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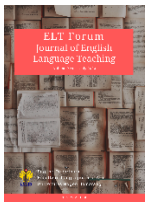

Implementation of QR-based treasure hunt game to improve young students' English vocabulary mastery

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Abstract

This study explores the effectiveness of a QR-based Treasure Hunt game in enhancing English vocabulary mastery among 7th grade students at a public junior high school located in Ungaran, a district in Semarang Regency, Central Java, Indonesia. Despite the growing interest in gamification and mobile-assisted learning, the use of QR codes specifically for vocabulary acquisition in EFL classrooms has received little scholarly attention—underscoring the need for targeted investigation in this area. Using a quasi-experimental design, students were divided into control and experimental groups, with vocabulary mastery assessed through pre-test and post-test evaluations. The control group, which followed traditional teaching methods, showed minimal vocabulary improvement, whereas the experimental group demonstrated significant gains after engaging with the QR-based gamified approach. The interactive nature of QR codes encouraged active participation, allowing students to scan, solve, and engage with challenges in a structured format. The findings confirm that gamified learning fosters engagement, reinforcing Cognitive Load Theory by breaking vocabulary learning into manageable, interactive components. While most students responded positively, observations revealed that some required additional guidance, highlighting the need for structured instructional support when implementing gamification. This study contributes to the field of educational technology, demonstrating the potential of gamification in language acquisition and student motivation. By integrating QR-based activities into EFL instruction, schools can modernize teaching practices, improving both learning outcomes and engagement. Future research should explore long-term retention, learner diversity, and expanded gamification models to further refine technology-enhanced vocabulary instruction.

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INTRODUCTION

English is one of the most widely spoken languages globally and has become a core subject in Indonesian education. Recognized as a foreign language, English is taught from elementary school to university levels (Zein et al., 2020). Despite this long exposure, many Indonesian students continue to struggle with English proficiency, particularly in vocabulary (Jon et al., 2021). According to Wijayana et al. (2018), vocabulary learning is hindered by challenges such as difficulty in understanding word meanings and low motivation. Moreover, the students make less use of dictionaries in the already limited time for an English lesson.

In response to these challenges, digital tools—especially digital dictionaries—have gained popularity among students as more effective and accessible learning resources. Nurhalimah & Azzahra (2023) highlighted that learning media, including tools and materials that support classroom activities, can make the learning process more engaging and effective. Therefore, the rapid expansion of digital technology has helped to fundamentally transform educational practices by providing innovative digital tools to enhance students' learning experience. Teaching and learning activities can now make use of advanced digital learning media and tools that are highly beneficial for both teachers and students as learning media plays an important role in students' learning process by providing them with more engaging and effective means of acquiring knowledge and skills.

Among all digital media and tools, Quick Response (QR) codes stand out for their adaptability in educational contexts, offering flexible opportunities to integrate digital technology into classroom activities. These codes can store substantial amounts of data and can be accessed instantly through smart devices. Their multifunctionality allows for various applications in educational settings, making them a valuable resource for both teachers and students.

This study explores the integration of QR code technology with gamification strategies, specifically through the implementation of a Treasure Hunt game to improve vocabulary acquisition in junior high school students. Gamification has gained recognition in education for its motivational benefits. Munaji et al. (2025) emphasized how game elements promote student engagement, while Amalia et al. (2023) found that game-centered teaching increases both motivation and achievement in vocabulary learning. Similarly, Rosyidah et al. (2024) identified the elements of gamification that most effectively enhance English language skills, suggesting that combining digital games with interactive learning can substantially support vocabulary mastery.

Among the various gamification strategies explored in language education, Treasure Hunt games have emerged as a compelling method for vocabulary learning. Alam & Khotimah (2021) demonstrated that Treasure Hunt games significantly improved students' interest and mastery in Arabic vocabulary. Nurpatima et al. (2020) confirmed their effectiveness for first-grade high school students, while Munawir & Masruddin (2022) designed a culturally enriched Treasure Hunt game that advanced both language skills and cultural awareness. These studies illustrate the value and effectiveness of using gamification in vocabulary skills development, which is relevant to the current study on English vocabulary.

While Treasure Hunt games have proven effective in vocabulary acquisition, their integration with QR code technology offers additional opportunities to enhance engagement and interactivity in language learning. Sukenasa et al. (2020) reported that a board game enhanced with QR codes significantly boosted students' vocabulary performance. Moreover, Yunus et al. (2020) supported the use of QR activities in improving vocabulary acquisition among junior high students. These findings suggest that QR-based gamification holds strong potential for educational use.

