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Title

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Journal

Dermatology Online Journal, 25(9)

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Publication Date

2019

DOI

10.5070/D3259045507

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Interactive teaching and repeat exposure maximize medical student satisfaction but do not promote long-term retention of dermatologic knowledge

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Abstract

Background: Instructional methods for teaching medical students to recognize common skin lesions vary widely. There is little published data comparing various teaching methods and their impact on medical student retention of dermatologic knowledge.

Methods: Our prospective cohort study analyzed how teaching methods (interactive teaching versus traditional didactic teaching versus self-guided review alone) impacted second year medical students' ability to recognize common skin lesions one year after initial exposure to the material. Our study also looked at student satisfaction with different teaching methods.

Results: There was no significant difference in long-term retention of knowledge between different teaching methods. However, students preferred the interactive format over the traditional didactic format. Spaced review is important for long-term retention, but an in-class review session two months after content was initially taught provided no added benefit over spaced self-review alone.

Conclusions: Medical students are able to maintain long-term retention of dermatologic knowledge irrespective of in-class teaching method. Repeat exposure to material is important but self-review of dermatology alone is sufficient for long-term retention. Dermatology course directors should incorporate interactive teaching into medical school curricula to increase learner satisfaction.

Keywords: medical education, skin cancer recognition, interactive learning, spaced retrieval, repeat exposure

Introduction

Early detection of skin cancer is increasingly important as the incidence of both non-melanoma skin cancer and malignant melanoma continue to rise [1]. Given non-dermatologists are often the first to encounter patients with potential skin cancers [2], recognition of malignancy is an important skill for all physicians. Long-term retention of basic dermatologic knowledge is challenging as instructional hours to teach dermatology during medical school are typically limited. Studies have found medical students receive an average of only ten hours of clinical dermatology instruction before they enter residency [3].

One of the primary educational challenges for any discipline, including dermatology, is to identify and incorporate effective methods of teaching that generate long-term retention of material. This is especially important in preclinical dermatology courses given formal dermatology rotations in the third and fourth year of medical school are typically not required components of the curriculum. An increasing number of medical schools are moving toward interactive teaching approaches with a goal of helping students effectively absorb key content [4-5]. Although interactive approaches have been

shown to improve student satisfaction scores, many studies show no difference in short- or long-term retention with these methods [6-12]. In addition, some medical schools have implemented capstone courses in which core material is briefly repeated months to years after the content was originally taught [13]. These capstone courses are a variation on the concept of spaced learning, which has been shown to lead to additional knowledge gains [14-16].

The aim of this study was to evaluate the impact of different teaching methods on long-term retention of visual features of benign and cancerous skin lesions. We evaluated the long-term impact of interactive teaching and traditional didactic teaching compared to self-guided review alone.

Methods

After an IRB exemption was granted, second-year and third-year medical students from Boston University School of Medicine (BUSM) were eligible for participation between January 2016 and January 2019. Medical students from the class of 2017 were designated as Cohort 1, medical students from the class of 2018 were designated as Cohort 2, and medical students from the class of 2019 were

designated Cohort 3. Cohort 1 and Cohort 2 received an initial week-long dermatology course followed by in-class repeat exposure to the material 2-3 months later. The method of repeat exposure for Cohort 1 was a traditional didactic lecture; the repeat exposure for Cohort 2 was a pre-test followed by an interactive discussion. Cohort 3 only received a week-long dermatology course with no in-class repeat exposure (**Figure 1**) and served as the control group.

Dermatology course: cohorts 1, 2, 3

All three Cohorts received initial exposure to cutaneous cancerous and benign growths during a week-long dermatology module. The content relevant to this study consisted of three fifty-minute lectures and one thirty-minute interactive review. One lecture covered common benign skin lesions, one discussed benign pigmented lesions and melanoma, and the third covered non-melanoma skin cancer features and treatment. During the course, there was an additional thirty-minute interactive audience-response question session reviewing visual features of benign and malignant skin neoplasms. This dermatology course served as the initial exposure to the material for Cohort 1 and Cohort 2 and the only in-class exposure to the

Table 1. One-year post test results showed no significant difference ($P=0.84$) when compared.

