

Advantages of Kahoot! Game-based Formative Assessments along with Methods of Its Use and Application during the COVID-19 Pandemic in Various Live Learning Sessions

Nagwa Kostandy Kalleny

Professor of Histology and Cell Biology, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Abstract

Background: Technology has played important roles in education, thus the application of online Kahoot! Game-based technology as a learning tool particularly in formative assessments might improve learning and achieve promising education. It can be applied live, either face to face or virtual in distance learning as during the current situation of COVID-19 pandemic that resulted in total shift toward online learning. **Methodology:** Kahoot! Game-based histology and cell biology lab formative assessments were prepared, equipped with light and electron microscopic photos, and applied for 2nd year undergraduate medical students. Students' engagement was evaluated by calculating number of engaged students in Kahoot! versus number of attended students in each lab. Students' satisfaction was evaluated according to students' feedback collected on Kahoot! platform and by an online questionnaire applied on Google Forms which included 5 items that were measured on a 5-point Likert scale, with 1 indicating strongly disagree and 5 indicating strongly agree, with overall satisfaction ranging between 5 (least satisfaction) and 25 (maximum satisfaction). YouTube videos were done to demonstrate and spread the idea of using Kahoot! platform in education particularly in the COVID-19 pandemic. **Results:** Kahoot! was successfully applied in Histology and Cell Biology lab sessions. Students' engagement for Kahoot! game-based formative assessments were 100% in most lab sessions. The mean overall students' fun assessment score for Kahoot! was 4.65 out of 5. Most students recommended the use of Kahoot! game-based formative assessments. The mean overall Kahoot! questionnaire satisfaction score was 24.25 (ranging between agree and strongly agree). YouTube videos were successfully published. **Conclusion:** Kahoot! produces marked students' engagement and satisfaction in formative assessments enabling it to be applied live for any learning session either face to face or virtual for distance learning.

Keywords: COVID-19, education, engagement, feedback, formative assessment, game-based, interactive learning, Kahoot, response system, satisfaction

INTRODUCTION

Nowadays, there is increase in the use of technology due to improved technologies and rising instructional needs particularly in the current situation of the COVID-19 pandemic that resulted in the total shift toward online learning all over the world. In addition, this increase is brought by the advent of new generation of students who learn differently from those of past years, as current students are becoming more technology dependent, loaded by many nonacademic tasks and stressed by time commitments; accordingly, it is mandatory to introduce medical students to the newest technologies available.^[1]

Technology has played several important and critical roles in education, particularly in the very challenging and visual subject "Histology and Cell Biology," regarding the invention of many tools as the light and electron microscopes. In addition, the emerging technology of virtual microscope in laboratory has many educational advantages.^[2] With more advances in technology, educators of morphology-based curriculums have learning methods together with virtual slides

Address for correspondence: Prof. Nagwa Kostandy Kalleny,
Department of Histology and Cell Biology, Faculty of Medicine, Ain Shams
University, Cairo, Egypt.
E-mail: nagwakostandy@gmail.com

Received: 25-06-2020 Accepted: 29-07-2020 Published: 09-11-2020

Access this article online

Quick Response Code:



Website:
<http://www.jmau.org/>

DOI:
10.4103/JMAU.JMAU_61_20

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Kalleny NK. Advantages of Kahoot! Game-based formative assessments along with methods of its use and application during the COVID-19 pandemic in various live learning sessions. *J Microsc Ultrastruct* 2020;8:175-85.

to be used to engage students and assess learning outcomes before performing graded examinations.^[3] Such methods are often formative assessments that allow classroom response systems^[4-6] or audience response systems.^[7]

Both light and electron microscopic structure of human cells, tissues and organs studied in Histology and Cell Biology is critical and valuable in the curriculum of medical and dental students. Added to that monitoring of students' learning through formative assessment is essential for adjusting pedagogical strategies. However, it seems difficult to apply online interactive lab sessions and display light and electron microscopic lab photos in a good resolution to improve students' learning of histology and cell biology. In addition, it seems difficult to integrate technology-supported formative assessments in lab learning sessions. However, nowadays, the incorporation of interactive learning activities via the use of the advanced technology might be promising in improving students' learning outcomes, engaging and satisfying students in an interactive lab learning environment together with assessing their learning achievement by formative assessments.^[3]

In the context of medical education, particularly learning, medical mentors now have a great chance to introduce and incorporate advanced technology of game-based learning in their educational process. The integration of playing games in learning sessions has witnessed the emergence of a very unique idea of game-based learning or gamification.^[8] Students are more likely to stay engaged in any educational activity if technology programs or platforms are involved and integrated with gamification.^[9-12] Gamification or game-based learning is basically the use of game elements and game design techniques in nongame contexts, and it refers to the use or implementation of game mechanics and techniques outside the context of traditional game activities as in education.^[13] The play nature of gamification gives students the opportunity to be fully engaged in the learning process and improves students' learning via increasing motivation among students.^[8,14]

One of the best examples of a gamified learning sessions is Kahoot!, a game-based learning platform, that supplement educational practices with new technological capabilities. Kahoot!, a unique almost free game-based learning platform, was launched by the Norwegian University of Science and Technology (Make Learning Awesome, n.d.). It aims to make learning fun and programmed to suit learners of all ages, across all subjects, and in any language. It can be used simply by using any digital device with a browser and an existing infrastructure that include good internet connection. Kahoot! platform enables educator–learner interaction in different learning sessions of various sizes through competitive learning games. Students are not required to register for a Kahoot! account, instead they will be provided with a game PIN prior to joining a specific game at <https://kahoot.it/#/> as directed by their mentor (game host). The strength of these games lies in having learning occurring naturally without the students realizing that

learning is taking place. The Kahoot! environment provides time limits and scoring to create a competitive reviewing environment. Scores are displayed at the end of each game and educators can save the students' results in a digital document.^[8]

Kahoot! is a new generation of digital game-based student response system that focuses on increasing students' engagement and motivation together with assessing students' understanding of a learning session.^[15] Another major advantage of Kahoot! while using it in formative assessments, includes its ability to display high-quality images or videos with great graphical resolution.^[16] The embedded visual and audio elements in Kahoot! present a gaming capability that can promote engagement, motivation, and learning among almost all students, including adult ones.^[8] In addition, another study on Kahoot! involving almost 600 students, revealed that the variation in the use of Kahoot! music features positively affected students' enjoyment, motivation, engagement, and concentration. Furthermore, the provided individual feedback in terms of points contributed in assessing students' learning is another great advantage for Kahoot!.^[17]

