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Using the E-Learning Gamification Tool Kahoot! to Learn Chemistry Principles in the Classroom

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Abstract

This study investigated the effectiveness of using the Kahoot! game in developing the cognitive achievement and direction of students of pharmacy at Alasmarya Islamic University, Libya. The study design is based on action research. Kahoot! was implemented once at the end of each of three units. The study sample consisted of 30 female students from the first year of university at the Pharmacy Science College in Libya. The students were selected randomly, and studied using Kahoot! technology. For the quantitative part of the study, data were collected through a 20-item questionnaire on 20 participants and 15 participants to gather information on students' perceptions about this application by the interview. Results indicate that the students were able to engage actively in the chemistry lessons and learned the unit on molecular weights effectively, leading them to enjoy basic chemistry, and the surveys allow for anonymous classroom participation, which further engages all students. The results hold implications for the development of more efficient, effective in educational process.

Keywords: Kahoot!, E-Learning, game based learning, chemistry teaching, motivation and engagement, classroom technology.

1. Introduction

Online learning is a kind of network-based learning behaviour that can provide an efficient and convenient way for students to learn with the help of information technology and Internet technology. However, while online education received a boost as a short-term response to the epidemic, it is also a long-term teaching revolution. At present, the COVID-19 situation is still uncertain, and the administrations of Libyan universities should take advantage of this opportunity[9]. Instructional games are gaining acceptance in the classroom as the e-Learning merits of student

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engagement and immediate feedback have been increasingly recognized. Student responses and our experiences using Kahoot! in graduate and undergraduate classrooms indicate that students welcome the use of this game ([17]; [25]). Recently, universities have started integrating recent technologies into the educational process in order to attract students and increase their engagement.

1.1. The Study Problem

Since gamification can take many forms and can combine game design elements in many different ways. Given the resulting lack of knowledge of how to effectively support students and university teachers with gamification, this study seeks to actively engage educators and students in educational process through game-based learning (GBL), which refers to the integration of gaming into learning experiences to increase engagement and motivation [1]. Although the College of Pharmacy Science was not equipped with the necessary technology, small steps had been taken toward a blended learning approach. In the absence of an established e-learning strategy.

1.2. Study Questions

Most researchers have agreed with Codish and Ravid [4] that the major challenge of any game design is the gamification application that can evoke the gameplay experience. Werbach [27] reported that points, badges, and leader boards are the most commonly used game mechanics in gamification. However, research on the effects of specific game design elements on psychological need satisfaction and knowledge remains scarce. To address the gap, this study explores the extent to which interactive technology influences classroom dynamics, engagement, motivation, and learning when using Kahoot!. This study aims to answer the following questions:

- Q1. How does Kahoot! influence classroom dynamics and enrich learning experiences?
- Q2. How does the use of Kahoot! affect student engagement?
- Q3. Does the use of Kahoot! influence students' motivation towards learning?
- Q4. To what extent do the game design elements of Kahoot! affect competence need satisfaction?

1.3. Objective of the Study

The first goal is to investigate different game designs on Kahoot! using an experimental study to identify the specific effects of Kahoot! game design elements on psychological need satisfaction in order to promote student engagement, to determine the effective learn-ability of students inside and outside the classroom, and to explain the motivational power of game design elements according to the theory of psychological need satisfaction [5]. This study provides instructors with foundational information about Kahoot! and suggests ways that it may be used to engage students and promote an active learning environment [24]. The remaining sections of this paper are organised as follows. Following a literature review in the next section, the 'Methods' section presents the details of the research methods and procedures. In the 'Results and Discussion' section, findings are discussed, limitations to the study are considered. Finally, in the 'Conclusion' section, concluding remarks are provided.

