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Gamifying mathematics education through Kahoot: Fostering motivation and achievement in the classroom

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Abstract

This study investigates the usefulness of integrating the Kahoot application as an instructional tool to boost motivation and academic achievement among 10th-grade mathematics students in Abu Dhabi Emirate Schools. A sample of 60 10th-grade students was deliberately selected and randomly assigned to either an experimental group (30 students) instructed with Kahoot, or a control group (30 students) taught using traditional methods. A quasi-experimental approach was selected for this study to investigate a cause-and-effect relationship between the utilization of Kahoot in mathematical education and its impact on student motivation and academic achievement. A comprehensive statistical analysis, specifically employing an independent samples t-test for the motivation scale and a one-way ANCOVA for academic performance, revealed statistically significant differences favouring the experimental group. These results signify that Kahoot integration holds promise in positively influencing motivation and academic achievement for 10th-grade mathematics students in Abu Dhabi Emirate Schools. This research underscores the potential of Kahoot as a valuable educational tool, offering insights for educators and policymakers seeking to enhance student motivation and achievement through technology-integrated instruction.

Keywords: Academic achievement, Kahoot, Mathematical education, Motivation, Secondary school students, United Arab Emirates

Introduction

The present era has witnessed remarkable technological advancements that have permeated all facets of human life, including education (Bhattacharya & Sharma, 2007). Educational institutions increasingly prioritize integrating technology into learning, guided by contemporary educational theories. These developments have brought transformative changes in traditional educational paradigms (Okunlaya et al., 2022).



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Educational technology, encompassing features like active participation and collaboration, is crucial for skill development and self-confidence in students (Duffys & Jonassen, 2013; Keane et al., 2014). Integrating technology with traditional teaching methods enhances enthusiasm and motivation (Akbarjono et al., 2022; Cui, 2022; Muthik et al., 2022). However, a universal shift to fully technology-driven learning faces resistance (Mirata et al., 2022). Educators, adopting a flexible approach, blend e-learning with traditional methods to strike a balance (Atwa et al., 2022; Ebbini, 2023; Setyosari et al., 2023).

This flexible approach, combining computer technology, the Internet, and traditional methods, caters to diverse learning styles and promotes student interaction (Rasmitadila et al., 2023). While e-learning is influential, traditional learning remains primary and impactful (Udvaros & Forman, 2023). Incorporating e-learning into traditional settings is a growing trend, enhancing online learning platforms (Khaldi et al., 2023). As Ayu (2020) emphasized, e-learning enables continuous, flexible learning, which is vital for adapting to the evolving educational landscape (Mosa et al., 2016). A flexible integration of technology and tradition optimizes the learning experience, acknowledging the significance of both approaches (Atwa et al., 2022; Ayu, 2020; Duffys & Jonassen, 2013; Keane et al., 2014; Khaldi et al., 2023; Mirata et al., 2022; Mosa et al., 2016; Rasmitadila et al., 2023; Udvaros & Forman, 2023;). One of the ways of introducing digital elements into a non-digital learning environment to strengthen learning is through gamification. Gamification involves the application of game dynamics, psychology, and mechanics to non-game situations and applications, as explained by Rozman and Donath (2019). Incorporating game elements such as scores, badges, rankings, rewards, and levelling-up into non-game learning environments characterizes gamification. Gamification has found extensive application in educational settings, particularly where it naturally aligns with the structure of learning new skills. The traditional approach to skill acquisition in institutional settings, like schools, involves progressing in steps and receiving feedback at each stage. Therefore, introducing gamification into such contexts does not seem inappropriate or awkward, as it complements the existing learning structure (Koivisto & Hamari, 2019). In education, the implementation of gamification leads to heightened levels of interest, engagement, motivation, and the cultivation of students' critical thinking and multitasking skills (Janković et al., 2023).

The surge in the use of smart devices has spurred competition among application developers, with educational apps gaining prominence for their support of the learning process (Porter & Heppelmann, 2014). These apps assist students in skill development and acquiring new abilities, enriching their overall learning experience (Bouck & Park, 2020). Technological advancements have led to various applications, including e-learning programs like Kahoot! (Saleem et al., 2021). Kahoot offers an interactive and engaging

learning experience, promoting interaction between students and teachers and among students (Licorish et al., 2017). Its innovative approach involves posing questions using symbols and images to capture students' attention. Kahoot's competitive ranking system also motivates students to excel and succeed in educational competitions (Elkhamisy & Wassef, 2021; Lestari, 2019; Nadeem & Al Falig, 2020; Prieto et al., 2019; Wahyuni et al., 2021).

The deliberate choice of Kahoot as the central focus of this research stems from a thorough and thoughtful assessment of available educational technologies. Kahoot stands out due to its distinctive features and proven effectiveness in enhancing student engagement and motivation across diverse educational environments. Its interactive, game-based design has consistently demonstrated a unique ability to capture students' attention, transforming learning into a more enjoyable experience. This study seeks to contribute novel insights by investigating the specific utility of the Kahoot application in elevating motivation and academic achievement among 10th-grade mathematics students in Abu Dhabi Emirate Schools.

What sets this research apart from previous studies is a meticulous examination of Kahoot's impact on a specific academic cohort in a distinct geographical context. By focusing on 10th-grade mathematics students in Abu Dhabi Emirate Schools, we aim to provide targeted and contextually relevant findings. This approach is particularly valuable in addressing the unique challenges and opportunities within this educational setting. Consequently, our research aligns with contemporary educational trends and emphasizes the untapped potential of technology-based tools, such as Kahoot, in significantly enhancing the overall learning experience.

