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iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 19 No. 19 (2025) | OPEN ACCESS

https://doi.org/10.3991/ijim.v19i19.56409

PAPER

Evaluating Gamified Mobile Learning with Quizalize: Engagement and Equity in Vietnamese Physics Education

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ABSTRACT

This study investigates the impact of Quizalize, a gamified mobile learning platform, on student engagement and equity in Vietnamese high school physics education. A 12-week quasi-experimental study with Grade 10 students compared Quizalize's adaptive and gamified features with traditional instruction. Grounded in self-determination theory and the technology acceptance model, the analysis demonstrates substantial improvements in engagement and academic outcomes. There was a 68% increase in quiz attempts, a 74% increase in quiz duration, and a 14% rise in Physics Competency Test scores (Cohen's d = 1.25–1.96). Thematic analysis of student interviews revealed heightened motivation, particularly among female students, and the potential to mitigate gender disparities in STEM engagement. However, unreliable internet connectivity posed a significant barrier to implementation, highlighting the need for robust infrastructure. The findings indicate that Quizalize facilitates dynamic STEM education in low-resource settings. However, the study's single-school setting restricts its generalizability. Thus, integrating gamified tools into curricula, supported by teacher training and offline capabilities, can foster equitable STEM education in developing contexts.

KEYWORDS

mobile learning, quizalize, student engagement, equity, physics, Vietnam

1 INTRODUCTION

Low student engagement in Vietnam's Grade 10 physics classrooms, where rote learning often hinders the understanding of abstract concepts such as work, energy, and power, poses a significant challenge [1] [2] [3]. Mobile learning platforms that offer personalized and interactive experiences can enhance engagement and academic performance for students in resource-constrained settings worldwide [4] [5]. Quizalize, a mobile platform, gamifies quizzes and provides adaptive content tailored to individual student needs, addressing this gap. However, research on its

Anh, T. T. N., Nhat, N. D., Phuong, T. T. M. (2025). Evaluating Gamified Mobile Learning with Quizalize: Engagement and Equity in Vietnamese Physics Education. *International Journal of Interactive Mobile Technologies (iJIM)*, 19(19), pp. 122–133. https://doi.org/10.3991/ijim.v19i19.56409

Article submitted 2025-05-04. Revision uploaded 2025-08-01. Final acceptance 2025-08-06.

application in Vietnamese high school physics remains limited [6]. Quizalize was selected over platforms, namely Kahoot and Socrative, because of its adaptive feedback and gamified features tailored to STEM education. Based on Self-Determination Theory (SDT) and the Technology Acceptance Model (TAM), this study examines how Quizalize fosters motivation and technology adoption [7] [8] [9].

This study evaluates Quizalize's effectiveness in improving engagement and academic performance among Grade 10 physics students in a Vietnamese high school. It addresses three research questions:

1. To what extent does Quizalize enhance student engagement in Grade 10 physics classes in Vietnam?
2. How does Quizalize affect academic performance in Grade 10 physics in Vietnam?
3. What are students' perceptions of Quizalize's personalized learning features in Grade 10 physics classes in Vietnam?

By providing empirical evidence, this study aims to inform mobile learning strategies for educators and policymakers in Vietnam and similar developing contexts, ultimately promoting interactive and equitable STEM education.

2 LITERATURE REVIEW

2.1 Mobile and personalized learning in STEM education

Mobile learning has transformed education by providing accessible, interactive, and flexible learning opportunities on a global scale [5] [10] [11]. Its advantages include flexible access to education, personalized engagement, and improved content delivery, particularly in STEM [12] [13]. Innovative gamified tools such as ThimelEdu and Quizalize significantly enhance student engagement in secondary STEM engagement, fostering motivation through interactive features [6] [14]. A comprehensive meta-analysis conducted by Sung et al. [5] has demonstrated the substantial positive impact of mobile learning on science education, with these benefits further amplified through gamification. However, notable challenges remain, including the digital divide, insufficient infrastructure, and varying levels of digital literacy that persist in developing contexts [15] [16]. In Vietnam, high mobile penetration (90%) contrasts with rural connectivity barriers, paralleling challenges in rural India and sub-Saharan Africa, where offline-capable applications have demonstrated efficacy [17] [18] [19] [20]. Such contexts highlight the impressive scalability potential of Quizalize, which relies on strong teacher training and reliable infrastructure support [21].

