitive skills without overwhelming novices [17].

Table 3 During-Game Feedback

During-Game Feedback Category	Question	Percentage of Positive Responses (%)
Game Complexity	"Did you find the game appropriately complex?"	56.0%
Clarity of Rules	"Were the rules of the game clear and easy to understand?"	52.8%
Engagement	"Did you find the game engaging and relevant to IT-related tasks?"	61.7%
Collaboration with Teammates	"How well did you collaborate with your teammates?"	68.4%

Table 3 shows that a majority found the complexity suitable (56.0 %) and the gameplay engaging (61.7 %), while teamwork rated highest (68.4 %), confirming that the mechanics effectively fostered collaboration. The lower rule-clarity score (52.8 %) highlights an opportunity for augmenting instructional aids in future iterations.

Table 4 Post-Game Reflections

During-Game Feedback Category	Question	Percentage of Positive Responses (%)
Overall Satisfaction	"How satisfied are you with your overall experience of the game?"	64.7%
Improvement in Critical Thinking	"Did the game help improve your critical thinking skills?"	57.1%
Engagement	"Did the game help improve your problem-solving skills?"	61.5%
Improvement in Problem-Solving	"Did the game help improve your collaboration and teamwork skills?"	70.2%

Table 4 reveals that 64.7 % of participants were satisfied overall, with notable gains in collaboration (70.2 %) and problem-solving (61.5 %), and moderate gains in critical thinking (57.1 %). These post-game reflections validate the game's efficacy in nurturing its target competencies.

Inferential Analyses, A one-way ANOVA detected no significant difference in satisfaction across experience levels ($p > 0.05$), and a chi-square test found no gender effect on satisfaction ($p > 0.05$), underscoring inclusivity. Pearson’s correlation ($r = 0.68$) demonstrated a strong positive relationship

between perceived complexity and improvements in critical thinking and problem-solving, confirming that higher cognitive challenge drives greater skill development.

3. Perceptions of Board Games as Instructional Tools

Open-ended feedback enriched the quantitative findings. Participants praised the tactile components and the necessity of peer negotiation for reinforcing technical concepts, noting increased confidence in articulating strategies. Educators highlighted the value of structured debriefings in linking gameplay events to IT theory, deepening student reflection. Suggested refinements included adding advanced scenarios for experienced players and streamlining session length to sustain focus. Collectively, these perceptions affirm that the board game serves as a practical, engaging medium for enhancing IT-education experiences in alignment with curricular goals.

Conclusion and Discussion

The study demonstrates that the board game effectively enhanced critical thinking, problem-solving, and collaboration skills among Thai IT undergraduate students. The positive reception across participants with varying levels of prior experience underscores the game's accessibility and potential as an educational tool.

1. Enhancing Essential Skills

The significant improvements reported in critical skills align with existing literature on game-based learning's effectiveness [5]. The game's design successfully simulated real-world IT scenarios, providing practical experiences that traditional methods may lack. Similar findings by Hebert [17] indicate that board games offer a dynamic platform for students to engage deeply with content, fostering a more profound understanding and retention of complex IT concepts. Nakano [18] also emphasizes the role of interactive tools in developing critical thinking skills, reinforcing the notion that experiential learning methods like board games can bridge the gap between theoretical knowledge and practical application.

2. Accessibility and Engagement

The lack of significant differences based on prior experience indicates that the game is suitable for a diverse student population. This inclusivity is crucial for educational tools aiming to reach a broad audience. Cornelissen [9] highlights that board games can cater to various skill levels, making them effective for both novice and experienced learners. Additionally, the high levels of engagement reported by participants are consistent with findings from Hussaini et al. [2], who observed increased motivation and participation in game-based learning environments compared to traditional instructional methods.

3. Complexity and Skill Development

The positive correlation between perceived complexity and skill improvement suggests that appropriately challenging games can enhance learning outcomes. This finding supports the emphasis on meaningful challenges in educational game design [11]. Fullerton [11] advocates for designing games that balance complexity to keep students engaged while promoting cognitive development. Moreover,

Mendez [7] discusses how challenging game mechanics can lead to desirable difficulties, fostering resilience and adaptive problem-solving skills among learners.

4. Recommendations for Future Research

Future studies could explore the long-term impacts of board game-based learning on academic performance and professional readiness. Incorporating objective assessments alongside self-reported measures would provide a more comprehensive evaluation of skill development. Expanding the sample size and including diverse educational settings can enhance the generalizability of the findings. Additionally, adjustments to game complexity and duration, based on participant feedback, could further optimize the learning experience. Exploring the integration of digital elements with traditional board games might also offer hybrid approaches that leverage the strengths of both mediums. More focus on critical thinking results is recommended since this study focused on the initial phase of development on participants opinions and satisfactions on their critical thinking development based on the boardgame.

Recommendations

1. Foster Curricular Integration and Instructor Support. Encourage embedding the board game within core IT modules—such as project management and software engineering—to reinforce theoretical content through hands-on simulation. Complement this integration with brief faculty development sessions that equip instructors to facilitate gameplay effectively and guide reflective debriefings.

2. Implement Adaptive Complexity. Introduce optional scenario tiers or expansion modules that modulate difficulty according to learners' experience levels. This modular approach allows instructors to tailor sessions for novices and advanced students alike, ensuring that cognitive challenge remains motivating without becoming discouraging.

3. Explore Blended and Collaborative Networks. Pilot digital companion tools—such as mobile apps for real-time feedback or progress tracking—to create a hybrid analog-digital experience. Simultaneously, establish an informal community of practice where educators can exchange game variants, facilitation tips, and student reflections, fostering shared innovation and sustainable adoption.

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