Expanding on the role of QR codes in vocabulary learning, gamification in the form of Treasure Hunt games has proven effective in encouraging students to engage in the given tasks. By scanning QR codes in a Treasure Hunt game, students can access clues, vocabulary exercises, multimedia content, and gamified challenges that support language acquisition. This interaction promotes active learning, collaboration, and individualized instruction. Additionally, QR codes allow teachers to embed instructional materials, such as definitions, pronunciation guides, or context-based activities, making the learning process more dynamic and immersive.

In an educational setting, the use of QR codes offers a vibrant way to integrate both physical and digital learning spaces. In teaching the English language, Inayati & Waloyo (2022) found that online gamified learning using QR codes positively influenced student engagement and outcomes, while Riantika & Wibawa (2024) showed how QR-enhanced Treasure Hunt games added value to problem-solving activities. Besides that, Himmah & Musdi (2022) further endorsed the role of QR

codes in promoting independent learning, highlighting their relevance to vocabulary acquisition strategies focused on exploration and autonomy.

In similar ways, QR technology also facilitates differentiated learning by delivering visually engaging and interactive content. For instance, Munaji et al. (2025) noted that QR-integrated games support personalized learning paths and bolster student motivation. Similarly, Mulyawati et al. (2024) illustrated the effectiveness of using QR codes in a Monopoly-based game, showing how gamification can transform traditional teaching methods into dynamic learning experiences. Such innovations point to QR codes as a tool that merges digital learning with real-world engagement.

Additionally, research by Rosyidah et al. (2024) found that specific gamification features significantly improved English proficiency in junior high students. Meanwhile, Yunus et al. (2020) documented the benefits of QR-based vocabulary instruction at the primary level, laying the groundwork for similar approaches in junior high school settings. These findings support the relevance of QR-enhanced Treasure Hunt games for addressing both the cognitive and emotional dimensions of language acquisition.

This study aims to investigate how QR-based Treasure Hunt games can elevate vocabulary instruction by leveraging digital media and student-centered approaches. The topic of "Improving Junior High School Students' English Vocabulary Using QR-based Treasure Hunt Game" is timely and impactful, offering both theoretical and practical contributions. Theoretically, it expands existing literature on gamification and ICT in EFL classrooms, providing new insights into technology-supported language instruction. Practically, it promotes the development and integration of digital gamification tools that aid teachers and students alike in cultivating vocabulary mastery through engaging methods. Additionally, it can be generally helpful by preparing students for technology-driven learning environments and encouraging them to become more comfortable with digital technologies. By blending QR codes with a Treasure Hunt framework, the researcher aims to create a space for exploration, interaction, and immediate feedback. Students are encouraged to learn actively rather than passively, leading to deeper understanding and retention of vocabulary.

In light of students' increasing exposure to smart devices and digital games, QR-based Treasure Hunt games tap into their everyday experiences and learning preferences. This method may help reduce anxiety and increase enthusiasm for learning English. Overall, such gamified interventions can foster more meaningful and sustained vocabulary development in junior high school students.

However, despite the growing interest in gamification and mobile-assisted learning, the use of QR codes specifically for vocabulary mastery in junior high school level EFL classrooms through Treasure Hunt Game has received little scholarly attention. This gap presents an opportunity to examine the impacts of this innovative approach and highlights the need to further examine the effects of such an intervention on the targeted educational setting. All in all, by investigating the practice of its implementation to the young students of a public junior high school in Central Java, this study seeks to provide valuable insights for educators, policymakers, and technology developers.

Ultimately, the aim is to contribute to the creation of more effective and engaging English learning experiences by harnessing the intersection of gamification, QR technology, and interactive pedagogy. The findings are expected to enrich instructional design in EFL education and promote digital literacy among students.

METHODS

This research follows a quantitative approach with a quasi-experimental design to explore the research problem. Quantitative research systematically collects and analyzes numerical data to identify patterns and relationships. A quasi-experimental design was chosen to examine cause-and-effect relationships without random assignment. The study was conducted at a public junior high school, a junior high school in Ungaran, Central Java, accredited with an A rating and recognized for its achievements in academic and extracurricular competitions. Two groups of 7th-grade students participated: a control group of 36 students who received conventional vocabulary instruction and an experimental group of 31 students who engaged in a QR-based Treasure Hunt learning activity. The participants, aged 12–13, had varying levels of English proficiency, with both groups receiving instruction on daily vocabulary topics relevant to their curriculum.

