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ORIGINAL ARTICLE

Assessing the learning potential of an interactive digital game versus an interactive-style didactic lecture: the continued importance of didactic teaching in medical student education

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Abstract
Background Games with educational intent offer a possible advantage of being more interactive and increasing learner satisfaction.
Objective We conducted a two-armed experiment to evaluate student satisfaction and content mastery for an introductory pediatric radiology topic, taught by either an interactive digital game or with a traditional didactic lecture.
Materials and methods Medical students participating in a fourth-year radiology elective were invited to participate. Student cohorts were alternatively given a faculty-supervised 1h session playing a simple interactive digital Tic-tac-toe quiz module on pediatric gastrointestinal radiology or a 1h didactic introductory lecture on the same topic. Survey questions assessed the learners' perceived ability to recall the material as well as their satisfaction with the educational experience. Results of an end-of-rotation exam were reviewed to evaluate a quantitative measure of learning between groups. Survey responses were analyzed with a chi-squared test. Exam results for both groups were analyzed with a paired Student's *t*-test.
Results Students in the lecture group had higher test scores compared to students in the game group (4.0/5 versus 3.6/5, $P=0.045$). Students in the lecture group reported greater understanding and recall of the material than students in the game group ($P<0.001$ and $P=0.004$, respectively). Students in the lecture group perceived the lecture to be more enjoyable and a better use of their time compared to those in the game group ($P=0.04$ and $P<0.001$, respectively). There was no statistically significant difference between the lecture and game group in ability to maintain interest ($P=0.187$). In comparison to pre-survey results, there was a statistically significant decrease in interest for further digital interactive materials reported by students in the game group ($P=0.146$).
Conclusion Our experience supported the use of a traditional lecture over a digital game module. While these results might be affected by the specific lecture and digital content in any given comparison, a digital module is not always the superior option.

Keywords Didactic lecture · Education · Gaming · Medical students · Pediatric radiology

Introduction

Medical students and residents have an ever-increasing level of technological literacy. To leverage their expertise, development of educational tools, including virtual reality simulators, digital games and other novel technologies, has been suggested as a way to maintain student interest. Reviews of effectiveness of interactive electronic media in student learning, both in and out of the medical field, have revealed not only high learner satisfaction [1] but also improved retention of material and utilization of content [2].

In particular, the use of games in education has been rated as more stimulating and equivalent to traditional didactic lectures in terms of learning and material retention [3]. Games have been assessed in both medical and nonmedical

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educational settings with a variety of methods [3–6]. Successful integration of electronic educational content has been shown to improve learner interest and satisfaction [6, 7]. Furthermore, previous studies of game theory have noted that human learning is based in part on reinforcement and that competition between groups of learners increases the level of participation [8–12]. When studied in the fields of mathematics and computer science, competitive games were also noted to promote greater interactivity, collaboration within groups and increased motivation for self-directed learning [12].

However, further objective assessment of the use of all types of electronic media in medical education is needed before widespread adoption can be justified [13, 14]. Specifically, it is unclear whether the improved interest and satisfaction seen with electronic educational content translates to improved learning and material retention. There is limited data comparing game-based teaching to didactic lectures with respect to information retention and concept understanding, and the few studies performed have shown conflicting results [15, 16]. Assessing the value of a game-based format has not been previously attempted in the setting of medical student education in radiology.

At our institution, the majority of informational content in our fourth-year medical student elective is delivered via didactic (but interactive) lectures. A smaller amount of material is presented via digital independent learning modules. While the digital learning modules are well-received components of the course, these typically are not scored as favorably as lectures in our course evaluations. We hypothesized that this might be due to their relatively non-interactive structure, and that an interactive game format would likely be more popular with students.

The objective of this study was to compare learner satisfaction and recall of pediatric radiology material delivered via a traditional lecture format versus independent study of the same material through a digital Tic-tac-toe game module. The Tic-tac-toe format was chosen for its simplicity of design and presumed familiarity for the student. Our hypothesis was that students would prefer the interactive game format and that they would better retain information presented by the game compared to a lecture format.

