Vol. 2 No. 1 2024

Exploring the Impact of Kahoot! as An Interactive Game-Based Tool in Learning Chemistry for Undergraduates: A Review

Article accepted: 24-06-2024

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ABSTRACT

Kahoot! is a popular game-based learning platform that leverages technology to create interactive and engaging classroom quizzes. It fosters the active participation of students and is believed to enhance students' comprehension more effectively than traditional methods in educational settings. Thus, this review paper systematically examines and integrates existing literatures on using Kahoot! for learning Chemistry at the undergraduate level. By exploring the impact of Kahoot! on various aspects of Chemistry education, including academic performance, student engagement, study motivation, and attentiveness, this review provides a thorough understanding of its effectiveness as an educational tool. A comprehensive search was conducted across academic databases such as Scopus, IEEE Xplore, ScienceDirect, and Google Scholar, using predetermined keywords like 'undergraduate students,' 'Kahoot, game-based learning,' 'Chemistry education,' and 'academic performance'. Inclusion criteria focused on peer-reviewed articles or conference papers published between 2014 and 2024. These articles or papers examined the impact of game-based learning tools, specifically Kahoot!, in Chemistry education. After an initial broad review, articles specifically discussing the use of Kahoot! in Chemistry education were selected for the final analysis. A thematic analysis of the four aspects mentioned above was employed to synthesize the findings. The results confirm that Kahoot! positively influences students' academic performance, heightens engagement, enhances study motivation and develops attentiveness in undergraduate Chemistry classrooms. However, further research is needed to address literature gaps and refine the implementation of Kahoot! to maximize its educational potential for Chemistry undergraduates.

Keywords:

undergraduate students, Kahoot, game-based learning, Chemistry education, academic performance.

INTRODUCTION

As we navigate the 21st century, the swift evolution of the Internet of Things (IoT) in education is reshaping students' learning experiences. Despite these advancements, educators continue to grapple with the enduring challenge of motivating students to actively engage in their own learning. This challenge is compounded by the difficulty of sustaining motivation, engagement, and concentration during lectures, especially with the issue of students' short attention spans (Wang and Tahir, 2020).

Studies have shown that students exhibit optimal concentration within the initial 10 to 15 minutes of a lecture, gradually declining thereafter (Le, 2021). This timeframe is crucial for information acquisition, posing a challenge in large undergraduate classrooms (Le, 2021).

Higher education intensifies this struggle as educators attempt to captivate students and present complex subjects effectively. Packed classrooms with minimal interaction exacerbate the need for active learning. The lack of meaningful interaction between students and teachers in higher education leads to diminished understanding of material and poor academic performance. While class size plays a role, the primary contributing factor is the instructional approach, predominantly through lectures (Byusa et al., 2022). The field of Chemistry education faces challenges such as student deficiencies in problem-solving skills, spatial visualization issues, and ineffective communication between students and teachers (Erman, 2017). Large classroom settings and limited interactions further hinder students' academic progress.

Recent technological advancements offer insights into addressing these challenges. Universities are increasingly incorporating contemporary technologies to attract students and enhance their involvement (Ghawail and Yahia, 2022). Game-based learning through platforms like Socrative, Edpuzzle, Quizizz, and Kahoot! has proven advantageous. These tools effectively enhance students' motivation, engagement, and concentration, providing a customizable solution for individual or group participation. The implementation of these tools brings joy to educators, offering a convenient solution as students use their own devices (Curto Prieto et al., 2019).

In this context, the integration of Kahoot! is particularly relevant. Kahoot! integrates a Student Response System (SRS) and leverages existing technical infrastructure, incorporating social networking and gaming elements into a unified learning platform. This aligns with the idea that students learn best when content is relevant, socially connected, and personally interesting (Wang and Tahir, 2020). Past research suggests incorporating game-based learning tools like Kahoot! can enhance students' understanding and motivation in tackling complex subjects. Essentially, the aim of Kahoot! is to enhance learning outcomes and classroom interactions by promoting higher engagement, motivation, enjoyment, and focus (Wang and Tahir, 2020). Educational games gain recognition for their e-learning advantages, providing prompt feedback and increasing student engagement.