Students can benefit from formative assessments only when provided with feedback that allows them to assess their learning^[18,19] aiming to improve learning strategies as it provides information about their performance,^[18,20,21] particularly if this feedback is immediate as students benefited most from immediate feedback^[22] and is provided during learning sessions while mentors are interacting with students, accordingly, it can significantly improve learning outcomes, and enhance teachers' teaching.^[23]

Another important advantage for Kahoot! is that it can be used in the current situation of COVID-19 pandemic and complete lockdown due to coronavirus. Kahoot! can be applied live virtual for distance learning same way as its application face to face in the current study. However, for distance learning, mentors should share their screen with students via any video conferencing tool with screen-sharing capability (e.g., Zoom, Skype, WebEx, Google Hangouts Meet, others), so the students can join and play the game in any location. A well-designed multimedia tool will perform a valuable role in distance learning programs of higher education.^[24,25]

Aim of the work

The purpose of this study was to identify the suitability of applying Kahoot!, a game-based learning platform, in lab sessions of histology and cell biology, as this is the first time to use Kahoot! as a formative assessment tool in histology and cell biology lab learning sessions in Extended Modular Program (EMP) of Faculty of Medicine Ain Shams University. In addition, the study aimed to assess students' engagement and satisfaction in Kahoot! formative assessments in histology and cell biology lab sessions of the respiratory system module.

Moreover, the study aimed to demonstrate methods of using and applying Kahoot! platform as a learning tool for any live learning session either face to face or virtual for distance

learning to be beneficial in the current situation of the COVID-19 pandemic.

METHODOLOGY

Ethical issues

The Institutional Review Board approval of the study was taken from the Research Ethics Committee at Faculty of Medicine Ain Shams University which is FMASU R 8/2020 in February 02, 2020, according to the guidelines of the International Council on Harmonization Anesthesiology and the Islamic Organization for Medical Sciences, the United States Officer for Human Research Protections, and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA 000017585.

All the study participants were oriented about the use of Kahoot! game-based learning technology and the photos taken and were informed that their participation in the Kahoot! game-based formative assessments is voluntary and has no impact on their final grades.

Study design

The participants of the current study were the undergraduate 2nd-year EMP medical students who were studying histology and cell biology of respiratory system module in the Faculty of Medicine Ain Shams University. The participants were divided into six lab groups according to their timetable.

The traditional histology and cell biology lab learning sessions were in the form of a lecture followed by a laboratory component. The lecture component uses PowerPoint slides coupled with an educational talk. In the laboratory component, students have access to multiple glass slides, light microscopes, and light and electron microscopic photographs. These traditional lab learning sessions were neither interactive nor providing any feedback to students and their mentors about learning achievements.

Hence, instead of this traditional nonmotivating way of education, I applied an online Kahoot! game-based formative assessment lab activity at the end of the laboratory sessions in each of the six lab groups.

The Kahoot! game-based formative assessment online sessions was prepared by me to be in the form of four multiple-choice questions (MCQs) supplied with both light [Figure 1] and electron [Figure 2] microscopic photos for different structures of the human respiratory system. Each question is adjusted with a timer giving the students 60 s to answer.

Kahoot! lab formative assessments were played in the form of single mode game by choosing the Classic game option [Figure 3] to test individual students' knowledge and learning achievements. Per quiz each student was able to receive a score of points that depends on accuracy and rapidity of answering the formative assessment.

Being the mentor, I revealed the game via a web browser on a laptop that was displayed on a large screen via a projector.

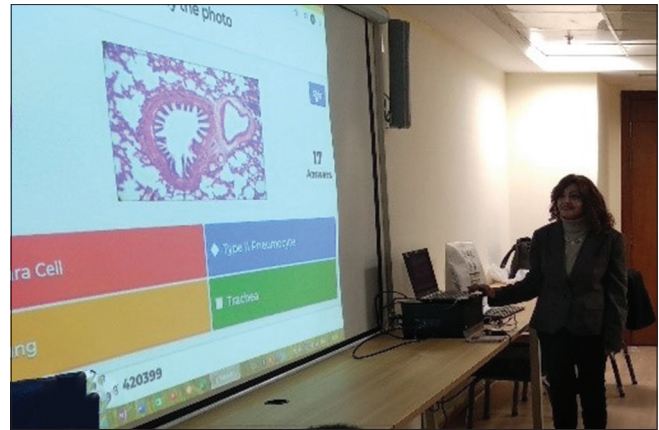


Figure 1: A photograph showing a light microscopic photo of one of the structures of the respiratory system uploaded on Kahoot! platform in a multiple-choice question and displayed on screen during online game-based formative assessment lab session



Figure 2: A photograph showing an electron microscopic photo of one of the structures of the respiratory system uploaded on Kahoot! platform in a multiple-choice question and displayed on screen during online game-based formative assessment lab session

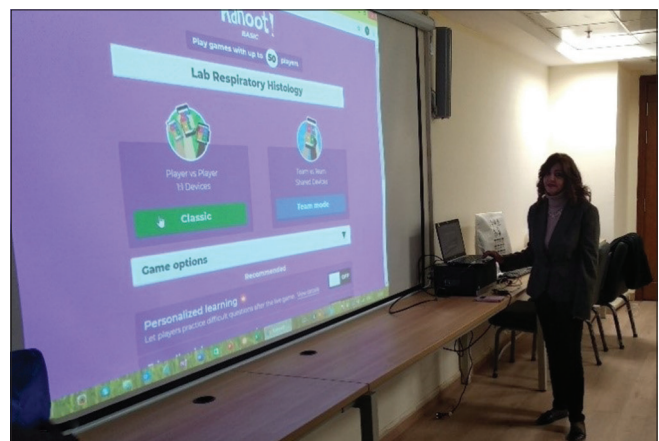


Figure 3: A photograph showing choosing the classic game option on Kahoot! platform, indicating that this lab formative assessment is played in the form of single mode game to test individual students' knowledge and learning achievements

Students logged in into the platform using a web-browser, entered the game PIN number and their names using their mobile phones, and all appeared on the screen [Figure 4]. All devices were connected to an internet source. During playing Kahoot! formative assessment, music and sounds were existing to give the quiz a playful and competitive atmosphere.^[15]

Each MCQ in the formative assessment was displayed on the large screen along with four alternatives in different colors with associated graphical symbols. Each one of the students gave his/her answer by choosing the color and symbol he/she considered correspond to the correct answer using his/her mobile phone, thus conveying a student response system. After each question, a distribution of how all the students answered was shown on the screen, thus giving an immediate feedback for both students and mentors [Figure 5].

