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Balancing Digital Scaffolding and Peer Interaction: A Quasi-Experimental Study on QR Code-Supported Board Games in Accounting Education

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Abstract

This study investigates whether Quick Response (QR) code-supported board games can effectively integrate digital scaffolding with peer interaction in introductory accounting education. Following the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) framework, a QR-enhanced accounting board game was developed and implemented in a first-year accounting course at a technological university in Taiwan. A quasi-experimental design was employed, with 38 students assigned to the QR-supported board game condition and 34 students participating in a conventional board game condition without QR assistance. Learning performance was evaluated across four core accounting competencies: financial statement calculation, journal entry preparation, account classification, and trial balance preparation. Although the experimental group achieved a higher mean total score than the control group, the difference was not statistically significant. Nevertheless, the experimental group significantly outperformed the control group in account classification, with the strongest advantage observed among students without a business-related academic background. This finding indicates that QR codes can function as effective digital scaffolds by helping novice learners connect business transactions with journal entries and account characteristics. By contrast, the control group performed significantly better in journal entry preparation, suggesting that this foundational competency remains highly dependent on peer explanation, instructor guidance, and repeated practice. Questionnaire responses and qualitative evidence further revealed a tension between digital support and social interaction. While QR codes facilitated timely access to hints, self-assessment, error correction, and review materials, students in the control group reported stronger teamwork, face-to-face communication, and overall learning experiences. These findings indicate that QR-supported board games should complement rather than replace interpersonal learning. Accordingly, QR resources should be designed to stimulate discussion, collective error analysis, and conceptual reflection, particularly for students with limited prior knowledge, while preserving the collaborative depth of board game-based learning.

Keywords: Analysis, design, development, implementation, and evaluation model, Quick response code, Game-based learning, Accounting education, Learning performance, Student engagement.

1 | Introduction

1.1 | Research Motivation

Introductory accounting is commonly taught through instructor-led lectures, worked examples, and repetitive exercises designed to reinforce accounting rules and procedures. Although these methods are effective for

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conveying foundational knowledge, they often encourage students to approach accounting as a sequence of isolated calculations rather than as an integrated information system. This problem is particularly pronounced among novice learners, who may be able to apply debit–credit rules mechanically while remaining uncertain about how business events are translated into journal entries, classified into accounts, summarized in a trial balance, and ultimately reported in financial statements. Such fragmentation can limit conceptual understanding and make it difficult for students to transfer procedural knowledge across accounting tasks. The problem is further complicated in multidisciplinary classrooms, where students frequently enter with markedly different levels of prior exposure. Learners from business-oriented educational backgrounds may already be familiar with commercial terminology and basic accounting procedures, whereas students from engineering or other non-business fields may encounter these concepts for the first time. In the absence of immediate feedback and differentiated instructional support, less-prepared students may repeatedly apply incorrect procedures, experience excessive cognitive demand, and gradually disengage from classroom activities. This has increased interest in experiential and student-centered pedagogies that situate accounting knowledge within active problem-solving contexts. The review conducted by Gittings et al. [1] indicates that case-based activities, simulations, and educational games can facilitate professional knowledge construction by involving students directly in contextualized tasks. Krom [2] likewise demonstrated that game-based simulation can improve engagement, conceptual comprehension, and learner interaction in introductory accounting. These findings underscore the value of instructional environments that combine authentic tasks, collaborative reasoning, and timely formative support.

Physical board games offer a particularly relevant format for operationalizing experiential learning in accounting. Their structured rules, tangible materials, simulated business events, and face-to-face interaction enable abstract accounting procedures to be represented as observable and sequential activities. Rather than studying journal entries, account categories, trial balances, and financial statements as separate topics, students can encounter them as interdependent components of a simulated accounting cycle. The shared nature of gameplay also creates opportunities for explanation, negotiation, and collective decision-making, thereby making students' reasoning visible to peers and instructors. Wisnantiasri et al. [3], for instance, designed an accounting board game that integrated entrepreneurial scenarios with financial statement preparation, allowing students to connect accounting data with the business activities from which those data originated. Nevertheless, the pedagogical value of board games is not guaranteed by the game format alone. Accounting tasks are cumulative and procedurally demanding, and an overly elaborate game may divert attention from the intended learning objectives. Excessive rules, lengthy task sequences, or ambiguous procedures can increase processing demands and reduce instructional efficiency. Accordingly, accounting board games must be designed with careful attention to the balance among realism, cognitive accessibility, operational simplicity, feedback availability, and classroom manageability.

The incorporation of Quick Response (QR) codes provides a practical means of introducing digital scaffolding into this physical learning environment. Because QR codes can be embedded directly into cards, worksheets, and game boards, they offer immediate access to task-specific explanations, procedural hints, worked examples, corrective feedback, and review materials without disrupting the flow of the activity. During transaction analysis or account classification, students can consult these resources at the point of difficulty rather than waiting for teacher assistance or continuing with an incorrect procedure. Such support may strengthen self-monitoring, facilitate error diagnosis, and reduce the uncertainty experienced by students with limited prior knowledge. In this sense, the learning environment becomes hybrid: physical interaction provides the experiential structure, while digital resources supply contingent support during task completion. However, this integration also creates a potential tension between individual assistance and collaborative learning. When QR codes are treated primarily as answer-retrieval mechanisms, students may bypass discussion and move directly to private verification. As a result, the explanatory dialogue, peer negotiation, and joint correction processes that constitute much of the educational value of board games may be weakened. The critical design question is therefore not whether QR codes provide useful information, but

whether they can be configured to support reasoning without displacing the interpersonal processes through which students develop and articulate accounting understanding.

Despite the expanding literature on active learning and educational technology in accounting, the specific combination of physical board games and QR-based scaffolding remains underexamined. Existing studies have tended to investigate simulations, case-based instruction, gamified activities, or student satisfaction as separate lines of inquiry. Comparatively little empirical work has assessed whether QR-supported board games generate measurable learning advantages over board games alone, whether their effects differ across accounting competencies, and whether students' prior educational backgrounds condition those effects. Moreover, the possible trade-off between digital support and peer interaction has received limited attention. To address these limitations, the present study developed a QR-enhanced accounting board game for use in a first-year introductory course and compared it with a parallel board-game condition without QR support. The investigation combines objective achievement measures, engagement-related evidence, and subgroup analysis based on students' prior academic backgrounds. Through this design, the study evaluates whether QR-based scaffolding can improve task-specific accounting performance, particularly among students with weaker prior preparation, while preserving the collaborative interaction that gives board game-based learning its distinctive pedagogical value.

1.2 | Research Objectives

This study employed the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) instructional design framework to develop a QR code-enhanced accounting board game and evaluated its instructional effects through a quasi-experimental design. The intervention was implemented in a first-year introductory accounting course and compared with a conventional board game-based learning condition that did not include QR support. The investigation focused on both cognitive and behavioral dimensions of learning, namely, students' accounting performance and their engagement in the learning process. More specifically, the study examined two central pedagogical concerns: whether QR-based digital scaffolding can support learners with limited prior accounting knowledge in mastering procedural content, and whether the integration of QR codes alters the nature and quality of peer interaction within a collaborative board game environment.

The first objective was to determine whether QR code-supported board games produced different learning outcomes from conventional board games. Student performance was assessed across several fundamental accounting competencies, including the calculation of assets, liabilities, and equity, the preparation of journal entries, account classification, and trial balance construction. By examining these task-specific outcomes, the study sought to identify not only whether QR support improved overall achievement but also whether its instructional benefits were concentrated in particular stages of the accounting cycle.

The second objective was to evaluate the influence of QR-based support on students' learning engagement. Engagement was examined through multiple dimensions, including Self-Directed Learning (SDL), group cooperation, perceived understanding of accounting knowledge, acceptance of the instructional approach, and overall evaluation of the learning experience. This analysis was intended to clarify whether digital scaffolding strengthened students' autonomy and access to timely support or, conversely, reduced the depth of face-to-face discussion, shared reasoning, and cooperative participation.

The third objective was to investigate whether students' prior educational backgrounds moderated the effectiveness of the intervention. Comparisons were therefore conducted between students with business-related backgrounds and those from non-business disciplines in terms of both learning performance and engagement. This subgroup analysis was designed to determine whether QR-supported board games offer particular advantages for students with weaker prior preparation and to generate evidence for differentiated instructional design in heterogeneous introductory accounting classrooms.

