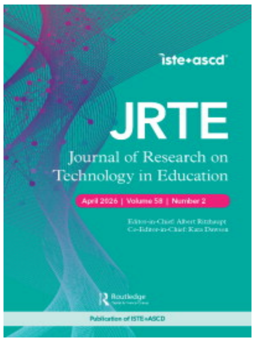

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Exploring the impact of teacher support in competitive digital learning games on primary students' learning and academic engagement

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ABSTRACT

This study examined the effects of teacher support and competition in digital learning games on fifth-grade students' learning and academic engagement. Sixty-three students participated in a pretest–intervention–posttest design, assigned to one of three groups: a control group, a competition-only group, and a competition with teacher support group. Results indicated that combining competition with teacher support produced the highest gains in engagement and learning, while competition alone also outperformed the control condition. These findings highlight the value of integrating both motivational elements and pedagogical support into digital learning games to maximize students' academic outcomes.

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Digital learning games; teacher support; academic engagement; competition; primary education; game-based learning

Introduction

Digital learning games hold considerable promise as effective educational tools, particularly for elementary and middle school students (Mayer, 2019; McLaren, 2024; McLaren et al., 2022a; Moradi et al., 2024; Wang et al., 2025). These games are designed not only to impart knowledge but also to empower and engage learners, fostering the development of essential skills such as critical thinking, problem-solving, and collaboration (Amzalag et al., 2024; Manesis, 2020; Molin, 2017). Research indicates that digital learning games can help students achieve shared learning objectives (Cagiltay et al., 2015) while enhancing their motivation, engagement, and cooperative abilities (McLaren, 2024; Zahra, 2023).

Building on this potential, the use of digital learning games in elementary education is particularly important, as these tools can enhance students' motivation, engagement, and literacy skills. For instance, Yang and Kuo (2022) reported increased motivation and social achievement in reading activities, while Sadan et al. (2024) found that digital vocabulary games elicited more positive emotions and persistence compared to traditional instruction. Similarly, DGBL can boost engagement, sustain students' attention in learning activities (Engerman et al., 2015; Yu & Tsuei, 2023), and support literacy development, including reading and vocabulary skills (Sadan et al., 2024).

Prensky's (2001) foundational work on digital game-based learning further supports these findings. He highlights that digital games combine challenge, engagement, feedback, and opportunities for repeated practice, creating learning environments aligned with the needs of today's

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"digital native" learners. Games naturally promote intrinsic motivation, emotional involvement, and a state of flow, enabling learners to sustain attention, engage persistently, and practice skills through repeated attempts.

Despite these benefits, significant challenges remain in the design and development of digital learning games that successfully engage students and promote deep learning (Rahimi et al., 2022; Shute et al., 2019a). In fact, some educational games have been described as mere "chocolate-covered broccoli," lacking genuine fun and engagement for learners (Li et al., 2021). Therefore, further research is needed to develop strategies that enhance both student engagement and the educational effectiveness of digital learning games.

A variety of game features have been identified as important contributors to the engagement potential of digital learning games. Malone and Lepper (1987) proposed a comprehensive motivational framework for digital games, incorporating both intrinsic motivation and extrinsic motivation. According to their framework, essential game elements include challenge, competition, cooperation, curiosity, recognition, and control.

More recent research has underscored the significance of competition among these elements. Chen et al. (2020) highlighted competition as a critical characteristic that can boost intrinsic motivation by fostering students' sense of autonomy and competence (Deci & Ryan, 1985), while also enhancing extrinsic motivation through rewards, challenges, and recognition (Acquah & Katz, 2020). Competitive elements in digital learning games not only increase engagement and motivation but also promote a sense of ownership over learning and support collaborative efforts among students (McGuire, 2025).

In addition to game features, recent research underscores the pivotal role of teacher support in fostering student engagement. For instance, Yang et al. (2024) found that both emotional and competence support from teachers positively influence students' engagement in mathematics. Similarly, Zhang and Hu (2025) demonstrated that teacher support predicts engagement by increasing students' learning motivation, while Zhang et al. (2024) reported that teacher support exerts both direct and indirect effects on student engagement in physical education, mediated by academic self-efficacy and positive emotions. Collectively, these findings indicate that teacher support not only directly impacts student engagement but also operates through mediating factors such as anxiety and self-efficacy, emphasizing the need to address students' emotional and motivational needs (Zhang et al., 2024).

Numerous studies have demonstrated that both competition (Cagiltay et al., 2015; Wang & Huang, 2023) and teacher support (Foster & Shah, 2020; Molin, 2017; Mutch-Jones et al., 2021) positively influence the learning outcomes and academic engagement of students using digital learning games. However, existing research has not yet examined the combined effect of competition and teacher support. Therefore, the present study aims to investigate the supportive role of teachers in a digital game-based competition and its impact on primary students' learning and academic engagement. To address this gap, the present study employed a pretest–intervention–posttest design involving three groups: a control group, a competition-only group, and a competition with teacher support group.