Purpose of the study

The existing literature highlights a decline in student motivation within mathematics classes (Chao et al., 2016), prompting educators to intensify efforts to enhance student engagement and motivation (Star et al., 2014). Both intrinsic and extrinsic motivation significantly influence student engagement, with intrinsic motivation stemming from personal enjoyment and accomplishment and extrinsic motivation arising from external rewards or pressures (Wlodkowski & Ginsberg, 2017). Various internal factors, such as personal interests, goals, and values, along with external factors, like the learning environment and teacher dynamics, shape students' motivation. The 'Teach Thought Motivation' theory underscores the importance of both intrinsic and extrinsic motivation in students' educational success (Miller & Cuevas, 2017). Pitsia et al. (2017) identified several reasons for diminished student motivation, including a lack of interest, communication skills, shyness, or fear of making errors in mathematics.

Previous research, exemplified by studies like Omar (2017) and Licorish et al. (2017), has highlighted the potential of the Kahoot application in enhancing student engagement and classroom participation. Kahoot facilitates immediate feedback and encourages active participation, fostering enthusiasm and student discussions. Given the intricate nature of motivational factors and their potential interconnections, there is a pressing need for a comprehensive investigation to elucidate their impact on academic accomplishments. Therefore, this study aims to assess the effectiveness of Kahoot in enhancing motivation and academic achievement among 10th-grade mathematics students. Through an in-depth analysis of Kahoot's impact on motivation and academic achievement, the research addresses diminishing motivation and enhances the overall classroom environment.

The study holds theoretical significance by contributing to the existing literature on e-learning and emphasizing the potential of the Kahoot application in enhancing student motivation and academic achievement. Additionally, it presents a model for effectively utilizing Kahoot in educational settings (Alawadhi & Abu-Ayyash, 2021; Minton & Bligh, 2021). As the first study within the UAE Ministry of Education, it adds valuable expertise to the region's educational technology and e-learning field. From a practical perspective, the study advocates for integrating modern technological applications like Kahoot into education, emphasizing their role as effective teaching tools to increase motivation, improve academic achievement, and enhance classroom participation. The findings can potentially influence educational practices in Abu Dhabi Emirate schools and beyond, guiding educators in utilizing technology to promote student engagement and learning success.

Research questions

The following research questions guided the investigation, providing a clear framework for the study's objectives and outcomes:

1. What is the influence of utilizing the Kahoot application on enhancing the motivation of 10th-grade students in mathematics within Abu Dhabi Emirate schools?
2. How does integrating the Kahoot application enhance academic achievement in mathematics among 10th-grade students within the Emirate of Abu Dhabi?

Literature review

Gamification and Kahoot as educational tools

Research into gamification in education has predominantly focused on university and high school students, uncovering heightened levels of interest, engagement, motivation, and the advancement of critical thinking and multitasking skills (Ding et al., 2018; Muntean, 2011). The integration of gamification enhances the educational experience by promoting active

student involvement, fostering interactive learning, and encouraging students to showcase and expand their knowledge (Göksün & Gürsoy, 2019; Hamari et al., 2016; Lopez & Tucker, 2019). Moreover, gamification injects an enjoyable element through collaborative efforts, motivating students to accumulate points, advance on leaderboards, and earn rewards while simultaneously allowing teachers to monitor, evaluate, and promptly provide feedback on student performance and accomplishments (Zainuddin, 2019).

Christians (2018) define gamification as the process of incorporating elements of games into tasks or activities to increase motivation and participation. Whether applied in educational settings or business scenarios, gamification is a strategy to prompt desired behaviours. By tapping into our competitive nature and the drive for success, gamification introduces elements of competition and achievable milestones. The literature mentions various design elements from games that can be incorporated into educational settings. Traditional and video games typically exhibit specific rules and objectives (Smith-Robbins, 2011). In gamified learning interventions, these rules structure the learning activities, establishing clear boundaries on learners' actions and distinguishing them from free-form learning activities like essays or presentations. Games introduce reward systems where individuals receive recognition, such as badges or prizes, for achieving goals or overcoming obstacles (Glover, 2013). Though not directly linked to the goal, these rewards signal competence attained and guide progress tracking, outlining advancement through a series of intermediate goals.

Gamification is often appealing to learners because it enhances the engagement of the learning process. However, individual attitudes towards gamified elements can differ based on personal experiences and educational objectives. Some individuals may find these elements motivating, while others perceive them as distractions. The educators' decision to integrate gamification is influenced by perceptions of its effectiveness, ease of use, and the resources needed for implementation. While some educators see gamification as a powerful tool for improving student engagement, others may be hesitant due to concerns about resource allocation and its overall effectiveness (Christopoulos & Mystakidis, 2023). A widely employed method to transform content review into a game involves utilizing immediate response quizzes, a strategy known to boost student participation and classroom engagement. Technology integration has streamlined the utilization of quizzes in the classroom, mainly through student-response systems, facilitating the seamless and rapid implementation of instant polling (Grinias, 2017). In educational games, quizzes are commonly incorporated, allowing students to test their knowledge on specific subjects. When designed to present correct answers after responses, these quizzes can effectively teach new factual and conceptual knowledge without additional learning materials. In the context of games, these quizzes may not directly relate to gameplay but serve as a rewarding mechanism for answering questions (Jičínská et al., 2021).

Kahoot is recognized as an educational program that effectively motivates students by transitioning them into an enthusiastic, competitive, and enjoyable learning environment (Wang & Tahir, 2020). Experts widely acknowledge Kahoot as a leading example of gamification principles in education, utilizing game elements to engage students in academic tasks within a competitive framework. Kahoot integrates technology with the physical classroom, enabling real-time interaction and collaborative learning (AlAli et al., 2023).

Kahoot offers versatile resources and tools for educators to deliver electronic information and study materials, facilitating electronic communication and collaboration among students across different age groups (Aliyu et al., 2022). It encourages creative teaching by incorporating multimedia elements like images and videos, breaking down time and space constraints.