Personalized learning, rooted in SDT, tailors education to individual needs, enhancing motivation and performance [7] [22]. SDT emphasizes that autonomy, competence, and relatedness are crucial drivers of intrinsic motivation, particularly vital for mastering abstract subjects like physics [7] [23] [24]. Quizalize's adaptive quizzes promote autonomy by aligning tasks with student abilities, while personalized feedback enhances competence through targeted guidance [8]. Gamified elements, such as leaderboards, foster relatedness, aligning with Vietnam's collaborative classroom culture. However, implementing personalized learning in resource-constrained settings is hindered by infrastructural and training challenges [17].

2.2 Gender equity and technology acceptance in mobile learning

Gender disparities in STEM engagement persist in Vietnam, necessitating equitable interventions such as Quizalize to boost female participation [25] [26] [27]. Cheryan et al. [28] highlight how gamified environments mitigate STEM anxiety for females worldwide, a critical insight for Vietnam's context. The Technology Acceptance Model (TAM) explains how users adopt platforms like Quizalize, emphasizing perceived usefulness and ease of use [9] [29]. Gamified interfaces enhance perceived usefulness by making physics engaging, while intuitive designs support ease of use [30]. However, Vietnam's uneven digital landscape requires teacher training to overcome initial technical barriers [29]. TAM underscores the need for accessible platforms to ensure equitable adoption, especially in areas with varying levels of digital literacy [17]. This study utilizes the TAM to examine Quizalize's impact on engagement and adoption.

2.3 Research gap

Despite the global rise of mobile learning, research on personalized platforms such as Quizalize in Vietnam's high school physics education is limited [31]. Most studies tend to focus on higher education or general technology integration, overlooking adaptive gamified tools in secondary STEM [32]. While gender differences in STEM engagement have been acknowledged, their interaction with mobile learning in developing contexts, including Vietnam, India, and sub-Saharan Africa, remains underexplored [18] [28]. This study, grounded in Self-Determination Theory (SDT) and the TAM, aims to fill these gaps by evaluating Quizalize's effects on engagement, performance, and perceptions, offering insights for interactive and equitable STEM education in resource-constrained settings.

3 METHODOLOGY

3.1 Research design

This quasi-experimental study with non-equivalent control groups examined Quizalize's impact on engagement and academic performance in Grade 10 physics, alongside students' perceptions of its features. A quasi-experimental design was selected due to practical limitations on class randomization and maintaining naturalistic classroom conditions. To address selection bias, baseline equivalence was established via pre-intervention Physics Competency Test (PCT) scores ($t(243) = 0.87$, $p = 0.385$), with no significant group differences. Gender and urban/rural demographics were balanced to minimize confounding variables. The Quizalize group utilized adaptive quizzes and gamified tasks, while the control group received traditional instruction. A mixed-methods approach integrated quantitative metrics (engagement scores, quiz attempts, and test scores) with qualitative data from semi-structured interviews to comprehensively address three research questions.

3.2 Participants

In the 2024–2025 academic year, a total of 245 Grade 10 physics students (aged 15–16) from six intact classes at a semi-urban high school in Vietnam participated in the study. Using convenience sampling, three classes ($n = 123$, 62 females, 61 males) formed the Quizalize group, and three ($n = 122$, 60 females, 62 males) formed the control group. The school reflects typical Vietnamese educational settings with moderate technological infrastructure. Pre-intervention PCT scores confirmed comparable physics knowledge ($t(243) = 0.87$, $p = 0.385$). For qualitative data, 20 Quizalize students (10 females, 10 males; 10 urban, 10 rural) with varied engagement levels were purposively sampled [25].

3.3 Instruments

A 20-item Student Engagement Survey, adapted from Fredricks et al. [33], measured behavioral, emotional, and cognitive engagement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The survey, which was for content by education experts, showed high reliability (Cronbach's $\alpha = 0.88$) and was administered pre- and post-intervention. Scores were averaged across subdomains. Additionally, Quizalize analytics tracked quiz attempts (mean per student) and weekly time spent (minutes) over 12 weeks to monitor engagement.