Furthermore interactive discussions were created in the sense that students and me as the mentor actively reviewed learning concepts after each question in the formative assessment and also created self-directed learning environment. After each question feedback, a scoreboard of the names of the five top

students was shown on the screen [Figure 6]. Accordingly, these Kahoot! formative assessment lab sessions are considered to be an interactive review session. The term interactive review session was chosen as a descriptor for Kahoot! sessions because the game-based activity was designed around previously learned topics and needed deep interactive learning.^[3]

At the end of the Kahoot! formative assessment session, the students' names who won the formative assessment game or the quiz and their points were shown on the large screen [Figure 7]. Finally, participants informed their immediate feedback on Kahoot! provided on the platform itself at the end of the formative assessment [Figure 8a-c] and Kahoot! provides the functionality for the mentor to download the results of the formative assessments in an Excel spreadsheet.^[15]

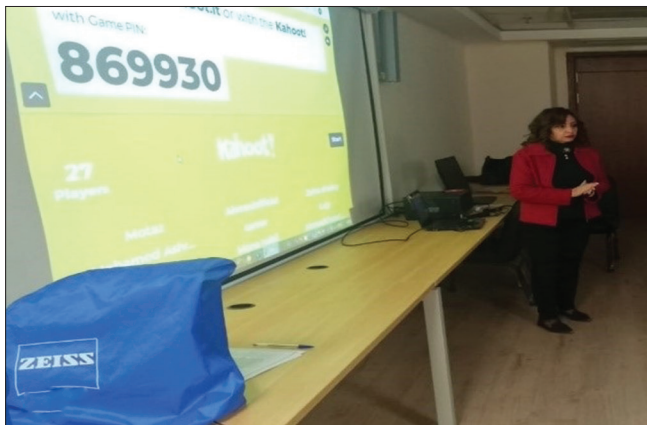


Figure 4: A photograph showing Kahoot! lab formative assessment game pin number and the students' names who are engaged in the game appearing on the screen while playing the game live



Figure 5: A photograph showing scores of each one of four alternatives of an multiple-choice question in the formative assessment, each having a specific color with associated graphical symbol, revealing students' responses and immediate feedback as appearing on the screen

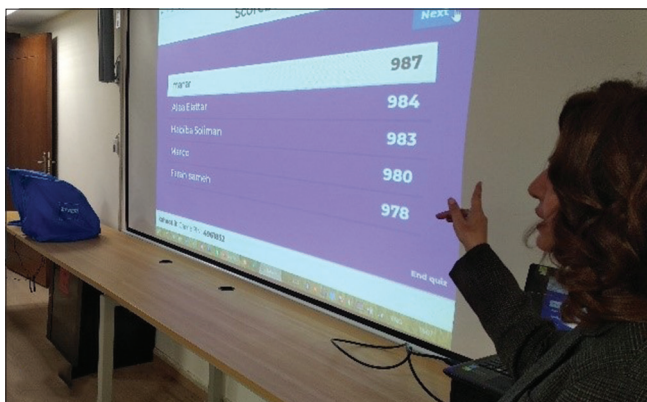


Figure 6: A photograph showing a scoreboard of the names of the five top students who responded accurately and the quickest and their scores appearing on the screen for all to show

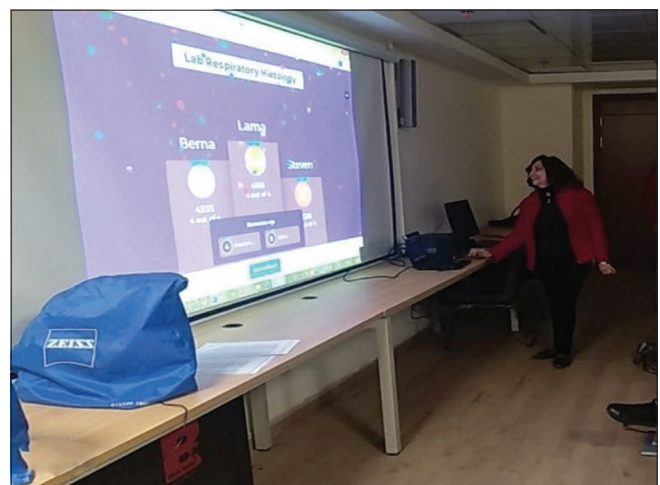


Figure 7: A photograph showing the names of the students who won the formative assessment game and their points appearing on the screen for all to show

Participants' engagement of the current study was evaluated by calculating the number of engaged students in Kahoot! game-based lab formative assessment versus the number of students who attended each histology and cell biology lab session of respiratory system module.

Moreover, participants' satisfaction in Kahoot! game-based formative assessments in lab sessions of the current study was evaluated both immediately as being collected on Kahoot! platform at the end of lab formative assessments [Figure 8a-c] and later by an online questionnaire that was applied on Google Forms whose link was sent to participants via E-mail. The questionnaire included 5 items that were measured on a 5-point Likert scale, with 1 indicating "strongly disagree" and 5 indicating "strongly agree" with overall satisfaction ranging between 5 (least satisfaction) and 25 (maximum satisfaction).^[8]

The questionnaire items were:

1. Kahoot makes me remember the knowledge better compared to traditional lab sessions
2. Kahoot helps me concentrate more during the session than traditional lab sessions
3. Kahoot makes learning the structure in the photos easy and quick
4. All photos (LM and EM) showed on Kahoot were clear and focused
5. I wish Kahoot to be used in all lectures and labs.

Methods of demonstrating the use and application of game-based Kahoot! platform technology in any learning session was done by performing two YouTube videos that were recorded during the current COVID-19 pandemic via zoom meetings by me with distant players. Finally, the two videos were uploaded on ASU-MENA-FRI Health Professions Education Channel to demonstrate, elaborate, and spread the idea of using Kahoot! Platform in education particularly in COVID-19 lockdown of Corona virus pandemic.