The Treasure Hunt treatment took place across four designated school locations: the classroom, the library, the garden, and the laboratory. Within each location, many QR-coded tasks were hidden, totaling ten various challenges across the entire game. Students used their own smartphones to scan the QR codes, which redirected them to images containing vocabulary-based activities. The tasks

varied in format to maintain engagement and target different aspects of vocabulary acquisition: Word Relay, in which students sort words into catgories; Word Puzzle, in which students arrange scrambled words; Object Hunting, in which students find and describe an object; and Spelling Relay, in which students take turns spelling words. Each completed task unlocked a clue that brought teams closer to identifying the final "treasure". The group that successfully completed all tasks and correctly guessed the treasure first was declared the winner. Throughout the sessions, the researcher acted as facilitator, providing technical support and maintaining the flow of the activity. The entire treatement was completed over three meetings spanning two weeks, with each session lasting approximately 45–60 minutes.

Data were collected using pre-tests, post-tests, and an observation sheet. Pre-tests assess students' initial vocabulary knowledge before the treatment of QR-based Treasure Hunt Game, while post-tests measure improvements after the treatment. Both groups take multiple-choice tests with 30 questions based on the teaching materials. The use of multiple-choice format serves both practical and analytical puposes. It allows consistent, objective evaluation of vocabulary mastery across different instructional methods, including recall, recognition, and context understanding. Each item is aligned with the vocabulary covered during the sessions, ensuring content validity and reliable performance comparisons between groups.

Following the pre-tests and post-tests, an observation sheet was used to monitor student engagement and responses during learning sessions, particularly in the experimental group that participated in the QR-based Treasure Hunt activity. The research analyzes data using the Paired Sample t-Test, comparing pre-test and post-test scores between the control and experimental groups to evaluate the effectiveness of the QR-based Treasure Hunt game in improving vocabulary learning.

To evaluate the instrument's validity, item validity was assessed through correlation analysis during both the pre-test and post-test stages. In the pre-test, the test yielded validity coefficients of 0.655, 0.903, 0.565, and 0.884, indicating moderate to high item validity. Reliability was examined using Cronbach's alpha, with a coefficient of 0.683 for the pre-test, suggesting acceptable internal consistency. Post-test results showed item validity scores of 0.455, 0.372, 0.822, and 0.971, reflecting a broader range of item validity. The post-test Cronbach's alpha was 0.731, demonstrating improved internal consistency across the tests.

This study faced a few limitations that may have influenced the results. First, the student groups were not randomly selected, which could introduce some bias in how the groups performed and responded to the treatment. The difference in group sizes, 36 students in the control group and 31 in the experimental group, may also have affected group dynamics and the comparison between outcomes. The duration of the intervention was relatively short, spanning only three sessions over two weeks. While this allowed for a focused application of the QR-based Treasure Hunt game, it may not have captured the full extent of students' vocabulary development or long-term retention. Another limitation was the reliance on students' personal smartphones for scanning QR codes. Not all students were equally familiar with using QR technology, and differences in device performance could have affected how smoothly they completed tasks. Lastly, because the research was conducted at a single school, a junior high school in Ungaran, Central Java, the findings may not reflect experiences in schools with different facilities, technology access, or student demographics. Future studies could expand the sample size, extend the duration of the intervention, and include schools in varied contexts to strengthen generalizability.

FINDINGS AND DISCUSSION

Vocabulary acquisition is a fundamental aspect of language learning, directly influencing students' reading comprehension, communication skills, and overall linguistic proficiency. Traditional vocabulary instruction often relies on rote memorization, which can lead to disengagement and limited retention. To address these challenges, gamification and technology-enhanced learning have emerged as effective strategies for fostering motivation and deeper cognitive processing, and so, this research focuses on investigating the use of QR-based Treasure Hunt game to teach English vocabulary to junior high school students in a public junior high school in Ungaran. This study integrates Constructivist Learning Theory and Cognitive Load Theory to examine the impact of a QR-based Treasure Hunt game on vocabulary development.

Constructivist theories by Piaget and Vygotsky highlight the importance of active learning and social interaction in cognitive development. The QR-based Treasure Hunt game aligns with constructivist principles by encouraging students to discover vocabulary through exploration, rather

than passive memorization. Vygotsky's Zone of Proximal Development (ZPD) suggests that students learn best when they engage in tasks slightly beyond their current abilities, supported by peers or teachers. The collaborative nature of the Treasure Hunt game facilitates peer-assisted learning, reinforcing vocabulary acquisition. In addition, John Sweller's Cognitive Load Theory explains how instructional design affects learning efficiency. QR codes streamline information access, reducing extraneous cognitive load by providing direct links to definitions, examples, and multimedia content. This allows students to focus on meaningful learning, enhancing vocabulary retention.