Studies have demonstrated Kahoot's effectiveness as a pre-assessment tool to evaluate students' comprehension before instruction (Arif et al., 2019). Kahoot's game-based approach centres on student responses, fostering active participation and progress tracking. It effectively supports direct and indirect learning (Licorish et al., 2018). A study by Wang and Lieberoth (2016) reports on an experiment investigating the impact of incorporating audio and points in the game-based learning platform Kahoot! during a software engineering lecture. Results revealed statistically significant differences in attitudes towards variations of audio and points, particularly in concentration, engagement, enjoyment, and motivation.

In the context of mathematics education, Tokac et al. (2019) explored Kahoot's impact on students' perceptions of technology acceptance. Their research indicated significant differences associated with Kahoot's use in education, suggesting the need for further investigations into instructional methods and learning outcomes.

Geesa et al. (2019) investigated electronic games, including Kahoot, for English language development among 1st-grade students. Their study favoured the experimental group, recommending integrating electronic games into curriculum design and providing guidance for educators.

Finally, Zhang and Wang (2020) researched Kahoot's impact on academic achievement and attitudes towards Hadith among secondary students. Their findings emphasized the benefits of Kahoot in education and recommended its utilization across different educational stages. These studies illustrate Kahoot's positive influence on motivation, engagement, and academic achievement in various educational contexts.

Student motivation

Motivation in the context of learning is a fundamental prerequisite for the success of the educational process. It plays a pivotal role in driving students to excel and enhance their

engagement level. According to Sirhan et al. (2015), motivation is an internal state arising from various factors, including interior elements like attitudes and external factors like reinforcement. These factors collectively generate specific individual behaviours and channel these behaviours towards reducing the motivation gap (Akinoso, 2023). Motivation signifies a state that individuals experience that activates their behaviours and directs them towards the knowledge they seek. This is accomplished by executing behaviours that lead to the desired learning outcomes, as noted by Bishara (2023).

Furthermore, Rubach and Bonanati (2023) characterize motivation as an internal sensation indicating a need that propels individuals towards specific objectives. Notably, motivation often remains subtle and can be inferred from outward achievements. Among the significant motives tied to the educational realm are the incentives for achievement, exploration, competition, and the need for recognition.

Motivation is essential for educational success, intensifying effort, boosting learners' resilience, and enhancing their capacity to assimilate information. This enhancement in achievement extends to classroom dynamics, where positive interactions and academic achievements thrive (Hettinger et al., 2023).

According to Chen et al. (2023), motivation pertains to internal conditions guiding individuals towards fulfilling specific psychological or physiological needs. These needs highlight imbalances or deficiencies in an individual's state, causing stress and prompting the individual to seek equilibrium.

Motivation fosters students' perception that learning leverages their abilities and is an internal driving force directing their behaviour. It urges students to pursue what they perceive as essential and valuable, propelling them towards more remarkable academic achievements (Rach, 2023). Additionally, certain principles can enhance students' motivation. These include guiding their interests through verbal means and stimuli that appeal to their senses or initiating lessons with captivating stories or incidents closely related to the subject matter. This approach is pivotal for the success of any educational context as it captivates students' attention before embarking on the learning journey. When motivation levels are low, the response to learning is diminished. Conversely, when educational methods and activities elevate motivation, students become inspired and channel their energy towards their educational goals (Hofer et al., 2023).

As Casinillo (2023) emphasized, motivation serves multiple functions, the most crucial of which is steering behaviour towards goals and intensifying students' efforts and energy dedicated to achieving these objectives. Motivated students are committed to better academic achievement, influencing how they process information. High motivation increases attentiveness in class, resulting in greater knowledge absorption. Moreover, motivation enhances perseverance and activity levels, stimulating a desire to persist even when faced with challenging tasks, intensifying efforts, and energy expenditure towards

goal attainment. It also plays a role in reinforcing learning outcomes, as students who are highly motivated to excel academically take pride in their accomplishments when they achieve high marks.

Wang (2015) highlighted Kahoot's role in fostering dynamic, play-based classrooms that enhance student engagement and motivation. The program introduces competition through technology, offering advantages such as ease of use and multimedia integration. Kahoot's competition structure reinforces motivation, participation and engagement. Licorish et al.'s (2017) study revealed that Kahoot effectively motivates students, fostering engagement and encouraging classroom interaction. The motivation stems from the desire to excel in Kahoot activities, prompting students to be attentive and actively participate with the lecturer, peers, and lecture content. Additionally, Kahoot instigates a sense of competition, driving students to aim for the top of the leaderboard, resulting in increased attentiveness during lectures and related discussions (Licorish et al., 2017).

Academic achievement

Academic achievement has garnered significant attention within the educational system due to its profound impact on student achievement. The educational level is often quantified as the cumulative grades a student attains in each subject, which is a topic of particular interest. Academic researchers have conducted numerous studies to measure achievement in the educational process.

According to Lynch et al. (2023), academic achievement is the extent of knowledge and information a learner has absorbed, encompassing concepts, knowledge, and facts typically measured through assessments. It also indicates a student's success in a particular subject and may involve estimated grades based on school examinations (Hammadi et al., 2023).

Children's academic achievement is a critical factor in their overall development since proficiency in reading and mathematics has far-reaching consequences. These skills impact various aspects of life, including educational success, job performance, physical and mental well-being, and even life expectancy. Over the past few decades, extensive research has been conducted to investigate the factors influencing academic achievement, aiming to identify ways to incorporate these factors into interventions and teaching methods to enhance academic achievement and address learning challenges (Peng & Kievit, 2020). Several factors contribute to academic achievement, such as self-efficacy beliefs and engagement. According to Ozkal (2019), self-efficacy beliefs in mathematics secondary school students strongly predict positive mathematical achievement. This suggests that students with higher confidence in their mathematical abilities tend to perform better.

Conversely, students who experience boredom, anxiety, and show disinterest or disruptive behaviors in mathematics classes tend to have lower mathematical achievement. Both behavioural and emotional engagement were found to have a positive and significant

impact on academic achievement. Providing teachers and teacher candidates with effective teaching methods and techniques to cultivate positive learning experiences and emotions among students can help prevent disengagement in mathematics classes (Ozkal, 2019).