Experiences with Kahoot! in undergraduate settings reveal positive student feedback and appreciation for the incorporation of this game (Ghawail and Yahia, 2022). Importantly, the application allows teachers to identify specific learning problems and take effective measures, making it a crucial element in the initial, formative, and final evaluation of students (Curto Prieto et al., 2019). In the context of undergraduate Chemistry learning, the integration of Kahoot! is seen as a potential catalyst for positive outcomes, including increased attention span, improved knowledge acquisition, heightened motivation, enhanced concentration, and improved engagement. Furthermore, Kahoot! facilitates understanding and participation for the entire class, contributing to the development of social skills (Bryant, Correll, and Clarke, 2018).

Hence, this article aims to provide a focused review of the specific impact of employing Kahoot! in learning Chemistry, with a particular emphasis on its relevance to undergraduate education. The integration of game-based learning tools offers a promising avenue for addressing the challenges associated with traditional instructional methods, providing a more engaging and effective educational experience.

MATERIAL AND METHODS

What is a game-based learning tool?

Kahoot! is an educational platform used for reviewing students' understanding, conducting formative assessments, or providing a refreshing break from conventional classroom routines (Wang and Tahir, 2020). It is a game-based student response system (GSRS) (Boden and Hart, 2018) that transforms the classroom into a game show, with the teacher acting as the host and the students as contestants (Wang, 2015). By incorporating game elements into non-game situations, Kahoot! captures attention, stimulates engagement, and enhances the learning experience (Zhang and Yu, 2021). It combines the concepts of student response systems and video games (Wang and Tahir, 2020), featuring several interesting attributes.

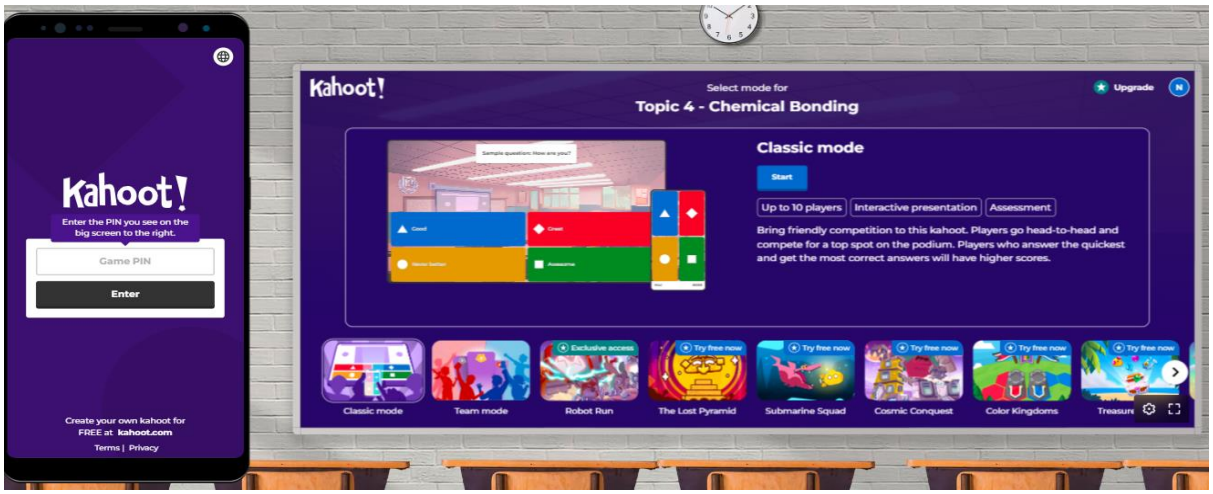


Figure 1: Interface of Kahoot! showing the game PIN prompt on student's devices (left) and the projected screen of educators before the game (right).