Theoretical framework of engagement

Prensky's (2001) foundational work on digital game-based learning highlights that digital games combine challenge, engagement, feedback, and opportunities for repeated practice, creating learning environments aligned with the needs of today's "digital native" learners. Essential game elements—such as structured rules, clear goals, interactive feedback, conflict/challenge, and social or story components together create a deeply immersive and motivating learning environment that supports cognitive development, active learning, and engagement. These characteristics make DGBL particularly effective for enhancing students' engagement, which is an important focus of the present study.

This study also draws on Vygotsky and Cole (1978) social constructivist theory and Bandura and Walters (1977) social learning theory, both emphasizing active involvement in learning. Student engagement, in this context, refers to the degree of active participation and effort that students invest in their learning. Engagement is conceptualized as a multidimensional construct encompassing behavioral, emotional, cognitive, and agentic dimensions (Reeve, 2013). Behavioral engagement refers to students' involvement in learning through attention, effort, and persistence, while emotional engagement reflects the presence of positive emotions, such as interest, and the absence of negative emotions, such as anxiety. Cognitive engagement involves using deep learning strategies, such as elaboration, rather than rote memorization. Agentic engagement reflects students' proactive involvement in shaping the flow of instruction and personalizing their own learning experiences. Collectively, these four dimensions constitute the theoretical

The role of competition in digital learning games

Competition in digital learning games typically takes two forms: social competition, where learners compete against peers, and self-competition, where individuals strive to surpass their own previous performance (Chen, 2014). Game elements such as leaderboards and badges often encourage these forms of competition (Hanus & Fox, 2015; Looyestyn et al., 2017). Competition also triggers social comparison, especially through leaderboards, aligning with Festinger's (1954) theory that individuals evaluate their abilities by comparing themselves to others, which is common in educational contexts (Morschheuser et al., 2019; Vandercruysse et al., 2013).

To facilitate social competition in this study, students participated in three competitive mini-games and utilized a leaderboard scoring system, which enabled them to compare their performance with others and gain a better understanding of their relative standing (McGonigal, 2011). Research by Dijkstra et al. (2008) suggests that students are most likely to identify with peers who are similar to themselves, engaging in upward social comparisons based on dimensions such as age and gender. While such comparisons can motivate students to improve, they can also have negative consequences, such as lower self-esteem and increased negative self-perception (Buunk & Gibbons, 2007; Festinger, 1954).

In addition to social competition, self-competition—where learners strive to surpass their previous achievements—can foster personal growth and intrinsic motivation. However, the impact of competition in digital game-based learning (DGBL) remains widely debated. Some studies suggest that competition can enhance engagement and improve learning outcomes (Cagiltay et al., 2015), while others caution that it may undermine intrinsic motivation (Deci et al., 1981), decrease motivation among low-performing students (Kohn, 1992), cause anxiety (Schaefer et al., 2016), and distract from the learning process (Chen & Law, 2016).

For example, Liu et al. (2013) found that competitive game designs may elicit varied emotional responses and behaviors, sometimes negatively impacting learning. Similarly, Vandercruysse et al. (2013) found that competition in a game-based language learning environment was not significantly related to learning outcomes and only partially related to motivation. Ke and Grabowski (2007) observed that while competition may improve cognitive performance, it does not necessarily foster positive learning attitudes. Additionally, social comparison *via* leaderboards has been linked to poorer academic performance and negative outcomes in classrooms (Christy & Fox, 2014; Hanus & Fox, 2015).

Despite these concerns, Zeng and McEneaney (2022) argue that competition within DGBL may foster motivation for some students, highlighting that much of the apprehension surrounding competition stems from research in sports contexts rather than educational settings. They suggest that, unlike sports, competition in educational games enables students to transform external rewards (e.g. winning the game) into internal rewards (e.g. acquiring knowledge, enjoying the learning process), thus allowing extrinsic and intrinsic motivation to work together. Furthermore, Zeng and McEneaney (2022) report that competition-induced anxiety in digital games is minimal, especially when students engage in both self- and social competition, as the pressure to avoid being a "loser" is reduced and all students have the opportunity to experience success.

Given the mixed findings regarding the role of competition in digital learning games, its impact remains inconclusive. Therefore, it is crucial for educators to be attentive to the potential effects of competition, fostering opportunities for positive social comparison and providing constructive feedback to optimize learning outcomes.

