Introduction of the Game- Based Learning Platform, Kahoot, as a Tool in Radiology Resident Training

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Abstract

While passive lecture-based learning practices remain popular among medical educators, their retention rates are generally poor. Current movements in medical education encourage alternative teaching methods designed to maximize knowledge retention, reduce lapses in attention and uncover the learner's intrinsic motivations.

Kahoot is a web-based program where the user can easily construct games, nicknames "kahoots" free of charge. By harnessing the benefits of the "fun theory" and "gamification", Kahoot can serve as a useful tool for radiology resident training.

In this manuscript we describe how to use the game-based learning platform, Kahoot, in radiology trainee education. This manuscript illustrates how to design interactive question sets and demonstrates the advantages of Kahoot over traditional approaches to teaching.

Keywords: RESIDENT, TRAINING, EDUCATION, GAMIFICATION

Introduction

It has been well established that the retention rate of traditional lectures is low. Edgar Dale in collaboration with the National Training Laboratory introduced the classification system termed the "cone of experience" which aimed to stratify learning experiences according to effective retention rates. At the top of the pyramid or cone, passive lectures had the lowest calculated rates with an approximate retention of 5% (1). Active learning techniques, including hands-on experiences, collaborative efforts and experiment design ranked significantly higher in retention rates and were placed at the base of the pyramid (1). While the specific percentages have later been disputed mainly based on the wide variability of factors that affect memory retrieval, the overall consensus has been that active learning techniques carry a higher benefit than passive methods.

Similarly, Dulonsky et al. evaluated several learning techniques for utility and generalizability and concluded that practice testing and distributed practice were the two techniques with highest utility (2). The term practice testing refers specifically to "testing that is completed as a low-stakes or no-stakes practice" or any "that students would be able to engage in on their own" (2). Distributed practice indicates a technique in which material is presented is a spaced manner over longer increments of time (2).

An additional incentive to employ practice testing in the educational setting lies in the optimization of learner's attention spans. While popular belief generally sustains that the average human has an attention span of approximately 10 to 15 minutes, current research has demonstrated that this initial evidence was likely shallow and imprecise and fails to take into account individual differences in student attention as well as lecture methods (3, 4). In a study conducted by Bunce et al.,

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students were provided clickers and were instructed to self-report periods of inattention. The average length of attention lapses were recorded, as well as their relationship with various teaching methods. Results concluded that short attention lapses ($\leq$ 1 minute in duration) were more common than long attention lapses ($\geq$ 5 minutes). Researchers also observed that attention throughout lectures had a characteristic waxing and waning pattern. The first lapse typically occurred early in the lecture, what they described as a "settling-in" period, then spread out and later became closer together toward the end of the lecture. Lastly, attention lapses were found to be more infrequent during active learning segments of the lecture, which included demonstrations and questions (5).

For these reasons the Liaison Committee on Medical Education has actively encouraged alternative teaching methods including self-directed learning, non-lecture-based learning and patient-oriented learning, among others (6). The introduction of interactive teaching and creative activities not only sparks the interest and concentration of the learners but also creates a more gratifying environment for the interaction between educators and trainees. However, passive lecture-based learning remains popular among medical educators and is still the predominant approach of medical schools in the United States (7). Interestingly, in a study conducted by Zinski et al. researchers surveyed first and second-year medical students regarding their preferred learning method and found that while second-year students preferred clinically-oriented learning, first year students favored lecture-based material (6). It was hypothesized that this unexpected finding may be due to the greater familiarity with this teaching approach as well as the ability to convey large amounts of factual information (6). Nonetheless, this data may suggest that alternative approaches may be better suited to individuals who have acquired basic knowledge foundations. Dulonsky et al. described similar patterns,

namely student preference for practices such as highlighting and rereading material which were proven to show limited utility, and termed the inclination as a "commitment to ineffective strategies" (2). They believed this phenomenon was due to lack of instruction regarding more effective techniques and how to employ them. Educational movements such as the "fun theory" and "gamification" have sprung up worldwide as educators strive to keep young, millennial minds engaged. The fun theory states that a simple way to alter people's behavior is by making it entertaining. Notably, Volkswagen popularized the concept of the fun theory in their advertisement campaign designed to ultimately modify how consumers felt about driving environmentally friendly cars. Their experiments included installing working piano keys to the staircase in a Stockholm subway station to entice commuters to use the stairs rather than the escalator. Another exercise included introducing a cartoon-like sound effect to public garbage cans that made it sound like the discarded garbage was falling down a deep well. This drew in passersby to dispose of their waste in the garbage can and even search for improperly discarded trash in public areas to test out the captivating sound (8).