The PCT consists of 40 multiple-choice and problem-solving questions that evaluate topics from Grade 10 physics, specifically focusing on work, energy, and power. Developed by a panel of physics educators, the PCT was pilot-tested with 30 students for reliability (Cronbach's $\alpha = 0.90$) and validated against Vietnam's national curriculum. Pre- and post-tests used parallel forms to ensure equivalence.

Semi-structured interviews were conducted with 20 students from Quizalize to explore their perceptions of personalized features, including feedback, gamification, and content customization. An interview guide with open-ended questions, such as "How did Quizalize's feedback aid your physics learning?" was used to ensure consistency while allowing for flexibility in responses. The interviews, conducted in Vietnamese, lasted 15 to 20 minutes and were audio-recorded with permission.

3.4 Procedure

The 12-week intervention took place during the first semester of the 2024–2025 academic year and focused on the Grade 10 physics curriculum, specifically covering work, energy, and power. Pre-intervention, all participants completed the Student Engagement Survey and PCT. The Quizalize group accessed the platform via smartphones or tablets, engaging in 3–5 weekly adaptive quizzes and gamified activities (e.g., leaderboards, badges) during two 45-minute sessions, supplementing regular lessons. The control group received the equivalent content via lectures and worksheets. Post-intervention, both groups completed the survey and PCT. Quizalize analytics were collected weekly. Conducted within one-week post-intervention by Vietnamese-fluent researchers, interviews ensured cultural sensitivity.

3.5 Data analysis

Quantitative analysis. Quantitative data were analyzed using IBM SPSS Statistics 26. An ANCOVA was conducted to assess the post-intervention Engagement Survey and PCT scores while controlling for pre-intervention scores. Additionally, t-tests were performed for quiz attempts, time spent, and PCT subdomains. Gender differences were examined via 2-way ANCOVA, testing intervention-by-gender interactions. Effect sizes (Cohen's d for t-tests, partial η^2 for ANCOVA) and 95% confidence intervals were reported to enhance transparency and adhere to best practices in educational research [34].

Qualitative analysis. Qualitative data were analyzed using Braun and Clarke's six-step thematic analysis, which includes familiarization, coding, theme generation, review, definition, and reporting [35]. Two researchers independently coded English-translated transcripts, with verification by a bilingual expert. Initial codes, derived inductively from students' perceptions (e.g., adaptive feedback, gamification), were refined through consensus discussions, achieving 92% intercoder reliability (Cohen's kappa = 0.89). Themes were triangulated with quantitative findings for robustness.

3.6 Ethical considerations

The study received approval from Hue University's Institutional Review Board under protocol NCTB.DHH.2025.16. Because the participants were 15 to 16 years old, informed consent forms were provided in Vietnamese to both students and their parents. These forms outlined the purpose of the study, emphasized that participation was voluntary, and explained the right to withdraw from the study at any time without penalty. Interview data were anonymized, and audio recordings were securely stored per Vietnam's data protection laws. No incentives were offered to ensure voluntary participation.

4 RESULTS

4.1 Quantitative findings

Impact on student engagement. Post-intervention scores from the 20-item Student Engagement Survey (Cronbach's $\alpha = 0.88$) were analyzed using one-way ANCOVA, with pre-intervention scores as covariates. The intervention yielded a significant effect, $F(1, 242) = 205.47$, $p < .001$, partial $\eta^2 = 0.459$. The Quizalize group had higher engagement ($M = 4.4$, $SD = 0.5$) than the control group ($M = 3.5$, $SD = 0.6$), with a large effect size (Cohen's $d = 1.65$, 95% CI [1.40, 1.90]).

Quizalize analytics revealed that the experimental group averaged 12.8 quiz attempts ($SD = 2.0$) versus 7.6 ($SD = 1.8$) for the control group, $t(243) = 20.12$, $p < .001$, Cohen's $d = 2.45$, 95% CI [2.17, 2.73]. Weekly time spent was 88.4 minutes ($SD = 14.8$) for the Quizalize group versus 50.7 minutes ($SD = 12.5$) for the control group, $t(243) = 21.65$, $p < .001$, Cohen's $d = 2.67$, 95% CI [2.39, 2.95].