The supportive role of teachers in digital learning games

In addition to competition, the active presence of the teacher is another factor that can significantly impact student learning and academic engagement in digital learning environments. Teachers serve as guides and facilitators, supporting student learning when educational software is used (Kangas et al., 2017; McLaren et al., 2022a). Their role is particularly critical in digital learning games, as teacher involvement can enhance engagement and promote deeper learning (Koh et al., 2012; Manesis, 2020). Learning support is widely regarded as one of the most effective strategies for maximizing achievement in digital learning games (Dai et al., 2023; Mehrvarz et al., 2025; Shute et al., 2019b).

Research indicates that teachers who provide support and feedback during game-based activities help foster engagement and understanding by creating a supportive classroom environment (Vangsnes & Økland, 2015). Teachers' activities in digital games span a range of tasks, including introducing and explaining the game, offering technical and scientific support, and guiding students during gameplay (Bado, 2022). In this study, teacher support is defined as both motivational (e.g. verbal encouragement, point-based incentives, and enthusiasm) and scientific (e.g. answering content-related questions and clarifying concepts) assistance.

A review by Kangas et al. (2017) of 35 articles on teacher roles in game-based learning concluded that teachers act as essential guides and supporters. Through active communication and guidance, teachers help students maintain concentration and stay focused on learning objectives during gameplay. Other research further supports the idea that teacher presence and active monitoring can positively influence student outcomes. For example, McLaren et al. (2022a) found that classroom students, whether receiving hints and feedback or not, showed higher completion rates and engagement than unmonitored at-home students, highlighting the positive impact of teacher presence and encouragement on learning effectiveness.

However, not all studies agree on the benefits of teacher support. Some researchers argue that such support is most effective for students with limited prior knowledge (Fensham & West, 1976) and may hinder more knowledgeable students by reducing opportunities for exploratory learning (Rahimi et al., 2022). As Molin (2017) observed, research on the teacher's role in game-based learning remains at an early stage, with gaps still present in understanding how teachers can best support students during digital game use (McLaren et al., 2022a; Shah & Foster, 2015).

In summary, despite the recognized importance of teacher support in digital learning games, its consistent impact on learning and engagement, especially in competitive settings, remains unclear. This study investigates the role of teacher support in enhancing student learning and engagement in competitive digital games.

Research questions

Given the mixed findings in the literature regarding the effects of competition and teacher support on student learning and academic engagement and the limited research addressing the supportive role of teachers in competitive digital learning environments, this study seeks to address the following research questions:

- What effect does competition have on students' learning and academic engagement in digital learning games?
- What effect does the supportive role of the teacher, including both motivational and scientific support in conjunction with competition, have on students' learning and academic engagement in digital learning games?

Method

The study examined whether teacher support enhances the effectiveness of competitive digital learning games. A pretest–posttest control design was used during a writing lesson. The research team, including experts in gamification, instructional design, and classroom teaching, provided guidance to ensure that the game design aligned with the study objectives and curriculum, and directly implemented the study in classrooms. The control group played the game without competition or teacher support; Experimental Group 1 played with competition only; and Experimental Group 2 played with both competition and teacher support. All groups first received classroom instruction, then used the game as a supplement over 14 sessions in 2 weeks, with the first and last sessions dedicated to pre- and post-tests of equivalent content and difficulty, and each session lasted 45 min.

Study sample

Initially, data were collected from 82 fifth-grade female students from three intact classrooms in Tehran. Due to the country's gender-segregated schooling system, schools operate as either all-male or all-female; therefore, the school that granted access for data collection was a female school. These classrooms were pre-organized by the school based on students' academic performance averages, and no modification was made to their composition by the researchers. All three classes were taught by the same teacher, ensuring consistency in instructional delivery across groups. The final sample comprised 63 students (21 per group). 19 students were excluded from the final analysis because they did not complete the pre- or post-test, or were unable to install the game.

Measures

To assess learning, a researcher-developed test comprising 13 descriptive questions based on the writing curriculum was administered. Questions were aligned with Bloom's taxonomy levels. Responses were rated as very good, good, acceptable, or needing more effort. Sample items included: (1) Write the antonyms of the following words: "sorrow, thick, rich, hidden"; and (3) Use the two given words in a sentence: "practice-paper".

Content validity was confirmed by seven experienced fifth-grade teachers and five university faculty members specializing in educational technology, who reviewed and approved the items. The test demonstrated high reliability, with a Cronbach's alpha of 0.93.

To ensure internal validity and control for practice effects, two parallel forms of the test were developed, equivalent in content, difficulty, and structure as verified by five subject teachers. In the pretest phase, half the students in each group completed Form A and the other half Form B; in the post-test, forms were alternated. This cross-administration minimized the risk of students' improved scores being due to repeated exposure to the same test items.