This research's integration of Constructivist Learning Theory and Cognitive Load Theory offers a comprehensive lens through which to view student engagement and performance. As the foundational ideas of Piaget, Vygotsky, and Sweller has been addressed previously, it is worth emphasizing how these theories manifested in observable classroom behavior. The Treasure Hunt game placed learners within Vygotsky's Zone of Proximal Development, where students worked collaboratively on challenges that were just beyond their individual abilities. The peer interaction and shared problem-solving observed during gameplay reflect active scaffolding in action, demonstrating how constructivist principles can unfold organically within gamified instruction. Similarly, Sweller's Cognitive Load Theory comes to life in the design of the QR-based intervention. Instead of overwhelming students with large blocks of static vocabulary lists, information was segmented and embedded within interactive challenges, reducing extraneous load. The students' ability to complete tasks efficiently and with sustained enthusiasm supports the idea that properly structured digital media can optimize cognitive processing. These insights not only validate the selection of the game format but also suggest new opportunities for instructional designers to develop learning environments that balance engagement and efficiency.

By integrating technology-enhanced strategies to constructivist learning, the QR-based Treasure Hunt game provides a multifunctional approach to vocabulary instruction. This framework supports the idea that interactive, student-centered learning environments foster deeper vocabulary acquisition and long-term retention. To prove this theory, the researcher has described the research framework which can be seen below.

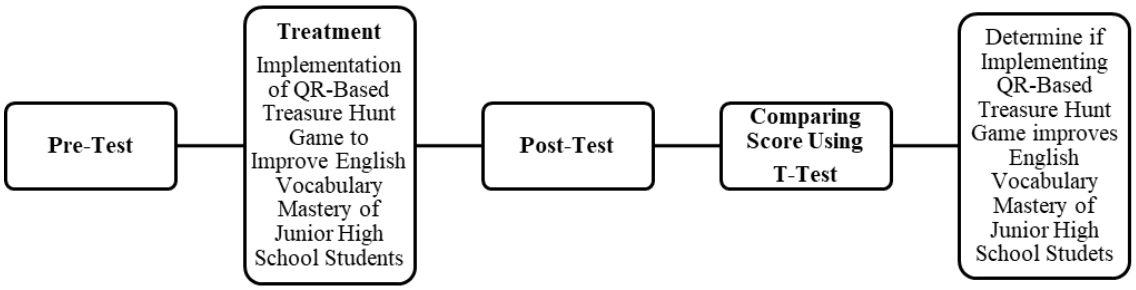

Figure 1. Research Framework

This research reveals that the QR-based Treasure Hunt game significantly improves vocabulary acquisition among 7th grade junior high school students, as indicated by the statistical results. Compared to traditional methods on English vocabulary learning, gamification with QR codes led to increased engagement and learning outcomes.

The findings of this research underscore the effectiveness of the QR-based Treasure Hunt game as a tool for enhancing vocabulary acquisition and mastery. The statistical results, processed through SPSS, show that the experimental group experienced a significantly greater improvement compared to the control group ($t = -6.473$, $p < 0.001$ vs. $t = -1.309$, $p = 0.199$). The lack of statistical significance in the control group suggests that standard instructional methods alone were insufficient in fostering substantial vocabulary growth. On the other hand, the strong significance in the experimental group highlights the positive role of gamification in language learning. This indicates that standard instructional approaches alone are insufficient for fostering substantial vocabulary growth, reinforcing the need for interactive and technology-enhanced learning environments. Therefore, by integrating interactive gameplay with QR-based vocabulary tasks, students engaged more deeply with the learning process, leading to better retention and comprehension.

Compared to the experimental group, the control group demonstrated minimal vocabulary improvement, despite receiving standard instruction. This contrast highlights the limitations of passive

learning approaches that rely on rote memorization and textbook exercises. Without the benefits of interactive challenges, contextual exploration, or collaborative gameplay, students in the control group had fewer opportunities to engage meaningfully with new vocabulary. This disparity suggests that traditional instruction may struggle to activate deeper cognitive processing or maintain student interest, reinforcing the value of gamified, technology-enhanced learning environments for more effective vocabulary acquisition.

These findings reinforce previous research on the effectiveness of gamification in education, as demonstrated by Sukenasa et al. (2020) and Alam & Khotimah (2021). Gamified learning strategies have been shown to increase student motivation, foster active engagement, and create memorable learning experiences that extend beyond traditional teaching methods. The results of this research further validate these principles, highlighting the role of game mechanics, competition, and interactive elements in improving vocabulary mastery.