Firstly, educators can generate their own questions and immediately disseminate them to students (Figure 2 and 5). Secondly, students can easily answer these questions and receive feedback (Figure 3). Thirdly, students can use their own mobile devices, tablets, or computers to participate (Cutri et al., 2016). Additionally, students can see their position in the ranking of scores (Figure 4), as the platform generates a leaderboard once all questions have been answered (Curto Prieto et al., 2019). These features make the platform engaging and exciting for both educators and students.

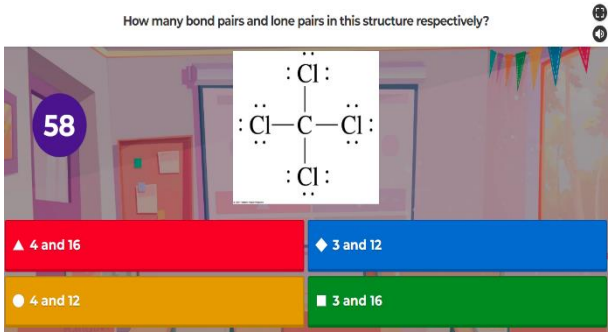


Figure 2: Sample of question with preset timing on the left.

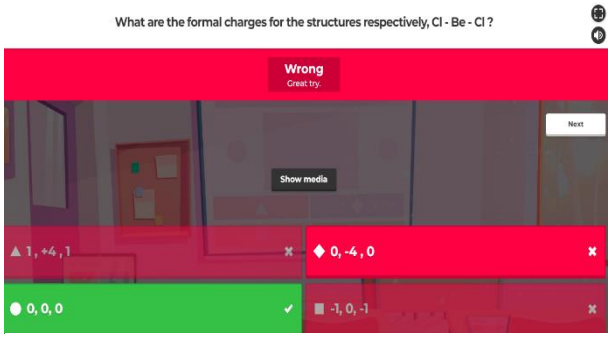
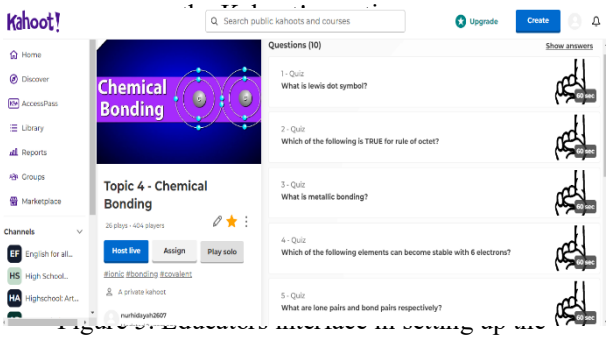


Figure 3: Prompt feedback once students answered

Figure 4: Display of the quiz results with class ranking.



questions.

Research methodology and approaches

The methodology employed in this review paper encompasses three key stages to ensure a comprehensive and systematic analysis of the impact of Kahoot! in learning Chemistry for undergraduates.

Stage 1: Focused Selection for Initial Review

The inclusion and exclusion criteria were formulated based on the foundational studies by Wang and Tahir (2020) and Zhang and Yu (2021). They established a validated framework for evaluating Kahoot!'s effectiveness and demonstrated the positive impacts of Kahoot! on student engagement, motivation, and learning outcomes. The guidelines for this approach are outlined below.

Inclusion Criteria for Initial Review:

- Publication Type: Articles published in international peer-reviewed journals or conferences.
- Time Frame: Studies published between 2014 and 2024.
- Subject Focus: Research focusing on game-based learning in education, particularly in Chemistry education. This includes studies discussing various game-based learning tools, including but not limited to Kahoot!.

Exclusion Criteria for Initial Search:

- Articles not accessible through university services or memberships.
- Non-peer-reviewed articles and opinion pieces.

Stage 2: Comprehensive Search and Preliminary Review

A thorough search for pertinent studies was conducted across several academic databases, including Scopus, IEEE Xplore, Science Direct, and Google Scholar. This search was augmented by examining references in identified studies. The search terms were developed according to the PICO format and included keywords such as "undergraduate students," "game-based learning," "Chemistry education," "academic performance," and "Kahoot." Articles meeting the initial inclusion criteria were meticulously reviewed, and relevant studies were downloaded in PDF format. A total of 37 articles were extracted at this stage.