1.3 | Research Scope and Limitations

The empirical investigation was conducted with first-year students enrolled in an introductory accounting course at a technological university in Taiwan. Because the study was implemented in two intact classes, a quasi-experimental design was adopted rather than individual random assignment. One class received accounting board game instruction augmented with QR code-based support, whereas the other completed an equivalent board game intervention without QR assistance. This setting is particularly relevant to Taiwanese technical and vocational higher education, where programs such as Industrial Engineering and Management commonly enroll students from diverse academic pathways. Consequently, learners within the same course may differ substantially in their prior exposure to business concepts and accounting procedures. Such heterogeneity constitutes an important contextual condition because variation in prior knowledge may shape students' ability to interpret transaction scenarios, participate in group activities, use digital scaffolds effectively, and achieve the intended learning outcomes.

The findings should nevertheless be interpreted in light of several methodological constraints. First, the use of intact classes prevented random allocation and therefore limited the study's capacity to isolate the effect of the QR-supported intervention from other potentially influential factors, including baseline accounting knowledge, learning motivation, classroom climate, patterns of peer interaction, and differences in teacher or teaching-assistant support. Second, the sample was restricted to a single course at one technological university, which constrains the external validity of the results. The observed effects may not transfer directly to general universities, accounting-major programs, other disciplinary contexts, or more advanced accounting courses. In addition, the study captured outcomes within a specific instructional period and did not examine the durability of learning gains over time. Future research should therefore employ larger, multi-institutional samples, longer intervention periods, pretest–post-test or longitudinal designs, and more systematic comparisons of alternative QR code functions, such as explanatory prompts, error-diagnosis tasks, discussion triggers, and adaptive feedback. Such extensions would provide more robust evidence regarding the sustained effectiveness, boundary conditions, and broader transferability of QR code-supported board game instruction in accounting education.

2 | Literature Review

2.1 | Game-Based Learning in Accounting Education

Accounting instruction requires students to master abstract concepts alongside tightly sequenced and rule-governed procedures. When teaching is dominated by decontextualized examples and repetitive exercises, learners may approach the subject as a set of journal-entry templates and computational rules rather than as an integrated system for representing economic events. This procedural fragmentation is particularly problematic for novice students, who may be able to reproduce individual accounting steps but remain unable to explain how business transactions are analyzed, translated into journal entries, classified into accounts, and ultimately summarized in financial statements. The growing emphasis on more authentic and participatory learning environments reflects an effort to address this disconnect. Experiential learning activities provide a particularly relevant pedagogical foundation because they situate accounting knowledge within tasks that require action, interpretation, interaction, and reflection. In their systematic review of university accounting education research published between 1993 and 2018, Gittings et al. [1] identified case-based activities, real-world projects, physical simulations, computer-assisted simulations, and educational games as prominent forms of experiential learning. These approaches enable students to engage with accounting knowledge through concrete problem situations rather than through passive reception alone. Apostolou et al. [4] similarly identified curriculum innovation, educational technology, and student learning experience as central themes in contemporary accounting education research, indicating a broader shift from content transmission toward pedagogies oriented to competency development and active knowledge construction.

Within this broader experiential orientation, simulation- and game-based approaches are especially relevant for introductory accounting because they allow learners to observe the consequences of accounting decisions within simplified but meaningful business contexts. Marriott [5], for example, incorporated computerized business simulations and spreadsheet-based models into accounting instruction and found that these tools helped students understand the role of accounting information in managerial decision-making while also improving their attitudes toward learning and their comprehension of course content. Krom [2] likewise demonstrated that a simulation game in introductory managerial accounting enabled students to recognize the relationships among resource allocation, cost behavior, and organizational outcomes, thereby strengthening engagement, conceptual understanding, and interaction with both peers and instructors. More recently, Rossouw and Steenkamp [6] developed an active learning intervention for first-year accounting students that combined flipped instruction, individual and collaborative tasks, simulations, and structured feedback. Their findings suggest that such integrated learning designs can contribute to the development of critical thinking. Taken together, these studies show that accounting education can move beyond routine procedural practice when learners are required to interpret situations, make decisions, discuss alternatives, and reflect on the consequences of their actions.

Physical board games represent a distinctive form of experiential learning because they combine explicit rules, tangible materials, simulated business events, and direct interpersonal interaction within a format that is generally feasible to implement in the classroom. Compared with fully digital games or computer-based simulations, board games make learning processes more visible and provide repeated opportunities for students to explain decisions, negotiate interpretations, and correct errors collectively. These characteristics are particularly appropriate for introductory accounting, where students must understand the sequential links among transaction analysis, journal-entry preparation, account classification, trial balance construction, and financial statement preparation. Wisnantiasri et al. [3] developed an accounting board game that embedded transaction processing and financial statement preparation within entrepreneurial scenarios, allowing students to relate accounting figures to the business activities that generated them. At the same time, their study highlighted an important design constraint: because accounting procedures are inherently cumulative and complex, excessive game rules or lengthy task sequences can increase cognitive demand, create confusion, and reduce classroom efficiency. The educational value of an accounting board game therefore depends not only on its realism or entertainment value, but also on whether its structure is sufficiently clear, economical, and aligned with the intended learning outcomes.

The effectiveness of board game-based accounting instruction is consequently contingent on several interacting design and learner-related factors, including rule complexity, students' prior knowledge, the duration of the activity, the composition of learning groups, and the availability of timely formative feedback. These issues are particularly salient in heterogeneous introductory courses, where students may come from business, mechanical engineering, electrical engineering, or other disciplinary backgrounds and therefore possess substantially different levels of familiarity with accounting language, commercial contexts, and procedural conventions. In such settings, board game participation and peer discussion alone may not be sufficient for learners with limited prior knowledge. Students may complete tasks without recognizing procedural errors or may depend disproportionately on more knowledgeable peers. Integrating structured instructional support into the game environment—such as targeted hints, verification mechanisms, worked examples, and immediate feedback—therefore represents an important direction for improving the pedagogical quality of accounting board games. Such support can help preserve the experiential and collaborative benefits of gameplay while reducing the risk that less-prepared students become cognitively overloaded or excluded from meaningful participation.

2.2 | Quick Response Code-Supported Instructional Applications

QR codes have become an established component of mobile, blended, and technology-enhanced learning because they provide a simple and inexpensive mechanism for linking physical instructional materials to digital content. When embedded in textbooks, worksheets, laboratory guides, or classroom artefacts, QR codes

enable students to access multimedia explanations, task instructions, supplementary activities, and extended learning resources through smartphones or tablets [7], [8]. Their educational use has been documented across a broad range of domains, including STEM education, engineering laboratories, healthcare training, language learning, mathematics, psychomotor skill development, and formative assessment [8–10]. Latif et al. [7], for example, showed that QR codes can support blended mobile learning by providing immediate access to instructional guidance, videos, and task-based resources. Abdul Rabu et al. [11] further reported that perceived ease of use and enjoyment influence students' acceptance of QR-based learning and may contribute to higher levels of classroom participation. The incorporation of QR codes into game-based learning is therefore consistent with the broader convergence of mobile learning, gamification, and context-sensitive instruction. Tsoukala et al. [10] observed that QR codes are frequently combined with gamified, outdoor, informal, and mobile learning activities in STEM contexts, where they can strengthen situational engagement and facilitate access to relevant resources. Collectively, this literature indicates that QR codes can operate as connective devices between physical learning tasks, digital information, and immediate instructional support.

Integrating QR codes into physical board games may extend the pedagogical affordances of game-based instruction beyond those available through tangible materials alone. When attached to task cards, game boards, or procedural checkpoints, QR codes can provide learners with just-in-time instructions, strategic hints, corrective feedback, worked examples, and extended explanations during task performance. Such functions can improve the alignment between game mechanics and intended learning outcomes by ensuring that students receive support at moments of difficulty [8], [12]. QR-based resources may also channel students' mobile-device use toward purposeful academic activity. Minard [13], for instance, found that a QR-enabled learning platform in a graduate clinical course supported SDL and reduced off-task behavior during collaborative practice. From this perspective, QR codes can serve as contingent digital scaffolds that direct learners toward task-relevant resources without removing them from the physical learning environment. Their implementation, however, is not without constraints. QR-supported activities depend on reliable devices, internet connectivity, adequate scanning conditions, and equitable access to technology [7], [12]. They also require substantial instructional design effort, as teachers must coordinate digital content, game rules, task sequences, and assessment criteria while preserving both playability and curricular relevance [8], [14]. More importantly, when QR codes are designed merely to reveal correct answers, they may short-circuit explanation, peer negotiation, and reflective reasoning. Effective QR-supported board games, therefore, require explicit learning objectives, transparent task structures, collaborative accountability, and formative prompts that encourage students to interpret and discuss feedback rather than simply verify responses.

