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Use of Kahoot! for Assessment in Chemistry Classroom: An Action Research

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Abstract

Kahoot! is a game-based learning platform used to review students' knowledge, for formative assessment, or as a break from traditional classroom activities. This study implements formative assessment in chemistry education classroom instruction using Kahoot! to monitor students' development and assess their interest in learning. The action research adopted experiments and survey design. Thus, two instruments (a test and a survey) were designed to obtain data from 32 enrolled undergraduate chemistry education students at Sokoto State University. A paired-sample t-test was conducted to monitor students' development between different test scores performed by the same respondents. The result indicated that while pairs 3 and 4 had no significant difference, there was a significant difference between pairs 1, pair 2, pair 5, and pair 6. Moreover, the results also revealed an effective enhancement of students' interest when Kahoot! is implemented as a tool for formative assessment in chemistry instructions. Kahoot! is a free online game-based application that includes quizzes, discussions, and surveys that make learning challenging, fun, and engaging. The study concluded that teachers should cautiously reap the benefits of Kahoot! in engaging, interesting, and monitoring students' development in learning.

Keywords: Kahoot!, Chemistry, Formative assessment, Instruction, Classroom.

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Introduction

In order to increase student engagement and motivation, technology is becoming more and more integrated into educational settings. Interactive classroom environment, student participation, activity, and instructional games, which are features of electronic learning, are the factors that define the quality of e-learning (Gokbulut, 2020). Indeed, the rapid increase in the availability and affordability of interactive technologies has contributed to the adoption of games in instructional science (Licorish et al., 2018).

The effective ideas or approaches included in game designs to encourage positive learning outcomes contribute to the engaging learning experience of game playing, even though fun and entertainment are typically what first draw individuals to games. Some of the most important factors in gamified instruction are concentration, focus, motivation, interest and engagement (Bicen & Kocakoyun, 2018; Cárdenas-Moncada, 2020; Chen et al., 2016; Kaur & Nadarajan, 2020; Kaur & Naderajan, 2019; Mohd Muhridza et al., 2018; Reynolds & Taylor, n.d.; Sanga Lamsari Purba et al., 2019; Tóth et al., 2019; Zarzycka-Piskorz, 2018). Along with these characteristics and the principles of effective learning, well-designed digital games can encourage and support learning by allowing players to actively and critically explore, practise, and reflect on their ideas in a problem-based, contextual, and low-risk context. According to Li & Tsai (2013), while playing games, learning happens organically. As Gee (2007) stated, "you can- not play a game if you cannot learn it".

Student participation in the classroom activities is crucial to their learning because it fosters stronger bonds between them, improves communication, and enables them to learn and practise new skills. When students are actively involved in the learning process, they commit to it, comprehend the learning objectives and goals, and remain motivated to learn. Student response systems (SRSs) were developed in the sixties to make large classes more interactive and have been used in classrooms since the early seventies. Clickers were one of the SRSs that introduced game features to increase the students' engagement during classroom instruction. According to Wang & Tahir, (2020b), Kahoot! was the first SRS designed to provide a game experience using game design principles from theory on intrinsic motivation and gameflow. When Kahoot! was launched, it distinguished itself from the rest of SRSs as it had a strong focus on being a game-based platform, and thus can be classified as a Game-based Student Response System (GSRS) (Cárdenas-Moncada, 2020; Wang, 2015; Wang & Tahir, 2020b).

Kahoot! is a game-based student response system (GSRS) launched by the teacher in a web browser on a laptop connected to a large screen. Kahoot! provides a tool for creating quizzes, including adding pictures and YouTube videos to the questions. It also makes it possible to publish and share your quizzes and edit quizzes made by others. When playing Kahoot!, the students log into the system using a game pin (a number) and a nickname. The goal for the students is to correctly answer the question as quickly as possible to get as many points as possible. A question is shown on the large screen along with four or fewer alternative answers in different colors with associated graphical symbols. The students give their answers by choosing the color and symbol they believe corresponds to the correct answer. Once all participants have responded to the question, the system will show the results, allowing students to see the correct response and the percentage of the class who responded correctly. Students are scored on response rate for accuracy and timeliness, with the 1st, 2nd, and 3rd participant names

shown across the screen.