Gamification refers to the application of game playing to other non-game contexts. This method operates under the assumption that by introducing gaming elements such as immediate feedback, progress indicators, competition, social connection, leveling up (mastery), player control and entertainment to the educational context, educators can harness the trainee's engagement and influence behavior (9, 10). Koepp et al. was able to demonstrate in 1998 how video game play activates striatal dopamine release which serves a crucial role in human reward systems and behavior reinforcement (11).

The need in our neuroradiology section for a novel way to engage our residents and fellows brought on a search for the new frontier in education. From the start our priority was

set on finding an approach that was both entertaining and effective. After exploring several game development tools available online, the idea of implementing Kahoot as a platform for interactive training and evaluation arose. Kahoot is a web-based program where the user can easily construct games, nicknamed "kahoots" free of charge from their computer or mobile device. The consolidation of both the fun theory and gamification can be applied with the use of the Kahoot platform. We have been able to implement this modality in resident lectures for radiology board reviews, multidisciplinary lectures with neurosurgery/ neuroradiology, and in the neuroradiology fellow's weekly lecture series, to name a few. Our objectives are to discuss how the game-based learning platform, Kahoot, functions and the different features it offers, to demonstrate how to design interactive kahoots for radiology resident training, to illustrate the advantages of Kahoot over traditional approaches of teaching and to give specific examples of how we have employed this method successfully in our neuroradiology section.

Kahoot Features and Potential Applications

Kahoot offers a variety of question formats depending on the instructor's objective, including: quiz, jumble, discussion and survey (Figure 1). The interface is aesthetically pleasing, user-friendly and intuitive. The quizzes provide a wide range of customizable options including the allotted time, whether or not to award points for a specific question, and individual vs. team-based play, among others (Figure 2).

Quiz Setting

In the quiz setting the instructor begins by creating a title for the kahoot, entering a description for the question set and defining whether the quiz is private or public (Figure 3). The creator can design a multiple-choice question prompting a diagnosis, finding, sign
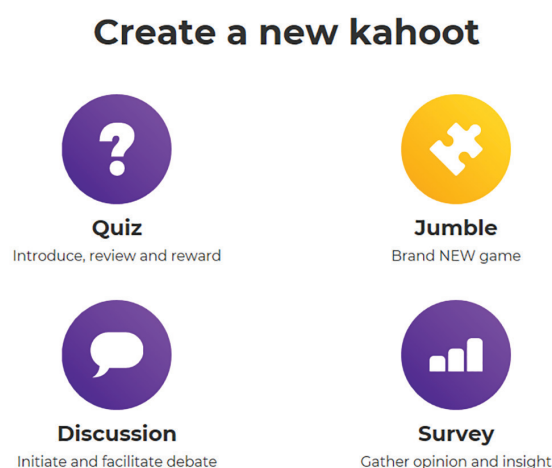

Create a new kahoot

Quiz
Introduce, review and reward

Jumble
Brand NEW game

Discussion
Initiate and facilitate debate

Survey
Gather opinion and insight

Figure 1: of the web browser version of the Kahoot platform. The process of constructing a kahoot begins with selecting the type of quiz the instructor wants to create.

or anatomic structure. Each question can be entered in a couple of minutes, depending on the user's expertise and familiarity with the program. The case can be accompanied by media content, such as images or video that the instructor can upload (Figure 4, 5, & 6). The game itself provides suspenseful game show-type music, countdown timers and a gong sound to signal when the time is up.

Jumble Setting

The jumble feature instructs the players to organize images in a chronological or sequential order. This element has proved particularly useful in explaining pathophysiological processes. We have applied this feature in the teaching of the evolution of infarcts on head CT, the varying appearance of blood products over time and the stages of neurocysticercosis, to name just a few (Figure 7).