Moreover, QR-based learning strategies have been widely recognized for their ability to seamlessly bridge physical and digital learning environments, creating dynamic opportunities for student exploration and autonomy (Malik et al., 2022; Al-Sababha, 2024). This hybrid functionality enables learners to access educational content instantly within real-world contexts, such as gardens, libraries, or laboratories, while interacting with multimedia resources like vocabulary exercises, pronunciation guides, and contextualized examples. By decentralizing information access through QR codes, the instructional design reduces dependence on teacher-led explanation, encouraging students to become independent navigators of their learning journey. This process aligns closely with Sweller's Cognitive Load Theory, which advocates for minimizing extraneous cognitive load and emphasizing materials that promote germane processing. QR codes streamline the information retrieval process, allowing students to bypass redundant steps and focus directly on meaningful vocabulary tasks. This not only enhances comprehension and retention but also supports the development of self-regulation and information-seeking skills—critical competencies in contemporary education.

Additionally, research by Celik (2023) and Paradiž (2021) emphasizes how QR-integrated activities can transform vocabulary instruction into a physically immersive experience. Unlike static methods that rely on word lists or definitions alone, QR-based learning encourages movement, discovery, real-world problem-solving, and social interaction. As students search for hidden QR codes across different school settings, they engage in kinesthetic learning that makes vocabulary acquisition more tangible and memorable. This study's findings further demonstrate that when language instruction incorporates exploration and challenge, students form stronger associative connections between new words and meaningful contexts. Moreover, the gamified structure, which includes timed tasks, team competition, and reward-based progression, heightens students' emotional and cognitive engagement. Students aren't just completing activities; they're investing in a mission. The integration of instant feedback through digital challenges allows students to self-correct and reflect in real time, promoting metacognitive awareness. These elements together embody the essence of technology-enhanced education, where active participation, curiosity, and collaboration drive not just outcomes but also enjoyment and personal growth.

While previous studies on gamification Vocabulary learning focuses more on online games and word-matching activities, this research builds on that foundation by demonstrating how QR-based gamification fosters deeper interactivity and learner autonomy. students were introduced to the QR-based Treasure Hunt game, specifically designed to enhance English vocabulary mastery through active exploration. From the outset, participants showed immediate interest and engagement, reflecting the motivational power of digital tools when integrated thoughtfully into instruction This finding aligns well with a study by Inayati & Waloyo (2022) which suggests that QR-integrated gamification positively impacts both student engagement and learning outcomes. Besides, the integration of ICT, which in this case is the QR code, marks a pedagogical shift from passive content delivery toward student-centered, exploratory learning. Sabiri (2020) emphasizes that such digital tools transform conventional teaching methods by offering novel media and platforms through which learners interact with information. By accessing multimedia vocabulary tasks embedded in QR codes, students become active participants rather than passive recipients, which significantly enhances their intrinsic motivation and retention. This shift also reflects a broader educational trend toward personalized, technology-enhanced instruction that prepares learners for the demands of a digitally complex world.

In this study, the interactive nature of the QR-based Treasure Hunt game enabled students to engage meaningfully with vocabulary through discovery, movement, and real-world challenges. Organized into small groups, students ventured beyond the classroom to explore a garden, a library, and and a laboratory, which were the locations where the QR codes were strategically hidden during this research. Each QR code scanned unlocked a unique challenge that required problem-solving, peer collaboration, and contextual application of vocabulary knowledge before students could receive clues to the "treasure." These activities transformed traditional memorization into a multisensory experience, stimulating curiosity and excitement. The students' physical involvement in scanning codes, interpreting clues, and sharing strategies made learning more memorable and enjoyable. This approach aligns with Constructivist Learning Theory which emphasizes that learners acquire knowledge most effectively when actively constructing meaning through hands-on engagement and social interaction. The integration of competition and instant feedback further amplified learning, fostering cognitive activation and emotional investment. In contrast to static exercises, this game-based structure promoted exploration, autonomy, and a sense of achievement which are key drivers of sustained motivation and vocabulary retention.