Academic engagement was measured using Reeve's Academic Engagement Questionnaire (2013), which includes 17 items distributed across four subscales: Behavioral Engagement with four items, Agentic Engagement with five items, Cognitive Engagement with four items, and Emotional Engagement with four items. Responses were provided on a 7-point Likert scale. The questionnaire's validity and reliability were previously established by Ramazani and Khamsan

(2017), with a Cronbach's alpha above 0.7. In the current study, reliability was confirmed with a Cronbach's alpha of 0.91.

Game design

The game used in this study, *Neuroland* digital learning game, is a two-dimensional, single-player Android game developed with Unity by Amulay educational game company. Although commercial in nature, this version was freely available to students. Designed to support academic development, it was modified by the research team to include a competitive version. *Neuroland* features 12 "learning planets," each representing a mini-game based on fifth-grade writing textbook exercises. These mini-games practice key writing skills such as sentence formation, punctuation, spelling, synonyms, contrast, reading comprehension, and extended writing, all aligned with the curriculum (Table 1).

Following a comprehensive review and analysis of *Neuroland* by experts and educational technologists, elements of competition and teacher support were integrated into the game. Specifically, three competitive mini-games—Jump-Jump, Ride a Car, and Jump over Valleys—were added (Table 2). To further enhance the competitive environment, a leaderboard scoring system was introduced, along with a score-sharing feature that allowed students to share their points with peers, thereby fostering social comparison among learners.

Description of playing the game

The digital learning game *Neuroland* features Gerdaly as the main character (Figure 1). As Gerdaly flies through the sky, he encounters a system of competitive Endless-style games—games that are popular on smartphones for their simple controls (e.g. phone rotation, directional swipes, or touch buttons) and their emphasis on achieving high scores rather than progressing through a storyline or reaching a specific ending.

Within the game's narrative, Gerdaly seeks to access the competitive game system but discovers his ship is low on fuel. At the start of the intervention, the teacher introduces Gerdaly's story and explains how students can unlock the competitive games. To fuel Gerdaly's ship, students must first complete 12 educational mini-games. Once completed, they gain access to the competitive game system, which consists of three mini-games. As students improve their performance in these games, they have the option to share their scores with their online classmates.

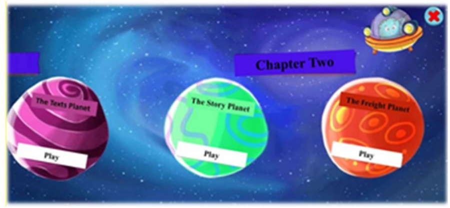
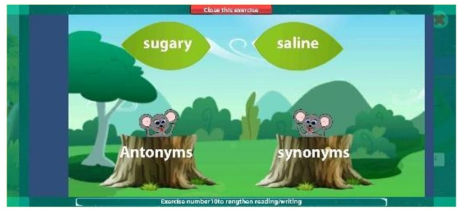
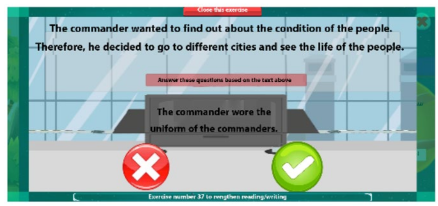
It is important to note that *Neuroland* is a certified digital game in Iran, officially approved by the Ministry of Education and the National Foundation of Computer Games. It is accessible to all fifth-grade students *via* a QR code on the back cover of their writing textbooks. Although students could install the game using the QR code, teachers took additional steps to ensure proper installation and smooth gameplay. The teacher distributed the installation link to all three study groups *via* virtual classrooms, provided guidance on installing the mobile version, and assisted students in resolving any technical issues that arose during installation or use.

Experimental groups

The study included three groups:

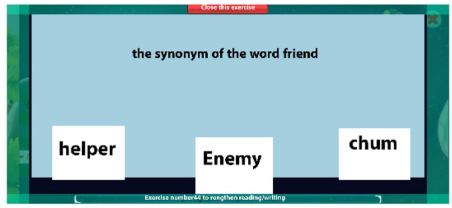
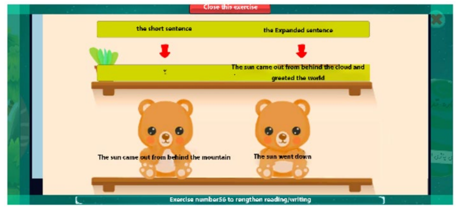
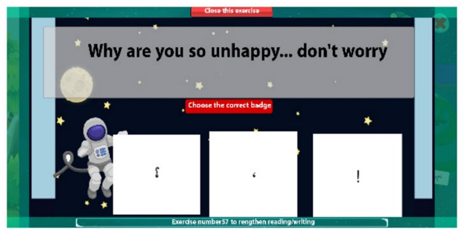
- *Control Group:*
  Students in the control group played the standard *Neuroland* game, which included only the 12 educational mini-games (Table 3), with no additional competitive features or teacher support.