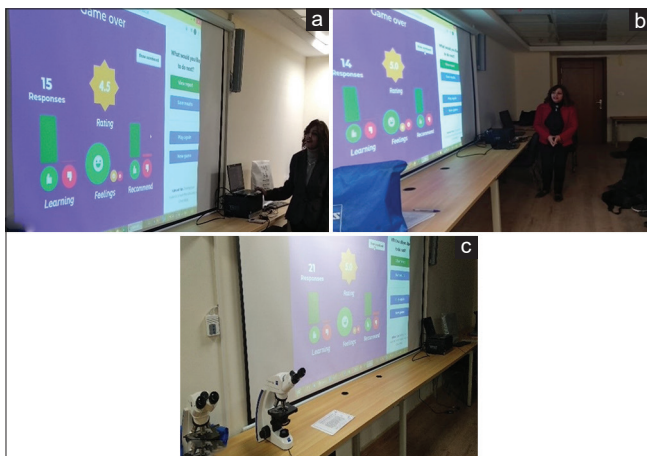


Figure 8: (a-c) Photographs showing the immediate students' feedback on Kahoot! platform regarding fun assessment, learning, recommendation, and feelings in using Kahoot! that was collected at the end of lab formative assessments in 3 different lab sessions

The first YouTube video was prepared by me using PowerPoint presentation and Kahoot! platform and was recorded via zoom meeting with distant players. It is concerned with "Using Kahoot Platform in Education as a Game Based Learning Tool."

The Second YouTube video was prepared by me using Kahoot! platform and recorded via zoom meeting with distant players. It is concerned with "Different Methods of Using Kahoot Platform Live in Learning Sessions."

RESULTS

Results of identifying the suitability of application of Kahoot! game-based learning platform, in lab sessions of histology and cell biology

The results of the current study revealed that online game-based formative assessments using Kahoot! platform can be successfully applied in histology and cell biology lab learning sessions because of the uploaded light and electron microscopic photos that were revealed in great resolution in this platform as shown in Figures 1 and 2. Kahoot! platform is suitable for this very visual and challenging subject also because this platform enables users to upload images either from their own device or from the web. Moreover, the uploaded photos can be either used in the question itself, or it can be one of the answer options.

Results of students' engagement

As regards participants' engagement of the current study, the number of engaged students in Kahoot! lab formative assessment versus the number of students who attended each histology and cell biology lab session of respiratory system module were calculated and shown in Table 1.

In Table 1, the number of students who attended the histology and cell biology lab sessions of the respiratory system module is not equal in the six groups. The difference in the number of students' attendance was because some students prefer attending lab sessions that were scheduled more earlier in the timetable than others that are scheduled at the end of the day.

As regards the number of engaged students in Kahoot! lab formative assessment versus the number of students who attended each of the six histology and cell biology lab sessions of the Respiratory system module, 4 of the 6 lab groups showed that all students who attended the lab sessions were engaged in Kahoot! formative assessments, so the students' engagement was 100% in these 4 lab sessions. However, only one student in each of the remaining two lab groups could not engage in applying their name in Kahoot! platform because their phones are out of charge as the timing of these two labs were performed in a late timing at the end of the day. Surprisingly, these students were motivated to answer the quiz by following the questions displayed on the screen and they were actively engaged in the discussion that was held after each question during playing the formative assessment.

Results of students' satisfaction

Results of students' satisfaction as assessed by students' feedback collected immediately on Kahoot! platform at the end of lab formative assessments

As shown in Figure 8a-c, the students' feedback on Kahoot! platform that was collected immediately at the end of lab formative assessments in the current study revealed the following:

1. The mean overall students' fun assessment of Kahoot! game was rated a score of 4.65 out of 5
2. The vast majority of the students stated that they had learnt by Kahoot!
3. The vast majority of the students recommended the way of learning using Kahoot!
4. Most of students feel positive towards Kahoot!

Results of students' satisfaction as assessed by the online questionnaire

As regards participants' satisfaction of the current study, the students' satisfaction questionnaire in Kahoot! lab formative assessments revealed that the mean overall Kahoot! satisfaction score of the 5 items (5-point Likert scale) was 24.25 (ranging between agree and strongly agree). Moreover, the satisfaction score of each item of the 5 items in the students' satisfaction questionnaire revealed mean in the range between 4 and 5 (ranging between agree and strongly agree) as shown in Table 2. Table 2 also showed the number and the percentage of students who responded in each of the 5 possible choices of each item, with 1 indicating "strongly disagree" and 5 indicating "strongly agree" with each item satisfaction ranging between 1 (least satisfaction) and 5 (maximum satisfaction).

Table 1: The number of engaged students in Kahoot! lab formative assessment versus the number of students who attended each Histology and Cell Biology lab session of Respiratory system module

	Number of engaged students in Kahoot! lab formative assessment as recorded in Kahoot platform results excel sheet	Number of students who attended lab learning session as counted by mentor and revealed in students attendance sheet	Number of engaged students in Kahoot! lab formative assessment versus the number of students who attended the lab session
Lab session of Group 1	27	27	27 out of 27 (all students who attended lab session of Group 1 were engaged in Kahoot! formative assessment)
Lab session of Group 2	23	23	23 out of 23 (all students who attended lab session of Group 2 were engaged in Kahoot! formative assessment)
Lab session of Group 3	22	22	22 out of 22 (all students who attended lab session of Group 3 were engaged in Kahoot! formative assessment)
Lab session of Group 4	18	19	18 out of 19 (only one student who attended lab session of Group 4 was not engaged in Kahoot! formative assessment because the phone of this student was out of charge)
Lab session of Group 5	14	15	14 out of 15 (only one student who attended lab session of Group 5 was not engaged in Kahoot! formative assessment because the phone of this student was out of charge)
Lab session of Group 6	30	30	30 out of 30 (all students who attended lab session of Group 6 were engaged in Kahoot! formative assessment)

Table 2: The mean satisfaction score of each item of the 5 items in the students' online satisfaction questionnaire and also the number and the percentage of students who responded in each of the 5 possible choices of each item, with 1 indicating "strongly disagree" and 5 indicating "strongly agree," with each item satisfaction ranging between 1 (least satisfaction) and 5 (maximum satisfaction)

Items	n (%)					Mean score of each item
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Kahoot makes me remember the knowledge better compared to traditional lab sessions	0	0	1 (1.5)	9 (13.4)	57 (85.1)	4.84
Kahoot helps me concentrate more during the session than traditional lab sessions	0	0	1 (1.5)	13 (19.4)	53 (79.1)	4.78
Kahoot makes learning the structure in the photos easy and quick	0	0	0	10 (14.9)	57 (85.1)	4.85
All photos (LM and EM) showed on Kahoot were clear and focused	0	0	1 (1.5)	5 (7.5)	61 (91)	4.9
I wish Kahoot to be used in all lectures and labs	0	1 (1.5)	0	4 (6)	62 (92.5)	4.9
Total answers=335	0	1	3	41	290	
Mean score of all items	24.25 (ranging between agree and strongly agree)					

n: Number of participants, Strongly disagree: 1, Disagree: 2, Neutral: 3, Agree: 4, Strongly agree: 5

The results of students' satisfaction online questionnaire are interesting as they coincide with all the findings of the immediate feedback collected on Kahoot! platform and the observed students' attitude and reactions towards application of Kahoot! in learning sessions.