Problem Statement

Wang & Tahir (2020) claims that when the class is entire, most teachers are aware of the difficulty in maintaining students' motivation, involvement, and attentiveness during direct instruction. Learning outcomes can be reduced, and the classroom environment can become unpleasant when students are not motivated, engaged, or focused during class. There are several examples of game-based learning being used both within and outside of the classroom, along with evaluations of their impact on classroom dynamics, engagement, learning, concentration, motivation, and enjoyment. Most of the research in this area focuses on evaluations of the use of game-based learning applications and the effect they have on the students revealing that a positive effect has been achieved compared to more traditional learning methods except for Murciano-Calles's (2020) study.

Murciano-Calles (2020) conducted a study to decipher the effectiveness of Kahoot! for chemistry students as an assessment tool for higher education with a comparative analysis with other traditional methods, such as solving problem sets. This study's findings reveal that a game's competitive incentive and playfulness is less preferred than the intrinsic challenge of solving a difficult question or problem. Although the study result could be helpful in a small classroom setting, it may not be in a great learning environment. Research in educational settings has shown that games and game elements can influence subjective experience as well as behavior and learning outcomes, but according to Wang & Lieberoth (2016), these factors are often intermingled within studies. Many teachers used multiple approaches for making lectures more interactive, including breaking the class into smaller groups, questioning the audience, using audience responses (systems), introducing cases the students can work on, using written material, organizing debates, reaction panels, and guest talks, using simulations and role-plays, using video and audio-visual aids, and using practical presentation skills.

According to Wang & Tahir (2020) Kahoot! is a game-based learning platform used to review students' knowledge, for formative assessment, or as a break from traditional classroom activities. Ismail and Mohammad (2017) applied Kahoot! as a formative assessment tool to promote learning among 113 freshman medical school students in Malaysia. The study investigated the effectiveness of two assessment platforms, Kahoot! and an e-learning portal, and gender differences in Kahoot! use. The results indicated that Kahoot! is effective as an assessment tool because it is easy to use, practical, fun, and enjoyable.

Furthermore, a study conducted by Bicen & Kocakoyun (2018b) to analyze the effect of the scientific word learning-based online game -Kahoot!- on students who had difficulty in learning physical science lessons in secondary schools reveals that when Kahoot! is played twice a week, there seemed to be increased in students' focus and task behaviors. The results of student satisfaction research showed that the students liked playing Kahoot! and found it easy to use. The goal of Kahoot! is to improve learning outcomes and classroom dynamics by raising engagement, motivation, enjoyment, and concentration. A study conducted by Wang & Tahir (2020) investigated how Kahoot! affects learning performance, classroom dynamics, students' and teachers' attitudes and perceptions, and students' anxiety concluded that Kahoot! can positively affect learning performance, classroom

dynamics, students' and teachers' attitudes, and anxiety.

Studies (Aliyu et al., 2021; Cárdenas-Moncada, 2020; Gokbulut, 2020; Licorish et al., 2017; Murciano-Calles, 2020; Prieto et al., 2019; Tóth et al., 2019; Wang & Lieberoth, 2016; Wang & Tahir, 2020) shown that students who are actively involved in the learning activity will learn more than passive students. This means that there is a possibility of achieving improved understanding and learning outcomes when students are effectively engaged during classroom instruction. The goal of Kahoot! is to increase engagement, motivation, enjoyment, and concentration to improve learning performance and classroom dynamics. Kahoot! is a game-based learning platform used to review students' knowledge for formative assessment or as a break from traditional classroom activities.

Objectives of the study

The study aims to evaluate students' development when learning the history and philosophy of chemistry with the Kahoot! student response system. Kahoot! was formerly used by researchers in different areas of chemistry, including general chemistry (Youssef, 2022); elemental quantum chemistry; acid-base and reduction-oxidation equilibrium; colligative properties of solutions; and reaction kinetics (Murciano-Calles, 2020). Consequently, Ghawail & Yahia (2022); María et al. (2018); Ramli et al. (2020); Sanga Lamsari Purba et al. (2019) executed studies by using Kahoot! to motivate students to learn chemistry, but the chemical concept or areas were not mentioned by both authors. Chemistry is a complex subject, and teachers require different approaches to facilitate the learning of different concepts. This is because some concepts require memorization, some require mathematical computation abilities, and for others, science process abilities and illustrations via model are significantly required. Thus, the findings of a study conducted in a particular chemical area will not directly affect other chemical concepts. Since this study focused on chemistry's historical and philosophical site, a distinction was made from further research conducted by several authors. This study provides teachers with foundational information about the significance of Kahoot! influencing the learning of an area of chemistry that combines the three levels of representation from which all concepts of the subject originated.