Materials and methods

This study was approved by our Institutional Review Board (IRB). All surveys were anonymous, therefore informed consent without signature was obtained for all participants.

Subjects

Subjects assessed were fourth-year medical students enrolled in a general senior radiology elective, a course taken by approximately 100 students (2/3 of the medical school class) each year. Attendance is required for this course with a strict attendance policy and recording of student attendance. Overall prior exposure to pediatrics was variable, though the majority of these senior medical students had completed at the minimum a core 6-week clerkship in Pediatrics. The course objectives were to teach familiarity with radiology and proper imaging utilization. Alternating student cohorts were randomly given either a 1h didactic introductory lecture on pediatric gastrointestinal radiology or a 1h session playing an interactive quiz module in pairs of 2 players per game. Students were obliged to participate in the educational activity, given it was designed to fulfill course learning objectives, though participation in the surveys related to this research were entirely optional. Students were not given any preparation materials in advance of either the game session or lecture. The study was carried out with two cohorts (11 and 14 students) with the game format and two cohorts (14 and 9 students) with the lecture format. Students provided feedback to the lecturer via the anonymous electronic feedback mechanism in place for University of California, San Francisco, Medical Student lectures for both the didactic session and game session.

The game

The interactive Microsoft PowerPoint (PowerPoint 2007; Microsoft Corporation, Redmond, WA) quiz module was designed using a Tic-tac-toe format with pediatric radiology content (Fig. 1). The game designer was a pediatric radiologist with experience and training in the development of educational materials for medical student and resident level learners as well as working knowledge of computer programming in Visual Basic (Microsoft Corporation, Redmond, WA) programming language. Pediatric radiology topics were focused on the common pediatric gastroenterology diagnoses including acute appendicitis, intussusception and malrotation/midgut volvulus (Table 1) Rudimentary programming with ActiveX (Microsoft Corp., Redmond, WA) was required to allow the game to be played while in presentation mode. In our course, medical students competed against each other in pairs. The game was designed so the rules and operation were self-explanatory. Participants were divided into teams centered at workstations with the Tic-tac-toe game installed. Each team consisted of two to three students with one team competing against another team at an individual workstation. Teams were designated as either the "X's" or "O's." Teams would select a position on the 3 × 3 Tic-tac-toe board, which would then direct them to a question relating to pediatric radiology gastrointestinal diseases. Questions were answered by consensus among team members. If the team responded correctly, their team's mark ("X" or "O") was placed in that position on the Tic-tac-toe board. However, if the team responded