Results of the two YouTube videos that demonstrated methods of how to use and apply Kahoot! Game-based learning platform particularly during the COVID-19 pandemic in any learning session

It was noticed that the two YouTube videos were successfully distributed as they recorded hundreds of viewers in a relatively short time. These videos are:

- A. YouTube Video 1 that is demonstrating "Using Kahoot! Platform in Education as a Game Based Learning Tool" link is: <https://youtu.be/dhk3Ct6rZCQ>

This video displayed the following objectives:

1. What Is Kahoot! Platform? And Why Using Kahoot! Platform in Education?
2. How to Create a Kahoot! Account?
3. How to Create a Kahoot! Game?
4. What Are Instructions for Students Before Playing a Kahoot! Game?
5. How Can You Play Kahoot! Live in Learning Sessions?

This video showed Kahoot! platform and its importance in education. It demonstrated steps of creating a Kahoot! account and game. It also demonstrated instructions for students before playing a Kahoot! game together with steps of how can Kahoot! be played live in learning sessions.

In fact, this video is ideal in demonstrating how virtual learning sessions can be applied for distance learning as in the current situation of COVID-19 pandemic.

- B. YouTube Video 2 that is demonstrating "Different Methods of Using Kahoot! Platform Live in Learning Sessions" link is: <https://youtu.be/EiG1b7pBHhk>

This video displayed the following objectives:

1. When Can You Play Kahoot! Live in Any Learning Session?
2. Where and Which Type of Kahoot! Learning Games Can Be Played Live in Learning Sessions?
3. How Can Kahoot! Learning Games Be Played Live in Learning Sessions?

This video showed that Kahoot! learning games can be played live anytime, in any learning sessions, either face to face in any educational hall or virtual for distance learning as in the current situation of the COVID-19 pandemic, via any video conferencing tool with screen sharing capability (e.g., Zoom, Skype, WebEx, Google Hangouts Meet, others,) in which you as a mentor has to share your screen with your students so they can join and play the game.

In fact, this video is an amazing one as it also demonstrates that the whole learning session can be prepared using Kahoot! platform only, no PowerPoint presentation to show that a

complete live learning session with its knowledge together with its assessment can be done using Kahoot! platform only. Accordingly, Kahoot! platform can be used not only for formative assessments, but also for interactive teaching of various learning sessions with students' response system giving immediate feedback for both mentors and students about learning achievement.

DISCUSSION

In the current study, Kahoot! game-based formative assessments were applied for the first time in EMP Faculty of Medicine Ain Shams University in Histology and Cell Biology lab learning sessions of the Respiratory system module after being successfully applied in Histology and Cell Biology lectures for the same participants. Kahoot! formative assessments were found to greatly improve students' enjoyment, engagement, motivation, and satisfaction towards application of formative assessments at the end of Histology and Cell Biology lectures and in attending the lectures themselves. The effects of Kahoot! game-based formative assessments in Histology and Cell Biology lectures on engagement and satisfaction was studied in a previous study whose abstract was submitted to Global Forum for Higher Education and Scientific Research Medical Education Summit 2020 and was provisionally accepted to be presented as a poster presentation.

Based on the participants' enthusiasm towards Kahoot! game-based formative assessments, and their engagement, enjoyment, motivation, and satisfaction in Kahoot! game-based formative assessments in lectures, I decided to apply Kahoot! game-based formative assessments in Histology and Cell Biology labs, because fortunately LM and EM photos of the Histology and Cell Biology Respiratory system module course can be uploaded on Kahoot! platform in a great resolution, accordingly it can be a successful gamification tool for Histology and Cell Biology lab formative assessments. The possibility of uploading images in Kahoot! platform that were displayed in high quality with great graphical resolution is considered a great advantage of this game-based platform to be used as a formative assessment tool as compared to other formative assessment online tools.^[3,16]

In the current study, Kahoot! game-based formative assessments were applied in the last 10 min of Histology and Cell Biology lab learning sessions aiming to review mentioned knowledge and assess learning of the session in an interactive way rather than the noninteractive traditional lab sessions that were non motivating, and don't provide any feedback. The application of Kahoot! game-based formative assessment as an interactive review session at the end of the learning sessions was partially as an attempt to prevent any negative influence to the learning sessions if students rejected the game-based formative assessment by Kahoot! platform, and partially based on an author's description of review sessions who mentioned that the review sessions are aimed to help students learn and prepare for upcoming exams particularly if these review

sessions were incorporated by active and cooperative learning approaches.^[26] In agreement, Kahoot! game-based formative assessments applied at the end of lab learning sessions in the current study were very interactive in the sense that students and me as being their mentor actively discussed concepts after each of the 4 displayed MCQs and also at the end of the formative assessment session aiming to fill any missing gap of information, ensure proper understanding and correct any misunderstanding of knowledge and review all learning outcomes.

Some authors identified that the questioning and answering is the most common form of interaction between students and lecturer and it created a Classroom Response System improving interactive discussion in the classroom and providing instant feedback to the teacher and students. They also noticed that the use of classroom response systems helped to promote students' class participation and enabled them to assess their understanding.^[27] In accordance, a classroom response systems, also known as interactive response system, student response system, personal response system, or audience response system, is intended to increase students' learning, confidence, attendance, interaction in class and the lecturer's ability to respond to students' misconceptions.^[28] Moreover, the student response system and the immediate feedback made students more likely engage in learning sessions and get more understanding of their subjects.^[7,29]

In the current study, Kahoot! platform provided immediate accurate feedback for both mentor and students. As for mentor, amazingly, these formative assessment sessions that were associated with interactive discussions have illuminated the strengths and weaknesses of my own teaching. These sessions also informed me about students' problems in learning rather than the noninteractive traditional lab sessions. Moreover, the immediate feedback after each question gave me an idea about what was not properly learnt or misunderstood during the learning sessions; accordingly, I can improve my teaching strategies to be suited for all students. This agrees with other authors who reported that the provided students' immediate feedback allowed mentors for early identification of areas for improvement and implementation of approaches to promote more effective education, teaching and learning.^[7]