2. Literature Review

2.1. Gamification

Gamification is described as 'using game-based mechanics, aesthetics and game thinking to engage people, motivate action, and promote learning' [28]. In a pedagogical context, Kapp [10] classified gamification as 'a didactic method, especially with respect to the validity of its integration'. Gamification refers to the use of game design elements in a non-game context and can be divided into: (i) game mechanics; (ii) game characteristics; and (iii) game dynamics. Werbach [27] stated that gamification may cause only short-term enhancements of motivation among the users, whereas Sailer [21] argued that gamification can improve motivation and engage student learning. Applying gamification without knowing what it is can be hard; therefore, an understanding of the nature of gamification is

Fig. 1. Game show interface projected on screen with Game Pin.

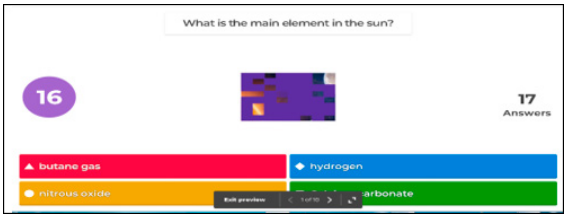

Fig. 2. This screen is before the start of the game.

necessary to identify its benefits. On the one hand, Mazarakis and Bräuer [15] suggest that gamification may improve learning by overcoming such learning barriers as lack of attention, involvement, and interest and introducing pleasure into performing tasks or learning activities, and that the use of realistic and virtual simulations allows the understanding and internalization of concepts and can be closer to reality (see Table 1).

Table 1. Game Mechanics Used in This Study: Mechanics, Synonyms, Descriptions ([16]; [28]).

Mechanic	Synonyms	Description
Points	Measure, metric, currency	Numerical unit indicating progress based on a progression. Users will receive a point when the mission is accomplished.
Rewards	Prizes or gifts	At the end of the lesson, the users will receive points,which can be a form of physical prizes as a reward that students can enjoy.
Level	Area or stage	Travel from one level to another level. Notification answering questions, messages, alerts.
Notification	Answering questions, messages, alerts	Acknowledgement of successfully executed actions.
Avatar	Icon	Virtual representations of the students, whereby they can choose their own mentor to interact with the system.
Progress Bar	Level up or levelling.	Milestones that indicate progression.

2.2. Design of the Kahoot! Environment

Wang and Lieberoth [25] found that the regular use of Kahoot! (one session per lecture for an entire semester) resulted in a small 'wear-off' effect of positive classroom dynamics in software engineering students. Although Wang and Lieberoth [26]utilised Likert-scale evaluations of Kahoot! with students' open-ended comments, the data were only analysed quantitatively, and thus it remains unclear whether semi-structured interviews were conducted to generate answers to specific questions, necessitating further exploration of whether students' perceptions of Kahoot! remain the same or can change over time. Interestingly, the Likert scales were not always consistent with students' open-ended comments [25]. Students are awarded points for answering questions correctly, and the timeliness of correct responses also impacts the points awarded. Displaying students' points on the screen motivates students to get to the top of the leader board ([13]; [2]). In order to begin using Kahoot!, teachers should register for a free account on http://create.Kahoot!it.

3. Method

In the present study, the tool was designed and used at the College of Pharmacy Science at Alasmarya Islamic University during three weeks of a chemistry course. Kahoot! implementation was intended and expected to increase the number of students passing the course, since the college has had a problem with not enough students passing the course.

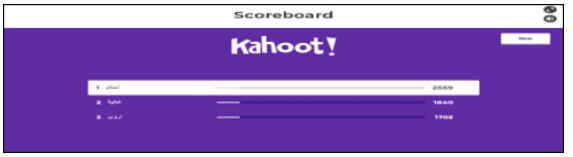

Fig. 3. Sample Kahoot! Leader board Display with Points.

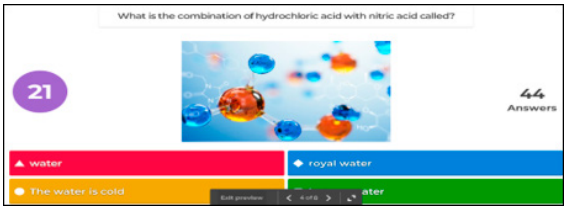

Fig. 4. The Number of Correct and Incorrect Answers (Shown before the Next Question Appears).