Table 1. Mini learning games.

Mini learning games	Description	A screenshot of the mini game
Mini-Game Selection Screen	Players scroll through mini-games in each unit and select one to play.	
1. The Mouse Planet	Students identify whether the words on the leaves are synonyms or antonyms.	
2. The Texts Planet	Students must comprehend the text and answer the related questions.	
3. The Story Planet	Students should read the story and then choose the best title.	
4. The Freight Planet	Wagons containing short sentences must be arranged in the right order behind the train.	
5. The Balls Planet	Players sort balls by placing words with the "Z" sound and "S" sound into their respective baskets.	

(*Continued*)

Table 1. Continued.

Mini learning games	Description	A screenshot of the mini game
6. The Questions Planet	Students must recognize the synonyms of given words.	
7. The Teddy Planet	Students must find the teddy bear that displays the expanded or shortened form of the given sentence.	
8. The Astronaut's Planet	Students help the astronaut find and insert the correct punctuation marks in the sentence.	
9. The Jumbled Letters Planet	Students must create a new word using the letters provided on the shelf.	
10. The Dictation Planet	Students must identify the correctly spelled words to guide the ships to land.	

(*Continued*)

Table 1. Continued.

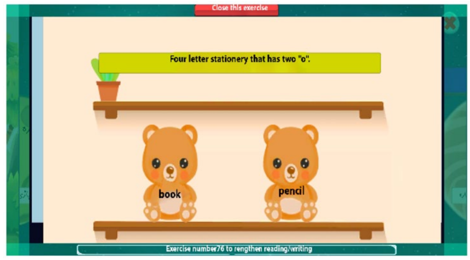
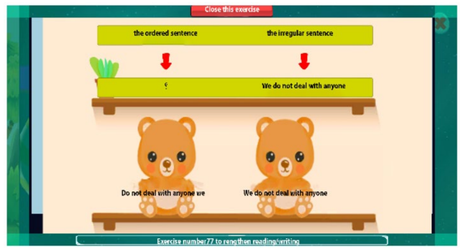
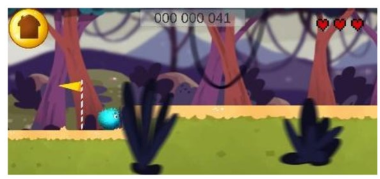
Mini learning games	Description	A screenshot of the mini game
11. The Questions and Answers Planet	Students must answer questions related to word formation.	
12. The Ancient Planet	Students must arrange the unordered sentences in the correct sequence.	

Table 2. Description of competitive game elements.

Mini learning games	Description	A screenshot of the mini-game
1. Jump-Jump	Gerdaly (the main character of the game) jumps off hills to set a new record, with increasing speed and three lives	
2. Car Ride	Gerdaly balances his car and collects apples to achieve a high score.	
3. Jump over the Valleys	Students help Gerdaly jump over valleys to achieve a higher record.	

- *First Experimental Group:*
  Students played the 12 educational mini-games, plus three added competitive mini-games. After gameplay, students could record their results within their groups using a "share key" in the game, and they had access to a leaderboard scoring system that allowed them to compare their performance with peers and track their relative standing. They could also

Figure 1. Gerdaly (the main character of the game).

Table 3. The comparison of groups and their activities.

Group	Competition	The supportive role of teacher	Description
Control Group	No	No	12 educational mini-games
Experimental Group 1	Yes	No	12 educational mini-games 3 competitive mini-games Recorded their scores within their respective groups Use leaderboard scoring system Teacher remained passive and did not provide any support
Experimental Group 2	Yes	Yes	12 educational mini-games 3 competitive games Recorded their scores within their respective groups Received ongoing teacher support *via* a class social network Earned extra credit for active participation and high scores Posted daily scores in the group Received continuous motivation and feedback from the teacher Tracked their performance on the leaderboard Got help with technical or educational challenges

replay activities to correct mistakes. In this group, the teacher did not provide any support (Table 3).

- *Second Experimental Group:*
  Like the first experimental group, these students played the 12 educational mini-games and the three competitive mini-games. However, they also received both motivational and scientific support from their teacher. At the end of each session, the teacher asked students to record their highest scores and provided ongoing support throughout gameplay. Motivational support included creating a positive classroom atmosphere, offering verbal and point-based incentives, generating enthusiasm, and keeping students informed of their progress. Scientific support involved answering students' questions about game-related concepts and helping them overcome challenges (Table 3).