Several studies (Göksün & Gürsoy, 2019; Halim et al., 2020; Lee et al., 2019) have indicated that Kahoot can positively influence student achievement, engagement, enthusiasm for learning, and competitiveness. Kahoot can help enhance concentration, increase class enjoyment, raise awareness of students' knowledge levels, improve understanding of taught concepts, and generally enhance the learning process. In the latest study by Janković and Lambić (2022), the results demonstrated that students from the Kahoot experimental group outperformed those in the traditional group with conventional teaching. Furthermore, pupils in the Kahoot group exhibited a superior understanding of science content compared to those in the Quizizz group, although the difference was not statistically significant. Implementing gamification activities through Kahoot enhances learning by fostering a deeper conceptual understanding and improving retention (Janković et al., 2023). Kahoot positively impacts students' knowledge and the practical application of learned concepts in real-life situations. According to Janković et al. (2023), Kahoot demonstrates significantly greater effectiveness in tasks requiring reasoning, such as problem-solving in similar situations, likely attributed to its ability to sustain student concentration throughout the lesson.

Methodology

Research design

A quasi-experimental design was employed to fulfil the study's objectives, aiming to establish a causal relationship between the use of Kahoot in mathematical education and student motivation and academic achievement. The study comprised an experimental group employing the Kahoot application and a control group adhering to traditional teaching methods.

Participants

Sixty students participated in the research, comprising 30 students in the two classes selected from the 10th grade within international schools under the Directorate of Education in Abu Dhabi, UAE. The selection criteria prioritized schools with access to advanced technological resources and established remote learning programs. One class, consisting of 30 students, was designated as the experimental group, where Kahoot was utilized to teach the fourth unit of Mathematics during the second semester of the 2019/2020 academic year. Meanwhile, the second class, also comprising 30 students, served as the control group and received instruction for the same Mathematics unit using

Table 1 The results of checking the equivalence of the control and experimental groups before applying the experiment

Tool	Group	n	Mean	S.D.	T	n-1	p
Test	Experimental	30	11.43	5.67	0.538	58	0.593
	Control	30	12.30	6.77	0.538	58	0.593
Motivation scale	Experimental	30	2.08	0.56	1.639	58	0.107
	Control	30	1.87	0.41	1.639	58	0.107

traditional teaching methods. Before initiating the experiment, the researchers assessed the equivalence of the control and experimental groups using the Independent Sample t-test. The results of this assessment are presented in Table 1, along with corresponding analysis outcomes.

The analysis results indicate no statistically significant differences between the two groups' pre-test scores on the achievement and motivation scales. This finding suggests that, before the intervention, the experimental group (using the Kahoot application) and the control group (employing traditional learning methods) demonstrated similar baseline academic achievement and motivation levels.

Achieving equivalence in pre-test scores holds vital importance in experimental studies. This equivalence ensures that any subsequent differences observed in the post-test scores can be confidently attributed to the intervention – in this case, the utilization of the Kahoot application – rather than pre-existing distinctions between the groups. By establishing similarity in pre-test scores, the study can proceed with greater confidence in attributing any observed changes in post-test scores to the Kahoot application's impact on motivation and academic achievement.

Research procedure

Experimental Group Treatment: In the experimental group, students received instruction utilizing the Kahoot application, facilitating interactive learning through quizzes and games. Specifically, the Kahoot quizzes were designed to align with the mathematical concepts covered in the curriculum's chosen unit. During instructional sessions, students engaged in real-time participation by accessing the Kahoot platform via their electronic devices, such as smartphones or tablets. The quizzes incorporated various question formats, including multiple-choice, true/false, and short-answer questions, to cater to diverse learning styles and foster active participation. Feedback mechanisms within the Kahoot application allowed students to receive immediate responses and reinforcement, enhancing their engagement and motivation levels. Moreover, instructors utilized the platform's analytics features to track students' progress and identify areas for remediation or further reinforcement.

Control Group Treatment: In contrast, the control group received traditional instruction, typically involving teacher-led lectures, textbook readings, and written assignments. The content delivery in the control group adhered to conventional teaching methods commonly practised in classroom settings. Teachers presented the mathematical concepts through verbal explanations, visual aids, and examples, followed by guided practice and independent study assignments. While traditional methods may vary in implementation, they generally rely on direct instruction and passive learning experiences, with limited opportunities for interactive engagement and immediate feedback.

Implementation of Kahoot Quizzes: The Kahoot quizzes were tailored to complement the content covered in the mathematics curriculum for the 10th grade. Each quiz consisted of questions designed to assess students' understanding of key mathematical concepts, problem-solving skills, and critical thinking abilities. The quizzes were structured to align with the learning objectives outlined in the curriculum, ensuring coherence and relevance to classroom instruction. Additionally, the quizzes were administered during dedicated instructional sessions, with instructors facilitating the process and providing guidance as needed. Students participated in the quizzes using their electronic devices, with instructors overseeing the administration and monitoring student progress.

Analysis and Monitoring: Throughout the intervention period, both the experimental and control groups were monitored closely to track their progress and engagement levels. Instructors collected data on students' performance, participation rates, and response patterns during instructional sessions. Regular assessments were administered to measure students' academic achievement and motivational levels, including pre-tests and post-tests. The data collected were subsequently analyzed using statistical methods to evaluate the effectiveness of the intervention and its impact on students' learning outcomes.

As well normality assumption assessed quantitatively based on Shapiro-Wilk (SW) test for normality Table 2.