As for students, the current study exhibited successful Student Response System integrated with the provided immediate feedback. All students were provided with the correct answer of each question as shown immediately on the screen, so each student could evaluate himself/herself without being embarrassed if he got the answer wrong. On the other hand, the top-five students' names and score points who answer the question correctly and quickly appear on the screen, thus students get more motivated to engage in the formative assessment and compete against each other in a safe fun learning environment aiming to be one of the top-five scorers in order to see his/her name displayed on the screen for all to show. Thus, the immediate feedback incorporated in the

interactive learning sessions in the current study prevented students' isolation and created safe fun self-directed active deep learning environment that was encouraging for all students to engage and collaborate in the interactive discussion during the formative assessment, and in learning in general. In accordance, some authors reported that Kahoot! game-based formative assessments created safe learning environment by avoiding some challenges in implementing a social constructivist learning activity, such as students' inadequate knowledge and their embarrassment in exposing one's inadequate understanding to peers, which are limiting factors for students' participation in answering the assessments and in learning engagement.^[30]

The advantages of interactive sessions for mentors and students revealed that students can independently evaluate themselves regarding their strength and weak points and the teacher can evaluate the depth and/or lack of their knowledge. Added to that, active review sessions made students concentrate on the knowledge, better prepared for problem solving and develop the thinking skills required for the exam.^[26] Great evidence proposed that student-focused methods improve learning and academic performance compared with traditional teacher-centered approaches.^[31] In accordance, the current study revealed that, as compared to traditional lab sessions, the students-mentor interaction created during Kahoot! formative assessments when applied in Histology and Cell Biology lab sessions presented an important component of learning and is considered a key to success in students' engagement and satisfaction towards the application of Kahoot! game-based formative assessments.

Regarding students' engagement, as shown in Table 1, the current study revealed that in 4 of the 6 lab groups, Kahoot! game-based formative assessment students' engagement measured 100%, in which the number of engaged students in Kahoot! lab formative assessment is equal to the number of students who attended each of these 4 Histology and Cell Biology lab sessions of the Respiratory system module, thus all students who attended these 4 lab sessions were engaged in Kahoot! formative assessment. However, in the remaining two lab sessions, only one student in each of these two lab groups could not engage because their phones are out of charge as the timing of these two labs were performed in a late timing at the end of the day. Fortunately, these two students who were unable to charge their phones and engage by their mobile phones in the assessment, they followed the questions displayed on the screen and actively engaged in the interactive discussion of the answers of each question displayed in Kahoot! game-based formative assessment. Accordingly, it was noticed that all students were motivated to engage in this lab game-based activity. Thus, Kahoot! formative assessment game-based interactive sessions are beneficial in education as they are successful in performing full engagement of all students and preventing separation of any student who attended the lab session even if he/she could not join the game by entering his/her name, amazingly, these students were successful in

joining the assessment, participating in the active discussion and assessing their learning achievement. In agreements, other studies showed that use of classroom response systems and student–mentor interaction increased students’ enthusiasm, attendance, attention, and in-class participation.^[32-34] Moreover, another study revealed that engaging students in the interactive discussion revealed many advantages in making them responsible for summarizing, integrating, or synthesizing the information.^[26]

Regarding the current study, these interactive Kahoot! game-based formative assessment lab sessions compared with traditional lab sessions were not only engaging, but also still having several other advantages regarding students’ satisfaction as verified by the results of both the students’ feedback on Kahoot! platform as shown in Figure 8a-c that was collected immediately at the end of lab formative assessments and the results of the online students’ satisfaction questionnaire as revealed in Table 2 of the present study. The students’ feedback that was collected on Kahoot! platform immediately at the end of lab formative assessments in the current study revealed that the vast majority of the students had learnt by Kahoot!, and recommended the way of learning Histology and Cell Biology using Kahoot!. Amazingly these findings coincided with the students’ online satisfaction questionnaire items concerning Kahoot! lab formative assessment effects on learning as compared to the traditional lab learning sessions, which are: “Kahoot makes me remember the knowledge better compared to traditional lab sessions” and “Kahoot helps me concentrate more during the session than traditional lab sessions,” these items showed mean students’ satisfaction score of 4.84 and 4.78, respectively (ranging between agree and strongly agree), denoting that the students definitely preferred Kahoot! game-based formative assessments in their lab learning sessions rather than traditional lab sessions. Gamification or game-based learning builds students’ full attention and fosters knowledge retention due to its “play nature.”^[8]

A serious game is an engaging interactive computer application that supplies the user with skills, knowledge, or useful attitudes. It has a challenging goal incorporating scoring mechanism and is fun to play.^[35] In agreement, in the current study most probably students preferred learning by these game-based sessions because of the fun competition between them while playing the formative assessment. Also, the created interactivity between them and between them and the mentor during the discussion of answers of each question ensured proper understanding of each question before shifting to the other. Most of students feel positive towards the use of Kahoot! and the mean overall students’ fun assessment of Kahoot! game rated 4.65 out of 5 as indicated in the students’ feedback on Kahoot! platform, that was collected immediately at the end of lab formative assessments. All these findings of the current study are specifically interesting as Kahoot! games aimed for engaging and satisfying students by its competitive interactive response system in a fun safe social context. Similarly, other studies based on students’ feedback on Kahoot! platform

revealed that most of the students considered Kahoot! activity fun and they felt positive during its use. Students judged that they had learned via Kahoot! and they recommended it to be used in learning.^[14,36] Having fun with others while playing an educational Kahoot! game is enjoyable and not stressful and goes beyond the traditional way of learning and it also enables students to practice and revise the knowledge.^[14] Added to that another study revealed that their students mentioned that the elements of fun and play are benefits of the Classroom Response Systems that made their lectures more interesting.^[27]

