Hybrid Interactive and Didactic Teaching Format Improves Resident Retention and Attention Compared to Traditional Lectures

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Purpose: To compare the traditional lecture to a hybrid interactive and didactic teaching format with regards to radiology resident short- and long-term retention, as well as attention.

Materials and Methods: The tested hybrid format consists of a 30-minute didactic lecture followed by 30 minutes of interactive cases based on material from the lecture portion. Faculty members were randomly selected to give a 60-minute lecture or a hybrid presentation. To assess short- and long-term retention, a test developed from the presenter's slides was sent to all residents approximately 15 minutes after each presentation, and again approximately 3 months later. The presenters were blinded to the survey questions. Attention was assessed by comparing the proportion of questions answered correctly from each quarter of the presentation. Equality in difficulty of questions was validated across teaching methods.

Results: For 6 hybrid presentations, 106 and 60 retention tests were submitted, answering 848 and 480 short- and long-term survey questions, respectively. For 6 lectures, 91 and 55 retention tests were submitted, answering 728 and 440 short- and long-term survey questions, respectively. Short-term retention was 75.7% (640/848) for hybrid presentations, versus 63.2% (460/728) for lectures ($p < 0.0001$). Long-term retention was 59.4% (285/480) for hybrid presentations, versus 49.3% (217/440) for lectures ($p = 0.002$). Regarding attention, 61.6% (554/600) of questions from the first 3 quarters of traditional lectures were answered correctly versus 49.3% (148/300) of final quarter questions ($p = 0.0003$). No significant drop-off was noted for hybrid presentations.

Conclusion: A hybrid interactive and didactic teaching format for radiology residents demonstrates better short-term retention, long-term retention, and attention when compared to traditional lectures.

INTRODUCTION

Didactic lectures are the chief method of instruction in graduate medical education, persisting in their widespread use despite evidence that student attention begins to decline just 10 minutes after the start of a lecture (1). Furthermore, passive learning (i.e., simply listening to a speaker) has been demonstrated to be inferior to active learning (i.e., engagement between the audience and presenter) with lower material retention, attention, and learner satisfaction (2). While studies have shown engagement and the use of case-based formats to be strong predictors of qualitatively high lecture quality (3), few educational methods which systematically incorporate these qualities have been studied.

Two active learning formats have been advocated for use in radiology resident education: the flipped classroom and audience response. The flipped classroom is a new educational format in which students review educational materials independently in advance of a classroom activity. Studies have demonstrated this format to produce better exam performance and student engagement than traditional didactic formats (6–9). A possible disadvantage of the flipped classroom model is added preparation time required of the learner in advance of the lecture, which could increase overall educational obligations and make increasing demands on busy resident schedules (10). The use of audience response systems (ARS) is another educational technique designed to promote active learning, but the evidence in support of short- and long-term retention of material with this format is conflicting (4,5). A possible disadvantage of ARS is the added technical requirement, which requires the incorporation of plug-ins

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into existing teaching material which may complicate delivery, particularly for teachers with little technical experience. The ARS and flipped classroom formats have great promise for radiology education; however, there may be potential for improvement.

We designed a "30/30" teaching format to leverage the evidence-based educational advantages of engagement and active learning, without requiring additional preparation time or added technical complexity. The 30/30 format consists of a 30-minute didactic lecture followed by 30 minutes of cases delivered in a "hot seat" style format which is widely used in radiology education, combined in a single 60-minute session. The 30-minute case portion allows trainees to synthesize and apply the knowledge from the didactic portion of the study. Additionally, since trainees may be called upon to participate as part of the cases portion, they are motivated to maintain attention during the didactic component.

The purpose of this study is to investigate the impact of the 30/30 teaching format upon trainee short-term retention, long-term retention, and attention in comparison to a traditional didactic lecture, with the hypothesis that the 30/30 would produce superior outcomes in all metrics by leveraging the benefits of active learning while mitigating possible disadvantages of other active learning formats.