Students learning is developed and monitored by teachers during instruction in the classroom through formative assessment. However, because of the ease of use and the practical implications of game-based student response as effective cognitive tools, researchers implemented Kahoot!'s online game as an assessment tool:

i. to monitor and assess students' development when learning the history and philosophy of chemistry
ii. to assess students' interests when learning the history and philosophy of chemistry.

Methodology

This section discusses the method employed by the researchers to guarantee the achievement of the established objectives of the study. Thus, the section comprises a research model, participants, measuring tools, a data collection process, and data analysis.

Research Model

This study is an action research project that monitors and evaluates chemistry students' progress in learning the history and philosophy of chemistry. Thus, it is a quantitative study that adopts a survey research design and a one-shot case study research design. In this pre-experimental research design, only one variable is considered. This is a posttest study where students are evaluated after having a course of treatment that was thought to result in change.

Participants

The participants are 200-level undergraduate students (UG2) of Sokoto State University enrolled in History and Philosophy of Chemistry (SED214) in the 2019/2020 academic session. A total of 32 students enrolled in the course. And since the class is not large, all students participated in the study as a whole.

Measuring Tools

Two different instruments were used for the study. Firstly, a total of 10 different five-minute online Kahoot! game multiple-choice tests are designed for the whole content of the "History and Philosophy of including the introduction, history of chemistry, philosophy of chemistry, philosophers, and the development of chemistry in the Nigerian educational system and goals of science education in Nigeria. Secondly, an online survey was adapted from Bicen & Kocakoyun (2018), Kaur & Naderajan (2019), and Wang & Lieberoth (2016) to assess students' perception and engagement during instructions supplemented by the Kahoot! online game. This instrument, Students' Perception and Engagement on the Kahoot! The instructional Game Questionnaire (SPEKIGS) was developed on a four-point Likert agreement scale.

If the data is ordinal, Cronbach's alpha can be used to calculate the internal consistency of a test with more than two options, such as the Likert scale (Tavakol & Dennick, 2011). Thus, the alternative responses were scored 1, 2, 3, and 4 from the anchor of the Likert scale of agreement (strongly disagree, disagree, agree, and strongly agree, respectively). These scores were later keyed into SPSS 25 to determine the reliability of the items as well as perform other analyses. To form a conclusion on whether the test items are measuring the same construct or whether they are closely related, the interpretation of the value of Cronbach's alpha is also provided by Tavakol & Dennick (2011), represented in Table 1 below. The closer the value gets to 1, the better the reliability.

Table 1. Tavakol & Dennick (2011) Reliability Index Interpretation for Cronbach's Alpha

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table 2 shows Cronbach's alpha values for the instrument. The higher the Cronbach's alpha coefficient of

reliability, the more reliable the scale is (Santos, 2013). The closer the coefficient value is to 1, the higher the reliability and the more items measure the same construct.

Table 2. Cronbach's Alpha Reliability Coefficient of the Instrument

Cronbach's Alpha	Cronbach's Alpha Based On Standardized Items	N of Items
.920	.940	10

It can be observed from Table 2 that Cronbach's Alpha coefficient is 0.920 indicates that the instrument is reliable. This is due to the coefficient being close to 1.

Data Collection Processes

There are 32 students who have enrolled in the course titled "History and Philosophy of Chemistry." This course is a two-unit undergraduate, 200-level core subject for chemistry education students at Sokoto State University. It is taught one day a week for about thirteen weeks in a semester, after which an end-of-semester summative assessment will be conducted. Each week, students are assessed three times, at the start, midpoint, and end of the lesson, for a duration of five minutes each. At the beginning of the class, students are evaluated on their current knowledge of the concept to be taught. At the midpoint, students' development is monitored, while the final evaluation is done at the end of the lesson to ascertain the attainment of the set objectives. This way, lessons are conveyed to the students in a fun and challenging manner that stimulates their curiosity.