The potential value of QR-based scaffolding is especially pronounced in introductory accounting, where students frequently require immediate confirmation of tightly sequenced procedural decisions. Transaction analysis, debit–credit determination, journal-entry preparation, and account classification all involve interdependent steps, and an error at an early stage may propagate through subsequent tasks. Reliance solely on teacher assistance or peer explanation may be insufficient in large or heterogeneous classes, particularly when instructional time is limited, and students possess unequal levels of prior knowledge. By providing transaction-specific prompts, procedural reminders, and opportunities for immediate self-correction, QR codes may help students identify errors before they become embedded in later stages of the accounting cycle. This support may also allow instructors to devote greater attention to conceptual misconceptions, comparative reasoning, and higher-order discussion rather than repetitive procedural correction. Nevertheless, QR codes should complement rather than displace interpersonal learning. Their pedagogical contribution is likely to be strongest when they support students' procedural independence while simultaneously prompting explanation, shared error analysis, and collaborative decision-making within the board game activity.

2.3 | Self-Directed Learning, Cooperative Learning, and Learning Performance

In experiential, game-based, and technology-mediated learning environments, educational outcomes are shaped not only by the quality of instructional content, but also by the extent to which learners regulate their

own learning and participate productively in collective activity. SDL refers to the learner's capacity to diagnose learning needs, formulate goals, identify relevant resources, select appropriate strategies, monitor progress, and evaluate outcomes [15]. It is widely regarded as a core competence for lifelong learning because it integrates motivation, self-regulation, personal responsibility, and learner autonomy [15], [16]. The development of SDL is therefore closely associated with students' willingness and ability to take ownership of learning rather than depend exclusively on external instruction. Previous research has linked SDL to intrinsic motivation, self-efficacy, positive learning dispositions, and problem-solving competence. Bosch [17] observed that intrinsically motivated learners are more likely to derive personal value from academic tasks and to assume greater responsibility for their progress. Wong et al. [18] further emphasized that SDL emerges through the interaction between learner characteristics and the surrounding instructional environment, while Chukwuere [19] associated it with independent reasoning, problem solving, and decision-making. Cooperative Learning (CL), by comparison, locates learning within structured social interaction. It is organized around shared goals, distributed responsibilities, peer explanation, mutual support, and individual accountability [20], [21]. Its instructional value lies not simply in placing students in groups, but in designing tasks that require interdependence, dialogue, negotiation, and revision. Under such conditions, instructors act as designers and facilitators of participation rather than solely as transmitters of subject knowledge [22–24]. Chukwuere [19] identifies positive interdependence, individual accountability, promotive interaction, social competence, and group processing as central conditions for effective CL. Empirical evidence further suggests that well-structured CL can improve academic achievement, learning attitudes, and intrinsic motivation [21], [25]. The meta-analysis conducted by Kyndt et al. [26] likewise reported generally positive effects of face-to-face CL on achievement, attitudes, and students' perceptions of the learning process, indicating that CL can support both cognitive attainment and affective engagement.

The contribution of CL becomes particularly important in game-based environments because gameplay generates repeated opportunities for explanation, coordination, feedback, and joint decision-making. Fonseca et al. [27] found that integrating cooperative structures with gamification and game-based learning can enhance academic performance, social interaction, and learning motivation. The increasing use of digital tools has extended this logic by creating new possibilities for resource sharing, peer support, and reflective activity. Sekano et al. [16] argued that technology-supported CL can strengthen interaction and reflection when digital resources are embedded within structured group processes. Importantly, CL and SDL should not be treated as competing pedagogical orientations. Mentz and Van Zyl [15] showed that cooperative interaction can contribute to the development of self-direction because peer dialogue, shared responsibility, and critical reflection gradually transfer part of the control over learning from the instructor to the learner. Lin and Chang [28] similarly reported that team-based learning structures, including preparation, team assessment, and application-oriented tasks, can deepen peer discussion and collaborative knowledge construction. Brandt [29] further noted that autonomy often develops through communication, negotiation, and interpersonal problem-solving rather than through isolated study alone. Consistent with this view, Swart and Sutherland [30] found that group-based problem solving can facilitate information exchange, peer assistance, and the development of teamwork skills. These studies collectively suggest that self-direction may be strengthened, rather than diminished, when learners operate within a well-designed social learning environment.

SDL and CL, therefore, perform complementary functions within technology-supported game-based instruction. SDL enables learners to monitor understanding, identify errors, seek appropriate resources, and make informed adjustments, whereas CL provides the social conditions through which explanations are articulated, misconceptions are challenged, and knowledge is jointly reconstructed. Their combination, however, requires careful instructional design. Cooperative activity without explicit roles, accountability, and facilitation may result in free riding, unequal participation, or diffusion of responsibility [19]. Similarly, technology that is not pedagogically integrated may encourage passive answer retrieval rather than deeper engagement. Effective learning environments must therefore align task structure, digital support, and cooperative processes in ways that preserve both learner agency and meaningful interaction [18], [31]. In the present study, QR codes are conceptualized as contingent digital scaffolds that assist students in checking

procedural steps, identifying errors, and accessing targeted support, while the accounting board game provides a shared environment for peer explanation, negotiated reasoning, and collaborative problem solving. This combined design is particularly relevant to heterogeneous introductory accounting classrooms, where students differ substantially in prior knowledge and may require both individualized support and structured opportunities to learn with and from their peers.

3 | Research Questions and Method

3.1 | Problem Statement

The preceding literature indicates that conventional introductory accounting instruction may not adequately help novice learners understand accounting as an integrated process. When teaching is dominated by lectures, worked examples, and paper-based exercises, students may learn to reproduce debit–credit rules or perform isolated calculations without developing a coherent understanding of how economic events are translated into journal entries, assigned to appropriate account categories, summarized through a trial balance, and reported in financial statements. This limitation is particularly consequential for first-year students with little prior exposure to business or accounting. Although physical board games can make these relationships more visible by embedding accounting procedures in simulated transactions, tangible materials, rule-governed activities, and face-to-face collaboration, gameplay alone does not necessarily ensure accurate learning. Students with weak prior knowledge may complete tasks incorrectly, rely excessively on more knowledgeable peers, or continue through subsequent stages of the accounting cycle without recognizing earlier procedural errors.

Integrating QR codes into accounting board games offers a potential mechanism for addressing this limitation. By linking specific game tasks to procedural prompts, worked examples, journal-entry checks, and corrective feedback, QR codes can provide contingent support at the point at which difficulties occur. This form of digital scaffolding may strengthen self-monitoring and error correction while directing students' attention to the conceptual reasoning underlying accounting treatments. At the same time, the availability of immediate digital assistance may alter how students interact with peers and instructors. QR codes may facilitate productive discussion when they are designed as prompts for explanation and reflection, but they may also reduce collaborative reasoning when used primarily for individual answer verification. Accordingly, the present study compared a QR-supported accounting board game condition with a conventional board game condition to determine whether digital scaffolding produces additional benefits for learning performance and engagement without undermining the interpersonal processes central to CL.

The study was guided by the following research questions:

RQ1: does QR code-supported board game instruction produce significantly different performance on an introductory accounting achievement test compared with conventional board game-based instruction?

RQ2: how does QR code-supported board game instruction affect students' learning engagement across the dimensions of SDL, group cooperation, perceived accounting knowledge, acceptance of the instructional method, and overall evaluation of the learning experience?

RQ3: how do students perceive the respective contributions of QR code support, board game tasks, peer collaboration, and teacher or teaching-assistant guidance to their accounting learning process?