As they progressed through each task by successfully completing challenges and uncovering the final "treasure", learners received verbal praise and tangible rewards such as candies, reinforcing their accomplishments in a playful yet meaningful way. These reinforcements helped students feel acknowledged and appreciated, enhancing their self-esteem and enthusiasm for learning. More importantly, the reward system served as an intrinsic motivator, transforming what might otherwise be perceived as a routine academic task into an exciting, collaborative adventure. Students displayed genuine excitement, pride, and satisfaction throughout the activity, with visible enthusiasm, cheering, and peer encouragement emerging spontaneously. These emotional responses reflect more than fleeting enjoyment as they reveal personal investment and a sense of ownership over the learning process. The game's design required students to scan QR codes, solve contextual challenges, and make decisions as a team, encouraging autonomy and agency in their learning. The combination of positive reinforcement and interactive gameplay fostered a psychologically safe environment, where effort was recognized and success celebrated. This emotional environment empowered students to take risks, collaborate more openly, and participate fully, contributing not only to vocabulary retention but also to broader academic confidence.

Beyond the game mechanics, the learning environment itself plays a crucial role in enhancing engagement. Unlike traditional classroom settings, where learning often feels structured and confined, the QR-based Treasure Hunt activity unfolds across diverse locations such as a garden, library, and laboratory. These settings introduce novelty and variety, transforming familiar school spaces into interactive learning zones. Such diverse settings stimulate curiosity and provide opportunities for contextualized vocabulary learning, allowing students to connect language acquisition with authentic environments. The act of navigating between locations, scanning QR codes, and completing physical tasks fosters a sense of exploration that encourages autonomy and sustained attention.

The incorporation of movement and place-based learning also enhances kinesthetic engagement, thus catering to students who benefit from tactile and active instructional methods. As learners physically search for QR clues, they engage with vocabulary through embodied interaction which can improve memory retention and conceptual understanding. The multisensory experience, which combines visual, auditory, and physical stimuli, aligns with principles of experiential learning where students construct meaning by doing, rather than by merely receiving information. This approach not only supports differentiated instruction but also contributes to emotional engagement as students experience joy, surprise, and satisfaction during the hunting game. Ultimately, the synergy between gamification, environmental design, and physical movement creates a compelling learning atmosphere where vocabulary development becomes a lived experience. Students no longer perceive language study as an isolated task confined to desks and textbooks; instead, they see it as a meaningful journey embedded in real-world spaces. This shift reinforces the idea that instructional context matters and that immersive learning environments can play a transformative role in modern education.

Another factor that may explain the experimental group's superior performance is Cognitive Load Theory, developed by John Sweller. The theory explains that learning is most effective when instructional design minimizes extraneous cognitive load, which is the unnecessary mental effort caused by poorly structured content, and maximizes germane cognitive load, which supports schema construction and meaningful learning. Traditional vocabulary instruction often involves memorization and static word lists that present a large volume of disconnected information at once.

This approach can overwhelm students, as it burdens working memory with data lacking contextual coherence, thus reducing retention and engagement. Students may struggle to form durable mental representations when vocabulary is separated from usage and relevance.

In contrast, the QR-based Treasure Hunt game is structured to reduce cognitive overload by segmenting vocabulary into separate, context-rich tasks. Instead of confronting students with an entire vocabulary list, the game distributes content across multiple interactive stages, allowing gradual absorption and reinforcement. Scanning QR codes initiates a discovery-driven process where each challenge builds on the previous one, creating a layered and manageable learning experience. These learning sequence foster germane load by prompting learners to actively process vocabulary in meaningful contexts rather than passively decode words from a list. Additionally, the integration of real-world environments and thematic clues encourages associative learning, helping students link vocabulary to physical experiences and visual cues. This multimodal approach not only enhances comprehension but also supports long-term retention by activating deeper cognitive pathways and sustaining mental engagement. Through effective instructional design grounded in Cognitive Load Theory, this gamified activity successfully balances cognitive demand with motivation and autonomy, ensuring students remain focused, mentally stimulated, and capable of internalizing new vocabulary more effectively.

The variety of vocabulary-based challenges embedded within the QR codes plays a pivotal role in sustaining student engagement and promoting meaningful learning. Each QR code presents a distinct task designed to activate cognitive processes through problem-solving, contextual exploration, and social interaction. For instance, one challenge prompts students to correctly reorder a set of shuffled words to unlock a clue, while another asks them to identify and describe a nearby object, applying newly learned vocabulary in a real-world context. This diversity not only prevents monotony but strategically distributes cognitive effort, enabling students to approach language tasks from different angles. By delivering content in concise, structured formats, the game minimizes extraneous load and ensures students can navigate each challenge efficiently—boosting focus, reducing fatigue, and optimizing retention.

