

DESIGN AND DEVELOPMENT OF A GAME-BASED LEARNING SYSTEM FOR COMPARING INQUIRY-BASED AND TASK-BASED STRATEGIES IN READING COMPREHENSION TO SUPPORT SUSTAINABLE DEVELOPMENT GOALS (SDGS)

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Abstract

This study presents the design and development of a game-based learning system for evaluating and comparing inquiry-based learning (IBL) and task-based learning (TBL) strategies in reading comprehension to support the sustainable development goals (SDGs), particularly SDG 4. The study employed a design-based research (DbR) framework consisting of analysis, design, implementation, and evaluation stages to guide system development. The proposed system integrates interactive reading tasks, inquiry-driven exploration, and structured task execution within a unified digital game environment. System feasibility was assessed through expert validation, indicating good usability, functional performance, and content-system alignment. The system was implemented with 72 eleventh-grade students, and its effectiveness was evaluated through experimental comparison. The results demonstrate that both IBL and TBL strategies embedded within the game-based system significantly improve reading comprehension, with differential effects influenced by learner profiles. These findings indicate that the developed system functions effectively as a technology-driven evaluation platform for instructional strategies and contributes to scalable, data-informed digital learning solutions aligned with sustainable education objectives.

Keywords: Design, Game, Inquiry-based learning, Reading comprehension, Task-based learning.

1. Introduction

The advancement of digital technology has driven the transformation of instructional practices through the development of interactive and system-oriented learning environments [1-5]. In recent years, game-based learning systems have emerged as a technological solution capable of integrating content delivery, learner interaction, and performance evaluation within a single digital platform. Such systems offer scalable and data-driven approaches to learning, supporting sustainable educational innovation aligned with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), by promoting inclusive and technology-enabled access to effective learning experiences.

In the context of English as a Foreign Language (EFL) learning, reading comprehension remains a fundamental yet challenging skill [6]. Many Indonesian high school students experience difficulties in understanding English texts due to limited vocabulary, low engagement, and the persistence of teacher-centred instructional approaches [7, 8]. These approaches often fail to stimulate higher-order thinking and active cognitive processing required for effective comprehension [9, 10]. Consequently, there is an increasing demand for instructional strategies and learning systems that actively engage learners and support deeper cognitive involvement.

Learner-centred pedagogical strategies such as Inquiry-Based Learning (IBL) and Task-Based Learning (TBL) have been widely recognized for their effectiveness in improving reading comprehension. IBL emphasizes exploration, questioning, and discovery, enabling learners to construct meaning through inquiry and reflection [11]. In contrast, TBL focuses on structured and goal-oriented tasks that simulate authentic language use and encourage practical application of reading skills [12]. While both strategies promote experiential learning, they differ in instructional emphasis, and their effectiveness may vary depending on learners' interests and cognitive preferences [13]. However, most previous studies have examined IBL and TBL primarily from a pedagogical perspective, with limited attention to their integration and comparison within a technology-driven game-based system [14-19].

From a science and technology perspective, digital games provide a controlled and interactive environment in which pedagogical strategies can be operationalized as system components. Game-based systems enable the synchronization of instructional design, user interaction, and learning analytics, allowing for systematic evaluation of instructional effectiveness [20-22]. Despite this potential, few studies have designed game-based learning systems specifically to compare different instructional strategies while considering learner characteristics in EFL reading contexts.

This study aims to design and develop a game-based learning system to compare the effectiveness of Inquiry-Based Learning and Task-Based Learning strategies on students' reading comprehension using a Design-Based Research approach. The novelty of this study lies in (i) the development of a digital game system that embeds IBL and TBL as evaluable system mechanisms, (ii) the use of game-based technology as an analytical platform for comparing instructional strategies, and (iii) the alignment of educational technology development with SDG-oriented sustainable learning objectives through scalable and interactive system design.

2. Literature Review

IBL and TBL are learner-centred instructional strategies that have been widely applied to improve reading comprehension in English as an EFL context. IBL is rooted in constructivist theory and emphasizes exploration, questioning, and reflection, enabling learners to actively construct meaning from texts [11, 23, 24]. Previous studies report that IBL enhances metacognitive awareness, critical reading strategies, and intrinsic motivation, which are essential for deep comprehension [25-27]. However, the open-ended nature of IBL may present challenges for learners with limited autonomy or language proficiency, requiring appropriate scaffolding [28].