3.2 | Research Method

The ADDIE model was employed as the overarching instructional design framework for the study. Its five sequential phases—ADDIE—provided a structured basis for identifying learner characteristics, constructing the two instructional conditions, preparing the required learning materials, delivering the interventions, and assessing their effects. Within this framework, particular attention was given to differences in students' prior accounting knowledge, as these differences were expected to influence both their use of QR-based support and their participation in board game activities. The framework, therefore, enabled the study to align learner

needs, instructional content, game mechanics, digital scaffolding, and assessment procedures within a coherent research design. As presented in *Fig. 1*, the process moved from an initial diagnosis of the learning context to the comparative evaluation of the QR-supported and conventional board game conditions in terms of learning performance and engagement.

Analysis phase: the analysis phase focused on the curricular demands of introductory accounting and the heterogeneous academic backgrounds of the participating students. All participants were first-year university students; however, their previous exposure to accounting differed substantially. Approximately one-third had completed business-related studies and had some prior familiarity with commercial concepts or accounting coursework, whereas the remaining students came from non-business backgrounds and had received little or no formal accounting instruction. This disparity indicated that the cohort could not be treated as a homogeneous group of novice learners. Differences were anticipated in students' familiarity with transaction analysis, debit–credit conventions, journal-entry preparation, account classification, and trial balance construction. Identifying these variations was essential because limited prior knowledge could increase procedural errors, cognitive demand, and dependence on teacher or peer assistance. The analysis therefore informed the need for an instructional design that combined shared, collaborative board game activities with differentiated and immediately accessible support for less-prepared learners.

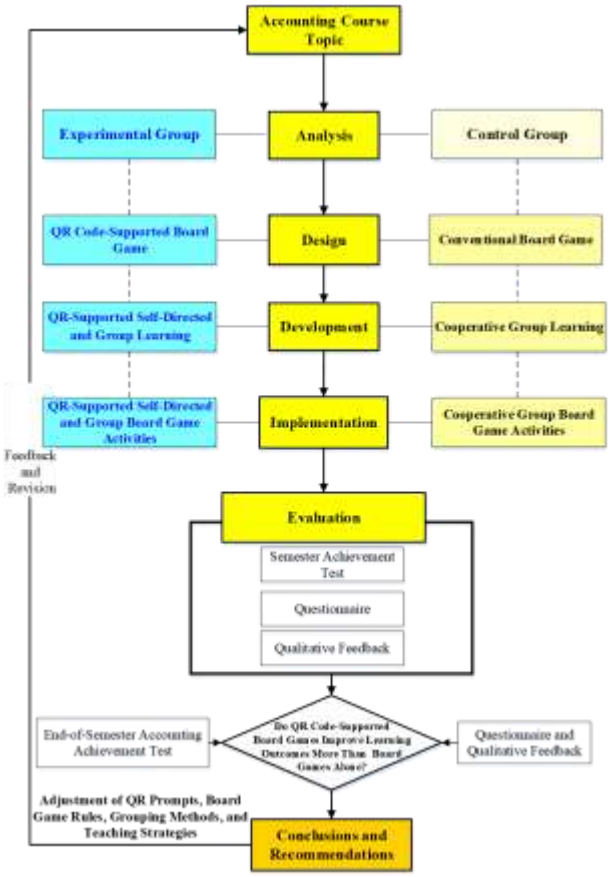

Fig. 1. Research framework.

Design phase: the design phase translated the identified learning needs and course objectives into two comparable instructional conditions, as illustrated in *Fig. 2* The experimental condition incorporated QR-enabled accounting board games in which digital prompts were embedded at selected points within transaction scenarios, task sequences, and game procedures. These prompts were intended to provide just-in-time guidance, procedural reminders, and opportunities for immediate verification when students encountered difficulties during gameplay. The comparison condition employed the same board game-based learning structure but excluded QR-mediated assistance, requiring students to rely primarily on the game rules, peer discussion, and instructor or teaching-assistant support. To preserve internal comparability, both groups received instruction on the same accounting topics, worked with equivalent transaction content, and completed closely matched learning tasks within similar classroom timeframes. Accordingly, the principal pedagogical distinction between the two conditions was the availability of QR-based scaffolding, allowing the study to examine its incremental contribution to learning performance and engagement beyond the effects of board game-based instruction alone.

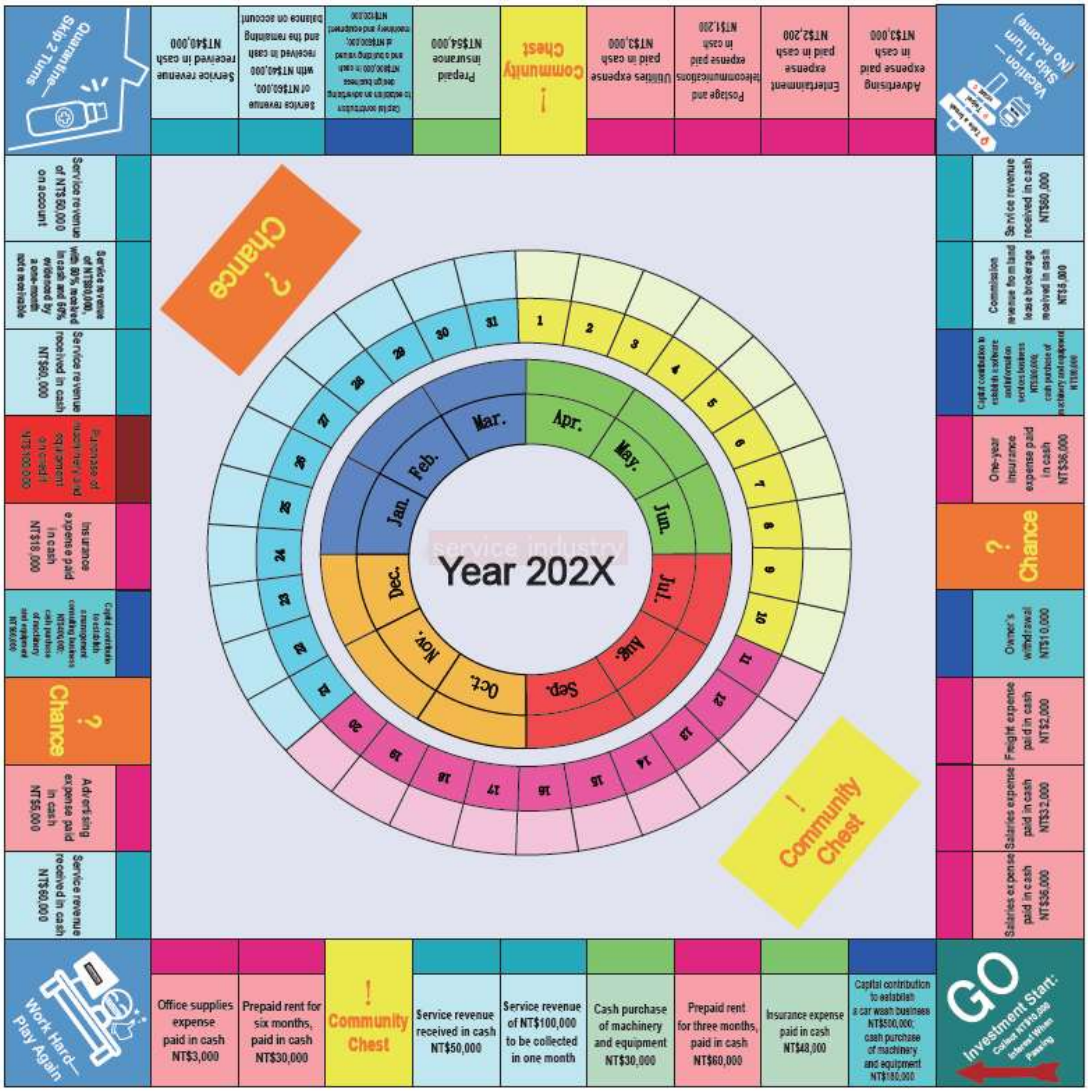

Fig. 2. Board games used in the experimental and control groups.

Development phase: during the development phase, a parallel set of instructional materials was produced for the two study conditions, including board game components, transaction cards, worksheets, teacher demonstration resources, and task guidance. For the experimental group, QR codes were incorporated into selected game elements and linked to task-specific learning supports, such as worked journal-entry examples, account-classification cues, procedural reminders, and stepwise guidance for trial balance preparation. The control group received equivalent accounting board game materials without embedded digital support and

completed the activities using cooperative worksheets, transaction-based task cards, printed instructions, and teacher-led demonstrations. As documented in Appendix A, the materials used in both conditions were constructed around the same accounting concepts, intended learning outcomes, task difficulty, and sequence of activities. This parallel development strategy was intended to minimize content-related variation between groups and to ensure that the availability of QR-mediated scaffolding constituted the principal instructional difference.