Clear instructions and immediate feedback within each QR task further streamline the learning experience. Students can process information, apply their understanding, and self-correct without facing unnecessary distractions. This level of instructional precision supports schema development by reinforcing meaningful associations between words, concepts, and usage. Additionally, the physical movement involved in scanning QR codes across multiple spaces such as the garden, library, and laboratory enhances kinesthetic engagement, anchoring vocabulary learning in embodied experience. As students interact with clues, collaborate with peers, and navigate diverse environments, they engage in multi-sensory learning that transcends rote memorization. Movement, exploration, and teamwork converge to create an immersive educational experience where vocabulary acquisition becomes active, situational, and deeply engaging. In this way, task variety not only maintains motivation but also elevates cognitive and emotional investment, making gamified instruction a dynamic and learner-centered approach to language development.

All in all, the success of the experimental group suggests that QR-based Treasure Hunt games offer a well-structured and pedagogically sound approach to vocabulary acquisition. By breaking down learning into interactive and manageable components, fostering curiosity through discovery-based challenges, and minimizing cognitive overload, this gamified strategy presents a compelling alternative to traditional instruction. Students not only engage with vocabulary actively but also retain it more effectively by connecting language to meaningful contexts and experiences. The combination of game mechanics, real-world exploration, and digital interactivity cultivates a learning environment that is both cognitively rich and emotionally resonant. These findings underline the value of designing vocabulary instruction that goes beyond memorization—favoring immersion, autonomy, and joy. As education continues to embrace digital integration, strategies like QR-based gamification stand out as promising tools for improving language mastery and deepening student motivation. Future classroom applications and research may further explore how such innovations can support diverse learners and expand the possibilities of experiential language learning.

In addition to the statistical findings processed through SPSS, qualitative observations from the teacher's evaluation provided further insights into the implementation and effectiveness of the QR-based Treasure Hunt game. The teacher's observation sheet highlighted several key aspects of the learning process, including student engagement, comprehension of instructions, collaboration dynamics, and the overall integration of ICT and gamification. The seamless incorporation of QR

codes into the lesson structure reinforced the positive impact of gamification, supporting the argument that interactive digital tools enhance student participation in vocabulary learning. Throughout the activity, most students demonstrated high levels of enthusiasm, actively scanning QR codes, solving vocabulary-based challenges, and working collaboratively to uncover the final "treasure." Their engagement with the interactive learning environment suggested a strong motivation to learn. However, despite the overall success of the gamified approach, the teacher's observations also pointed to challenges and limitations that emerged during treatment of this QR-based Treasure Hunt game activity.

First, variability in student-owned devices affected participation: one group, for example, struggled to scan QR codes due to incompatible phone apps or absent camera functionality, requiring external assistance to install the necessary tools. This highlights the importance of ensuring equitable access to reliable and compatible technology when designing digitally mediated learning experiences. Second, although verbal briefings and printed instructions were provided, alongside clear task prompts embedded within each QR code, some students still expressed confusion about gameplay mechanics, particularly during transitions between locations, navigating from one challenge to another, and comprehending the vocabulary tasks within the QR codes. They require direct guidance throughout the activity. This suggests that instructional clarity must be reinforced not only through design but also through ongoing in-game scaffolding.

Additionally, logistical challenges emerged during supervision. With students dispersed across multiple locations, such as the garden, the library, and the laboratory, and guided by only one facilitator, direct oversight was limited. While groups were initially assigned specific areas, free movement within those zones, combined with high levels of excitement, resulted in classroom noise that may have affected neighboring students. Another challenge is that, as only one teacher was overseeing the students, the inability to view and monitor all groups simultaneously created moments of disorganization and distraction. The fairly uncomfortable noise generated during the activity posed a risk of disturbing other classes, underscoring the need for careful planning when implementing gamified learning in shared school environments. Furthermore, the teacher observed that certain students were less active during the game, indicating that while gamification was highly effective for most, some learners may require individualized encouragement to participate more fully. This suggests that students learn best when guided within their capabilities, reinforcing the idea that differentiated instruction is necessary in technology-enhanced learning environments.

Lastly, while the teacher's qualitative observation provided rich insight into student behavior, the absence of structured interviews or focus group data limited the scope of affective interpretation. Informal student feedback during the closing activity revealed that many found the game enjoyable, though some felt slightly confused perhaps due to unfamiliarity with the format and time constraints. These reflections suggest that further studies could integrate formal post-activity assessments to better capture students' emotional and cognitive experiences. Addressing these limitations in future research will strengthen the design, implementation, and scalability of QR-based gamified learning interventions.