Interactive review sessions help students call attention to the learning processes and was associated with better achievements in their learning goals. Moreover, these sessions also reduced the pretest anxiety that often be associated with high-stakes exams.^[26] Added to that in a recent study, the students reported that Kahoot! exercises set a more relaxed environment for discussions by creating an atmosphere of trust, without any judgment. Students also reported that Kahoot! gamification made them enjoyed themselves more and were willing to learn Histology classes.^[16] In accordance, the current study students’ satisfaction questionnaire item concerning “Kahoot makes learning the structure in the photos easy and quick” revealed mean students’ satisfaction score of 4.85 (ranging between agree and strongly agree), denoted that Kahoot! game-based formative assessments could improve learning students’ outcomes more than traditional lab sessions. Also, this agreed with the mean students’ satisfaction score that revealed 4.9 (ranging between agree and strongly agree) of the item “All photos (LM and EM) showed on Kahoot were clear and focused.” In fact, one of the main great advantages that made Kahoot! appropriate for learning Histology and Cell Biology in the current study was the display of light and electron microscopic photomicrography in high resolution in this platform. Thus, students could easily and quickly identify the structure of the cells, tissues, and organs of the body from images that were projected in Kahoot! platform. In agreement, other studies revealed that the display of high-quality images with great graphical resolution is a major advantage of web-based learning platforms in learning Histology.^[3,16]

Similarly, the current study revealed that the students prefer using Kahoot! platform as a game-based formative assessment tool in Histology labs and even in all various learning sessions. This was indicated by the mean students’ satisfaction score measuring 4.9 (ranging between agree and strongly agree) regarding the last item in the questionnaire about “I wish Kahoot to be used in all lectures and labs,” which in fact indicates that the use of technology in the form of gamification using Kahoot! platform as a game-based formative assessment tool in learning sessions is very successful and could achieve promising education. The present study can be supported by other study, which indicated that students perceived that the use of innovative technology in education significantly influenced their motivation towards learning the concepts of Histology, also had a positive impact on the students’ attention and satisfaction in learning compared to traditional microscope-based studies.

Learning the fundamentals of histology may benefit from a shift from educator-focused/traditional learning session to technology directed, student-oriented education.^[37] Added to that a more recent study showed that the overall student learning performance for the gamification in Histology was rather high.^[16]

The present study students' satisfaction and engagement agreed with other study which indicated that the students found Kahoot! to be beneficial in terms of reinforcing and fostering their learning of both theoretical and practical aspects. The later study also indicated that Kahoot! induced students' motivation as well as engagement in the learning process.^[8] In agreement, it was noticed that the gamified formative assessments via using the advanced technology of Kahoot! platform induced a beneficial student response system and enhanced students' enjoyment, engagement, motivation, and concentration in learning.^[15]

The utilization of emerging game-based technology of Kahoot! as a formative assessment tool investigated in another study in Histology and Cell Biology lectures and in the current study in Histology and Cell Biology labs Respiratory system module course, both acknowledged a way to improve learning in Histology and Cell Biology. As compared to traditional learning sessions, Kahoot! better presented, reviewed the learning material in an interactive fun competitive and stimulating manner, enhanced students' engagement, and satisfaction by making the learning sessions more informative, yet retaining the student-directed response system together with providing immediate accurate feedback for both mentors and students. Thus, as technology is being progressively integrated as a part of teaching in view of improving students' engagement, motivation and satisfaction in the learning process, thus innovative changes have become a critical part of education particularly in complete lockdown as in the current situation of COVID-19 pandemic. Accordingly, it is preferred to use the new technology of Kahoot! platform as a game-based learning tool in educational activities.

Added to that the performed YouTube videos that aimed to demonstrate, elaborate, and spread the idea of using Kahoot! platform in education particularly in the COVID-19 lockdown, is in fact a very beneficial and successful tool for presenting and distributing the idea to many different people in any place using any device to encourage and educate them the use and implementation of Kahoot! platform in education even if they teach any subject to any age, and even if they spoke different languages, since the visualization of the method in a video can benefit them. These videos recorded hundreds of viewers in a relatively short time. In agreement, the use of video-based lectures are one of the valuable tools in online learning that offers many advantages and can overcome the numerous obstacles that can challenge classic educational activities.^[38]

Moreover, in accordance to the idea and the results presented in the current study together with the YouTube videos links included in the present study regarding the use of Kahoot! game-based technology live in any learning sessions either

face to face or virtual for distance learning, a systematic review regarding the application of digital serious games for medical education revealed that the application of these games for education of medical professionals form an innovative approach to the education of medical professionals and its application is increasing. Interactive learning by means of serious games played on platforms by personal computers or smartphones can apply multi modal interactive content in any virtual environment and can be applied to train both technical and non-technical skills.^[9] In addition, a recent study identified that using technology-based tools, such as Kahoot! enhances formative assessment and subsequently, improves students' learning. Kahoot! helps in providing individualized learning and feedback which, in turn, leads to engaging students in an effective interactive learning environment and makes the educational formative assessment activity informative, interesting with fun.^[6]

CONCLUSION AND RECOMMENDATIONS

Based on the current study results, findings, and the YouTube videos, it is concluded that Kahoot! platform proved to be a perfect formative assessment tool in learning Histology and Cell Biology revealing many advantages. Kahoot! can display high-resolution LM and EM photos, facilitates fun interactive informed discussions between students and mentors, allows accurate immediate feedback. Kahoot! succeeded in inducing students' engagement, motivation, and satisfaction in formative assessments as well as in learning sessions. Kahoot! platform can be used not only for formative assessments, but also for learning various sessions by interactive teaching enabling students' responses system and giving immediate feedback for both mentors and students about learning achievement.

As Kahoot! formative assessments are beneficial in integrating assessment with teaching, accordingly, this study recommends educators to integrate Kahoot! game-based technology in learning to engage their students, assess understanding and correct misconceptions; and to improve students' learning aiming to achieve promising education.

Limitations

The only limitations of the use of Kahoot! game-based technology are shortage of internet coverage or connection and/or lack of charge of electronic devices.

Future work

Although gamification seemed to be effective in learning Histology and Cell Biology, this belief must be generalized to other subjects with further research.

Also, empirical research to investigate the effectiveness of using Kahoot! game-based technology as a formative assessment tool on students' learning achievements and performance should be done.