Teacher's supportive role in the competition with a support group

The teacher's support was delivered through several structured strategies:

- Guidance and Incentives:
  The teacher provided motivation by awarding extra credit for active participation and high achievement, thereby encouraging students to engage more deeply with the game.
- Active Leaderboard Management:
  The teacher regularly compiled and shared a leaderboard ranking students based on their game scores. Unlike the passive display of rankings in other groups, the teacher in this

group actively encouraged students to improve their positions through consistent verbal praise and recognition of individual effort. This approach fostered persistence and a drive for better performance.

- Group Communication:
  A dedicated online group was established using a class social network. Upon receiving students' scores, the teacher provided immediate feedback and encouragement through various channels, including text messages, emojis, voice notes, and in-class verbal praise. This ongoing communication helped maintain students' motivation and sense of belonging.
- Technical and Educational Support:
  Throughout the intervention, the teacher promptly addressed both technical and content-related questions, whether raised in person or in the online group. This ensured that students experienced minimal disruption to their learning and gameplay, and that both the competitive and educational aspects of the game were fully supported.

Data analysis

Data were analyzed using SPSS version 27. Learning outcomes were examined using ANCOVA. Academic engagement was analyzed using MANCOVA. For additional robustness, academic engagement was also examined using a non-parametric Kruskal–Wallis test.

Results

To evaluate the effects of competition and teacher support on students' learning and academic engagement, both descriptive statistics and inferential statistical analyses were employed (Table 4).

Based on Table 4, the mean post-test learning scores were 15.46 for Experimental Group 1, 18.21 for Experimental Group 2, and 13.73 for the Control Group. The results indicated that learning improved in both experimental groups, with the greatest increase observed in Experimental Group 2. Similarly, the mean post-test scores for academic engagement were 96.09 for Experimental Group 1, 106.09 for Experimental Group 2, and 87.57 for the Control Group, with the largest improvement again reported in Experimental Group 2.

ANCOVA and MANCOVA were performed to examine the effects of teacher support in a competitive digital game. Following Shavelson (1996), equal group sizes ($n = 21$) justified the use

Table 4. Descriptive statistics of variables.

		Pretest		Post-test	
Variable	Group	Mean	SD	Mean	SD
1. Learning	Experiment 1	14.13	3.07	15.46	2.21
	Experiment 2	15.04	3.36	18.21	1.86
	Control	14.72	2.86	13.73	3.02
2. Academic Engagement	Experiment 1	70.14	13.45	96.90	8.96
	Experiment 2	63.61	9.52	106.09	2.52
	Control	86.80	10.73	87.57	12.02
2.1 Behavioral Engagement	Experiment 1	18.76	2.75	23.71	2.03
	Experiment 2	17.52	1.88	24.76	1.17
	Control	23.76	2.86	23.90	3.93
2.2 Agentic Engagement	Experiment 1	20.42	4.38	26.47	4.46
	Experiment 2	18.57	3.21	29.57	2.27
	Control	25.00	5.97	24.14	4.16
2.3 Cognitive Engagement	Experiment 1	15.52	4.34	24.28	2.28
	Experiment 2	14.76	4.52	25.90	0.94
	Control	18.19	4.85	19.23	5.15
2.4 Emotional Engagement	Experiment 1	15.42	5.99	22.42	2.80
	Experiment 2	12.76	4.86	25.85	1.23
	Control	19.85	4.25	20.28	5.50

of ANCOVA for learning outcomes, while academic engagement was additionally analyzed with the non-parametric Kruskal–Wallis test to ensure robustness.

Results related to learning

ANCOVA results (Table 5) showed a significant effect of group on learning outcomes after controlling for pretest scores (F (2,59) = 30.52, $p < .001$). The partial eta squared ($\eta^2 = .508$) indicates that 50.8% of the variance in learning scores was explained by group differences at the 95% confidence level.

Post-hoc pairwise comparisons (LSD, Table 6) showed that the Supportive group scored significantly higher than both the Control and Competition groups ($p < .05$). The Competition group also outperformed the Control group.

Results related to engagement

A MANCOVA was conducted to examine group effects on student engagement while controlling for covariates. The results indicated a significant effect of groups on overall engagement, $p < .05$ (Table 7).

Pairwise comparisons for overall engagement and its subscales showed that both the supportive and competitive groups scored higher than the control group.

The supportive group had higher scores than both the control group (mean difference = 26.41, $p < .001$) and the competitive group (mean difference = 11.49, $p < .001$) across all dimensions. The competitive group also outperformed the control group on all subscales, $p < .05$ (Table 8).

Report on Kruskal-Wallis test results

A Kruskal–Wallis test was conducted as a non-parametric supplementary analysis due to violations of homogeneity of variance (Table 9).

The findings indicate statistically significant differences among the groups in both pretest ($H(2) = 28.160$, $p < .001$) and post-test ($H(2) = 31.896$, $p < .001$) scores. These results support the hypothesis that academic engagement differed significantly across the experimental conditions.