Stage 3: Focused Selection for Final Review

Inclusion Criteria for Final Review:

- Studies specifically discussing the use of Kahoot! in Chemistry education for undergraduates.
- Research providing quantitative data (e.g., test scores, engagement metrics) or qualitative data (e.g., student feedback, interviews) on the impact of Kahoot!.

Exclusion Criteria for Final Review:

- Studies where Kahoot! is not the primary tool discussed.
- Research not specifically focused on Chemistry education.

After the preliminary review, the articles were further screened for their focus on the application of Kahoot! as a game-based tool in the context of learning Chemistry. Out of the initially selected 37 articles, 7 publications met the criteria for the final review (Appendix 1). Finally, to synthesize the findings, a thematic analysis approach was employed to discern common outcomes across the selected studies. The results were subsequently categorized based on four key themes of investigation such follows:

Premise 1 : Impact of Kahoot! on Academic Performance

Premise 2 : Impact of Kahoot! on Students' Engagement

Premise 3 : Impact of Kahoot! on Study Motivation

Premise 4 : Impact of Kahoot! on Student's Attentiveness

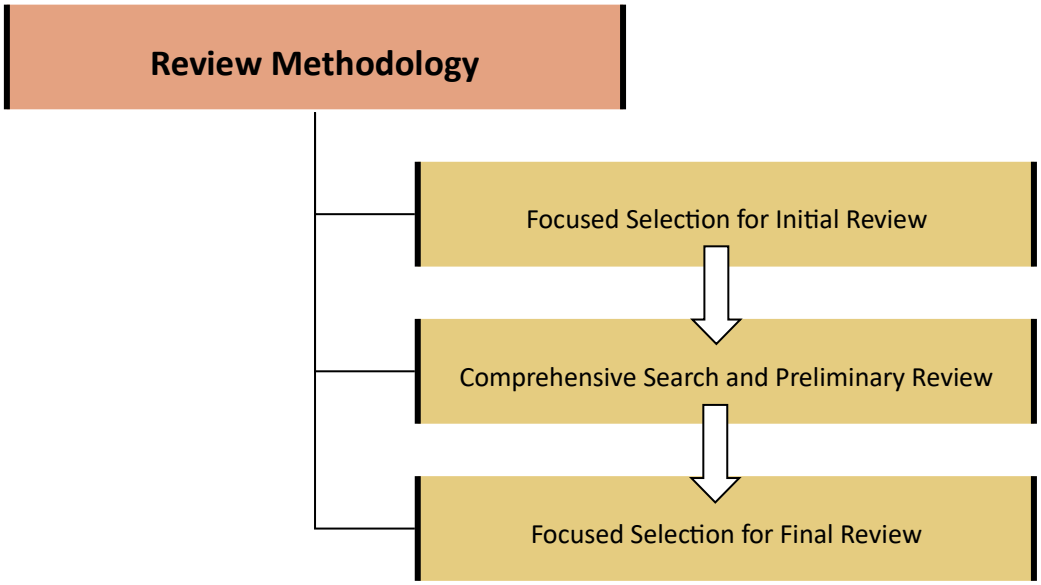


Figure 6: A brief flowchart of the methodology

RESULTS

This section outlays the results from the literature reviews in thematic analysis as mentioned earlier in the introduction and methodology section.

Impact of Kahoot! on Academic Performance

Upon reviewing various studies, it becomes evident that multiple findings support the idea that Kahoot! indeed has a noteworthy influence on students' academic performance.

In an empirical-analytical study for third-year Chemistry degree students conducted at the University of Valladolid, Spain, it was found that students' overall marks significantly increased in both groups that used Kahoot!, leading to a higher passing rates (Bernal et al., 2018). The outcomes consistently demonstrated significant improvement in both groups' overall grades and the number of students successfully completing the subject. Additionally, when the frequency of Kahoot! quizzes was tested, Group 1 exhibited a higher mean mark for repeated Kahoot! sessions compared to the other groups, indicating that frequent engagement with Kahoot! had a substantial impact on students' grades (Bernal et al., 2018).