Implementation phase: before beginning the intervention, students in both groups received direct instruction on the accounting concepts and procedures required for the activity, including transaction analysis, debit–credit determination, journal-entry preparation, account classification, and the operational rules of the board game. They subsequently completed the instructional tasks in small groups, as illustrated in Fig. 3. In the experimental condition, students scanned QR codes at designated stages of gameplay to access contextualized hints, worked examples, procedural checks, and immediate corrective feedback. These resources were used during both individually completed self-monitoring tasks and collaborative group activities, thereby combining learner autonomy with peer-based problem solving. In the control condition, students completed equivalent tasks without QR access and depended instead on printed game instructions, discussion with group members, and clarification from the instructor or teaching assistants. Apart from the digital scaffolding available to the experimental group, the instructional topics, activity structure, task sequence, and general classroom procedures were kept as comparable as possible across the two conditions.

a.

b.

Fig. 3. Group-based accounting board game activities: a. Experimental group, and b. Control group.

Evaluation phase: the evaluation phase assessed the comparative effects of the two instructional conditions on both accounting achievement and students' engagement with the learning process. Learning performance

was measured across the principal procedural competencies addressed in the course, including the calculation of assets, liabilities, and equity, journal-entry preparation, account classification, and trial balance construction. Evidence was collected from semester achievement tests, multidimensional questionnaires, and students' qualitative comments, thereby allowing the intervention to be examined from both outcome-based and experience-based perspectives. The quantitative analyses were used to determine whether the addition of QR-mediated scaffolding produced measurable advantages over conventional board game instruction, either in overall performance or in specific accounting tasks. Questionnaire responses and qualitative feedback were then used to interpret how students experienced SDL, peer cooperation, instructional support, and the usability of the board game activities. The findings also informed a formative review of the intervention design, including the relevance and timing of QR prompts, the clarity of game rules, the composition of learning groups, and the role of instructors and teaching assistants. In this way, the evaluation phase served not only to compare the two conditions but also to identify refinements required for more effective implementation of QR-supported accounting board games.

4 | Results

4.1 | Comparison of Learning Performance in Semester Achievement Scores

In accordance with the quasi-experimental design, Class A was designated as the experimental group and received QR code-supported board game instruction, whereas Class B served as the control group and participated in conventional board game-based instruction without QR support. Learning outcomes were evaluated using the end-of-semester introductory accounting achievement test, which assessed four core competencies: accounting calculations, journal-entry preparation, account classification, and trial balance preparation. Because the two groups comprised independent samples and the score distributions contained zero values, multiple tied observations, and departures from the assumptions required for parametric testing, between-group differences were examined using a two-sided Mann–Whitney U test.

4.1.1 | Comparison of learning performance for all students

The experimental and control groups comprised 38 and 34 students, respectively. As reported in *Table 1*, no statistically significant between-group differences were observed for accounting calculations or trial balance preparation. The difference in overall achievement was likewise not statistically significant. Although the experimental group achieved a higher mean total score than the control group (71.16 versus 63.24), the observed difference did not reach the conventional threshold for statistical significance. Thus, the addition of QR-based scaffolding did not yield a statistically demonstrable improvement in overall semester achievement relative to conventional board game-based instruction. This aggregate result, however, does not preclude the possibility that the intervention produced task-specific effects across individual accounting competencies.

Table 1. Comparison of learning performance between the experimental and control groups for all students.

Test Dimension	Experimental Group M ± SD	Control Group M ± SD	Z	p	Result
Calculation	12.39 ± 5.63	13.09 ± 5.64	-0.729	0.466	Not significant
Journal entry preparation	22.42 ± 11.14	29.62 ± 11.10	-3.040	0.002	Control group significantly higher
Account classification	24.42 ± 9.37	13.25 ± 13.24	3.272	0.001	Experimental group significantly higher
Trial balance preparation	11.92 ± 11.77	7.28 ± 10.64	1.638	0.101	Not significant
Total score	71.16 ± 30.02	63.24 ± 32.13	1.139	0.255	Not significant

Further examination of the subscale results showed opposite patterns across different accounting competencies. For journal entry preparation, the control group performed significantly better than the experimental group ($Z = -3.040$, $p = 0.002$), indicating that conventional board game-based instruction may be more effective in supporting students' basic judgment of journal entries. In contrast, for account

classification, the experimental group significantly outperformed the control group (Z = 3.272, p =0.001), suggesting that QR code support provided clearer assistance for transaction classification tasks. These findings indicate that the benefits of QR-supported board games were not evenly distributed across all accounting competencies. Instead, their effects appeared to be more evident in procedural tasks that required students to connect business transactions, journal entries, and account attributes.

4.1.2|Comparison of learning performance among students with a business-related background

To investigate whether prior academic preparation moderated the effects of the intervention, students were stratified into business-related and non-business-background subgroups according to their senior high school entrance examination category. Within the business-background subgroup, 15 students belonged to the experimental condition and 13 to the control condition, as reported in *Table 2*. The Mann–Whitney U test revealed no statistically significant between-group differences in accounting calculation, journal-entry preparation, account classification, trial balance preparation, or overall achievement. Although the control group obtained higher central tendency values for journal-entry preparation than the experimental group, the difference did not reach statistical significance (p = 0.071). These results indicate that, among students with prior exposure to business-related subjects, QR-based scaffolding did not generate a detectable performance advantage over conventional board game-based instruction across the assessed accounting competencies.

Table 2. Comparison of learning performance between business-background students in the experimental and control groups.

Test Dimension	Experimental Group M ± SD	Control Group M ± SD	Z	p	Result
Calculation	14.07 ± 5.93	15.77 ± 5.34	-0.862	0.389	Not significant
Journal entry preparation	28.00 ± 9.56	32.81 ± 9.64	-1.804	0.071	Not significant
Account classification	28.62 ± 7.37	22.36 ± 11.08	1.344	0.179	Not significant
Trial balance preparation	17.30 ± 11.37	15.12 ± 10.26	0.841	0.401	Not significant
Total score	87.99 ± 26.62	86.05 ± 30.70	0.000	1.000	Not significant

The absence of statistically significant differences within the business-background subgroup suggests that the incremental value of QR-based scaffolding was limited for students who already possessed relevant accounting knowledge. Their prior familiarity with accounting concepts and procedures may have enabled them to complete the learning tasks effectively regardless of the instructional condition, drawing on existing knowledge, peer interaction, and the structure of the board game itself. Under these circumstances, QR codes appear to have functioned primarily as supplementary reference tools for verification, procedural reminders, and error checking rather than as a source of substantial additional learning gains. This interpretation should nevertheless remain cautious, as the non-significant findings do not establish equivalence between the two approaches; rather, they indicate that no statistically detectable advantage of QR support was observed for students with stronger prior preparation.

4.1.3|Comparison of learning performance among students with a non-business background

For students with a non-business background, the experimental group included 23 students and the control group included 21 students, as shown in *Table 3*. The results indicated that there was no significant difference between the two groups in calculation, suggesting that their basic calculation ability was comparable. However, for journal entry preparation, the control group significantly outperformed the experimental group (Z = -2.685, p =0.007). This finding suggests that, among non-business students, conventional board game-based instruction was more effective in supporting basic journal entry judgment. One possible explanation is that the board-game-only environment required students to rely more heavily on peer discussion, teacher explanation, and repeated practice, which may have strengthened their understanding of journal entry rules.

However, for account classification, the experimental group significantly outperformed the control group, with a relatively large effect size (Z = 3.531, p <0.001). This result indicates that QR-supported board games provided clear learning support for non-business students in transaction classification tasks. Because account

classification requires students to connect transaction content, journal entry results, and account attributes, the timely hints, checking mechanisms, and feedback provided through QR codes may have helped reduce the accumulation of errors and strengthen non-business students' understanding of accounting procedures. In terms of total score, the experimental group also obtained a higher mean score than the control group, but the difference did not reach statistical significance. These findings suggest that QR-supported board games did not produce a comprehensive advantage in overall achievement among non-business students. Nevertheless, they showed a clearer instructional benefit for specific competencies, particularly account classification.