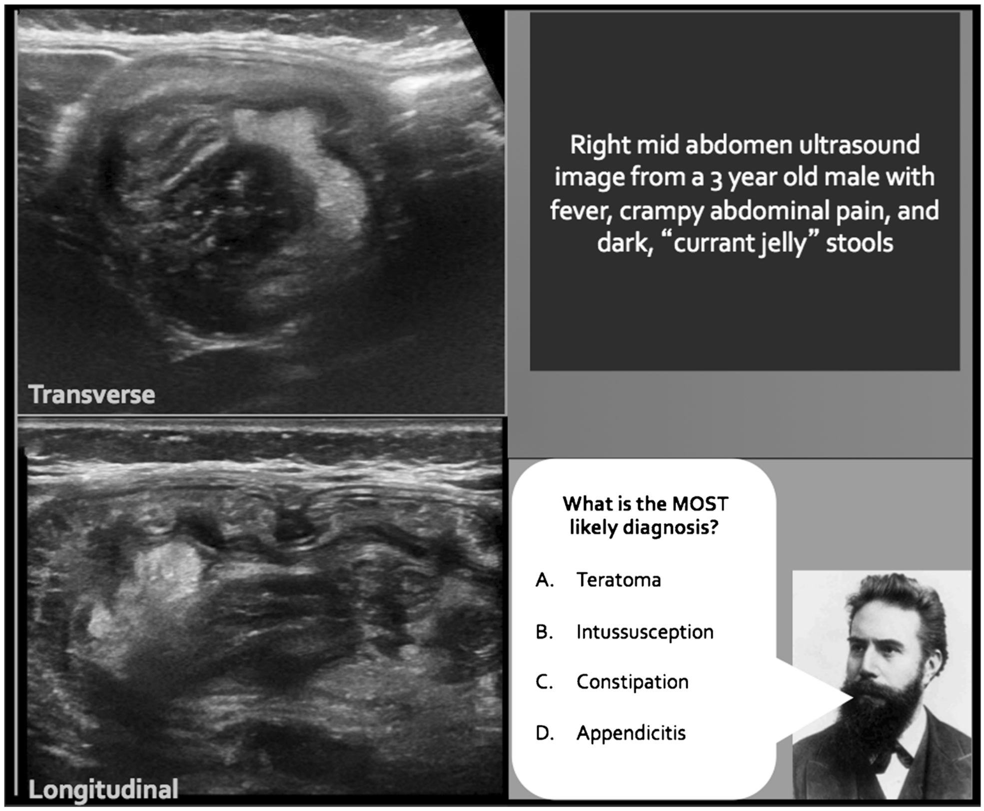

Fig. 1 An example question from the game module displays two ultrasound images. A clinical vignette is described on the right, as is the question. Students could indicate the correct answer by clicking their selection or typing the corresponding letter

incorrectly, the opposing team's mark was placed in that position. The initial question slide was followed by additional informational slides on the disease entities. Each team was asked to play the game twice so as to get through all of the material at least once. Prior to final implementation of the game for this study, the game was initially piloted with a group of radiology residents and pediatric radiology fellows and feedback was obtained. This feedback was then incorporated into the final game module. An attending pediatric radiologist was present during the game session to answer any logistical questions about the game module as well as any questions that arose regarding the learning topics.

The lecture

The lecture was created using Microsoft PowerPoint (PowerPoint 2007; Microsoft Corporation, Redding, WA). The lecture was 50 min long, including time for questions, and was delivered by a board-certified pediatric radiologist. The lecture covered the same material as was presented in the digital game module. The lecturer was also the designer of the

Table 1 Pediatric radiology topics and educational objectives

Topic	Educational objectives
Acute appendicitis	Learn common findings and best-practice imaging study options for assessment (ultrasound as first-line imaging modality)
Intussusception	Learn common findings and best-practice imaging study options for assessment (ultrasound as first-line imaging modality)
Malrotation/midgut volvulus	Learn common findings and best-practice imaging study options for assessment (emergent upper gastrointestinal examination for assessment)
Pyloric stenosis	Learn common findings and best-practice imaging study options for assessment (ultrasound as first-line imaging modality)
Hirschsprung disease	Learn common findings and best-practice imaging study options for assessment (use of an abdominal radiograph to guide decision-making and use of contrast enema for distal bowel obstruction)

game. The lecturer had completed a departmental faculty speaker-training course and had favorable lecture ratings from medical student elective participants in prior sessions. The lecturer (J.C.) at the time had 4 years of experience teaching multiple levels of trainees (from medical student to continuing medical education audiences). Medical students had not previously heard or interacted with the lecturer prior to this session. The didactic lecture had interactive elements, including polling the audience and questions directed to individual students. Given the smaller class size, an audience response system was not used and group questions were answered via show of hands.

Quantitative assessment

An end-of-rotation examination is administered routinely in our course, and included five questions pertinent to the content covered by both the lecture and game. The final end-of-rotation examination was comprised of several other radiology topics as part of the fourth-year radiology elective. The number of questions ($n=5$) used for this study was the number allotted for each of the individual subject areas in the total test. In one of the cohorts, there was a shorter time between the lecture and final quiz (a change in schedule had been made, affecting the timing of the lecture). The scores for the relevant questions were extracted in an anonymized fashion.