In a different study conducted at the same university by Ares et al. (2022), the impact of using Kahoot! on students' academic performance in a Chemistry course was evaluated. Results showed that Group 3, where Kahoot! was used daily and students were aware of a final partial exam, had the highest overall scores compared to Group 1 (no Kahoot! used, unaware of the final exam) and Group 2 (no Kahoot! used, aware of the final exam). Scores were significantly better in Group 2 than in Group 1, indicating the influence of knowledge about the final exam. However, Group 3 outperformed both other groups, suggesting that the combination of Kahoot! and awareness of the final exam positively impacted performance.

In the same year, research conducted at Sokoto State University for undergraduate Chemistry students performed a paired-sample t-test to evaluate students' progress in learning the philosophy of Chemistry. Significant differences were found between the two scores, with p-values of 0.000 and 0.006 reported for more than 60% of the correspondences. This result indicated significant improvement in student scores across multiple assessments, suggesting better performance over time (Aliyu, Talib, and Garba, 2022).

Meanwhile, an action research study by Ghawail and Yahia (2022) using 20 questionnaires on a 5-point Likert scale during three weeks of a Chemistry course reported high levels of success improvement, with a mean of 4.41 (SD = 0.61). The application was also found to increase lesson effectiveness with a mean value of 4.48 (SD = 0.60). Semi-structured interviews further revealed that students felt Kahoot! helped in active participation in Chemistry lessons and effectively grasping the unit on molecular weights, fostering better performance in basic Chemistry.

Briefly, these studies reported that using Kahoot! as a gamification tool in undergraduate Chemistry courses positively impacts students' academic performance.

Impact of Kahoot! on Students' Engagement

From the study by Ghawail and Yahia (2022), it was observed that the incorporation of Kahoot! led to active student engagement in Chemistry lessons. This was demonstrated through a 5-point Likert-scale, where the data suggested significant enhancements in various aspects of student engagement. Specifically, Kahoot! fostered a collaborative learning environment (M = 4.56, SD = 0.61), generated excitement through time-limited responses (M = 4.40, SD = 0.61), motivated students by allowing them to share activities on social media (M = 4.42, SD = 0.59), and encouraged participation in class activities (M = 4.35, SD = 0.54). Initially, 13 out of 20 participants noted heightened engagement and interaction during lectures, facilitated by Kahoot! through answering questions, engaging in quizzes, and contributing to discussions. This was in contrast to traditional classroom settings where discussions typically revolve around a selected group of outgoing students.

In a separate study conducted at a public university in Indonesia, it was reported that Kahoot! significantly enhanced classroom engagement. Descriptive quantitative analysis revealed an impressive average score of 4.47, categorizing student experiences as excellent. Students felt challenged by Kahoot! quizzes, which introduced a refreshing approach to classroom activities. The platform transformed learning dynamics and injected enjoyable competition, with students eagerly competing for top spots in the Kahoot! rankings. Additionally, with an average rating of 4.04 (also classified as excellent), students' active engagement in classroom discussions resembled vibrant exchanges, deliberating potential answers for each question. One student commented positively on the application: "Absolutely! With the competitive vibe, we're all in a race to learn. It feels as if we're embarking on this learning adventure side by side, which inspired the idea of creating a learning forum. We keep sharing information, staying connected, and actively engaging with each other in the classroom" (Iman, Ramli, and Saridewi, 2021).

Another study by Ramli, Yohana, and El Islami (2020), employing a descriptive qualitative approach in two Analytical Chemistry classrooms, found that students experienced both excitement and anticipation during Kahoot! sessions. One student shared, "I'm feeling a combination of nervousness and excitement. I also wanted to be the first one who can answer the question" (student#4). Another student remarked, "The test using Kahoot! is fun because the atmosphere of the test is like the atmosphere of playing

games" (student#2). These statements highlight the students' enthusiasm and perception of Kahoot! as an enjoyable and effective platform for classroom use.