Study tools

To achieve the primary objective of assessing the usefulness of the Kahoot application in improving motivation and academic achievement among 10th-grade mathematics students

Table 2 Normality test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test for control group 1	0.166	29	0.093	0.832	29	0.144
Post-test for control group 1	0.137	29	0.166	0.855	29	0.265
Pre-test for experimental group 2	0.178	29	0.094	0.866	29	0.153
Post-test for experimental group 2	0.143	29	0.204	0.887	29	0.360

in Abu Dhabi Emirate Schools, the researchers developed the motivation scale and achievement test as follows:

Motivation scale

The researchers examined two essential measurement tools: the Learning Motivation Scale adapted from López-Fernández et al. (2020) and the Achievement Scale based on He's (2000) framework. These scales were thoughtfully incorporated into the study, each comprising 20 items assessed on a five-point Likert scale. Careful attention was given to tailoring these items to the specific subject matter and age group under investigation.

After a rigorous evaluation by external experts, specific item wordings were refined and improved, resulting in the final versions of the scales, each retaining its original 20-item format (see Appendix 1).

Motivation scale validity

The validity of the scale was established through a comprehensive process. Initially, the 20-item scale was reviewed by a panel of 11 external experts, who assessed its suitability for measuring student motivation regarding appropriateness, clarity, and alignment with the student's grade level. Reviewers' feedback was incorporated with an 80% agreement criterion, leading to adjustments such as rephrasing and item reordering, while no items were removed.

The final version of the 20-item scale, as outlined in Appendix 1, was utilized. Additionally, the study assessed the internal consistency of the scale's items and computed correlation coefficients among the items and the overall scale, with detailed findings presented in the study.

The results presented in Table 3 demonstrate robust and statistically significant correlation coefficients, with a significance level (α) set at 0.5. This outcome further affirms the internal consistency and validity of the motivation scale's items.

Table 3 The correlation coefficient between achievement on the items and overall motivation score

Items	R	Sig.	Items	R	Sig.
1	*0.90	*	11	*0.83	*
2	*0.88	*	12	*0.73	*
3	*0.85	*	13	*0.91	*
4	*0.74	*	14	*0.82	*
5	*0.92	*	15	*0.82	*
6	*0.50	*	16	*0.89	*
7	*0.95	*	17	*0.84	*
8	*0.89	*	18	*0.82	*
9	*0.89	*	19	*0.74	*
10	*0.88	*	20	*0.90	*

* Statistically significant at ($\alpha = 0.5$)

Table 4 Motivation scale reliability

Tool	Cronbach alpha	Split Half Correlation
Motivation scale	0.98	0.95

Motivation scale reliability

The researchers computed Cronbach's alpha and the split-half reliability coefficient to assess the accuracy and reliability of the study tool, namely the motivation scale. The results of this analysis are presented in Table 4.

It is worth highlighting that all the reliability coefficient values were exceptionally high, which underscores the precision and appropriateness of the tool for fulfilling the study's objectives.

Mathematics achievement test

To gauge the achievement of the 10th-grade Mathematics unit's objectives, a 30-item achievement test was meticulously developed by following a systematic process:

1. **Defining General Objectives:** The study was initiated by setting the overarching objective for the fourth unit in the 10th-grade Mathematics curriculum.
2. **Content Analysis:** A comprehensive analysis of the unit's content followed to ensure alignment.
3. **Educational Outcomes Identification:** Clear educational outcomes were defined and aligned with the general objective.
4. **Specification Table:** A specification table detailing question types and content distribution was crafted.
5. **Question Levels and Quantities:** Question difficulty levels and quantities were determined based on the specification table.
6. **Item Generation:** Questions were created in line with the specified educational outcomes and difficulty levels.
7. **Test Instructions and Scoring:** The test instructions and maximum achievable score were established for clarity.

Validity

To ensure test validity, an initial version of the test, including the specification table and behavioural objectives, was scrutinized by 13 external experts. They assessed alignment with educational goals, linguistic clarity, and grade-level suitability. Feedback from these experts led to refinements in certain test items.

Reliability

The achievement test's reliability was evaluated through two methods. Firstly, a separate sample of 13 students was employed. Reliability was assessed using:

- Internal Consistency Method (KR-20): This method gauged internal consistency among test items, employing the KR-20 equation.
- Test-Retest Method: The same group of students took the test and then retook it after a two-week interval. Test-retest reliability was measured using the Cronbach alpha coefficient.

Furthermore, the study tool's correlational validity was examined by calculating the correlation coefficient between student scores on the test and their scores evaluated by the teacher in the respective field.

Reliability coefficients, including Cronbach's alpha, the Cooder-Richardson-20 coefficient, and the test-retest reliability coefficient, are displayed in Table 5.

It's crucial to note that all the coefficient values about validity and reliability were remarkably high, emphasizing the study tool's validity, precision, and appropriateness in fulfilling its objectives. The elevated coefficient of collative validity indicates a robust interrelationship among the items within the motivation scale, effectively capturing the intended construct, which, in this context, is motivation.

Furthermore, the high-reliability coefficients, including Cronbach's alpha, affirm that the motivation scale consistently exhibits internal consistency, with its items reliably measuring the same underlying construct. This underscores the scale's reliability and ability to assess motivation levels among 10th-grade students accurately. Additionally, the achievement test underwent assessments for difficulty and discrimination coefficients, as elaborated in Table 6.

Table 6 offers a comprehensive overview of the achievement test items, presenting a spectrum of difficulty coefficients ranging from 0.31 to 0.69 and discrimination coefficients from 0.20 to 0.82. The researchers, following the criteria initially suggested by Botes et al. (2020) and later refined by He (2020), based their decisions on the following principles:

1. Items featuring negative discrimination coefficients were eliminated as they did not contribute to the test's validity.
2. Items displaying discrimination coefficients between 0 and 0.19 were considered inadequately discriminatory and were recommended for removal.