Leaderboards

A leaderboard appears at the end of each question and displays the current ranking of the learners (Figure 8). Learners can enter their answers using their laptop computers, tablets or mobile devices either on any web browser or using the Kahoot application. The immediate feedback and progress indicators serve as
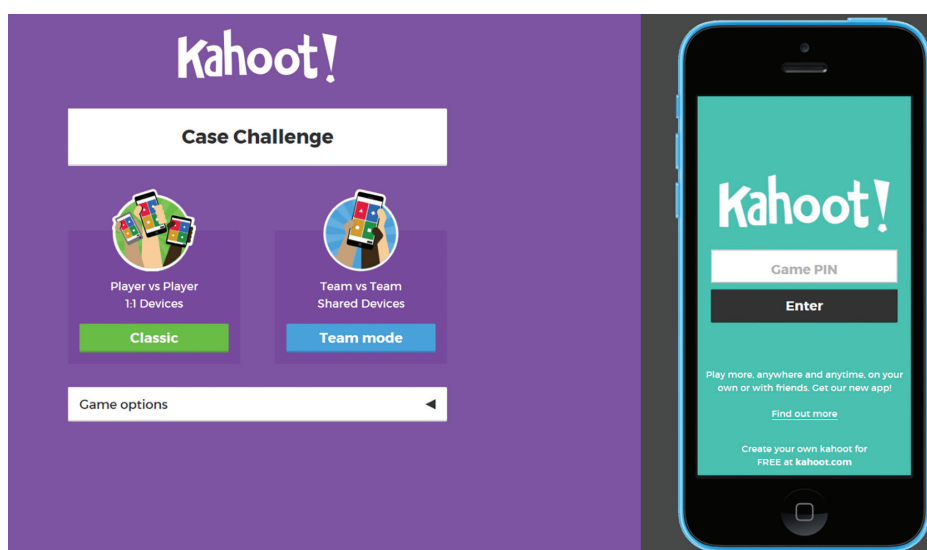
Figure 2: This image shows an example of the instructors view on the left where he/she elects whether the trainees will participate in the kahoot on an invididual basis or in groups. Under the game options drop down menu the instructor can choose to customize several features of the quiz including randomization of questions and answers and answer streak bonuses, to name a few. On the right is an example of what the learner would see on his or her mobile device. He or she enters the game PIN to access the instructor's kahoot.
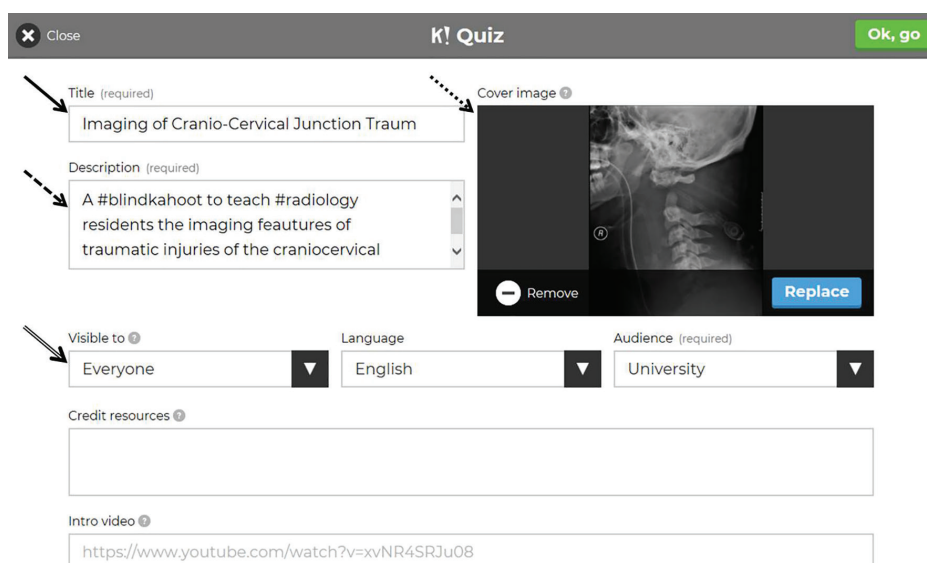
Figure 3: Screenshot of the web browser version of the Kahoot platform. The kahoot creator enters a title for the quiz (solid arrow). A cover image or video can be uploaded and will serve as the main image for the quiz (dotted arrow). The user enters a description of the quiz with hashtags for visitors to find when searching (dashed arrow). The visibility, language and audience can be selected in order to make the quiz private or public (hollow arrow).

gaming elements that aid in maintaining motivation and interest.