In contrast, TBL focuses on the completion of structured, goal-oriented tasks that simulate authentic language use [12]. Empirical evidence shows that TBL improves reading comprehension accuracy and learner engagement by emphasizing communicative outcomes and procedural clarity [29, 30]. The structured design of TBL makes it particularly suitable for learners who prefer systematic and task-focused learning processes. Although both approaches are effective, their instructional mechanisms differ and may produce varying outcomes depending on learner characteristics such as learning interest [13].

From a science and technological perspective, game-based learning systems provide an interactive and controlled digital environment in which instructional strategies can be implemented and evaluated as system components. Digital games enhance reading comprehension by combining cognitive challenges, interactivity, and motivational elements [31-33]. Within such systems, IBL-oriented designs promote exploration and hypothesis testing, while TBL-oriented designs emphasize structured progression and task completion [33, 34]. The integration of pedagogy and game mechanics enables systematic comparison of instructional strategies, as conceptualized in integrated game-based learning design models [35].

To clarify the conceptual positioning of IBL, TBL, and game-based systems, previous studies are summarized in Table 1. Existing research has largely examined these approaches independently, with limited focus on game-based system design for direct instructional comparison. This gap highlights the need for a technology-driven learning system that embeds and evaluates IBL and TBL strategies in reading comprehension to support effective and sustainable digital learning aligned with SDG 4 (Quality Education).

3. Research Methodology

This study employed a Design-Based Research (DbR) approach to design, implement, and evaluate a game-based learning system for comparing IBL and TBL strategies in reading comprehension. The DbR process consisted of four stages: analysis, design, implementation, and evaluation. During the analysis stage, instructional requirements and the suitability of IBL and TBL characteristics for reading comprehension were examined. The design stage focused on developing a digital game system that operationalizes IBL and TBL as interactive learning mechanisms. The system was implemented as a digital game developed using Unity and CorelDRAW and subsequently validated by media, language, and content experts to ensure usability, functionality, and content accuracy. The system was tested with 72 eleventh-grade students, divided equally into IBL-based and TBL-based game groups. Evaluation was conducted to examine system effectiveness and

comparative learning outcomes through controlled implementation. Detailed procedures are reported elsewhere [36].

Table 1. Summary of instructional approaches and game-based learning systems in reading comprehension.

Aspect	Inquiry-Based Learning (IBL)	Task-Based Learning (TBL)	Game-Based Learning System
Instructional focus	Exploration, inquiry, reflection	Structured tasks, goal completion	Interactive system integrating pedagogy
Cognitive emphasis	Critical thinking, metacognition	Procedural understanding, accuracy	Cognitive-affective integration
Learner suitability	Exploratory-oriented learners	Task-oriented learners	Diverse learner profiles
Technological role	Limited	Limited	Pedagogy embedded as system mechanics
Research limitation	Rarely system-based	Rarely system-based	Limited comparative system studies

4. Results and Discussion

Figure 1 illustrates the development workflow of the game-based learning system integrating IBL and TBL. The system development began with content preparation, followed by an analysis of reading comprehension competencies and the pedagogical characteristics of IBL and TBL. These strategies were operationalized into game mechanics through storyboard design and subsequently implemented using Unity and CorelDRAW. The completed system was validated by media, language, and content experts, who confirmed that the game was suitable for instructional use, with several minor revisions applied before implementation.

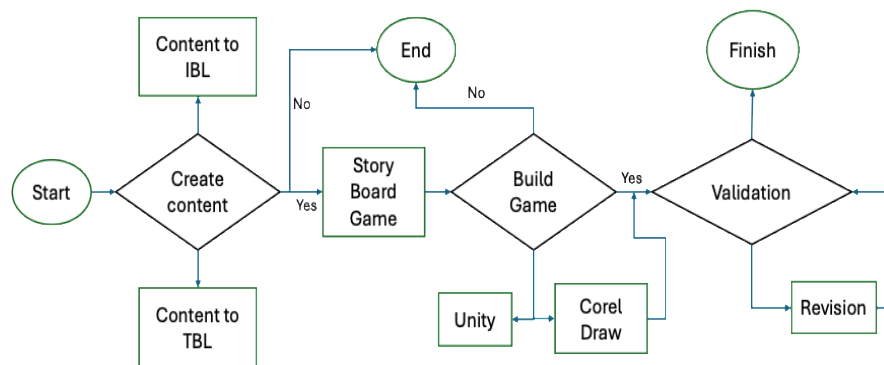


Fig. 1. Flowchart build Game IBL and TBL.