METHODS

Study Design

Waiver of IRB approval was granted for this study. At our institution, an hour-long conference for radiology residents is given every weekday at 7:30 AM. All residents, apart from those on call, on vacation, out with illness, or on procedural rotations are expected to attend. Week-long lecture series rotate between radiology subspecialties, with a given subspecialty responsible for the entire week. From the study's initiation, three lecturers scheduled for each week were randomly selected using a random number generator provided by Random.org and approached about their proposed lecture format approximately 14 days prior to the start of the week. If a lecturer was planning a nontraditional lecture format, they were excluded from the study. From the three initially selected lecturers, one randomly selected lecturer was asked to give a 30/30 presentation in lieu of a traditional lecture and was given the 30/30 teaching presentation guidelines. At the start of each teaching presentation, the lecturers informed the trainees that a test would be sent to them after the presentation. In all, six 30/30 and six traditional lecture presentations were studied.

For each 30/30 and traditional lecture presentation, an electronic eight-question retention test was prepared by a member of the study group, with two questions from each of the first, second, third, and fourth quarters of the lecture, as determined by slide number. The test was designed to be completed in 10 minutes. Approximately half of the questions included an image. The final test was approved by all members of the study group: a vice chair of education, program director, junior faculty member, and chief resident.

To assess short-term retention, the test was sent to all residents via electronic mail immediately after the presentation. Residents were instructed to take the test only if they attended morning conference that day. After the presentation, residents were allowed 10 minutes to complete the test on a voluntary and anonymous basis. Voluntary submission of the test comprised consent to participate in this study.

To assess long-term retention, the same retention test was sent to all residents approximately 3 months from the date of the presentation, with instructions to take the test only if the resident had attended the corresponding morning conference.

In this study, learner attention was measured by examining changes in retention over time during each presentation. To assess resident attention, retention was calculated independently for the first, second, third, and fourth quarters (determined by slide number) of all 30/30 and lecture presentations. Each quarter was then compared against all other quarters.

To control for difficulty of retention test questions between the 30/30 and traditional lecture groups, a control group was established comprising of two residents per presentation who were absent from the morning conference due to night call obligations. These residents were asked to complete the retention test for the presentation during which they were on call. These residents included one resident in the second year of Radiology residency (PGY-3) and one resident in either the third or fourth year (PGY-4 or 5). Test performance between the 30/30 and traditional lectures within the control group was compared.

Comparison of retention between groups and attention across quarters was performed using the two-tailed Fisher's exact test with the use of statistical software (GraphPad, La Jolla, California). A p value of 0.05 was considered statistically significant.

RESULTS

For the six 30/30 lecture presentations, 106 short-term retention tests were completed (848 questions answered), and 60 long-term retention tests were completed (480 questions answered). For the six traditional didactic lectures, 95 short-term retention tests were completed (760 questions answered), and 55 long-term retention tests were completed (440 questions answered). A total of 316 tests were submitted (Table 1).

On the short-term retention tests, there was significantly improved performance ($p < 0.0001$) following the 30/30 lecture presentation (75.5%, 640/848) compared to the traditional didactic lectures (63.8%, 485/760), as seen in Figure 1. Similarly, there was significantly improved performance ($p = 0.002$) on the long-term retention tests for the 30/30 lectures (60.0%, 288/480) compared to the traditional didactic lectures (49.3%, 217/440).

TABLE 1. Distribution of Tests Submitted by Training Level and Education Modality

	R1 *n* (row %)	R2 *n* (row %)	R3 *n* (row %)	R4 *n* (row %)	Total *n*
Short term					
30/30	49 (46%)	25 (24%)	25 (24%)	7 (7%)	106
Lecture	48 (51%)	24 (25%)	17 (18%)	6 (6%)	95
Long term					
30/30	34 (57%)	9 (15%)	10 (17%)	7 (12%)	60
Lecture	33 (60%)	7 (13%)	11 (20%)	4 (7%)	55
Total	164 (52%)	65 (21%)	63 (20%)	24 (8%)	316

To ensure equal difficulty of questions in each group, a control group of residents on call at the time of the lecture took the tests as well. There was no significant difference in the percentage of correct responses between the 30/30 and the didactic lectures (59.4% versus 56.8%, $n = 12$ and $n = 11$, respectively, $p > 0.05$).