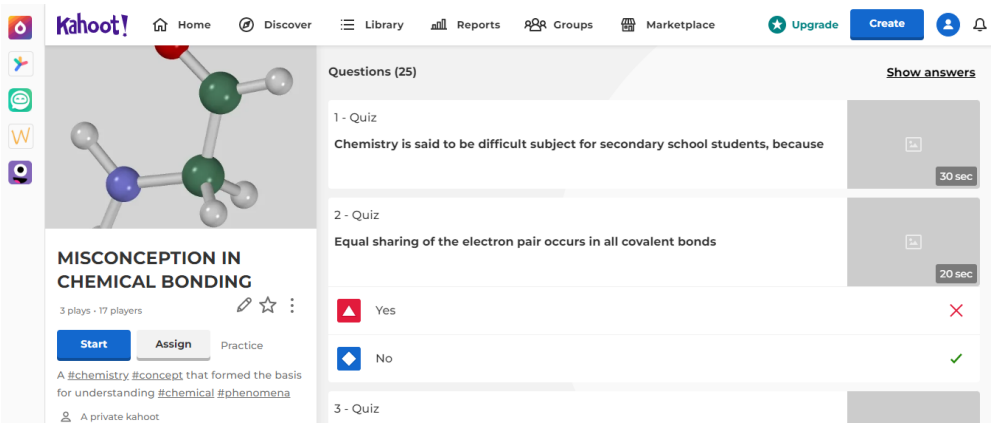

Figure 1. Chemical Bonding Assessment Created by Chemistry Teacher on Kahoot!! Platform (retrieved from https://Kahoot!.com)

Data Analysis

The collected data is analyzed using the Statistical Package for Social Science (SPSS) version 25. A paired-sample t-test was used to determine students' progress in learning the history and philosophy of chemistry. Moreover, mean and standard deviation were used to determine students' interest in using Kahoot as a game-based student response system.

Result

The data obtained was keyed into Microsoft Excel and later computed in the Statistical Package for Social Science (SPSS) version 25. Since the respondents are undergraduate students of chemistry education, only gender was considered as the demographic information of the respondents of the study indicated in Figure 1. Furthermore, the student's development and interest in learning are analyzed using a paired sample t-test and the standard deviation.

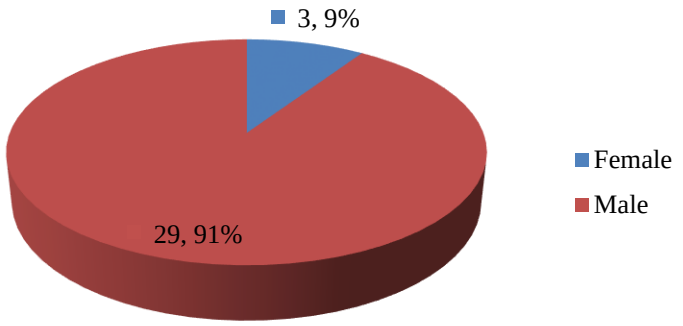

Figure 2. Gender of the Respondents

Figure 2 indicates that while 3 (or 9%) of the respondents are female, about 29 (or 91%) of them are male. This result indicates that more male students are taking "history and philosophy of chemistry" than females.

Table 3. Paired Sample t-test for Students' Development in Learning (formative assessment)

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair 1	WEEK1 - WEEK3	-3759.438	2111.906	-10.070	31	0.000
Pair 2	WEEK3 - WEEK5	-11519.375	22060.288	-2.954	31	0.006
Pair 3	WEEK5 - WEEK7	-379.063	33922.863	-0.063	31	0.950
Pair 4	WEEK7 - WEEK10	3394.281	23205.544	0.827	31	0.414
Pair 5	WEEK1 - WEEK5	-15278.813	22067.304	-3.917	31	0.000
Pair 6	WEEK1 - WEEK10	-12263.594	2492.573	-27.832	31	0.000

It can be observed from Table 3 that the first pair of 1st and 3rd test p-values = 0.000 is less than the 0.05 significant level, which indicates that there is a significant difference between the two scores of the same individual. Similarly, the second pair of p-values for the third and fifth tests, 0.006, is less than the 0.05 significant level, indicating that the two scores differ significantly. However, the third pair of 5th and 7th test p-values = 0.950 is greater than the 0.05 significant level, revealing no significant difference between the two scores. The fourth pair of 7th and 10th test p-values is 0.414, which is greater than the 0.05 significant level, indicating no significant difference between the two scores. While the fifth pair of the 1st and 5th test p-values equals 0.000, the sixth pair of the 1st and 10th test p-values equal 0.000, revealing a significant difference between the scores. These results reveal that students perform woefully on the first test but do better on the subsequent tests, in which the last test

has the highest scores.