Acknowledgments

I would like to acknowledge ASU-MENA-FAIMER Institute, in addition to administrators, IT staff, officers, and students of

EMP Faculty of Medicine Ain Shams University and players who shared in the YouTube videos.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Reidenberg JS, Laitman JT. The new face of gross anatomy. *Anat Rec* 2002;269:81-8.
- Harris T, Leaven T, Heidger P, Kreiter C, Duncan J, Dick F. Comparison of a virtual microscope laboratory to a regular microscope laboratory for teaching histology. *Anat Rec* 2001;265:10-4.
- Rinaldi VD, Lorr NA, Williams K. Evaluating a technology supported interactive response system during the laboratory section of a histology course. *Anat Sci Educ* 2017;10:328-38.
- Paschal CB. Formative assessment in physiology teaching using a wireless classroom communication system. *Adv Physiol Educ* 2002;26:299-308.
- Schell J, Lukoff B, Mazur E. Catalyzing learner engagement using cutting-edge classroom response systems in higher education. In: Wankel C, Blessinger P, editors. *Increasing Student Engagement and Retention Using Classroom Technologies: Classroom Response Systems and Mediated Discourse Technologies (Cutting-Edge Technologies in Higher Education)*. Vol. 6. Part E. Bingley: Emerald Group Publishing Limited; 2013. p. 233-61.
- Peculea L. Perspectives of future teachers on formative e-assessment using the classroom response system. *EpSBS*; 2020. p. 401-9.
- Alexander CJ, Crescini WM, Juskewitch JE, Lachman N, Pawlina W. Assessing the integration of audience response system technology in teaching of anatomical sciences. *Anat Sci Educ* 2009;2:160-6.
- Ai Lin DT, Manjet Kaur GM. Kahoot! It: Gamification in higher education. *Pertanika J Soc Sci Hum* 2018;26:565-82.
- Graafland M, Schraagen JM, Schijven MP. Systematic review of serious games for medical education and surgical skills training. *Br J Surg* 2012;99:1322-30.
- Akl EA, Kairouz VF, Sackett KM, Erdley WS, Mustafa RA, Fiander M, *et al*. Educational games for health professionals. *Cochrane Database Syst Rev* 2013;1:CD006411.
- Pettit RK, McCoy L, Kinney M, Schwartz FN. A multimedia audience response game show for medical education. *Med Sci Educ* 2014;24:181-7.
- Attali Y, Arieli-Attali M. Gamification in assessment: Do points affect test performance? *Comput Educ* 2015;83:57-63.
- Deterding S, Sicart M, Nacke L, O'Hara K, Dixon D. Gamification: Using game design elements in non-gaming contexts. In: CHI'11 Extended Abstracts on Human Factors in Computing Systems. (CHI EA '11). Association for Computing Machinery, New York, NY, USA; 2011. p. 2425-8.
- Zarzycka-Piskorz E. Kahoot it or not? Can games be motivating in learning grammar? *Teach English Technol* 2016;16:17-36.
- Wang AI, Zhu M, Sætre R. The effect of digitizing and gamifying quizzing in classrooms. In: *Proceedings of the 10th European Conference on Games Based Learning*. University of the West of Scotland, Paisley, Scotland; 2016.
- Felszeghy S, Pasonen-Seppänen S, Koskela A, Nieminen P, Härkönen K, Paldanius KM, *et al*. Using online game-based platforms to improve student performance and engagement in histology teaching. *BMC Med Educ* 2019;19:273.
- Wang AI, Lieberoth A. The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot!. Reading: Academic Conferences International Limited; 2016. p. 738-46.
- Perera J, Lee N, Win K, Perera J, Wijesuriya L. Formative feedback to students: the mismatch between faculty perceptions and student expectations. *Med Teach* 2008;30:395-9.
- Trumbull E, Lash A. *Understanding Formative Assessment: Insights from Learning Theory and Measurement Theory*. San Francisco, CA; 2013. Available from: https://www.wested.org/wp-content/files_mf/1370912451resource13071.pdf. [Last accessed on 2016 Jul 07].
- Nicola DJ, Macfarlane-Dick D. Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Stud High Educ* 2006;31:199-218.
- Clynes MP, Raftery SE. Feedback: An essential element of student learning in clinical practice. *Nurse Educ Pract* 2008;8:405-11.
- Mullet HG, Butler AC, Verdin B, von Borries R, Marsh EJ. Delaying feedback promotes transfer of knowledge despite student preferences to receive feedback immediately. *J Appl Res Mem Cognit* 2014;3:222-9.
- Shute V. Focus on formative feedback. *Rev Educ Res* 2008;78:153-89.
- Koohang A, Weiss E. Effect of prior experience with the Internet on graduate students' perception toward courseware usability & web-based distance learning instruction: an exploratory study in a hybrid instruction environment. *Issues Informat Syst* 2003;4:535-42.
- Koohang A, Durante A. Learners' perceptions toward the web-based distance learning activities/assignments portion of an undergraduate hybrid instructional model. *J Informat Technol Educ* 2003;2:105-13.
- Favero TG. Active review sessions can advance student learning. *Adv Physiol Educ* 2011;35:247-8.
- Siau K, Sheng H, Nah F. Use of a classroom response system to enhance classroom interactivity. *Education IEEE Transactions* 2006;49:398-403.
- Suchman E, Uchiyama K, Smith R, Bender K. Evaluating the impact of a classroom response system in a microbiology course. *Microbiol Educ* 2006;7:3-11.
- Ludvigsen K, Krumsvik R, Furnes B. Creating formative feedback spaces in large lectures. *Comput Educ* 2015;88:48-63.
- Moskal A, Loke S, Hung N. Challenges implementing social constructivist learning approaches: The case of Pictation. In: Barker S, Dawson S, Pardo A, Colvin C, editors. *Show Me The Learning*. Proceedings ASCILITE Adelaide; 2016. p. 446-54.
- Walker A, Leary H. A problem based learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdiscip J Probl Based Learn* 2009;3:12-43.
- Bullock D, LaBella V, Clingan T, Ding Z, Stewart G, Thibado P. Enhancing the student-instructor interaction frequency. *Phys Teach* 2002;40:535-41.
- Wit E. Who wants to be. the use of a personal response system in statistics teaching. *MSOR Connections* 2003;3:14-20.
- Roschelle J, Penuel WR, Abrahamson L. Classroom response and communication systems: Research review and theory. In: *Annual Meeting of the American Educational Research Association*, San Diego, CA; 2004. p. 1-8.
- Bergeron BP. *Developing Serious Games*. Hingham, United States: Charles River Media; 2006.
- Cutri R, Marim LR, Cordeiro JR, Gil HA, Guerald CC. Kahoot, a new and cheap way to get classroom-response instead of using clickers. *ASEE Annual Conference & Exposition*; 2016.
- Felszeghy S, Pasonen-Seppänen S, Koskela A, Mahonen A. Student-focused virtual histology education: do new scenarios and digital technology matter? *MedEdPublish* 2017;6:40.
- Hassanien M, Abou-Kamer R. YouTube videos as a tool for faculty development in medical education: A learning analytic overview. *MedEdPublish* 2018;7:14.