Figure 2 presents the main interface and functional components of the developed game system. We also showed Game IBL and TBL in the initial display (Fig. 2a), main menu (Fig. 2b), reading comprehension (Fig. 2c), and continue or end options (Fig. 2d). The system consists of four primary components: the initial

interface, the main menu providing access to IBL and TBL modes, interactive reading comprehension tasks, and an exit confirmation module. The design enables users to engage with either instructional strategy within the same system environment, ensuring controlled comparison while maintaining consistent content delivery. This unified system structure supports systematic evaluation of instructional strategies without confounding interface or content variability.

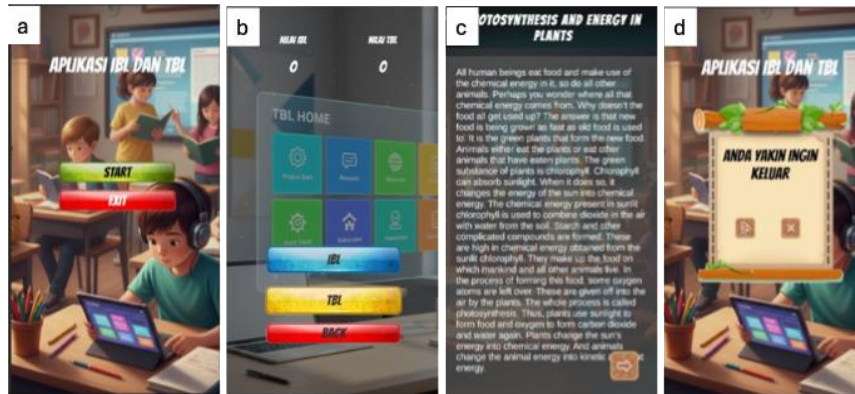


Fig. 2. Game IBL and TBL: (a) initial display, (b) main menu, (c) reading comprehension, and (d) continue or end options.

The experimental implementation involved 72 eleventh-grade students divided into two groups based on instructional strategy. Results indicate that learning effectiveness was influenced by the alignment between instructional design and learner interest. Students with exploratory learning interests achieved higher gains under the IBL-based game system (Mean Gain = 19.22; Post-test = 82.33) compared to those in the TBL-based system (Mean Gain = 14.94). Conversely, task-oriented students demonstrated greater improvement under the TBL-based system (Mean Gain = 17.34) than under the IBL-based system (Mean Gain = 15.39). These findings suggest that the effectiveness of the game-based system is contingent upon the interaction between system mechanics and learner profiles.

Statistical analysis further confirms these trends. Both instructional strategy ($F = 9.74$, $p = 0.003$) and learning interest ($F = 6.61$, $p = 0.012$) significantly affected reading comprehension outcomes. A significant interaction effect ($F = 5.15$, $p = 0.026$) indicates that system effectiveness depends on the compatibility between game design and learner characteristics, with an effect size of 0.071. These results demonstrate that the game-based system functions effectively as an evaluation platform for comparing pedagogical strategies.

Consistent with previous studies, both IBL and TBL embedded within game-based environments significantly improve reading comprehension [11, 12, 14-21]. However, the higher gains observed in the IBL-based system for exploratory learners indicate that inquiry-oriented mechanics promote deeper engagement through questioning, hypothesis testing, and reflection. In contrast, the structured progression of the TBL-based system benefits task-oriented learners by providing clear objectives and procedural guidance. These findings align with prior research emphasizing the importance of matching instructional design with learner preferences in game-based learning environments [33-35]. The results demonstrate

that the developed game-based learning system effectively integrates instructional strategies as system components, enabling systematic comparison and performance evaluation while supporting technology-driven and sustainable instructional innovation aligned with SDG 4 (quality education).

5. Conclusion

This study developed a game-based learning system to compare IBL and TBL strategies in reading comprehension. The system proved feasible and effective as a digital platform for evaluating instructional strategies through interactive game mechanics. Results indicate that both approaches improve reading comprehension, with effectiveness influenced by learner characteristics. From a technological perspective, the system supports scalable and data-driven instructional evaluation. Moreover, the developed system aligns with SDG4 (quality education) by enabling technology-enhanced and learner-centred reading instruction.

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