The attention of trainees, assessed by examining retention over each quarter of the presentations, is shown in Figure 2. There was no significant difference in attention among quarters for the 30/30 presentations ($p > 0.05$). For the traditional didactic lectures, attention significantly decreased in the fourth quarter ($p = 0.0003$), with 554 of 900 (61.6%) correct responses in the first 3 quarters versus 148 of 300 (49.3%) correct responses in the fourth quarter. Retention for the 30/30 group was higher than that of the traditional lecture group for all quarters.

DISCUSSION

The 30/30 teaching format improves short-term retention, long-term retention, and attention when compared to traditional didactic lectures. These findings reinforce the value of active learning methods in a field in which traditional lectures remain common. This benefit is likely due to the synthesis and application of recently learned material during a "hot seat" case-based format, as well as heightened attention in anticipation of being asked to apply lecture material on cases in a public forum.

The benefits achieved by the 30/30 are "time neutral"; no additional preparation time is necessary by residents for the 30/30 outside of the allotted conference hour. This contrasts with the flipped classroom, which requires extra time on the part of the learners to review material independently. Studies of exam performance in radiology clerkships and pharmacology education following a flipped classroom learning session showed improved performance; however, both studies also reported an overall increase in instructional time for learners to realize that benefit (6,7).

An advantage of the 30/30 format to teaching faculty is its ability to use existing educational resources instead of requiring the creation of new content. While Deslauriers et al produced impressive improvements using flipped classroom techniques, the educational interventions in that study were extensive and applied to only three 50-minute lectures taught by the same instructors (9). Interventions included "pre-class reading assignments, pre-class reading quizzes, in-class [ARS] questions with student-student discussion, small-group active learning tasks, and targeted in-class instructor feedback" (9).

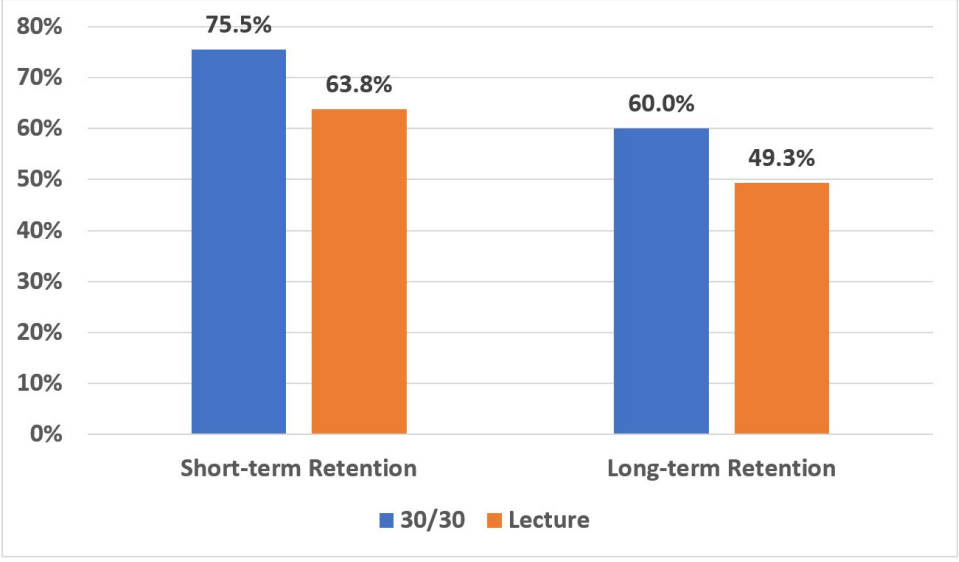

Figure 1. Short- and long-term retention for 30/30 and traditional lectures. (Color version of figure is available online.)