These challenges and limitations reflect a broader need for scaffolding strategies that support students throughout the gamified learning process, particularly those less familiar with digital technologies. Effective scaffolding extends beyond instructional design; it involves providing just-in-time assistance, clarifying gameplay mechanics, and ensuring students feel confident navigating both the digital and cognitive demands of the activity. When students encounter technical difficulties, such as not knowing how to scan QR codes or being unfamiliar with the app interface, their learning momentum can be disrupted. Targeted support, whether through peer mentoring, teacher guidance, or pre-activity orientation, can help bridge these gaps and foster a more inclusive experience. This aligns with the findings of Leshchenko et al. (2022) who emphasized that successful implementation of QR-based instructional strategies hinges on technological preparedness. Their study noted that students must have access to functioning smartphones equipped with reliable cameras and compatible QR code readers, as well as the skills to operate them effectively. Without these resources, learners risk disengagement due to unnecessary cognitive strain introduced by technical hurdles. Therefore, while QR codes offer exciting potential for enhancing English language education, their integration must be carefully managed. Teachers should evaluate the technological landscape of their classrooms, offer scaffolded digital support, and ensure that all learners can engage with the activity as intended. Only then can the pedagogical benefits of gamification, enhanced motivation, active participation, and meaningful language use be fully realized.

These observations correlate closely with the paired sample t-Test results, which demonstrated a highly significant improvement in vocabulary mastery among students in the experimental group ($t = -6.473$, $df = 35$, $p < 0.001$). The teacher's assessment validates the statistical data, confirming that the QR-based gamification approach not only improved vocabulary retention but also fostered a more engaging and interactive learning experience. Despite minor challenges in execution, the overall effectiveness of gamification was clear, strengthening the argument that technology-enhanced teaching strategies can revolutionize traditional language learning methods.

The teacher's positive evaluation of the QR-based Treasure Hunt game further supports the validity of gamification as an instructional tool. This study provides strong evidence that gamified learning increases student motivation, collaboration, and vocabulary retention, while also emphasizing the importance of well-structured implementation to address challenges in comprehension and participation. As technology continues to reshape education, integrating gamification with digital tools like QR codes presents a promising direction for future vocabulary learning practices.

Taken together, the quantitative results and qualitative observations underscore the transformative potential of QR-based gamification in vocabulary instruction. By blending digital interactivity, physical exploration, and pedagogical strategy, this study affirms that gamified learning is more than a motivational gimmick as it is an instructional design capable of fostering deep engagement, meaningful retention, and inclusive learning experiences. While implementation challenges remain, the evidence points to a promising shift in language education toward dynamic, learner-centered environments where vocabulary development is both effective and enjoyable.

CONCLUSION

This study examined the effectiveness of gamification in vocabulary learning, focusing on the use of a QR-based Treasure Hunt game with 7th grade junior high school students. Quantitative results from the Paired Samples t-Test revealed statistically significant improvements in the experimental group ($t = -6.473$, $df = 35$, $p < 0.001$), while no significant changes were observed in the control group. These findings confirm that gamified instruction fosters deeper engagement, encourages active learning, and enhances retention, offering a powerful alternative to traditional vocabulary teaching methods. Complementing these results, qualitative insights from teacher observations underscored the impact of ICT integration and interactive game mechanics on student participation and motivation. While the activity was largely successful, some students struggled with instruction clarity and required guidance which reveals the importance of instructional scaffolding and differentiated support.

Building on these findings, several practical recommendations emerge. Teachers should craft well-structured gamified activities using step-by-step guidance, visual aids, and explicit instructions to minimize confusion and enhance accessibility. Embracing digital tools, such as quizzes and interactive platforms, alongside QR-based tasks can enrich engagement and support diverse learning styles. Collaborative learning should be encouraged through team-based challenges that reinforce vocabulary acquisition. For less active students, differentiated strategies and tailored support can improve participation and inclusivity. At the policy level, educational stakeholders should advocate for the integration of gamified methodologies into curriculum design, invest in digital infrastructure, and provide teacher training programs focused on game-based instruction. These steps can help scale effective practices across varied educational settings and ensure sustainable, innovation-driven learning environments.

While the study offers compelling evidence of gamification's value, challenges such as device limitations, supervision constraints, and variability in learner engagement highlight the need for thoughtful planning and continued research. Future studies should explore long-term vocabulary retention, compare diverse gamification formats, investigate learner diversity, and expand to other language domains like grammar and reading comprehension. Ultimately, this research reinforces that gamified learning, when carefully designed and supported, can revolutionize language education, transforming passive instruction into dynamic, memorable experiences that empower students to thrive in a digital age.

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