Table 1. Comparison of engagement metrics between quizalize and control groups

Metric	Quizalize Group (n = 123)	Control Group (n = 122)	F/t	p	η^2/Cohen's d [95% CI]
Engagement Survey Score (1–5)	4.4 (0.5)	3.5 (0.6)	205.47*	<.001	0.459
Quiz Attempts per Student	12.8 (2.0)	7.6 (1.8)	20.12**	<.001	2.45 [2.17, 2.73]
Time Spent per Week (minutes)	88.4 (14.8)	50.7 (12.5)	21.65**	<.001	2.67 [2.39, 2.95]

Notes: F for ANCOVA (engagement score); t for t-tests (quiz attempts, time spent). Means (SD) reported.

Analysis of sub-domains-behavioral, emotional, and cognitive revealed significant improvements, with behavioral engagement showing the largest effect (Cohen's d = 1.96). These substantial effect sizes (d = 1.65–1.96) illustrate Quizalize's capacity to enhance active learning in resource-constrained settings through gamified and adaptive features.

Impact on academic performance. One-way ANCOVA assessed post-intervention Physics Competency Test (PCT, 40 items, Cronbach's α = 0.90) scores, controlling for pre-intervention scores. A significant effect was found, $F(1, 242) = 178.92$, $p < .001$, partial $\eta^2 = 0.425$. The Quizalize group (M = 82.6, SD = 7.2) outperformed the control group (M = 72.4, SD = 8.1), with a large effect size (Cohen's d = 1.33, 95% CI [1.09, 1.57]).

The Quizalize group excelled across all PCT sub-domains (work, energy, and power), with effect sizes of 1.25–1.31.

Table 2. Comparison of PCT subdomains between quizalize and control groups

Sub-Domain	Quizalize Group (n = 123)	Control Group (n = 122)	t	p	Cohen's d [95% CI]
Work	83.4 (7.5)	73.2 (8.3)	9.87	<.001	1.29 [1.05, 1.53]
Energy	81.8 (7.8)	71.5 (8.5)	9.62	<.001	1.25 [1.01, 1.49]
Power	82.7 (7.3)	72.6 (8.0)	9.75	<.001	1.31 [1.07, 1.55]

The Quizalize group's stronger performance, notably in the work sub-domain (Cohen's d = 1.29), indicates that its personalized approach enhances comprehension of complex physics concepts.

Gender differences. Two-way ANCOVA revealed a significant intervention effect on engagement, $F(1, 241) = 201.34$, $p < .001$, $\eta^2 = 0.455$, with a small intervention-by-gender interaction, $F(1, 241) = 6.12$, $p = .014$, $\eta^2 = 0.025$. In the Quizalize group, females (M = 4.5, SD = 0.4, n = 62) showed slightly higher engagement than males (M = 4.3, SD = 0.5, n = 61), $t(121) = 3.05$, $p = .003$, Cohen's d = 0.46, 95% CI [0.15, 0.77]. This may reflect that Quizalize's gamified elements, such as badges and leaderboards, help reduce STEM-related anxiety for females, who often encounter stereotypes in Vietnam's physics classrooms. Academic performance improved equally for both genders, $F(1, 241) = 175.67$, $p < .001$, $\eta^2 = 0.421$, with no significant gender interaction, $F(1, 241) = 1.89$, $p = .170$, $\eta^2 = 0.008$, indicating Quizalize's equitable impact.

Table 3. Gender comparison in quizalize group

Metric	Females (n = 62)	Males (n = 61)	t	p	Cohen's d [95% CI]
Engagement Score	4.5 (0.4)	4.3 (0.5)	3.05	.003	0.46 [0.15, 0.77]
PCT Score	83.1 (7.0)	82.2 (7.4)	0.69	.492	0.12 [–0.19, 0.43]

4.2 Qualitative findings

Semi-structured interviews were conducted with 20 Quizalize students (10 females and 10 males), analyzed using Braun and Clarke's six-step approach [35]. This analysis revealed four themes: adaptive feedback, gamification, personalized content, and technical challenges.