Impact of Kahoot! on Study Motivations

In Ghawail and Yahia's (2022) research, participants reported heightened motivation to learn concepts such as molality, normality, atomic mass, and molar mass following their participation in Kahoot! games. The descriptive analysis data indicated a significant increase in student interest in Chemistry lessons when utilizing Kahoot! (M = 4.48, SD = 0.52). Additionally, activities developed with Kahoot! were perceived as more engaging, further enhancing student interest (M = 4.45, SD = 0.54). The use of Kahoot! also correlated with heightened motivation among students (M = 4.43, SD = 0.56) and facilitated permanent learning, suggesting that the motivational benefits extend beyond immediate engagement (M = 4.56, SD = 0.53). These findings suggest that Kahoot! serves as a motivational tool in Chemistry education, fostering long-term learning outcomes among students.
In the study by Iman, Ramli, and Saridewi (2021), the quantitative analysis revealed an average score of 4.24 in the motivational sub-aspect questionnaires, placing student's motivation within the outstanding category. Before the regular lectures, students showed increased motivation to prepare for Kahoot! quizzes. Each question offered an opportunity to earn points, encouraging them to respond quickly. In an interview, one student supported these results, stating, "I'm driven by the goal of providing answers quickly and precisely. Understanding computational concepts is crucial for achieving this objective. I'm highly motivated to learn this material and improve my response abilities." (Iman, Ramli, and Saridewi, 2021).

In the study by Sanga Lamsari Purba et al. (2019), a qualitative descriptive study using a quasi-experimental method investigated study motivation using Kahoot!. There was a significant increase in students' motivation to learn Chemistry following the use of Kahoot! online games. The test results showed a value of 0.73 (interpreted as high from the formula presented in the study), indicating an increase in motivation to learn. The questionnaire analysis revealed significant enhancements in study motivation, particularly regarding the intention to succeed in learning, with an average gain value of 0.82 across six statements. The most substantial improvement was observed in the indicator reflecting the desire to succeed in learning, with a high gain value of 0.84. Overall, the utilization of Kahoot! online games notably augmented students' motivation to learn Chemistry.

In the research by Aliyu, Talib, and Garba (2022), study motivations were also analyzed. All 32 respondents unanimously reported increasing their study time through gamification methods. They felt highly motivated by competing in Kahoot! games with friends, which fostered positive attitudes towards learning. These findings were consistent across the board, with each aspect receiving a perfect average score of 4.00 and exhibiting no deviation. The scoring mechanism of Kahoot! drove students' ambition to secure a position among the top five

scorers, as reported by 31 out of 32 respondents, resulting in an average score of 3.97 and a standard deviation of 0.18.

Impact of Kahoot! on Students' Attentiveness

Students reported a positive impact on the knowledge and skills they gained through the use of Kahoot!. The gamification element increased attention, interaction, and competition, supporting a more engaging learning environment (Ghawail and Yahia, 2022). Enhanced rapid thinking skills were observed among participants when using Kahoot! (M = 4.47, SD = 0.68) (Ghawail and Yahia, 2022). There was unanimous agreement among all participants regarding the positive impact of Kahoot! on their attention and focus in the classroom. Many expressed that engaging with Kahoot! helped them maintain attention throughout the lecture, resulting in accurate responses to questions. The competitive element, with a leaderboard displaying top performers, contributed to increased attentiveness during lectures and discussions, as reported in the semi-structured interviews by Ghawail and Yahia (2022).

Similarly, in the study by Ramli, Yohana, and El Islami (2020), students believed that Kahoot! encouragingly enhanced their focus during learning sessions. One student remarked, "Kahoot! offers practical benefits as test results are instantly available, encouraging students to think swiftly" (student #5). The average score for the focus sub-aspect was 3.89, indicating excellent performance. This suggests that Kahoot! effectively enhances students' ability to concentrate during lectures (Iman, Ramli, and Saridewi, 2021). Another student supported this finding, stating, "Yes, Kahoot helps in focusing on learning. The impact is quite high because it guides us too…. learning can be focused" (Iman, Ramli, and Saridewi, 2021).