Qualitative surveys

Qualitative surveys were created to assess students' perceived learning, perceived retention, sense of the educational efficiency, enjoyment and interest in further use of gaming or didactic material. A 5-point Likert scale was used for the survey responses. Surveys were anonymous and voluntary. A pre-study survey was administered to all participants (Table 2). Post-lecture and postgame surveys were administered following the respective sessions (Table 3).

Statistics

Comparison of pre-and post-survey ratings was performed with a chi-squared test. Mean rotation end-of-rotation examination scores were obtained of lecture and game module groups and also analyzed with a paired Student's *t*-test.

Results

Pre-survey

Overall response rate was 92% (48 of 52). Full response results are shown in Table 2. The majority of students agreed that interactive education improves memory (85% "somewhat agree" or "strongly agree"). A smaller majority of students agreed that an interactive game would be superior to a *non*-interactive lecture (63% "somewhat agree" or "strongly agree"). Only half of the students agreed that more games should be incorporated into the elective (48% "somewhat agree" or "strongly agree"). And finally, only a minority of students (29%) expressed a preference for a digital game over a similar live teaching session.

Lecture vs. game

Quantitative assessment

On the end-of-rotation exam, the post-lecture group scored significantly higher (4/5 or 81% correct responses, standard deviation [SD] = +/−1.0) compared to the post-game group (3.6/5 or 72%, SD = +/− 0.76, $P=0.045$).

Qualitative surveys

Overall response rate was 96% (23 of 24 students) for the post-lecture group and 89% (25 of 28 students) for the post-game group. When asked whether the educational content "helped me remember the material," more students in the lecture group chose "agree" or "strongly agree" than the students in the game group (87% versus 36%, respectively, $P=0.004$). When asked whether the educational content "helped me better understand concepts," more students in the lecture group chose "agree" or "strongly agree" than the students in the game group (91% versus 28%, respectively, $P=0.005$). Full response results are shown in Table 3.

Most students reported the game took between 15 and 45 min (64%) to complete. Although students overall spent less time on the digital game compared to the 50-min lecture, students perceived the lecture to be more time efficient (96% responding "strongly agree" or "agree") compared to those in the game group (32%, $P<0.001$).

Students in the lecture group expressed a preference for having the material presented as a live lecture (84% "strongly agree" or "agree") compared to those in the game group where a minority reported that they preferred the digital format (39%). Likewise, more students found the lecture format "enjoyable" compared to the game format (78% "agree" or "strongly agree" versus 44%, respectively, $P=0.046$). There was no statistically significant difference between the game and lecture group in ability to maintain interest (87% "agree" or "strongly agree" versus 48%, respectively, $P=0.187$). In comparison to pre-survey results, there was a statistically significant decrease in interest for further digital materials in the game group ($P=0.013$).