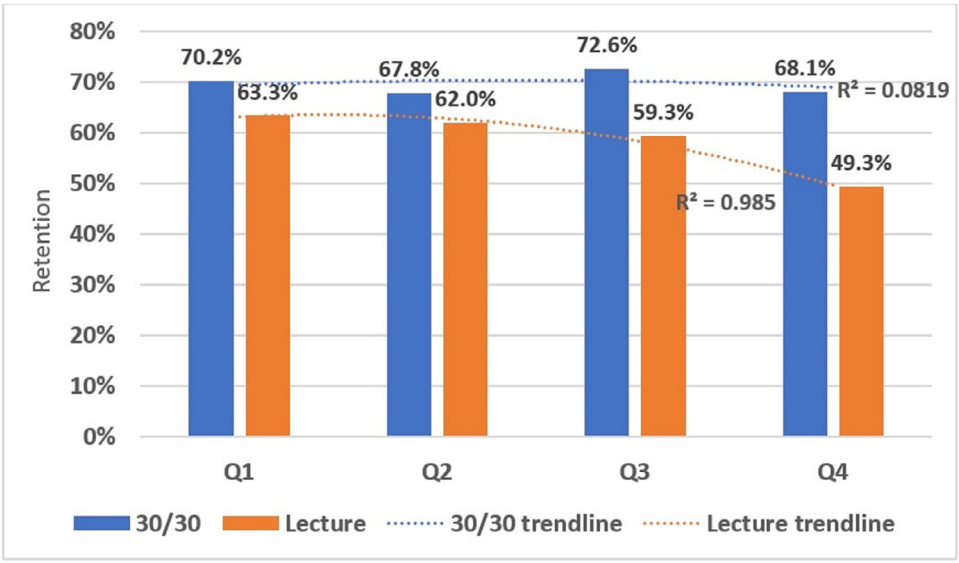

Figure 2. Overall (combined short- and long-term) retention shown by lecture quarter for 30/30 and traditional lecture. (Color version of figure is available online.)

The application of complex teaching methods may be difficult, and reduce adoption among medical teaching faculty as a result. The ineffective implementation or execution of these methods could result in diminished educational benefits (11). This is also seen in ARS, which requires the potentially cumbersome integration of software plug-ins into existing presentations. The 30/30 was designed, in part, for ease of implementation for radiology teaching faculty, most of whom already have existing lecture and case conference material which can be used for the 30/30.

The 30/30 also demonstrated superior learner attention when compared to traditional lectures. Our results showed reduced attention in the final quarter of traditional lectures, but no loss in attention during 30/30 presentations. Improved retention in the 30/30 group for every quarter suggests that the retention benefit of the 30/30 format is not solely attentional in nature, although improved attention during the teaching presentation is likely a contributing factor. Since residents know there will be a case-based component in the second half of the lecture, they may be more attentive throughout the lecture. Attention is not assessed in most of the existing medical education literature, with much data coming from studies by Risko et al, Farley et al, and Lindquist et al in the field of psychology (1,12,13). The findings in the present study suggest that improving learner attention is an effective method of improving short- and long-term retention, and the educational effects of improved learner attention deserve further evaluation in future studies.

This study has several limitations. To protect resident anonymity, identifying information was not collected when obtaining test results. As a result, residents may have submitted responses to tests for lectures that they did not attend, despite being asked not to do so. There was no incentive to do this, however. The time period between the short- and long-term retention tests allowed for additional confounders, such as reinforcement of learned material via reading or completing a rotation on a service related to a presentation. Additionally, lecturers and lecture topics were not matched in this study and were instead randomly chosen. This creates the possibility of confounding by presenter quality and presentation topic, although randomization was performed to mitigate this bias as much as possible. Finally, no satisfactory method to measure or control for absolute quantity of material being taught in any given presentation was developed, with the exception of asking 30/30 presenters to continue presenting new material throughout the cases portion of the presentation. Consequently, many presenters in either the 30/30 or lecture group who present a disproportionately small or large amount of material could influence retention percentage, which is measured relatively.

There are many promising future studies regarding the 30/30 format. Given the separately demonstrated benefits of both ARS and the 30/30, a hybrid of the two formats could be studied, with ARS used during the lecture portion and/or to conduct the cases portion of the 30/30. The 30/30 can also be compared to other common formats of radiology education, such as "hot seat" style case conferences.

CONCLUSION

The 30/30 teaching format improves short-term retention, long-term retention, and attention among radiology residents when tested across a variety of radiological subspecialties and lecturers. Improvements provided by the 30/30 are likely created by increased learner attentiveness in anticipation of the interactive component, and by the opportunity to synthesize and apply learned material during the interactive component. The 30/30 format uses already existing lecture and interactive case educational content without the need for additional educational time or technical expertise required by

other studied active learning formats, which may increase adoption of the format among radiology educators.

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