Fig. 5. Sample Kahoot! Bar Graph Displaying Results for Correct Responses.

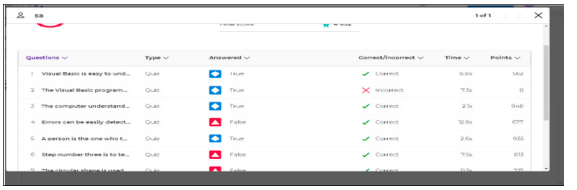

Fig. 6. Sample Kahoot! Display of the Results for Correct Responses.

3.1. The Design of Kahoot! Tool

Kahoot! is an online global educational brand that offers a free student response platform resembling the popular trivia game Quizzes. Educators use Kahoot! to create game-based quizzes, discussions, and surveys. To start, instructors register for a free account by going to http://create.Kahoot!it. After registration, the teacher can then create an interactive quiz or select from a library of publicly available quizzes (see Fig.1).
Teachers can also use Kahoot! during reading and listening activities, asking students to read or listen to a portion of a text and then providing comprehension questions through the platform. However, the free version is limited to closed-response question types, such as true/false, yes/no, or multiple choice (see Fig. 2).
Once everyone has answered the question or the time the instructor set for answering the question expires, the correct answer is displayed on the instructor's screen and the aggregate results shown in bar graph form. The game keeps track of each student's or team's answers, awards points, and ranks players based on speed and accuracy (see Fig. 3). The game's home page is displayed at top of the screen. Kahoot! can be used with smart phones, tablets, or laptop computers. Kahoot! was used as a part of the first semester of a first-year course on principles of chemistry between September and December 2021. This game was used in three different lectures by teachers and students for about 30 min on average (students could also play Kahoot! outside of the classroom). The next figure shows the number of correct and incorrect answers (see Fig. 4).
Kahoot! includes two modes of play, team versus team and player versus player, wherein all students answer the questions on their own devices simultaneously, competing for scores against their peers. This Bar Graph Display Results for Correct Responses after each question (see Fig. 5).
Teachers can also use Kahoot! during reading and listening activities, asking students to read or listen to a portion of a text and then providing comprehension questions through the platform. However, the free version is limited to closed-response question types, such as true/false, yes/no, or multiple choice (see Fig. 2).

3.2. Classroom Applications and Engagement

Researchers have broadly conceptualised classroom dynamics as the interaction between students and teachers. Student engagement relates to the level of attention, curiosity, focus, and interest that students show during the course. Motivation is engagement and desire to interact in the classroom. Students can also create their own Kahoot! quizzes as an assignment or to study for a test (see Fig. 6).

Quizzes: In our classroom, we use graded and ungraded quizzes to assess knowledge, comprehension, and retention after the completion of reading assignments, lectures, and reviews of the course material. Mazarakis and Bräuer [15] reinforce this methodology, noting that games as educational tools have an intrinsic motivation factor that encourages curiosity and creates the impression that students are in control of their own learning. Burguillo [3] speaks to the importance of competition-based learning to ensure stronger motivation for students to increase their performance. .

3.3. The Proposed Chemistry Curriculum

The curriculum of undergraduate level chemistry suggests covering several of the most common or important elements along with their compounds in order to understand their initial practical usage, for example, the periodic law and periodic table, chemical bonds, amounts of substance, energy changes in chemical reactions, reaction rates and chemical equilibrium, electrolyte solutions, and oxidation and reduction reactions (see Table 2). Educationally this class has significance in increasing the interest of students in the formation of chemical concepts and in cultivating their abilities of observation and learning.

Table 2. The Chemistry Principles Curriculum Map.

The Chapter Title	Details	Week
1- Transitional elements:	The first transition series, periodic law and periodic table	6-11-2021
2- Chemical analysis: Anions	Chemical bond, amount of substance, energy change in chemical reactions, reaction rate and chemical equilibrium.	27-11-2021.
3- Organic Chemistry:Alkanes	Oxidation and reduction reactions.	2021-12-18.