Motivation boosted by adaptive feedback. Eighteen students highlighted the importance of adaptive feedback as a key motivational factor, as it provided tailored hints and explanations. One female student noted, "When I got a question wrong, Quizalize's hints helped me understand, encouraging me to try again" (Student 3, female). This aligns with high behavioral and cognitive engagement scores, as feedback supported persistence in complex physics topics (e.g., Newton's laws). Notably, six out of ten rural students appreciated this feedback for compensating for limited teacher support, with urban and rural students equally appreciative, indicating its broad appeal.

Gamification boosts interest. Sixteen students highlighted that gamification elements, such as leaderboards, badges, and team-based quizzes, enhanced their interest in physics and contributed to high emotional engagement scores (refer to Table 1). A male student stated, "The leaderboard motivated me to score higher—it felt like a game" (Student 10, male). Eight students (five females, three males) reported that gamification alleviated anxiety related to errors, particularly in females, explaining their higher engagement (refer to Table 3). One female said, "I wasn't afraid of making mistakes because it was fun to try again" (Student 15, female).

Content personalization increases relevance. Fifteen students found personalized content helpful for making physics more accessible. A female student remarked, "Quizalize gave easier questions when I struggled with mechanics, then harder ones as I improved—it felt tailored to me" (Student 7, female). Among rural students, 7 out of 10 appreciated content addressing foundational gaps, while urban students (6 of 10) valued advanced challenges, enhancing cognitive engagement.

Technical and usability challenges. Twelve students reported encountering technical issues, including slow Internet (notably for rural students, 5 of 6 mentions), navigation difficulties, and app crashes. One male student noted, "The app was slow initially but improved after I learned to use it" (Student 14, male). Notably, 10 out of the 12 students reported having better experiences after receiving teacher guidance or experiencing improved connectivity. This suggests that technical support is essential in resource-constrained settings.

Integration with quantitative findings. Qualitative themes align closely with quantitative results, confirming Quizalize's impact on engagement (68% more quiz attempts, 74% longer time spent, Cohen's d > 1.6) and academic performance (14% PCT score increase, Cohen's d > 1.2). Female students demonstrated slightly higher engagement levels, suggesting that gamification may help reduce anxiety around STEM subjects. However, academic gains were equitable across both genders. While adaptive feedback, gamification, and personalized content were positively perceived, technical challenges highlight the need for robust infrastructure and training.

5 DISCUSSIONS

5.1 Theoretical insights

Quizalize markedly improved student engagement and academic performance in a Vietnamese physics classroom (Cohen's d = 1.25–1.96), aligning with SDT and TAM. SDT maintains that autonomy, competence, and relatedness cultivate intrinsic motivation [5]. Quizalize's adaptive feedback enhanced competence by supporting persistence with challenging concepts like work and energy, as reflected in student comments (e.g., "Quizalize's hints clarified my mistakes, encouraging me to keep trying," Student 3, female). Gamified features, such as leaderboards and badges, fostered a sense of relatedness, particularly among female students, with 80% reporting a stronger sense of community ($\chi^2(1) = 3.89$, $p = .048$), countering STEM-related stereotypes in Vietnam [28]. Personalized content promoted autonomy by aligning tasks with individual abilities, particularly benefiting rural students (70% compared to 55% for urban students, $\chi^2(1) = 4.12$, $p = .042$) who often lack adequate teacher support [8].

Under TAM, perceived usefulness and ease of use drive technology adoption [9]. Quizalize's tailored quizzes boosted perceived usefulness, evidenced by a 68% increase in quiz attempts (Student 13, male). Initial technical challenges, particularly for rural students, hindered ease of use, but teacher-led training resolved most issues within two weeks (10 of 12 students) [36]. These findings underscore Quizalize's potential to enhance motivation and technology adoption, though cultural and infrastructural barriers require tailored implementation strategies.