Table 4. Statistics of Students' Interest when Kahoot!! is Used as a Tool for Formative Assessment

SN	Items	SD	D	A	SA	Total	Mean	Std. Dev
1	A gamification method increases my interest in the lesson	0	1	5	26	32	3.78	0.49
2	I prefer my teacher to conduct Kahoot!! activities at least twice a week.	0	0	2	30	32	3.94	0.25
3	Using a gamification method on my smartphone makes me feel better.	0	1	12	19	32	3.56	0.56
4	I want gamification methods to be used in other lessons as well	0	0	5	27	32	3.84	0.37
5	Winning badges through a gamification method makes me feel important	0	1	0	31	32	3.94	0.35
6	I will study more to become more successful via gamification methods.	0	0	0	32	32	4.00	0.00
7	The gamification method allows me to see my achievement status and improve myself in the areas that I am weak in	0	1	2	29	32	3.88	0.42
8	I feel motivated when I compete with my friends to get higher scores in Kahoot!! game	0	0	0	32	32	4.00	0.00
9	I feel positive towards my learning when I participate in Kahoot!! games	0	0	0	32	32	4.00	0.00
10	The scoring system of Kahoot! increases the ambition of students to be a top-five scorer	0	0	1	31	32	3.97	0.18

It can be observed from Table 4 that items 6, 8, and 9 have a mean value of 4.00 with a 0.00 standard deviation. This means that the data for items 6, 8, and 9 are entirely centered on the mean. Consequently, items 5, 1, 7, 4, 5, 2, and 10 have their standard deviations a little bit spread around the mean. Generally, the mean values of all items revealed that there is an effective enhancement of students' interest when Kahoot! is implemented as a tool for formative assessment in chemistry instruction. To make the result clearer, Figure 3 represents the chart of the mean and standard deviation of the data.

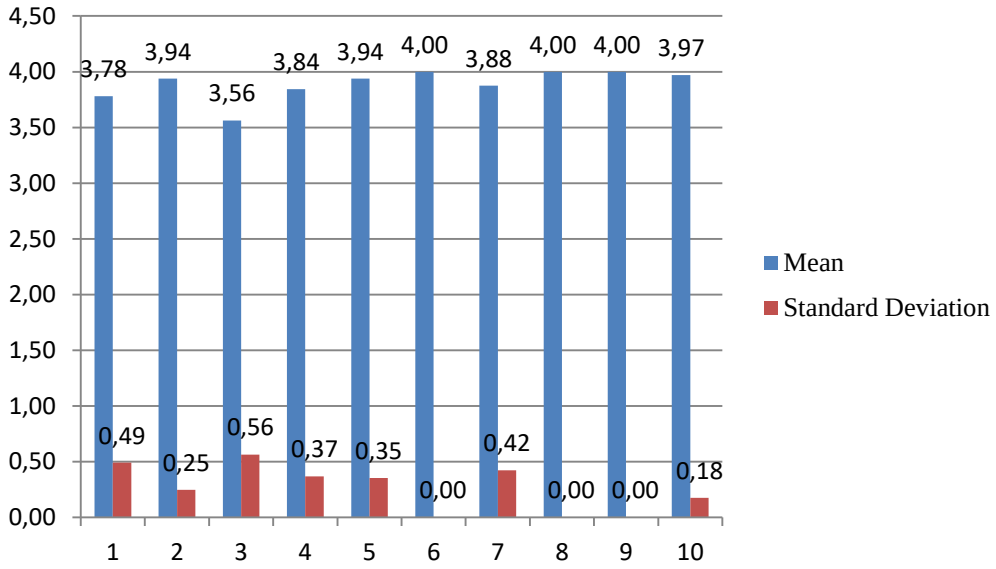

Figure 3. The Mean and Standard Deviation of the Data

It can be observed that items 6, 8, and 9 have consistent data, while item 3 has widely spread data. All respondents

strongly agree on items 6, 8, and 9. Although few respondents have other opinions, most strongly agree with items 5, 1, 7, 5, 4, 2, and 10.