Table 2 Pre-study survey

Questions	Answer choices	Responses
Q1: I learn best from a PowerPoint lecture delivered in-person by a speaker.	1 = Strongly agree	1 (14.6%)
	2 = Somewhat agree	2 (39.6%)
	3 = Neutral	3 (29.2%)
	4 = Somewhat disagree	4 (14.6%)
	5 = Strongly disagree	5 (2.1%)
Q2: The amount I learn from a PowerPoint lecture is affected by whether the speaker is engaging.	1 = Strongly agree	1 (91.7%)
	2 = Somewhat agree	2 (8.3%)
	3 = Neutral	3 (0%)
	4 = Somewhat disagree	4 (0%)
	5 = Strongly disagree	5 (0%)
Q3: Any interactive method of delivering educational material (where I participate) helps me remember the material better than a non-interactive presentation.	1 = Strongly agree	1 (62.5%)
	2 = Somewhat agree	2 (22.9%)
	3 = Neutral	3 (14.6%)
	4 = Somewhat disagree	4 (0%)
	5 = Strongly disagree	5 (0%)
Q4: The amount I learn from any educational activity is affected by whether I am interested in the subject matter.	1 = Strongly agree	1 (70.8%)
	2 = Somewhat agree	2 (27.1%)
	3 = Neutral	3 (2.1%)
	4 = Somewhat disagree	4 (0%)
	5 = Strongly disagree	5 (0%)
Q5: I learn best by studying material independently.	1 = Strongly agree	1 (22.9%)
	2 = Somewhat agree	2 (41.7%)
	3 = Neutral	3 (22.9%)
	4 = Somewhat disagree	4 (10.4%)
	5 = Strongly disagree	5 (2.1%)
Q6: A game in which I compete between my peers would help me maintain interest in the material.	1 = Strongly agree	1 (12.5%)
	2 = Somewhat agree	2 (31.3%)
	3 = Neutral	3 (35.4%)
	4 = Somewhat disagree	4 (20.8%)
	5 = Strongly disagree	5 (0%)
Q7: An interactive game would help me learn material better than a non-interactive PowerPoint lecture.	1 = Strongly agree	1 (20.8%)
	2 = Somewhat agree	2 (41.7%)
	3 = Neutral	3 (27.1%)
	4 = Somewhat disagree	4 (8.3%)
	5 = Strongly disagree	5 (2.1%)
Q8: I would learn as much from a computer-based interactive game as from a live interactive game.	1 = Strongly agree	1 (4.2%)
	2 = Somewhat agree	2 (25.0%)
	3 = Neutral	3 (37.5%)
	4 = Somewhat disagree	4 (29.2%)
	5 = Strongly disagree	5 (4.2%)
Q9: I would be interested in having more material in this course delivered in an interactive game format.	1 = Strongly agree	1 (8.3%)
	2 = Somewhat agree	2 (39.6%)
	3 = Neutral	3 (39.6%)
	4 = Somewhat disagree	4 (10.4%)
	5 = Strongly disagree	5 (2.1%)
Q10: A digital interactive game's most significant advantage compared to a PowerPoint lecture is which of the following: [*list all that apply*].	1 = Improved retention	1 (19.1%)
	2 = Improved understanding of concepts	2 (9%)
		3 4%)
		4 (16.7%)

Table 2 (continued)

Questions	Answer choices	Responses
	3 = Improved time efficiency	5 (34.0%)
	4 = More engagement	
	5 = More enjoyable	
Q11: A PowerPoint lecture's most significant advantage compared to a digital interactive game is which of the following: [*list all that apply*].	1 = Improved retention	1 (12.8%)
	2 = Improved understanding of concepts	2 (29.8%)
	3 = Improved time efficiency	3 (48.9%)
	4 = More engagement	4 (12.8%)
	5 = More enjoyable	5 (6.4%)

Discussion

The results did not support the hypothesis. Students were less interested in learning by a digital game than by a traditional lecture. Moreover, the students in the lecture group had higher test scores than the students in the game group.

Technology-enhanced active learning is a concept that has arisen in response to the current generation of medical learners who are highly adept with the use of technology in their learning [17, 18]. The frame shift of the "sage on the stage" to the "guide on the side" has been suggested as a response to this trend [19]. Medical students have previously reported a strong desire for interactivity as part of their learning and, in general, have also reported favorable attitudes toward the use of digital games and similar electronic media in medical education [7]. Our study was designed with these considerations in mind with the aim to not only validate the use of technology-enhanced active learning game materials in radiology education, but also to demonstrate that these methods lead to equal or improved learning over traditional methods. However, the students in our study demonstrated a clear preference for the didactic lecture format, as well as better learning outcomes as evidenced by final exam results.