Table 5. Results of ANCOVA for learning scores.

Dependent Variable	SS	df	MS	F	Sig.	Partial η^2
Learning	194.452	2	97.226	30.515	.000	.508
Error	187.982	59	3.186			

Table 6. Pairwise comparisons for learning scores.

Group (I)	Group (J)	Mean Difference (I-J)	Std. Error	Sig.
Control	Competition	−2.041	0.553	.000
	Supportive	−4.306	0.551	.000
Competition	Control	2.041	0.553	.000
	Supportive	−2.265	0.555	.000
Supportive	Control	4.306	0.551	.000
	Competition	2.265	0.555	.000

Table 7. Multivariate tests for student engagement.

Test	Value	F	Sig.	Partial Eta Squared
Pillai's Trace	0.619	6.058	.000	.310
Wilks' Lambda	0.446	6.597	.000	.332
Hotelling's Trace	1.097	7.133	.000	.354
Roy's Largest Root	0.942	12.719	.000	.485

Table 8. Pairwise comparisons for academic engagement.

Dependent Variable	Group (I)	Group (J)	Mean Difference (I-J)	Sig.
Overall Engagement	Control	Competitive	−14.920	.000
		Supportive	−26.408	.000
	Competitive	Control	14.920	.000
		Supportive	−11.488	.000
	Supportive	Control	26.408	.000
		Competitive	11.488	.000
Behavioral Engagement	Control	Competitive	−2.540	.011
		Supportive	−4.357	.000
	Competitive	Control	2.540	.011
		Supportive	−1.816	.020
	Supportive	Control	4.357	.000
		Competitive	1.816	.020
Agentic Engagement	Control	Competitive	−3.724	.014
		Supportive	−7.576	.000
	Competitive	Control	3.724	.014
		Supportive	−3.852	.001
	Supportive	Control	7.576	.000
		Competitive	3.852	.001
Cognitive Engagement	Control	Competitive	−5.747	.000
		Supportive	−7.691	.000
	Competitive	Control	5.747	.000
		Supportive	−1.944	.062
	Supportive	Control	7.691	.000
		Competitive	1.944	.062
Emotional Engagement	Control	Competitive	−2.910	.040
		Supportive	−6.785	.000
	Competitive	Control	2.910	.040
		Supportive	−3.876	.001
	Supportive	Control	6.785*	.000
		Supportive	3.876*	.001

Table 9. Kruskal-Wallis test statistics for academic engagement.

Variable	Kruskal-Wallis H	df	Asymp. Sig.
Pretest	28.160	2	.000
Post-test	31.896	2	.000

Note: a. Kruskal-Wallis Test; b. Grouping Variable: Groups.

Discussion and conclusion

This study examined the impact of teacher support on fifth-grade students' learning and academic engagement in a competitive digital learning game. The first research question was: "What effect does competition have on students' learning and engagement?" The game included three mini-competitive games with a leaderboard for performance comparison. The results showed that students who played the game in a competitive environment achieved higher learning and academic engagement compared to those who played the same game in a noncompetitive environment. According to Morschheuser et al. (2019), competition serves as a motivator for individuals in DGBL environments, as it provides immediate feedback through social comparison and values their competence. Additionally, Cagiltay et al. (2015) investigated the element of competition in digital learning games and its effect on university students' learning. Their findings showed that students in competitive environments showed higher motivation and performance than the other students in the control group. Thus, the presence of competitive elements in digital learning games can create a sense of challenge and excitement for students, pushing learners to exert continuous effort in learning by observing and monitoring their progress in comparison to others (Morschheuser et al., 2019).

Perhaps the other reason for the success of students in digital competitive games can be attributed to the cognitive and affective impact of competition on learners (Chen et al., 2020). In their meta-analysis research, Chen et al. (2020) suggested that incorporating the element of competition into learning games can enhance students' cognitive learning outcomes, including error rates and progress, as well as non-cognitive outcomes, such as pleasure and interest. Several studies have noted that the inclusion of competition in digital learning games can increase students' motivation, curiosity, creativity, intrinsic interests, and participation (Cagiltay et al., 2015; Wei et al., 2018), while also reducing anxiety (Wei et al., 2018). Zeng and McEneaney (2022) argue that competition in DGBL can effectively reduce student anxiety by allowing all students to be winners and providing them with more chances to win. In the current game study, since players could improve their scores in a relaxed environment, they played individually, allowing for self-competition, and were able to correct their mistakes if they made any. Students competed with each other without fear of failure and had the opportunity to repeat game activities to improve. When the fear of losing is eliminated, students are more willing to engage in competitive activities, thereby facilitating their motivation to participate in competitions (Zeng & McEneaney, 2022). Wei et al. (2018) conducted a study to examine the effects of a competitive digital learning game on students' English vocabulary learning. Their results showed that the competitive game decreased students' anxiety and increased their sense of control, curiosity, and intrinsic interests. Including the element of competition, such as competitive mini-games, leaderboards, and score-sharing options, can improve students' learning and academic engagement. These features allow users to compare their performance with others and become aware of their relative strengths and weaknesses. By observing and monitoring their progress in comparison to others, students can gain a better understanding of their own abilities and work to improve them.