Blind Kahoots

"Blind kahoot", a term coined by Stephanie Castle, a biology teacher in New York City, essentially references a specific dynamic to a kahoot game where new material is introduced. By setting milestones and ordering the questions in a specific fashion, the instructor can introduce a new concept by sequentially layering rules and applying new knowledge to subsequent questions (12). The blind kahoot makes use of the quiz setting and begins with an introductory question to prepare the students for the subject they

Figure 4: Screenshot of the web version showing an example of how to enter a multiple-choice question. The instructor types in the question in the corresponding box (solid arrow). A time limit can be predetermined and the creator can establish if points will be awarded for the question (dashed arrow). An accompanying image or video can be uploaded for each question (dotted arrow). A minimum of two possible answers need to be entered and the correct answer is selected (hollow arrow). Resources can be cited in the field at the bottom of each question.
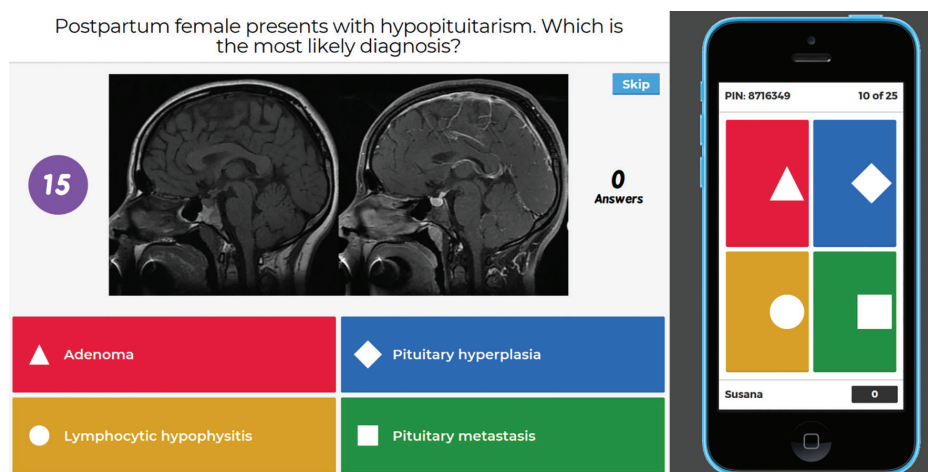

Figure 5: Once the question in figure 3 has been constructed, on the left of this image is an example of the presentation screen the learner would view with the question displayed at the top, the image in the center and the answer options at the bottom. A countdown timer is seen on the left in a purple circle. The left represents what the learner would see in their mobile device in order to select the correct answer.

are about to review. This is followed by a blind question regarding something they have not yet learned. The instructor then proceeds to include a prompt to discuss the answer to the blind question and to establish a simple rule to deduce the correct answer on subsequent examples. This is followed by a reinforcement question so the learner can immediately apply their newly acquired knowledge. Reinforcement questions can be repeated a number of times and rearranged in different ways to emphasize the concept. Once the learners have mastered the lesson an exception to the rule can be introduced and the process is repeated. The use of blind kahoots reinforces game-play elements such as "scaffolded learning" with challenges that increase in difficulty as the game progresses.