The traditional lecture has been shown to be an effective teaching method, in particular when using an interactive, "Socratic method" style of teaching [20, 21]. Interactive-style lecturing has also been found to promote more active learning, increased memory and retention, and well as promoting feedback to both learner and lecturer [22]. Prior studies that have indicated student enthusiasm for self-directed digital learning formats describe the benefits as being centered on efficiency of student and instructor time resources and flexibility regarding place of learning [23, 24]. Few radiology studies have directly compared student preference or efficacy of the techniques for learning outcomes between formats [25, 26]. As such, there has been limited opportunity for students to express a direct preference or demonstrate improved learning outcomes derived from a lecture-based curriculum. Our study demonstrated that a didactic lecture remains an effective and well-received means of delivering radiology content to medical students.

There are a number of factors that may have influenced these findings. Students in the lecture group had the opportunity to interact directly with a content expert, a board-certified pediatric radiologist (J.C.). Therefore, they were able to ask specific questions whenever they needed clarification or wanted to know more about a topic. While the digital game was created to be interactive in its design, there is clearly a limit to digital interactivity. Specific points of confusion can't be clarified unless anticipated by the game designer. This may have contributed to the lower scores for perceived content retention and conceptual understanding among students in the digital game group. Additionally, students in the game group, overall, spent less time on the material (15–45 min for most), compared to those who received the 50-min lecture. This decreased time effort may have independently affected learning outcomes beyond any differences attributable to the formats. At our institution, as well as nationally [21, 27], there has been an increasing push to develop more digital learning materials. Interestingly, despite the preference for more digital materials among medical school administration and some educators, students expressed little interest in expanding the digital content in our course, both before and after the experimental teaching session. It is possible that the students' preexisting satisfaction with the lecture-based format of our course may have negatively impacted their subsequent attitudes toward the digital game.

There are multiple risks associated with a predominantly digital radiology curriculum that must be considered. First, presenting important information solely in a digital format means that students may have more variable exposure depending on their attention to and time spent on the material, as we saw in our study. It is certainly easier to skip a digital assignment as opposed to a lecture with mandatory attendance. More so however, there may be some natural tendency to assume that material that is not allotted class time is somehow less

Table 3 Post-lecture/post-game surveys

Questions	Answer choices	Responses: Lecture group	Responses: Game group	*P*-value
Q1: The (PowerPoint/game format) helped me remember the material.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (26%) 2 (61%) 3 (13%) 4 (0%) 5 (0%)	1 (16%) 2 (20%) 3 (32%) 4 (28%) 5 (4%)	.0043
Q2: The (PowerPoint/game format) helped me better understand concepts .	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (48%) 2 (43%) 3 (9%) 4 (0%) 5 (0%)	1 (12%) 2 (16%) 3 (16%) 4 (44%) 5 (12%)	.00054
Q3: The pacing of the PowerPoint lecture was conducive to learning the material.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (30%) 2 (52%) 3 (9%) 4 (9%) 5 (0%)		
Q3: The ability to proceed at my own pace helped me learn the material.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree		1 (16%) 2 (40%) 3 (28%) 4 (12%) 5 (4%)	
Q4: The 1h presentation was an efficient use of study time.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (48%) 2 (48%) 3 (4%) 4 (0%) 5 (0%)	1 (8%) 2 (24%) 3 (32%) 4 (28%) 5 (8%)	<.001
Q5: The (lecture/game) format helped me maintain interest in the material.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (22%) 2 (65%) 3 (9%) 4 (4%) 5 (0%)	1 (28%) 2 (40%) 3 (24%) 4 (8%) 5 (0%)	0.19

Table 3 (continued)