These studies demonstrate the positive effects of Kahoot! on attentiveness in Chemistry lessons. However, it is worth noting that few studies have specifically examined attentiveness in Chemistry lessons using Kahoot!. Most research has primarily focused on academic performance within the classroom. Consequently, only a limited number of relevant literature sources are available for inclusion in this report.

DISCUSSION

The integration of Kahoot! into undergraduate Chemistry education has shown a transformative impact in enhancing student's academic performance, engagement, motivation and attentiveness. Henceforth, this discussion section delves into the implications of these findings, providing insights into how Kahoot! can be effectively utilized to improve educational outcomes in Chemistry courses.

The studies reviewed consistently indicate that Kahoot! has a significant positive impact on students' academic performance. The increased marks and higher passing rates observed in various studies suggest that frequent use of Kahoot! quizzes can lead to substantial improvements in academic outcomes. This improvement likely results from the gamified approach, which makes learning more interactive and engaging, encouraging students to invest more effort. Empirical evidence shows that regularly integrating Kahoot! into the curriculum fosters better understanding and retention of Chemistry concepts, leading to improved grades and higher course completion rates. Additionally, as supported by Ningrum (2018) study, Kahoot! accelerates students' understanding through immediate feedback. Hence, this rapid reinforcement of learning material instantly boosts their interest and motivation, leading to an improved academic outcomes.

Kahoot! significantly boosts student engagement in Chemistry lessons. Kahoot!'s interactive nature, with real-time feedback and competitive elements, transforms traditional classrooms into dynamic learning environments. This shift promotes active participation, as students are motivated to engage in discussions and answer questions promptly. The findings suggest that Kahoot! not only makes learning more enjoyable but also fosters a collaborative atmosphere where students can interact and learn from each other. This approach is evidenced by Chaiyo and Nokham, (2017), which states that Kahoot! encourages teamwork and the sharing of knowledge among students. An increased engagement is crucial for creating an inclusive educational environment that caters to diverse learning styles and keeps students interested and involved in the subject matter.

The motivational benefits of Kahoot! are evident from the reviewed studies. Students reported heightened motivation to study and prepare for quizzes, driven by the desire to perform well in the competitive Kahoot! environment. This gamified approach taps into students' intrinsic motivation, encouraging deeper engagement with the content. The studies highlight that Kahoot! can be a powerful tool for sustaining students' interest in Chemistry, making them more enthusiastic about learning complex concepts. This sustained motivation is essential for long-term academic success and can lead to a deeper appreciation of the subject.

Kahoot! has a positive impact on students' attentiveness during lectures and discussions. Its competitive nature keeps students engaged and alert by encouraging quick responses to questions, which helps maintain their focus throughout the lesson. This increased engagement significantly enhances attentiveness, as students are motivated to stay active and responsive. Furthermore, this heightened focus directly contributes to improved exam performance, as highlighted by Martín-Sómer, Moreira, and Casado (2021). Attentiveness is critical for effective learning, ensuring that students actively process and engage with the material being taught. Additionally, the immediate feedback provided by Kahoot! reinforces attentiveness by allowing students to quickly identify and correct their mistakes, promoting a continuous learning process.

Nevertheless, the outcomes derived from the pilot study by Ares et al. (2022) underscore the need for more comprehensive research across various Chemistry courses and levels to ascertain the efficacy of Kahoot! in enhancing academic performance. The restricted focus on Chemistry topics while conducting the study warrants consideration. The Ghawail and Yahia (2022) study, which delved into just three units instead of the entire course, emphasizes the urgent need for higher education institutions to adopt learning technologies like e-learning systems. This would facilitate anonymous student engagement and offer improved methods for revision, addressing the identified shortcomings in the educational approach. In summary, Kahoot! offers a gratifying and meaningful learning experience. Inspired by its advantages, students expressed a willingness to incorporate this platform into their future teaching internships, as reported by Ramli, Yohana, and El Islami (2020).