Rewards and Awards

In our particular setting we have introduced the added motivation of a small prize to
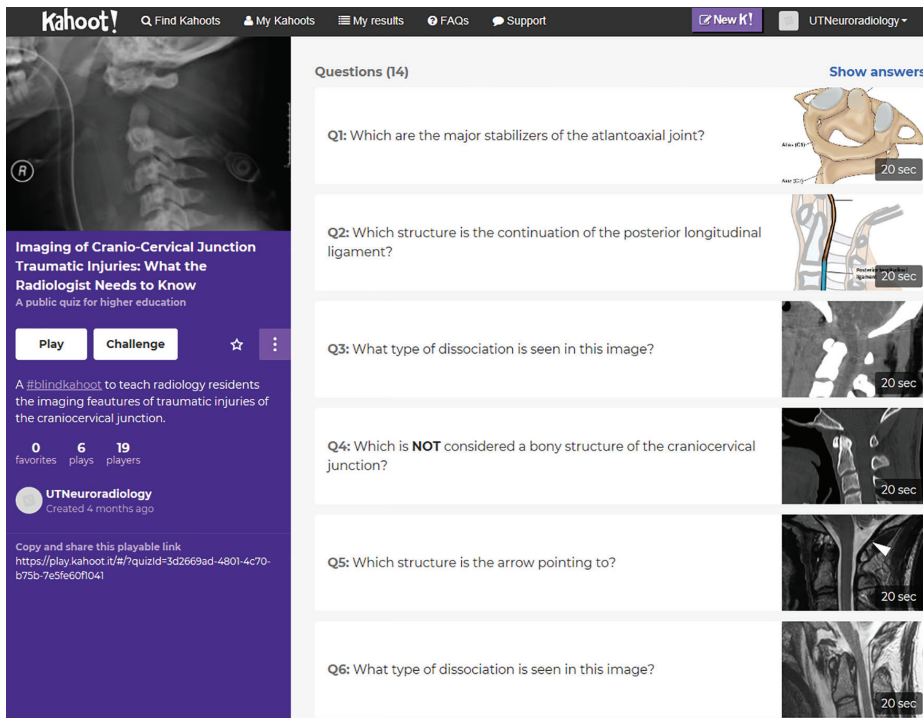
Figure 6: Screenshot of what a constructed kahoot looks like when all the questions and their corresponding images have been entered.
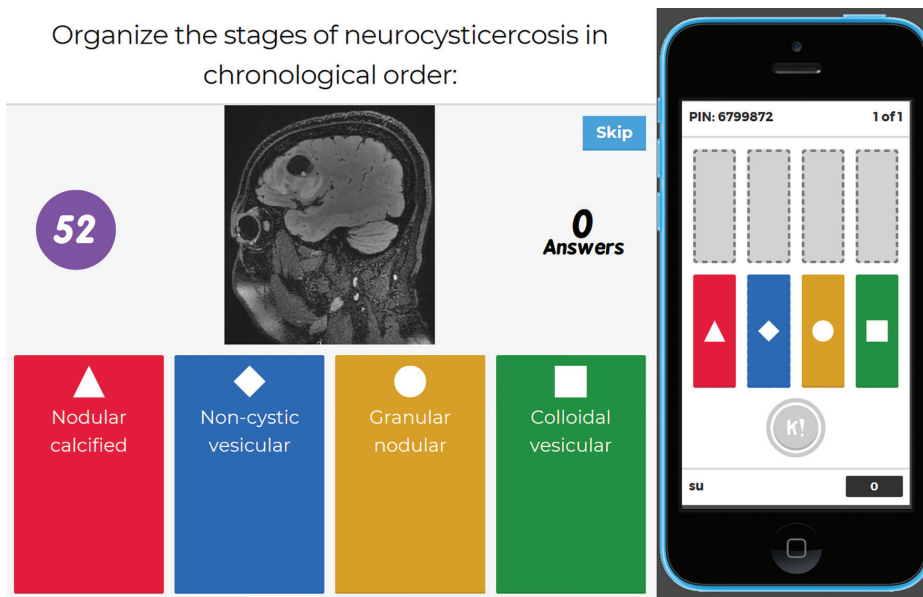

Figure 7: On the left is an example of the presentation screen in jumble mode. On the right is the example of the display on each of the participant's devices. The learner must drag and drop the options in the correct sequential order to be awarded points.

the winner of the competition with rewards ranging from a brownie to a new radiology text book. We have opted to keep the prize a surprise until the end of the quiz and have found that this serves as an additional factor of commitment to the game.

Kahoots as Homework

A new feature that has been recently introduced into the site is the ability to send kahoots as homework. The "challenge" feature allows the instructor to create kahoots for learners to complete at home. This can aid in assessing

Figure 8: After all the learners have entered their answers or the time has run out the leaderboard is presented on the presentation screen with the correct answer signaled with a checkmark. The bar graph shows how many learners selected each of the answers. This information gives the instructor the opportunity to emphasize why the leading incorrect answers are wrong. The show media option allows the creator of the kahoot to show the image for that question and to summarize key findings. On the left is an example of what is displayed on the learner's mobile device with immediate feedback and the amount of allotted points.

how much material the learner was able to grasp following a lecture or as a way of preparing learners for future material. It gives the instructor an overview of the status of the different students and their understanding of certain subjects. An instant assessment is produced that includes a leaderboard, a list of who completed the change and when, a ratio of correct to incorrect answers and statistics of which questions proved more difficult. This serves as invaluable insight into the strengths and weaknesses of the individual trainees and allows the instructor to better tailor discussions based on recurrent misconceptions.

Conclusion

In the era of trainees that grew up with influential educational 1980s computer games such as Number Crunchers, The Oregon Trail and Where in the World is Carmen Sandiego?, exploiting the ease and comfort with which these students navigate electronic games is both rewarding and effective. Since the implementation of Kahoot in resident training,

we have noticed a remarkable change in attitude. The trainees now take on an active role in the learning process and appear attentive and awake. The potential applications of the Kahoot platform as an educational method, as well as its customizable design, the integration of mobile devices, and the entertainment factor represent a truly innovative take on radiology training.

Conflict of Interest: None Declared.

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