Questions	Answer choices	Responses: Lecture group	Responses: Game group	*P*-value
Q6: I enjoyed the game format/lecture format.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (30%) 2 (48%) 3 (22%) 4 (0%) 5 (0%)	1 (16%) 2 (28%) 3 (32%) 4 (24%) 5 (0%)	.046
Q7: I would have preferred that the material be presented in a digital interactive game format.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (9%) 2 (30%) 3 (35%) 4 (22%) 5 (4%)		
Q7: I would have preferred that the material be presented in a lecture format.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree		1 (56%) 2 (28%) 3 (4%) 4 (12%) 5 (0%)	
Q8: I would be interested in increasing the amount of material delivered in an interactive game format.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree	1 (9%) 2 (39%) 3 (35%) 4 (13%) 5 (4%)	1 (12%) 2 (12%) 3 (28%) 4 (40%) 5 (8%)	0.15
Q9: The interactive game assignment took the following amount of time to complete:	1 = Less than 15 min 2 = 15–45 min 3 = 45-60 min 4 = 1–2 h 5= >2 h		1 (4%) 2 (64%) 3 (28%) 4 (4%) 5 (0%)	

important or potentially even superfluous. Therefore, students may give this material less attention, even if they might find it intrinsically interesting. Secondly, presenting radiology material only in a digital format can decrease our visibility as physicians and consultants. Particularly at medical schools with a limited radiology curriculum, taking every opportunity to teach medical students face-to-face can impact their perceptions of the importance of radiologists and radiology in medical practice [28]. This has potentially important implications for the imaging utilization practices of these future referring clinicians and our perceived added value, and in terms of recruiting potentially interested students to the field [27].

Our study has a number of limitations. The number of students surveyed was relatively small, although within each class there was an overall high response rate. In addition, the total number of questions on the end-of-rotation exam was also relatively low (5 questions total). However, it was sufficient to yield a statistically significant result based on our overall total number of respondents. In addition, in one of the lecture cohorts, there was a shorter time between lecture and end-of-rotation quiz (related to an unavoidable scheduling change in the course), potentially allowing for better recall of information. The remaining cohorts, however, had similar times between game/lecture and quiz (12 days on average). Faculty at our institution undergo extensive faculty development in lecturing skills, including a speaker training course that is required for new faculty members. This formal training is relatively unique in that faculty lecturing skills are traditionally developed through trial and error and vary depending on the motivation level of the individual faculty member. In the didactic lectures in our medical student courses, specific emphasis is placed on speaker-student interactivity. As all students indicated that the amount they learn from a lecture is dependent on whether the speaker is "engaging," results may not be broadly applicable. Further, the study was performed at a single institution. Additionally, the game itself was not created by a professional game or software designer, but rather by a pediatric radiologist without formal training in game design or computer programming. As such, the elements of aesthetic appeal and game design that are critical in development of video-game software were not incorporated to the level that is commonly encountered commercially. Nevertheless, most materials utilized in undergraduate radiology education in the United States are similarly homegrown [29] and our game is likely a fairly representative example of a digital module for this purpose. Furthermore, while the overall formatting is that of an educational game, the fundamental game being played is Tic-tac-toe. This game was chosen due to its familiarity to a wide audience, simplicity and ease of play, while at the same time combining basic strategy and competition. This "Hollywood Squares" implementation of Tic-tac-toe has also been utilized in a variety of educational levels and fields of study [30, 31]. Finally, the lecturer was also the creator/game designer of the game module. As such, the lecturer had equal incentive to do well as both the lecture and game module received speaker ratings/reviews from the medical students (the data were saved in the faculty member's file and used in promotion assessment).

Conclusion

Our study demonstrates that an interactive, didactic lecture can provide an effective and well-received method of content delivery in medical student education. Live lectures can more successfully incorporate interactive elements critical for learner retention, concept understanding and enjoyment of the material. While our study does not support the replacement of traditional didactic lectures with digital game modules, it does not exclude their utility as supplemental materials. Further study of a larger series of multiple lectures in comparison to gaming modules would be valuable to further explore the optimal balance between didactic and supplementary materials.

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Compliance with ethical standards

Conflicts of interest None

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