3.4. The Study Community and Study Sample

The research community is comprises all the first-year students in the pharmacy science college of Alasmarya Islamic University, Libya. The sample selected of 30 students chosen randomly, and the study was conducted using Kahoot! technology. The participants were all female aged 18–20, and their English level was pre-intermediate level. They completed the course at an upper-intermediate level, and only learned chemistry principles during lesson hours. During the 2021–2022 academic year we used Kahoot! with undergraduate students in two chemistry courses. Sample questions were displayed on Kahoot! for three units of the course, and according to the syllabus, one unit should be completed every week [7]. Kahoot! was thus implemented three times, once at the end of each of three units. The multiple choice questions created on Kahoot! applications were chosen randomly from the curriculum of the chemistry course. Table 3 shows the distribution of the study sample.

Table 3. The Chemistry Principles Curriculum Map.

Number of students	Gender	Hours of study each week	Exam (/100)	Dependent variable	Independent variable
30	Female.	3	74.5	use of the Kahoot! game in the classroom	The quality of learning outcomes in chemistry, as cognitive, achievement, skill performance in chemistry and behaviour towards using applications of gamification.

3.5. Procedures and Data Analysis

3.5.1. Students' Responses in the Questionnaire on the Use of Kahoot!

The questionnaire was an close-ended type with 20 items scored on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5) developed from the instrument used in [28], [8]. The value of Cronbach's alpha, an internal consistency measure, was found to be 0.95. The questionnaire was online for 50 days and 20 valid responses

were received. Data were analysed with IBM SPSS Statistics 20.0 software. The statistical analyses used for data analysis were frequency analysis, descriptive statistics, a non-parametric test (chi-square), and hierarchical cluster analysis. The scale was tested using confirmatory factor analysis. The measurements revealed that the result had high goodness of fit and was suitable for use in the measurement of students' perceptions of and attitudes towards the Kahoot! application. According to these results, the chi-square test yielded $x^2 = 28.91$, p-value < 0.01. The other goodness of fit indices had the following values: root mean square error of approximation (RMSEA) = 0.036; standardized root mean square (SRMS) = 0.047; and relative fit index (RFI)= 0.79, which are all within acceptable limits even if not optimal. Table 4. shows the results of the confirmatory factor analysis.

Table 4. Confirmatory Factor Analysis.

Confirmatory factor	Value	x^2
RMSEA	0.036	28.0
SRMS	0.047	28.0
RFI	0.79	28.0

The data show that the use of Kahoot! provides more permanent learning than a traditional classroom environment ($M = 4.44, SD = .59$). The results suggest that Kahoot! application improves students' success levels ($M = 4.41, SD = .61$) and enhances student interest in the lesson ($M = 4.48, SD = .52$). Activities created using Kahoot! are more interesting for learners ($M = 4.45, SD = .54$) and also foster a collaborative learning environment ($M = 4.56, SD = .61$). Kahoot! increases the effectiveness of the lessons ($M = 4.48, SD = .60$) and provides students the opportunity to express themselves in a comfortable atmosphere ($M = 4.42, SD = .65$). Also, the application enhances motivation ($M = 4.43, SD = .56$) and facilitates active learning ($M = 4.39, SD = .54$). Question techniques in the activities performed with Kahoot! provide the students with different perspectives ($M = 4.49, SD = .55$), and the Kahoot! application improves the skills of students in terms of rapid thinking ($M = 4.47, SD = .68$). Kahoot! also provides permanent learning in classroom activities ($M = 4.56, SD = .53$), and students feel excited because of the time limits for answering ($M = 4.40, SD = .61$). Students reported having the opportunity to access a richer content with the help of this application ($M = 4.46, SD = .57$). According to the students, sharing activities on social media increases their motivation ($M = 4.42, SD = .59$), and the scoring system of Kahoot! increases the ambition of students ($M = 4.39, SD = .65$). Students believe that the use of Kahoot! encourages students in class ($M = 4.49, SD = .52$) and allows students to participate in activities ($M = 4.35, SD = .54$). Using the Kahoot! application helps students learn more easily ($M = 4.32, SD = .51$), and the teacher can gain information immediately on how many students get the right answer, and can compare that information with students' current level of knowledge ($M = 4.42, SD = .66$). Table5 shows the understanding levels of students in order to get their opinions about implementing Kahoot!