Discussion

A paired-sample t-test was conducted to monitor students' development between different test scores performed by the same respondents. The result indicated that while pairs 3 and 4 had no significant difference, there was a significant difference between pairs 1, 2, 5, and 6. These findings are compelling enough to conclude that students' learning has advanced significantly. Kahoot!, as a game-based student response, enhanced academic performance in learning the history and philosophy of chemistry. Moreover, the results also revealed an effective enhancement of students' interest when Kahoot! is implemented as a tool for formative assessment in chemistry instruction.

This finding contradicts the outcome of a study conducted by Murciano-Calles (2020) to utilize Kahoot to instill problem-solving skills in students. The contradiction resulted from the varying concepts explored by the researchers and the role presumed to be played by Kahoot. Firstly, the study conducted by Murciano-Calles (2020) covered topics that include elemental quantum chemistry, acid-base, reduction-oxidation equilibrium, colligative properties of solutions, and reaction kinetics. These concepts are categorized at the macroscopic level of representation in chemistry, which refers to the observable state of matter. Physical skills are essential to learning at this level of representation. Moreover, Kahoot may not serve a significant purpose in enhancing problem-solving skills in chemistry education. This is because problem-solving skills involve an understanding of the language in which the problem is stated, the interpretation of what is given in the situation and what is sought, an understanding of the scientific concepts involved in the solution, and the ability to perform mathematical operations if these are involved in the problem. Kahoot was reported to be effective in enhancing engagement (Ghawail & Yahia, 2022; Wang & Tahir, 2020; and Youssef, 2022), encouragement (Wang & Tahir, 2020), motivation (Wang & Tahir, 2020)' performance (María et al., 2018; Wang & Tahir, 2020; and Youssef, 2022); and interest (Wang & Tahir, 2020). Thus, the findings of this study and those of Murciano-Calles (2020) are independent and valid based on the research area explored.

Kahoot! is a practical assessment tool used in undergraduate chemistry classrooms, according to a conclusion made by Youssef (2022) in research titled "Assessing the Use of Kahoot! in an Undergraduate General Chemistry Classroom." The conditions under which the studies were conducted (Kahoot!) and the findings of Youssef's (2022) study and the current study shared similarities. Both studies used Kahoot! for a formative assessment of an undergraduate chemistry course. They both used a whole class experiment approach. Moreover, their outcome reveals that Kahoot! is an effective tool for assessing undergraduate students too. Not only is Youssef's (2022) study, but also in María et al. (2018), Kahoot! improved students' learning and grades. Moreover, another study whose findings conform with the current research is a work executed by Ghawail & Yahia (2022), who utilized a similar action research approach to examine how well the Kahoot! game works for improving cognitive performance.

Other studies similar to the current study's findings were carried out to address different goals, such as determining

the effectiveness of using online games Kahoot! to increase student motivation to learn chemistry (Sanga Lamsari Purba et al., 2019); investigating the efficacy of using the Kahoot! game in developing cognitive achievement (Ghawail & Yahia, 2022); and measuring the extent to which the student's knowledge has developed (María et al., 2018). According to Wang & Tahir (2020), the main challenges mentioned by students include technical problems such as unreliable internet connections, hard-to-read questions and answers on a projected screen, not being able to change an answer after submission, stressful time pressure for giving answers, not enough time to answer, fear of losing, and being unable to catch up if an incorrect answer had been given. Kahoot! is a free online game-based application that includes options like quizzes, discussions, and surveys that make the learning process challenging, fun, and engaging (Yürük, 2019).

Conclusion

This study monitors and assesses students' development and interest when learning the history and philosophy of chemistry. The research is a quantitative study that adopts a survey research design and a one-shot case study research design. In this pre-experimental research design, only one variable is considered. 32 enrolled undergraduate chemistry students were the participants in the study. The result reveals that Kahoot! is an effective tool for assessing students' development in learning the history and philosophy of chemistry. Moreover, the survey shows that the participants were interested in Kahoot! as a game-based student response system.

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