Table 5 Reliability coefficients

Authenticity coefficient	Calculated Reliability factor		
Compulsory	The Cronbach alpha reliability coefficient	Codder-Richardson reliability coefficient 20-	Half-partition reliability coefficient
0.94	0.95	0.95	0.86

Table 6 Difficulty and discrimination coefficients for achievement test items

Items	Difficulty coefficient	Discrimination coefficient
1.	0.54	0.8
2.	0.46	0.2
3.	0.69	0.71
4.	0.46	0.46
5.	0.31	0.46
6.	0.46	0.36
7.	0.62	0.82
8.	0.62	0.66
9.	0.31	0.71
10.	0.54	0.8
11.	0.46	0.2
12.	0.69	0.71
13.	0.46	0.46
14.	0.31	0.46
15.	0.38	0.59
16.	0.62	0.82
17.	0.46	0.73
18.	0.31	0.71
19.	0.69	0.69
20.	0.62	0.66
21.	0.62	0.75
22.	0.54	0.57
23.	0.62	0.8
24.	0.31	0.36
25.	0.62	0.8
26.	0.54	0.68
27.	0.62	0.82
28.	0.62	0.53
29.	0.31	0.4
30.	0.38	0.34

3. Items showcasing discrimination coefficients ranging from 0.19 to 0.39 were considered acceptable but required enhancements to bolster their discriminatory usefulness.
4. Items demonstrating discrimination coefficients surpassing 0.39 were deemed robust and retained within the test.
5. All items with difficulty coefficients falling within the 0.30 to 0.80 range were considered acceptable and retained in the test.

Given these criteria, all 30 achievement test items were deemed appropriate and retained for integration into the study.

Regarding the experimental group, a lesson plan was designed to align with the specified teaching objectives in the fourth unit of the 10th-grade Mathematics textbook during the second semester of the 2019/2020 academic year. This comprehensive plan integrated the Kahoot application into the teaching process and encompassed two lessons, encompassing the following key components:

1. Clearly defined learning outcomes for each lesson.

2. Identification and citation of sources employed during the teaching procedures.
3. Detailed teaching procedures, accompanied by descriptions of the activities utilized throughout the teaching process.
4. Supplementary worksheets related to the lesson content.

By integrating the Kahoot application into the lesson plan, the researchers aimed to cultivate an engaging and interactive learning environment designed to augment student motivation and enhance academic achievement in mathematics.

Data analysis

In this study, a variety of statistical methods were employed to address the research questions. Specifically, to evaluate the usefulness of the Kahoot application in boosting motivation (the first research question), the study calculated the mean and standard deviation for motivation scale scores. Subsequently, one-way ANCOVA (analysis of covariance) was conducted, with the pre-test motivation scores serving as the covariate. This analysis aimed to determine if statistically significant differences existed in the motivation levels of 10th-grade mathematics students between the experimental and control groups after controlling for pre-existing differences in motivation.

For the second research question, which explored the Kahoot application's impact on academic achievement, the study computed the mean and standard deviation for achievement test scores. One-way ANCOVA (analysis of covariance) was then utilized, with pre-test achievement scores serving as the covariate. This analysis aimed to detect significant differences in the academic achievement of 10th-grade mathematics students between the experimental and control groups after accounting for pre-existing differences in achievement levels.

Pearson's correlation coefficient was employed to ensure the validity and internal consistency of the Motivation scale. This measure assessed how well the items within the scale were related to each other, thereby establishing the scale's validity.

The study assessed the reliability of the motivation scale using Cronbach's alpha coefficient, which indicates the scale's internal consistency and stability. Also, the Kuder-Richardson equation (KR20) and the fractionation coefficient measured the reliability of the motivation scale through test application and reapplication.

Through these statistical analyses, the study aimed to evaluate the usefulness of the Kahoot application in enhancing motivation and academic achievement among 10th-grade mathematics students in Abu Dhabi Emirate Schools.

Results

First research question

The study's analysis focused on addressing the first research question, which explores the impact of the Kahoot application on the motivation of 10th-grade mathematics students in Abu Dhabi Emirate Schools. To evaluate the post-application data, the study calculated the mean and standard deviations, and the resulting analysis results are detailed in Table 7.

The provided information highlights noticeable disparities in the mean scores of the motivation scale between 10th-grade students who utilized the Kahoot application (experimental group) and those who followed conventional teaching methods (control group) in the subject of Mathematics. Specifically, the experimental group (Kahoot users) achieved a higher mean score of 3.21 on the motivation scale, whereas the control group (traditional learning users) attained a lower mean score of 2.00.

To assess whether these observed variations in mean scores carry statistical significance at the predetermined significance level $\alpha = 0.05$, a suitable statistical test, such as an independent samples t-test, may have been employed. The t-test compares the means of two distinct groups, determining whether a substantial difference exists between them. The pivotal determinant of the statistical significance of these mean differences hinges on the p-value derived from the t-test. This p-value indicates whether the observed disparities in means hold statistical significance or could have arisen by random chance. In cases where the p-value falls below the chosen significance level ($\alpha = 0.05$), it signifies that the differences in means are statistically significant. Conversely, if the p-value surpasses $\alpha = 0.05$, the differences are considered statistically insignificant, and the differences are considered statistically negligible if the p-value exceeds $\alpha = 0.05$.

The outcomes of the one-way ANCOVA (analysis of covariance) on the motivation scale are in Table 8. Notably, a difference in dimensional achievement on the Motivation measure emerges between the two groups. This is underscored by the remarkably low p-value of 0.00 at the significance level of $\alpha = 0.05$. This statistical significance strongly favours the experimental group, where the average achievement score stands at 3.21, significantly surpassing the control group's average achievement score of 2.00. Furthermore, the effect of utilizing Kahoot was gauged using eta square (η^2), resulting in a value of 0.336. This signifies that approximately 34% of the observed increase in

Table 7 Post-achievement motivation scale

Groups	n	Mean	SD	Adjusted mean
Control	30	3.21	1.04	3.22
Experimental	30	2.00	0.65	1.99

Table 8 One-way ANCOVA (analysis of covariance) on the motivation scale

Source	Sum squares	df	Mean square	F	Sig.	Partial eta square
Pre-test	0.319	1	0.319	0.417	0.521	
Group	22.092	1	22.092	28.871	*0.000	0.336
Error	43.617	57	0.765			
Total	65.897	59				

motivation among students in the experimental group can be attributed to using the Kahoot application.