3.5.2. Students' Perspectives in Interviews on the Use of Kahoot!

At the end of the course, students enrolled in the course were interviewed using a semi-structured approach. Questions of the interview and Discussions asked students: 'How would you describe your experience using Kahoot! in this course?' Students who agreed to participate were asked to spare 15 minutes for a semi-structured interview on15 participants to gather information on students' perceptions about this application in which they were asked questions on the use of Kahoot! during the course (interviews in fact took between 15 to 20 minutes). The questions focused on understanding students' experiences using Kahoot! and the tool's influence on classroom dynamics and on students' engagement, motivation, and learning.

- Attention and focus:
  All participants seemed to agree that the use of Kahoot! triggered positive attention and focus in the classroom. Some suggested that interacting with Kahoot! captured and sustained their attention during the lecture and helped them answer questions correctly. A major barrier to staying focused in class was the length of the lecture as well as the time of day when the lecture took place. Our analysis revealed that 11 participants highlighted the importance of having a break during lectures in order to maintain balance and sustain a desirable level of attention during lectures, as they found staying focused in a three-hour lecture challenging, with some describing the experience as boring (see Fig. 7).

Table 5. Questionnaire Results.

N	Item	Mean	*SD*
l.	Lessons performed with Kahoot! enable permanent learning compared to learning in traditional classroom environments.	4.44	0.59
2.	Kahoot! improves success.	4.41	0.61
3.	Kahoot! increases interest in the lesson.	4.48	0.52
4.	Kahoot! increases the effectiveness of the lessons.	4.48	0.60
5.	Using Kahoot! makes for more effective collaborative learning.	4.56	0.61
6.	Activities created using Kahoot! are more interesting.	4.45	0.54
7.	Kahoot! allows for comfortable self-expression.	4.42	0.65
8.	Using Kahoot! in education increases student motivation.	4.43	0.56
9.	he Kahoot.! gamification tool is an excellent alternative for university students . offering easy access to computers, and it enables active learning	4.39	0.54
10.	The scoring system of Kahoot! increases the ambition of students to be a top-five scorer.	4.39	0.65
11.	Sharing activities via social media increases motivation.	4.42	0.59
12.	Kahoot! gives students the opportunity to access richer content.	4.46	0.57
13.	Kahoot! improves the rapid-thinking abilities of students.	4.47	0.68
14.	Timely questions in Kahoot! activities increase student excitement.	4.40	0.61
15.	Question techniques in the activities performed by Kahoot! provides the students with different perspectives.	4.49	0.55
16.	Kahoot! provides permanent learning in classroom activities.	4.56	0.53
17.	The teacher can gather information about how many students get the right answer at once and can compare that information with students' current level of knowledge.	4.42	0.66
18.	Activities performed using the Kahoot! application allow for easy learning of the topic.	4.32	0.51
19.	The active use of Kahoot! builds student courage to participate in activities.	4.35	0.54
20.	The use of Kahoot! in the classroom encourages learners when the Internet is available.	4.49	0.52