Table 3. Comparison of learning performance between non-business-background students in the experimental and control groups.

Test Dimension	Experimental Group M ± SD	Control Group M ± SD	Z	p	Result
Calculation	11.30 ± 5.27	11.43 ± 5.28	-0.224	0.823	Not significant
Journal entry preparation	18.78 ± 10.75	27.64 ± 11.70	-2.685	0.007	Control group significantly higher
Account classification	21.68 ± 9.66	7.62 ± 11.32	3.531	<0.001	Experimental group significantly higher
Trial balance preparation	8.41 ± 10.87	2.43 ± 7.68	1.963	0.051	Not significant
Total score	60.18 ± 27.31	49.12 ± 24.30	1.551	0.121	Not significant

4.2 | Learning Motivation and Outcomes

This study used a modified questionnaire scale developed from Cheng et al. [32]. The questionnaire covered five dimensions: SDL, group cooperation, professional knowledge, method comparison, and overall evaluation. The reliability of the scale was examined using internal consistency analysis in SPSS. A total of 72 valid responses were obtained, with no missing or excluded cases. The overall Cronbach's Alpha value was 0.991 across 60 items, indicating that the questionnaire had a high level of internal consistency.

4.2.1 | Comparison of questionnaire results between the experimental and control groups

This study further compared the questionnaire results of the experimental and control groups, as shown in *Fig. 4* The experimental group included 38 valid responses and received the QR code-supported accounting board game intervention. The control group included 34 valid responses and received the conventional board game intervention without QR code support. The questionnaire results showed that the two groups differed across several learning dimensions.

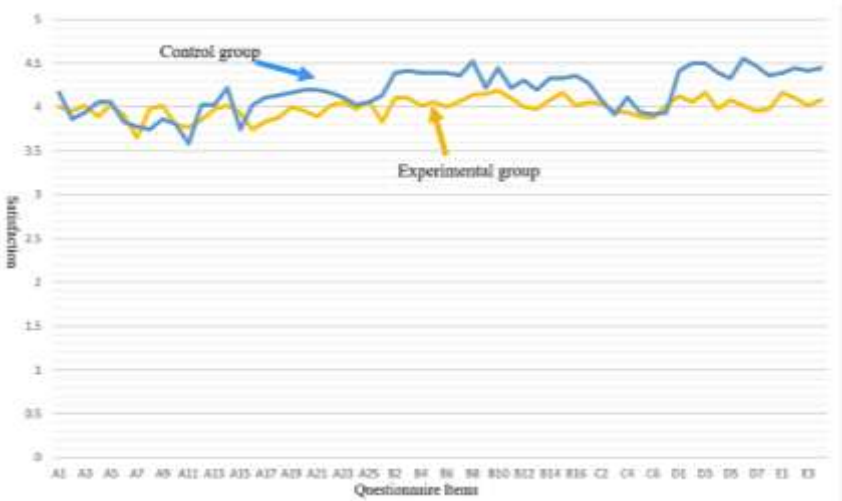

Fig. 4. Comparison of student satisfaction between the experimental and control group.

For the SDL dimension (A1–A25), no significant difference was found between the experimental and control

groups (t = -1.634, p =0.109). The mean difference was -0.07, with a 95% confidence interval ranging from -0.15 to 0.02. This result indicates that students in the two groups had similar perceptions of SDL.

For the professional knowledge dimension (C1–C7), the difference between the two groups was also not statistically significant (t = -0.979, p =0.347). The mean difference was -0.06, with a 95% confidence interval ranging from -0.18 to 0.07. This finding suggests that students in both groups perceived the board game activities as helpful for understanding accounting knowledge.

However, the control group reported significantly higher ratings than the experimental group in the dimensions of group cooperation, method comparison, and overall evaluation. For group cooperation (B1–B16), the difference was statistically significant (t = -8.219, p <0.001), with a mean difference of -0.28 and a 95% confidence interval from -0.34 to -0.21. For method comparison (D1–D8), a significant difference was also found (t = -10.297, p <0.001), with a mean difference of -0.39 and a 95% confidence interval from -0.48 to -0.31. Similarly, for overall evaluation (E1–E4), the difference was statistically significant (t = -9.808, p <0.001), with a mean difference of -0.33 and a 95% confidence interval from -0.41 to -0.25.

These results indicate that although QR code-supported board games provided timely hints and self-checking functions, the conventional board game group reported higher levels of cooperative interaction, acceptance of the instructional method, and overall learning experience. One possible explanation is that students in the control group did not have QR code prompts and therefore relied more on peer discussion, teacher explanations, and teaching assistant support. This may have strengthened their sense of group interaction and cooperation. In contrast, students in the experimental group may have relied more on QR codes to confirm answers, which could have shifted part of the learning process toward individual self-checking and reduced the frequency or depth of face-to-face discussion. This finding suggests that QR code support should not replace group discussion. Instead, QR codes should be designed as tools that promote CL, shared reasoning, and collective reflection.

4.2.2 | Comparison of questionnaire results between students with business and non-business backgrounds

To further understand the influence of prior knowledge on students' learning feedback, this study classified students into business-related and non-business backgrounds based on their entrance examination category in senior high school. There were 28 students with a business-related background and 44 students with a non-business background. The results showed that students with a business-related background reported significantly higher ratings than non-business students across all five questionnaire dimensions.

For the SDL dimension (A1–A25), business-background students reported significantly higher ratings than non-business students (t = 6.757, p <0.001). The mean difference was 0.29, with a 95% confidence interval ranging from 0.20 to 0.37. For the group cooperation dimension (B1–B16), a significant difference was also found (t = 7.370, p <0.001), with a mean difference of 0.27 and a 95% confidence interval from 0.19 to 0.34. Similarly, the professional knowledge dimension (C1–C7) showed a significant difference (t = 9.047, p <0.001), with a mean difference of 0.49 and a 95% confidence interval from 0.37 to 0.60.

In addition, business-background students rated the method comparison dimension (D1–D8) significantly higher than non-business students (t = 11.431, p <0.001). The mean difference was 0.45, with a 95% confidence interval ranging from 0.36 to 0.53. The overall evaluation dimension (E1–E4) also showed a significant difference (t = 12.676, p <0.001), with a mean difference of 0.35 and a 95% confidence interval from 0.28 to 0.42.

Overall, students with a business-related background provided more positive feedback on SDL, group cooperation, professional knowledge understanding, acceptance of the instructional method, and overall learning evaluation. This finding suggests that students with prior accounting learning experience were better able to understand the transaction scenarios, journal entry rules, and accounting procedures embedded in the board game activities. In contrast, although board games and QR code support helped reduce the learning

threshold for non-business students, these students may still have required more teacher guidance, worked examples, and peer support when completing journal entry judgment, account classification, and trial balance tasks.

4.3 | Qualitative Questionnaire Results

Students' qualitative feedback showed that both groups generally agreed that accounting board games helped them understand the content of introductory accounting. However, the sources of learning support differed between the two groups. In the experimental group, where QR codes were integrated into the learning activities, students more frequently mentioned that QR codes helped them immediately check journal entries, confirm answers, correct errors, and review materials after class. This finding indicates that QR codes served as a learning medium in the experimental group. When students were uncertain about transaction judgment, debit–credit directions, or account classification, QR codes enabled them to conduct more immediate self-checking. In contrast, students in the control group, who did not use QR codes, more often attributed their learning gains to board game operation, peer discussion, and immediate assistance from the teacher and teaching assistants. This suggests that the conventional board game approach relied more heavily on face-to-face interaction and in-class guidance.

Regarding the instructional sequence of teacher explanation followed by board game activities, both groups provided positive feedback. Students generally believed that teacher explanations of journal entries, game rules, and operating procedures before the board game activities helped reduce uncertainty for novice learners. Students in the experimental group further noted that teacher explanation combined with QR code prompts supported self-checking during the game process. In contrast, students in the control group emphasized that, without preliminary teacher guidance, novice learners might not know how to begin the board game activities. Therefore, the findings from both groups support an instructional sequence consisting of teacher instruction, board game operation, group discussion, and immediate correction. QR codes further strengthened the experimental group's access to immediate feedback and SDL support.