Regarding the second study question, "What effect does the supportive role of a teacher, including motivational and scientific support, along with the element of competition, have on the student's learning and academic engagement in the digital learning game?" the result indicated the positive and significant impact of the teacher's supportive role, including motivational and scientific support, along with the element of competition on students' learning and academic engagement in the digital learning game environment. Motivational and scientific support during the game kept learners engaged in the learning process, resulting in higher learning success. In the present study, learning was designed in an attractive, competitive game environment with a system of points and rewards. Teachers created a positive learning environment by providing verbal and point incentives, generating enthusiasm during play, and keeping students informed of their progress. The motivational support of the teacher was considered one of the key factors in the game, and students believed this factor contributed to the game's correct and attractive process. As a result, they tried to improve their records and received their teacher's support. In the present study, the reward and scoring system, along with appropriate support and feedback from the teacher, engaged students to play the game repeatedly in order to achieve a high score. Students, while aware of their game results, attempted to present their maximum ability (the highest record) in playing the game, leading to improved learning outcomes. It can be inferred that re-engagement with the game in competitive settings leads to a more comprehensive review of the game's content, which ultimately results in better learning outcomes and performance. The control group and the digital learning game group, based on competition, stopped playing after three and six sessions, respectively. However, the digital learning game group, based on competition and teacher support, played all thirteen sessions. These students became so immersed in the learning game that they even played it outside of class time to improve their record and attract the teacher's opinion and support. Therefore, teachers' intervention and facilitation in a game-based classroom can lead to meaningful learning experiences and increased student engagement (Mutch-Jones et al., 2021). In digital learning games, teachers provide scientific support to help students achieve the educational goals of the game (Manesis, 2020).

In terms of scientific support in this game, the teacher answered the students' questions about the scientific concepts of the game. If students had difficulty understanding different parts of the game from a scientific perspective or encountered scientific questions during the game, the teacher guided and helped them overcome these challenges by providing feedback. In fact, in-game learning supports facilitate content knowledge for learners and show better progress in the game as a result of learning (Cai et al., 2022). The teacher's active role as a supporter during gameplay is crucial for maintaining students' concentration and engagement in the learning process (Foster & Shah, 2020; Kangas et al., 2017). However, many teachers report limited training on game-based learning during their teacher preparation programs, which may hinder their ability to effectively integrate DGBL into classroom settings (Von Gillern et al., 2024). This highlights the importance of teacher training and professional development focused on gamification strategies. Effective DGBL integration depends on comprehensive teacher training, as teachers' instructional skills strongly influence student engagement and learning outcomes (Cantoia et al., 2024).

Therefore, it can be acknowledged that competition in learning games, when taking place under the supervision and support of a teacher, not only does not have a destructive and stressful effect but also creates an attractive and enjoyable learning environment. In such educational environments, students face safe and challenging situations in which they can try, fail, receive feedback, and try again, without facing assessment pressure.

Limitations and implications

This study has several limitations. Firstly, data analysis was performed without considering students' gender. Firstly, data analysis was performed without considering students' gender due to the gender-segregated schooling system in the country. Future studies should consider gender differences in game-based learning, as several researchers have examined the performance of girls and boys in digital games and concluded that, in the specific context of their game, girls performed better than boys (McLaren et al., 2022a; 2022b; Nguyen et al., 2022). Secondly, this study focused solely on the impact of teacher support in a single digital learning game. Future research should investigate its role across different game types and explore interactions with factors such as game difficulty, adaptive systems, and longer periods of implementation, as a longer engagement with the game may yield different results. Finally, while this study employed quantitative methods, qualitative approaches are recommended for future research to gain deeper insights into students' experiences and the mechanisms through which teacher support and competition enhance engagement and learning outcomes.

Despite these limitations, the implications for teachers implementing competitive digital learning games are considerable. Teachers should provide both motivational and academic support by creating a positive classroom climate, offering incentives, sustaining enthusiasm, and keeping students informed of their progress. They should also answer questions, guide students in understanding scientific concepts, and provide feedback to help overcome challenges. Effective game design should incorporate features such as leaderboards and both self- and social-competition, enabling students to compare performance, learn from mistakes, and improve without fear of failure. Emphasizing both motivational and academic teacher support in competitive digital learning games is essential for fostering meaningful learning experiences and enhancing students' academic engagement.

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Data availability statement

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

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