CONCLUSION

The selected literature clearly illustrates that the utilization of Kahoot! has significantly boosted students' dynamic learning in Chemistry. By incorporating enjoyable elements, Kahoot! enhanced the classroom experience and increased student involvement, catering to all learners, including the more reserved ones. The findings indicate that Kahoot! positively influences academic performance, student engagement, motivation, and attentiveness in Chemistry lessons. This enrichment of the learning experience fosters both cooperative and competitive elements, making the educational process more dynamic and inclusive. Despite these promising findings, further studies are needed to optimize

Kahoot!'s performance and maximize its benefits for undergraduate Chemistry classes. In conclusion, Kahoot! holds immense potential to revolutionize undergraduate Chemistry education, making learning more engaging, interactive, and effective. With continued research and refinement, Kahoot! can become an integral tool in fostering an enriching and stimulating learning environment for students.

LIMITATIONS AND FUTURE RECOMMENDATIONS

Despite the promising findings, the current body of research has limitations. The existing literature addressing the four previously mentioned premises in Chemistry education is still limited. Specifically, studies focusing on long-term effects and attentiveness are particularly scarce. This gap potentially affects the comprehensiveness of the analysis. Moreover, the effectiveness of Kahoot! or any interactive learning tool in Chemistry education might vary depending on factors such as instructor expertise (Sadykov and Čtrnáctová, 2020), student engagement levels, and technological infrastructure. These variables introduce complexity in determining the actual effectiveness of Kahoot!.

Future research should aim to address these gaps by conducting more comprehensive studies across various Chemistry courses and educational levels. Ensuring reliable internet connectivity and adapting Kahoot! to different educational contexts will also be crucial to maximize its benefits. Additionally, further research could explore the effectiveness of Kahoot! in covering extensive Chemistry topics, specifically for foundation and degree-level students who require higher comprehension of the syllabus.

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APPENDIX

Appendix 1: Foci and the major findings of main citations in the study

No.	Authors	Foci	Major Findings
1	Ares et. al (2022)	Use of Kahoot! as a gamification tool to explore mixed learning strategies.	Kahoot! generally improved students' learning and marks, particularly among those who performed better in Kahoot! activities.
2	Aliyu, Talib and Garba (2022)	Formative assessment in Chemistry education using Kahoot! to assess development and interest in learning.	Implementation of Kahoot! in Chemistry education not only enhances students' interest in learning but also effectively monitors their development through formative assessment.
3	Bernal et al. (2018)	Bring Your Own Device-BYOD" with Kahoot! as a gamification tool in a university Chemistry course.	The implementation of Bring Your Own Device (BYOD), specifically utilizing Kahoot!, yielded overall positive effects on academic outcomes, enhancing both learning and grades, particularly benefiting students who attained higher scores through Kahoot!.
4	Ghawail and Yahia (2022)	Effectiveness in using Kahoot!	Implementing Kahoot! in education enhanced engagement, learning, and classroom participation, with implications for educational efficiency.
5	Iman, Ramli and Saridewi (2021)	Students' perceptions of Kahoot as a game-based learning platform.	Students view Kahoot favourably as an assessment tool in chemistry education, finding it both challenging and enjoyable, with increased motivation for learning and effective feedback mechanisms.
6	Ramli, Yohana and El Islami (2020)	Students' experiences and perspectives on using Kahoot!.	Students felt anxious during Kahoot! assessments due to immediate feedback and time pressure but remained motivated to excel and recognized its benefits for future teaching.
7	Sanga Lamsari Purba et al. (2019)	Effectiveness of using the online game Kahoot! in increasing student motivation to learn Chemistry.	Kahoot! effectively enhances student motivation in learning chemistry, particularly in fostering a desire to succeed, underscoring its benefits for engagement in learning.