In terms of mixed grouping and peer cooperation, both groups indicated that grouping students with business and non-business backgrounds together had learning value. Non-business students could receive support from business-background peers in understanding journal entries, account classification, and transaction processing. At the same time, business-background students could review and consolidate their own understanding while explaining accounting concepts to their peers, creating a reciprocal learning effect. However, both groups also noted that CL could be limited when group members lacked sufficient accounting ability, showed unequal participation, or experienced communication difficulties. Therefore, future grouping arrangements should not be based only on whether students have business or non-business backgrounds. Students' actual accounting ability, communication skills, and role division within groups should also be considered.

5 | Conclusion and Recommendation

5.1 | Research Conclusion

This study evaluated the effects of QR code-supported board game instruction on accounting achievement, learning engagement, and subgroup differences in a first-year introductory accounting course. The results did not indicate a uniform advantage of QR-supported board games across all measured outcomes. Although students in the experimental group achieved a higher mean total score than those in the control group, the difference was not statistically significant. The intervention, therefore did not produce a statistically detectable improvement in overall semester achievement relative to conventional board game instruction. Nevertheless, the disaggregated results revealed meaningful task-specific differences. Students in the QR-supported condition performed significantly better in account classification, and this advantage was particularly pronounced among learners without a business-related background. This finding suggests that QR-based scaffolding may be especially useful for tasks requiring students to connect transaction information, journal-

entry outcomes, and account attributes across successive stages of the accounting cycle. A contrasting pattern emerged for journal-entry preparation, in which the control group achieved significantly better performance. This result indicates that foundational journal-entry competence may depend less on immediate digital verification and more on repeated practice, verbal explanation, instructor guidance, and collaborative reasoning. The findings, therefore caution against assuming that additional technological support will benefit all procedural accounting tasks in the same way. QR codes appear to be more effective when they clarify classification relationships and support error detection than when they are used to reinforce the underlying logic of debit–credit decisions. The questionnaire and qualitative findings further revealed a pedagogical trade-off between digital assistance and social interaction. Students in both groups generally perceived the board game activities as supportive of accounting learning. However, the conventional board game group reported stronger group cooperation, greater acceptance of the instructional approach, and more favorable overall evaluations. These results suggest that the absence of QR-based prompts may have encouraged students to rely more heavily on peer discussion, instructor explanation, and teaching-assistant support. By contrast, students with immediate access to QR resources may have shifted part of the learning process from collaborative interpretation to individual answer verification. Although such support can improve access to hints, feedback, error correction, and review materials, it may also reduce the frequency or depth of face-to-face reasoning when not explicitly integrated into group interaction.

The principal conclusion is therefore not that QR-supported board games are superior or inferior to conventional board games, but that their educational value depends on how digital support is embedded within the collaborative learning process. QR codes should be treated as supplementary scaffolds rather than substitutes for peer interaction, instructor mediation, or repeated procedural practice. Their most appropriate role is to direct attention, reveal misconceptions, support differentiated learning, and initiate discussion at points of difficulty. This design principle is especially important in heterogeneous classrooms, where students with limited prior knowledge require immediate support but also need sustained opportunities to articulate reasoning, compare interpretations, and learn through interaction with more knowledgeable peers.

The study makes two main contributions. First, it extends the empirical literature on technology-enhanced accounting education by examining QR code-supported physical board games through a quasi-experimental comparison rather than relying solely on descriptive perceptions or single-group evaluations. The inclusion of objective achievement measures, multidimensional engagement indicators, qualitative feedback, and subgroup comparisons provides a more differentiated account of when QR-based support is educationally beneficial. Second, the study advances the concept of balancing digital scaffolding with peer interaction. The results show that the instructional contribution of QR codes is competency-specific and learner-dependent: they were particularly useful for account classification and for students with lower prior preparation, whereas journal-entry learning and cooperative engagement remained more strongly associated with interpersonal explanation and guided practice. This perspective can inform the future design of accounting board games, blended learning environments, and differentiated instructional strategies.

5.2 | Recommendation

Several instructional implications follow from these findings. First, teachers should assess students' prior accounting knowledge before implementing board game-based activities. A brief diagnostic assessment covering journal-entry preparation, account classification, and trial balance construction would allow instructors to identify differences in baseline competence and organize groups more strategically. Heterogeneous grouping should consider not only students' academic backgrounds but also their demonstrated accounting ability, communication skills, and capacity to assume collaborative roles. Such grouping may reduce the risk that less-prepared students become passive participants or depend excessively on stronger peers.

Second, QR code content should be redesigned to promote reasoning rather than merely provide answers. Instead of displaying final solutions, QR prompts could ask students to justify debit–credit decisions, diagnose

incorrect journal entries, explain the basis for account classification, compare alternative treatments, or record a collective rationale before proceeding. In this form, QR codes would function as triggers for discussion, reflection, and error analysis rather than as endpoints for individual verification. Requiring group responses after scanning may further preserve the collaborative character of the board game.

Third, differentiated support should be aligned with students' prior preparation. Learners from non-business backgrounds may benefit from additional worked examples, account-classification guides, stepwise trial-balance procedures, and post-class QR review materials. Students with business-related backgrounds, by contrast, may be assigned structured responsibilities such as peer tutor, group facilitator, or error diagnostician. These roles can strengthen their own conceptual understanding while improving the quality of support available to less-prepared group members.

Future research should test the robustness of these findings across multiple institutions, course sections, academic disciplines, and instructional periods. Stronger designs could include baseline achievement measures, randomization where feasible, longitudinal tracking, and delayed post-tests to distinguish immediate task performance from sustained learning. Further studies should also collect QR usage logs, classroom observation data, interaction transcripts, and group-process measures to determine how students actually use digital prompts and whether those uses enhance or displace collaborative reasoning. Such evidence would clarify the mechanisms through which QR-supported board games influence SDL, CL, procedural understanding, and long-term retention.

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Authors' Contributions

The author confirms sole responsibility for the conceptualization, methodology, investigation, formal analysis, data curation, writing—original draft preparation, writing—review and editing, visualization, project administration, and final approval of the manuscript.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest.

Consent for Publication

The author confirms consent for the publication of this work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants performed by the author.

References

[1] Gittings, L., Taplin, R., & Kerr, R. (2020). Experiential learning activities in university accounting education: A systematic literature review. *Journal of accounting education*, *52*, 100680. https://doi.org/10.1016/j.jaccedu.2020.100680

[2] Krom, C. L. (2012). Using FarmVille in an introductory managerial accounting course to engage students, enhance comprehension, and develop social networking skills. *Journal of management education*, *36*(6), 848–865. https://doi.org/10.1177/1052562912459029

[3] Wisnantiasri, S. N., Paramitha, D., & Hidayah, P. A. (2024). Developing a board game-based supplementary learning material prototype for accounting. *Journal of science and education (JSE)*, *5*(1), 178–196. https://doi.org/10.58905/jse.v5i1.320

[4] Apostolou, B., Dorminey, J. W., & Hassell, J. M. (2022). Accounting education literature review. *Journal of accounting education*, *59*, 100781. https://doi.org/10.1016/j.jaccedu.2022.100781

[5] Marriott, N. (2004). Using computerized business simulations and spreadsheet models in accounting education: A case study. *Accounting education*, *13*(sup1), 55–70. https://doi.org/10.1080/0963928042000310797

[6] Rossouw, M., & Steenkamp, G. (2025). Developing the critical thinking skills of first year accounting students with an active learning intervention. *The international journal of management education*, *23*(1), 101086. https://doi.org/10.1016/j.ijme.2024.101086

[7] Latif, L. A., Fadzil, M., Azzman, T. A. M. T. M., & others. (2011). Can the use of QR codes enhance m-learning in a blended learning environment? *Journal lifelong learning society*, *8*(2), 1–20. https://doi.org/10.26857/JLLS.2012.08.8.2.1

[8] Sağit, P., Esra, U. Ç. A. K., & GENCER, A. S. (2024). A systematic review on the pedagogical use of QR codes. *Journal of STEM teacher institutes*, *4*(2), 106-126. https://jstei.com/index.php/jsti/article/view/73

[9] Karia, C. T., Hughes, A., & Carr, S. (2019). Uses of quick response codes in healthcare education: A scoping review. *BMC medical education*, *19*(1), 456. https://doi.org/10.1186/s12909-019-1876-