- Interaction and discussion:
  First, 13 of the 20 participants said that Kahoot! increased their interaction and involvement in the lectures. Participants reported the use of Kahoot! fostered interactivity and engagement during lectures, through answering questions and participating in quizzes and discussions, as opposed to conventional classrooms where discussions are often dominated by a few extraverted students.
- Competition:
  Competition was viewed as a strong motivator, with one respondent describing how students like to 'perform' and another expressing their motivation to reach the top. Nine students discussed the competitive element of Kahoot! in relation to their interaction and engagement. Many respondents liked the competitive aspect of Kahoot!, seeing it as a motivating factor to participate, encouraging them to think critically, increasing their energy levels, and creating a lively classroom dynamic.
- Anonymity:
  While viewed as a negative aspect of participation in technology mediated learning environments, allowing anonymity and allowing students to enter a name of choice into the system each time they participated can foster deep and enriched participation. Providing anonymous participation in a learning environment can encourage wider participation, as it inculcates a sense of safety and privacy ([10];[9]). The results of our study suggest that maintaining anonymity is critical for facilitating engagement among students.
- Learning and knowledge retention:
  In all, 12 participants stated that Kahoot! was a useful learning tool, and 14 described Kahoot! as having a positive influence on their learning experience. Throughout the interviews, participants made positive references to how Kahoot! supported their learning. They stated that engaging with Kahoot! during lectures helped them not only to remember previously covered material but to understand new Research and Practice in Technology Enhanced Learning, this agrees with [13].
- Fun and enjoyment:
  The data showed that respondents enjoyed the Kahoot!, and 12 Participants said they enjoyed the game and its

use in class, which made the course more enjoyable. Further, their fun and enjoyment seem to have helped a number of students overcome barriers to interaction that they face in a traditional lecture environment.

- Retaining knowledge and revision for exam:
  Participants felt strongly that Kahoot! could be used for revision, with 12 participants seeing it as a useful revision tool for exam preparation. Participants commonly felt that the best use of the tool was to review lecture content and key topics. Kahoot! supported students to re-grasp and retain key points of the lecture, providing a reminder of what was covered.

4. Results and Discussions

In addition to analysing the quantitative data obtained from Kahoot!, responses to interview and opinion-based questions were also examined to identify qualitative trends. These results indicate that this study cultivated a positive attitude and raised students' level of motivation towards learning chemistry principles using the Kahoot! game platform. The participants' responses show that they feel motivated in learning molality, normality, atomic mass, and molar mass after they engaged in Kahoot! games.

- Q1. How does Kahoot! influence classroom dynamics?
  We observed that Kahoot! gave students more opportunities to engage with the lecturer, their peers, and the lecture content. It also helped create a positive learning experience. Licorish et al. [13] described the game as 'fun', stating that it contributed to useful classroom engagement dynamics, enhanced lecturer-student engagement, and increased constructive discussions with peers (e.g. [23]; [26]; [14]; [18]).

- Q2. Does the use of Kahoot! influence students' engagement, and how?
  Students felt that Kahoot! held their attention and interest during the course but was also timely in allowing breaks. This was particularly necessary for reflection on lectures and class discussion, especially in lectures that were longer than three hours. Thus, the teacher's design of questions and skills in leading discussions are important factors in getting the most value out of Kahoot!

- Q3. How does Kahoot! influence students' motivation towards learning?
  This study shows that Kahoot! motivated students to be engaged, and encouraged interaction in the classroom. This in turn motivated students to engage with the lecturer, their peers, and the lecture content in the classroom, where students were driven to see their names at the top of the leader board, and thus were more attentive during lectures and discussions. These effects of enhanced attention and competition are consistent with the findings of [26].

- Q4. How does the use of Kahoot! enrich learning experiences?
  Students stated that the use of Kahoot! in the course had a positive impact on the knowledge and skills they attained. Students noted that the drive to increase their attention and interaction strongly supported their learning in the course. This is consistent with several studies ([8]; [18]; [11]) of the use of Kahoot! for learning. Our results corroborate Rice's (2012) statement that the use of games to promote students' learning should serve to capture students' interest, as all of us learn better when we are motivated. Wang and Tahir [25], Singer [23], and Kaur and Nadarajan [11] note that engagement and learning go hand in hand and that you cannot have one without the other. There was an 88.5% positive response rate. Sample positive comments included the following: 'I looked forward to coming to class when I knew we had a [Kahoot!] quiz'; students bonded during the semester, talked about the course, and read the material: 'I participated more than I have in any other class because Kahoot! made me want to that'. Most responses were positive; five of the students did not provide any answer to the question and seven made negative comments. Negative responses included the following: 'It was difficult to stay motivated once I got a couple of questions wrong because I could not win the game,' 'the same students won each time, which wasn't fun for the rest of us,' and 'it was stressful because I had to read the question and answer it so quickly I didn't have time to' (see Table 6). This agrees with Plump and LaRosa [18] which explained that the students were satisfied with the use of Kahoot game (see Fig.7).