The substantial effect size and the significant difference highlight the positive impact of integrating Kahoot into the learning process on students' motivation levels. The application's interactive and competitive nature and engaging learning approach effectively cultivate students' enthusiasm and interest in mathematics. These findings underscore the significance of embracing modern educational technologies like Kahoot to establish dynamic and stimulating learning environments. By harnessing technology to elevate student motivation, educators can cultivate a more productive and enjoyable learning experience, ultimately leading to enhanced academic achievements.

Second research question

The outcomes of the second research question, which centres on assessing the usefulness of the Kahoot application in enhancing the academic achievement of 10th-grade students in mathematics within Abu Dhabi Emirate Schools, were subjected to rigorous statistical analysis. The mean values and standard deviations for the post-application dataset were computed, and the ensuing analytical findings are presented in Table 9.

The analysis outcomes reveal noticeable student achievement disparities across the two groups. To ascertain the statistical significance of these distinctions, with a significance level set at $\alpha = 0.05$, a one-way ANCOVA (analysis of covariance) was implemented, as shown in Table 10.

Table 9 Post-achievement of the achievement test

Group	Sample size	Mean	SD	Adjusted mean
Experimental	30	28.73	1.05	28.77
Control	30	18.93	4.05	18.90

Table 10 One-way ANCOVA (analysis of covariance) for 10th-grade mathematics achievement test by teaching strategy

Source	Sum squares	df	Mean square	F	Sig.	Partial eta square
Pre-test	16.824	1	16.824	1.953	0.168	
Teaching strategies	1455.410	1	1455.410	168.989	0.00*	0.748
Error	490.909	57	8.612			
Total	1948.333	59				

The outcomes presented in Table 10 signify substantial statistically significant distinctions at a significance level of $\alpha = 0.05$ concerning the achievement of 10th-grade students in mathematics on the post-achievement test based on the teaching strategy employed. This is evident from the calculated value (q) of 168.989, which yields a significance level of 0.00, firmly establishing the statistical significance at $\alpha = 0.05$. These differences favour the experimental group that utilized Kahoot, with an average achievement score of 28.73, significantly surpassing the control group's mean score of 18.93.

To gauge Kahoot's impact on mathematics test scores, an eta square (η^2) was computed, resulting in a value of 0.748. This signifies that a substantial 75% of the improvement in students' achievement in the experimental group on the post-achievement test can be attributed to the utilization of Kahoot.

Discussion

This study sought to explore the impact of the Kahoot application on the motivation and academic achievement of 10th-grade students in mathematics within Abu Dhabi Emirate schools. The study involved 1,119 10th-grade students from Abu Dhabi Emirate Schools, with an experimental group using Kahoot and a control group receiving traditional teaching methods. The researchers purposefully selected classes with access to advanced technological resources and remote learning programs. This research provides valuable insights into the potential benefits of integrating technology into the educational process.

Influence on motivation

The findings on the first research question regarding the influence of the Kahoot application on student motivation are noteworthy. The analysis revealed substantial disparities in the mean scores of the motivation scale between two distinct groups: the experimental group that utilized Kahoot and the control group that followed traditional teaching methods in mathematics. Notably, the experimental group of Kahoot users achieved a significantly higher mean score of 3.21 on the motivation scale than the control group's lower mean score of 2.00.

These results are supported by the outcomes of the one-way ANCOVA (analysis of covariance) on the motivation scale, which showed a statistically significant difference in achievement between the two groups. The low p -value of 0.00 at the significance level of $\alpha = 0.05$ strongly favoured the experimental group. Furthermore, the effect size (η^2) of 0.336 indicated that approximately 34% of the observed increase in motivation among students in the experimental group could be attributed to using the Kahoot application.

The substantial effect size and significant differences underscore the positive impact of integrating Kahoot into the learning process on students' motivation levels. The interactive

and competitive nature of Kahoot, coupled with its engaging learning approach, effectively cultivates students' enthusiasm and interest in mathematics. The influence of Kahoot on student motivation in this study aligns with the findings of Wang (2015) and Licorish et al. (2017). Both studies indicated that Kahoot is an effective motivator, as students are driven by the aspiration to perform well in Kahoot activities, leading to increased attentiveness and active participation with the lecturer, peers, and lecture content.

The study findings highlight the importance of embracing modern educational technologies like Kahoot to establish dynamic and stimulating learning environments. By leveraging technology to enhance student motivation, educators can foster a more productive and enjoyable learning experience, ultimately leading to improved academic achievements.

Contribution to academic achievement

Addressing the second research question regarding the contribution of the Kahoot application to academic achievement, the results are equally compelling. The analysis revealed notable achievement disparities between the two groups, with the experimental group that utilized Kahoot achieving a significantly higher mean score of 28.73 on the post-achievement test compared to the control group's mean score of 18.93.

The outcomes of one-way ANCOVA (analysis of covariance) on the post-achievement test scores further reinforced these findings. The computed value (q) of 168.989 yielded a significance level of 0.00 at $\alpha = 0.05$, firmly establishing the statistical significance of the differences in achievement between the two groups. The effect size (η^2) of 0.748 indicated that a substantial 75% improvement in the performance achievement of students in the experimental group on the post-achievement test can be linked to the use of Kahoot.

These findings mirror those discovered by Göksün & Gürsoy (2019), Halim et al. (2020), Janković and Lambić (2022), and Lee et al. (2019), who have observed that the use of Kahoot positively impacts student achievement by promoting a deeper conceptual understanding and enhancing retention. The competitive structure of Kahoot further strengthens motivation, participation, and engagement.

The results of this study suggest that the Kahoot application has a profound positive effect on academic achievement in mathematics. The engaging and interactive nature of Kahoot, coupled with its real-time feedback and competitive elements, appears to be a potent combination in enhancing student achievement and fostering a deeper connection with the subject matter and the learning process.