[10] Tsoukala, E., Lefkos, I., & Fachantidis, N. (2023). Exploring the applications of QR codes in STEM subjects. In *Interactive mobile communication, technologies and learning* (pp. 129–139). Springer. https://doi.org/10.1007/978-3-031-54327-2_13

[11] Abdul Rabu, S. N., Hussin, H., & Bervell, B. (2019). QR code utilization in a large classroom: Higher education students' initial perceptions. *Education and information technologies*, *24*(1), 359–384. https://doi.org/10.1007/s10639-018-9779-2

[12] Rikala, J., & Kankaanranta, M. (2012). The use of Quick Response codes in the classroom. *mLearn* (pp. 148-155). CEUR Workshop Proceedings. https://ceur-ws.org/Vol-955/papers/paper_40.pdf

[13] Minard, C. (2024). Use of QR codes to enhance learning in a graduate-level clinical course. *Journal of formative design in learning*, *8*, 63–70. https://doi.org/10.1007/s41686-024-00092-0

[14] Giannakas, F., Kambourakis, G., Papasalouros, A., & Gritzalis, S. (2018). A critical review of 13 years of mobile game-based learning. *Educational technology research and development*, *66*(2), 341–384. https://doi.org/10.1007/s11423-017-9552-z

[15] Mentz, E., & Van Zyl, S. (2018). The impact of cooperative learning on self-directed learning abilities in the computer applications technology class. *International journal of lifelong education*, *37*(4), 482–494. https://doi.org/10.1080/02601370.2018.1513426

[16] Sekano, G., Laubscher, D., & Bailey, R. (2026). Growing independent thinkers: The role of technology-supported cooperative learning in fostering self-directed learning in mathematics. *Frontiers in education, 11*, 1724270. https://doi.org/10.3389/feduc.2026.1724270

[17] Bosch, C. (2016). *Promoting self-directed learning through the implementation of cooperative learning in a higher education blended learning environment. Johannesburg, SA: Doctoral dissertation at north-west university* [Thesis]. http://hdl.handle.net/10394/26102

[18] Wong, F. M. F., Tang, A. C. Y., & Cheng, W. L. S. (2021). Factors associated with self-directed learning among undergraduate nursing students: A systematic review. *Nurse education today*, *104*, 104998. https://doi.org/10.1016/j.nedt.2021.104998

[19] Chukwuere, J. E. (2023). Exploring the application of self-directed and cooperative learning in information systems education: A critical analysis. *Journal of science and education (JSE)*, *3*(3), 232–249. https://jse.rezkimedia.org/index.php/jse/article/view/216

[20] Dillenbourg, P. (1999). What do you mean by collaborative learning? In *Collaborative learning: Cognitive and computational approaches* (pp. 1–19). Elsevier. https://tecfa.unige.ch/tecfa/teaching/aei/papiers/Dillenbourg.pdf

[21] McInerney, M. J., & Fink, L. D. (2003). Team-based learning enhances long-term retention and critical thinking in an undergraduate microbial physiology course. *Microbiology education*, *4*(1), 3–12. https://doi.org/10.1128/me.4.1.3-12.2003

[22] Parker, R. E. (1985). Small-group cooperative learning—Improving academic, social gains in the classroom. *Nassp bulletin*, *69*(479), 48–57. https://doi.org/10.1177/019263658506947908

[23] Forsyth, D. R. (1999). *Group dynamics*. Brooks/Cole. https://books.google.com/books/about/Group_Dynamics.html?id=jYCzQwAACAAJ

[24] Shaw, J. D., Duffy, M. K., & Stark, E. M. (2000). Interdependence and preference for group work: Main and congruence effects on the satisfaction and performance of group members. *Journal of management*, *26*(2), 259–279. https://doi.org/10.1177/014920630002600205

[25] Tan, N. C. K., Kandiah, N., Chan, Y. H., Umapathi, T., Lee, S. H., & Tan, K. (2011). A controlled study of team-based learning for undergraduate clinical neurology education. *BMC medical education*, *11*(1), 91. https://doi.org/10.1186/1472-6920-11-91

[26] Kyndt, E., Raes, E., Lismont, B., Timmers, F., Cascallar, E., & Dochy, F. (2013). A meta-analysis of the effects of face-to-face cooperative learning. Do recent studies falsify or verify earlier findings? *Educational research review*, *10*, 133–149. https://doi.org/10.1016/j.edurev.2013.02.002

[27] Fonseca, I., Caviedes, M., Chantré, J., & Bernate, J. (2023). Gamification and game-based learning as cooperative learning tools: A systematic review. *International journal of emerging technologies in learning (IJET)*, *18*(21), 4–23. https://www.learntechlib.org/p/223722/

[28] Lin, P. C., & Chang, Y. H. (2025). Short-term effects of team-based learning on self-directed learning, cooperative learning, and critical thinking among nursing students studying medical-surgical nursing. *Nurse education in practice*, 89, 104618. https://doi.org/10.1016/j.nepr.2025.104618

[29] Brandt, W. C. (2020). Measuring student success skills: A review of the literature on self-directed learning. 21st century success skills. *National center for the improvement of educational assessment*. https://files.eric.ed.gov/fulltext/ED607782.pdf

[30] Swart, A. J., & Sutherland, T. (2014). Co-operative learning versus self-directed learning in engineering: Student preferences and implications. *2014 IEEE frontiers in education conference (FIE) proceedings* (pp. 1-5). IEEE. https://doi.org/10.1109/FIE.2014.7044229

[31] Simanjuntak, H., Maruli, S., & Silitonga, L. L. (2025). The relationship between learning goal orientation, self-readiness computer-supported collaborative learning, and self-directed learning. *Journal of educators online*, *22*(1), n1. https://files.eric.ed.gov/fulltext/EJ1462405.pdf

[32] Cheng, S. F., Kuo, C. L., Lin, K. C., & Lee-Hsieh, J. (2010). Development and preliminary testing of a self-rating instrument to measure self-directed learning ability of nursing students. *International journal of nursing studies*, *47*(9), 1152-1158. https://doi.org/10.1016/j.ijnurstu.2010.02.002

Appendix

A teacher's practice guide for accounting board game teaching materials

Fig. A1. Step 1: Players establish companies.

Fig. A1. Step 2: Company establishment date and journal entries.

Fig. A1. Step 3: Round 1 space: Transaction date, journal entries, and playing order.

Fig. A1. Step 4: Round 2 space: Transaction date, journal entries, and turn order.

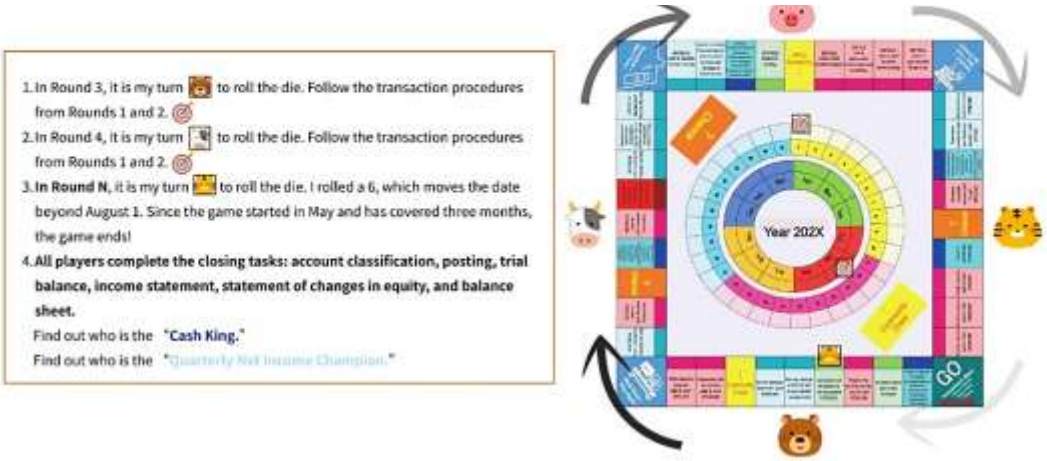

Fig. A1. Step 5: Rounds 3 to N: Transaction dates, journal entries, and turn order.

Fig. A1. Step 6: Other situation: Landing on one's own company space again and recording journal entries.