Table 6. The Chemistry Principles Curriculum Map.

Positive comments (word/expression, times mentioned)	Negative comments (word/expression, times mentioned)
Teamwork, Collaboration, and Communication	Time constraints/limited time given to the players.
Interaction (with team members)	Confusing/difficult to understand game rules/instructions.
Creativity	Educators cannot ask open-ended questions or receive open-ended responses.
Enjoy and Fun	
Sharing different point of views/ different perspectives	

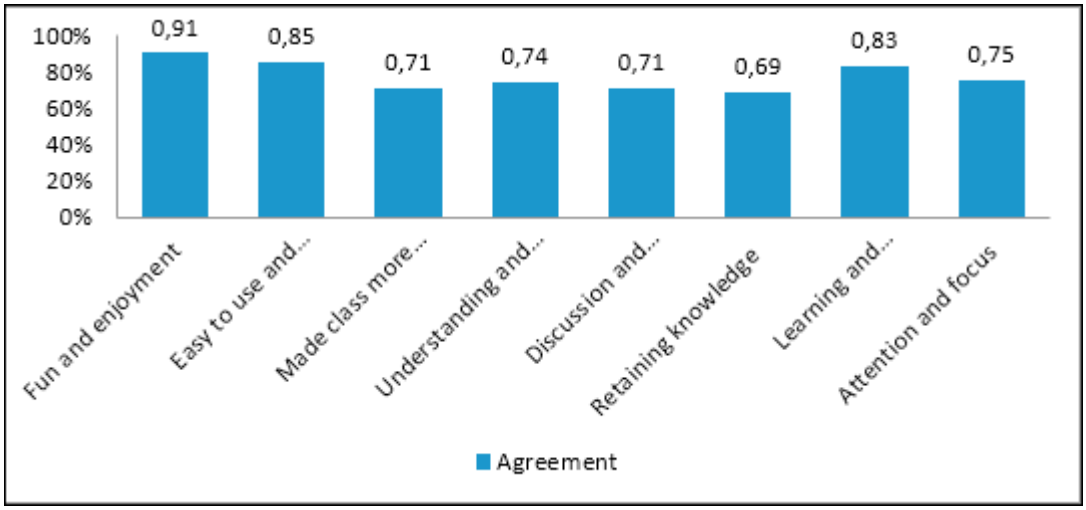

Fig. 7. Students' Answers on the Interview.

5. Limitations

This sample was relatively small, and thus our outcomes may not generalise to all lecture environments. However, we believe that our outcomes may generalise to first-year pharmacy science college students. Moreover, the students' perceptions of the use of Kahoot! may be influenced by their background, which should be considered when interpreting our findings. Time constraints on the use Kahoot! in class must be borne in mind because of college requirements on the coverage of the student book. Teachers must therefore carefully structure their lecture time so that it is appropriately allocated.

6. Conclusion and Future Work

The current study explored how the use of Kahoot! contributed to students' motivation, engagement, and learning in the domain of chemistry, added fun to the classroom, and increased student engagement by appealing to all students in the learning process, even the most introverted, by combining a cooperative fast-paced learning environment and competition. The use of Kahoot! had a positive influence on classroom dynamics, students' engagement and motivation and learning. This corroborates the statements of other researchers that students reported being satisfied with the use of Kahoot! and enjoyed their experiences using it. Moreover, the teacher can gather information about how many students get the right answer at once. We conclude that gamification application in distance education is still an undeveloped field in Libyan higher education lacking rigorous empirical investigations. We note, that the present study only covered three units rather than a full course. Therefore, higher education institutions in Libya should start deploying learning technologies, such as e-learning systems, to encourage students to participate in class anonymously, and to provide them with more meaningful revision methods.

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