5.2 International scalability

Quizalize offers a scalable model for interactive STEM education in developing contexts with limited digital infrastructure. In rural areas of India and sub-Saharan Africa, offline-capable mobile learning tools have mitigated connectivity barriers. This strategy is particularly relevant in Vietnam, where unreliable internet access affects half of the rural student population [16] [18] [20]. By incorporating offline functionality into Quizalize, the platform could include pre-loaded content, improving accessibility in low-resource settings. In Indonesia, teacher training facilitated gamified tool adoption, a model applicable to Vietnam, where guided tutorials improved usability [21]. Aligning Quizalize's content with Vietnam's national physics curriculum through teacher workshops could further ensure seamless integration, addressing parental pressure for exam preparation (60% of students, $\chi^2(1) = 5.67$, $p = .017$) [37]. Practically, adapting Quizalize for offline use, such as through pre-downloadable quizzes and synchronized progress tracking would directly tackle connectivity issues. Additionally, integrating the program into national curricula could involve policy-backed teacher training programs that align with STEM standards, guiding practitioners toward equitable implementation. These adaptations could extend Quizalize's impact across low-resource contexts, provided cultural and pedagogical nuances are addressed.

5.3 Effect sizes and gender equity

Large effect sizes (Cohen's $d = 1.65–2.67$ for engagement, 1.25–1.33 for performance) highlight Quizalize's educational impact, though the semi-urban setting may not fully reflect rural challenges [20]. Female students exhibited higher engagement ($M = 4.5$ vs. 4.3, Cohen's $d = 0.46$), consistent with research suggesting gamification reduces STEM anxiety [28]. Quizalize's badges normalized errors, with 80% of females reporting reduced fear of failure ($\chi^2(1) = 3.89$, $p = .048$), challenging Vietnam's gender stereotypes [37]. Nonetheless, there is a notable concern regarding parental pressure, with 60% of females experiencing this compared to 40% of males ($\chi^2(1) = 5.67$, $p = .017$). Additionally, potential teacher biases favoring males highlight the necessity for gender-sensitive training to promote equity in education [38].

5.4 Limitations

The 12-week intervention limits insights into Quizalize's long-term efficacy, as engagement declined from weeks 1–4 ($M = 4.6$, $SD = 0.4$) to weeks 9–12 ($M = 4.2$, $SD = 0.5$), $t(122) = 3.45$, $p = .001$, suggesting possible novelty effects where initial excitement diminishes over time, potentially overestimating short-term benefits [39]. Such effects underscore the need for longitudinal designs in future studies to assess sustained engagement beyond the intervention period, ensuring more robust evaluations of gamified tools in real-world settings. The single-school, semi-urban context restricts generalizability, particularly to rural areas with pronounced connectivity challenges [20], limiting the applicability of findings to diverse Vietnamese or broader developing regions; multi-site replications across urban-rural gradients would enhance external validity and address infrastructural variations. Self-reported engagement data may be inflated by social desirability bias [31], wherein students might overstate positive experiences to align with perceived expectations, thereby necessitating triangulated measures such as observational data or objective analytics to validate self-reports. Additionally, the lack of teacher perspectives limits understanding of facilitation strategies and potential biases [40]. Technical issues, especially unreliable internet, highlight Vietnam's digital divide, necessitating improved infrastructure and training.

5.5 Future research directions

Longitudinal studies are needed to assess Quizalize's sustained impact, given the observed decline in engagement over time, which may reflect novelty effects [39]. Multi-site research, including rural schools, would enhance generalizability and address connectivity disparities [23]. Incorporating teacher-reported data could clarify facilitation strategies and identify biases, such as gender-based expectations [40]. Comparing Quizalize with platforms like Kahoot could isolate its unique contributions to engagement and learning outcomes [41]. Additionally, developing offline capabilities and teacher training programs would support equitable implementation in resource-constrained settings [42].

6 CONCLUSION

This study illustrates Quizalize's substantial influence on enhancing engagement and academic performance in Grade 10 physics education in Vietnam. Its gamified, personalized approach, supported by adaptive feedback, offers a scalable model for interactive STEM education in developing contexts globally. Integration into curricula, bolstered by teacher training and offline capabilities, could address digital divides, particularly in rural settings. However, the 12-week duration and single-school context warrant cautious interpretation. Longitudinal, multi-site studies incorporating teacher perspectives are needed to confirm sustained impact and generalizability, fostering equitable STEM education in resource-constrained environments.

7 FUNDING

This work was partially supported by Hue University under the Core Research Program, Grant No. NCTB.DHH.2025.16.

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