Conclusion

This study delved into the impact of the Kahoot application on the motivation and academic achievement of 10th-grade students in mathematics at Abu Dhabi Emirate Schools,

shedding light on the potential benefits of integrating this modern educational technology into traditional classroom settings. Regarding motivation, the results unequivocally demonstrated that students in the experimental group who engaged with Kahoot exhibited significantly higher motivation scores than their peers in the control group. The interactive and competitive nature of Kahoot was instrumental in igniting interest and enthusiasm among students. The application's ability to actively engage learners and foster a stimulating educational environment contributed to this notable increase in motivation levels.

In terms of academic achievement, the findings were equally compelling. In the post-achievement test, students in the experimental group outperformed their counterparts in the control group. Kahoot's playful learning approach and emphasis on healthy competition facilitated deeper comprehension and a more enjoyable learning experience. Students were motivated and driven to excel academically, resulting in improved academic achievement. In light of these compelling findings, it is evident that the Kahoot application has a positive and transformative impact on both student motivation and academic achievement in mathematics. This study strongly recommends the integration of Kahoot into the teaching practices of mathematics educators, recognizing it as a valuable tool to enhance student engagement and overall learning outcomes.

Furthermore, considering the significance and novelty of this study within the Abu Dhabi Emirate Schools, it encourages educators and policymakers to embrace modern educational technologies, like Kahoot, to create dynamic and interactive learning environments. Providing training courses for teachers on effectively utilizing Kahoot in the classroom is advised to optimize its impact on student motivation and academic achievement.

While this study has shed invaluable light on the positive effects of Kahoot in a specific context, it also serves as a springboard for future research. Exploring the application's usefulness in other subjects and grade levels and its impact on diverse student populations can offer deeper insights into tailoring educational strategies to individual learning needs.

In conclusion, the findings of this study underscore the potential of the Kahoot application as an effective tool to boost motivation and academic achievement in mathematics among 10th-grade students. Embracing technological advancements in education aligns with the evolving needs of modern education and paves the way for enriched and engaging learning experiences that benefit educators and learners alike.

Recommendations and suggestions

Based on the findings of the study, the following recommendations and suggestions are made:

1. **Incorporate Kahoot in Mathematics Teaching:** Educational institutions and teachers should pay attention to the application of Kahoot in teaching mathematics, given its

positive impact on increasing student motivation. Using Kahoot, teachers can create an engaging and interactive learning environment that encourages active participation and enhances students' interest in the subject.

2. **Encourage Teachers to Use Kahoot:** Both male and female teachers should be encouraged to utilize the Kahoot application in their mathematics classes. Its usefulness in improving students' academic achievement levels can lead to better learning outcomes and academic success.
3. **Organise Training Courses:** Conduct training courses for mathematics teachers on effectively using the Kahoot application in the educational process. This training will equip teachers with the necessary skills to implement Kahoot effectively, leading to increased student motivation and engagement in the classroom.
4. **Conduct Further Studies:** Encourage further research and studies on using Kahoot in various academic subjects and for students at different levels. Educators can identify best practices and tailor their implementation to suit diverse learning environments by exploring their usefulness in other contexts.

By implementing these recommendations and exploring the potential of Kahoot in various educational settings, educators can create a more engaging and practical learning experience for students, ultimately enhancing their motivation and academic achievements.

Study limitations

1. **Objectivity of Student Answers:** The study relies on the objectivity and accuracy of 10th-grade students' answers to the questions and tasks provided. There may be variations in students' interpretation or understanding of the questions, which could impact the results.
2. **Representativeness of the Sample:** The extent to which the study sample represents the broader community from which it was drawn may be a limitation. The findings may not apply to all students in the community, especially if the sample is not fully representative.
3. **Context of the coronavirus pandemic:** The study was conducted during the COVID-19 pandemic, which may have influenced the learning environment and students' experiences. The impact of the pandemic on education could affect the generalizability of the study's results to non-pandemic contexts.

Appendix: Motivation scale

No.	Items	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Using Kahoot in math class brings me joy.					
2.	Kahoot motivates me to participate in math class actively.					
3.	Kahoot provides ample time for me to answer questions.					
4.	Collaborating with my peers through Kahoot helps me overcome the fear of giving wrong answers.					
5.	Kahoot captures my attention during math class.					
6.	I find math lessons on Kahoot to be engaging.					
7.	Kahoot encourages me to prepare for lessons in advance to compete and strive for the top spot.					
8.	I enjoy competing with my classmates to solve Kahoot questions in math.					
9.	I frequently join Kahoot competitions during math class.					
10.	Kahoot helps me remember math lesson content for a longer duration.					
11.	I prefer learning math through Kahoot.					
12.	Anticipating Kahoot activities makes me look forward to math class.					
13.	I feel enthusiastic about using Kahoot to excel in math.					
14.	Kahoot reduces my shyness when participating and answering questions.					
15.	I enjoy watching educational videos provided by Kahoot.					
16.	The visuals on Kahoot caught my eye.					
17.	Kahoot allows me to discuss answers with my peers before making a choice.					
18.	The music on Kahoot adds excitement to my learning experience.					
19.	Kahoot boosts my motivation to learn.					
20.	I do not get bored when using Kahoot in math class.					

Authors' contributions

Conceptualization, Y.W.; methodology, A.M. and Y.W.; software, A.M.; validation, N.A., P.F.; formal analysis, Y.W. and A.M.; investigation, Y.W.; resources, P.F.; data curation, Y.W. and A.M.; writing—original draft preparation, Y.W.; writing—review and editing, Y.W., P.F.; visualization, P.F.; supervision, A.M. All authors have read and agreed to the published version of the manuscript.

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Availability of data and materials

The data for this study is not publicly available; however, it can be made available upon genuine request to authors.

Declarations

Competing interests

The authors declare that they have no competing interests.

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