Correct answer	Cohort 1 (% correct) Dermatology Course +Traditional Didactic Lecture Repeat Exposure	Cohort 2 (% correct) Dermatology Course +Interactive Repeat Exposure	Cohort 3 (% correct) Dermatology Course + No Formal Repeat Exposure
Nodular basal cell carcinoma	91	88	91
Melanoma in situ	83	80	79
Infiltrative basal cell carcinoma	26	31	35
Keratoacanthoma	67	59	81
Squamous cell carcinoma	65	63	63
Acral melanoma	94	96	94
Skin-colored nevus	54	71	60
Pigmented basal cell carcinoma	85	84	93
Brown nevus	39	37	53
Ulcerated basal cell carcinoma	57	57	37
Melanoma	100	100	100
Tan/white seborrheic keratosis	57	71	64
Congenital nevus	94	86	100
Squamous cell carcinoma	50	61	73
Brown seborrheic keratosis	70	73	76
	Average score = 68.8%	Average score = 70.4%	Average score = 73.2%

material for Cohort 3. Enrollment in this course was a required part of the curriculum and the faculty for this course was the same all three years.

Repeat exposure (traditional didactic lecture): Cohort 1
 An average of 9 weeks after the initial dermatology course, Cohort 1 attended a cancer detection/prevention seminar, which was required for all students. Students rotated through learning stations in groups of ten to fifteen. During the skin cancer station, all students in this cohort received a twenty-five-minute traditional didactic PowerPoint lecture reviewing visual features of cancerous and benign skin lesions at the skin cancer station. Satisfaction scores were collected for each station after the conclusion of the seminar.

Repeat exposure (in-class interactive discussion): Cohort 2

An average of 8.5 weeks after the initial dermatology course, Cohort 2 also participated in the cancer detection/prevention seminar in groups of ten to fifteen students. During the skin cancer station, this cohort received an image-based fifteen question pretest followed by an interactive discussion including review of the pretest answers. All pretest questions were multiple choice with five possible answers. Students had the option to submit their anonymous pretest answer sheets for collection. The length of the skin cancer station, including pretest and discussion, was the same as that for Cohort 1. Satisfaction scores were collected for each station after the conclusion of the teaching session.

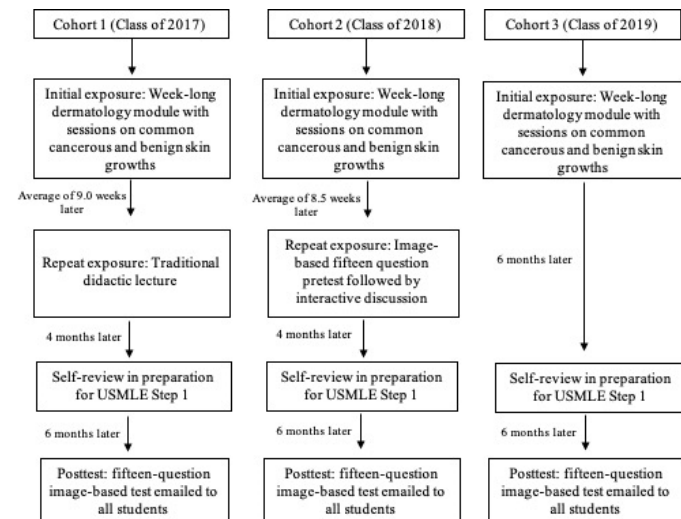


Figure 1. Flowchart of study design.

Repeat exposure (self-guided review): Cohorts 1, 2 and 3
 Approximately four months after the in-class repeat exposure for Cohort 1 and 2 and six months after the initial dermatology course for Cohort 3, all students self-reviewed dermatology in preparation for Step 1 of the United States Medical License Examination (USMLE).

Posttest: one-year after initial exposure

Twelve to thirteen months after the initial dermatology course (ten to eleven months after re-exposure for Cohort 1 and Cohort 2), a fifteen-question image-based test was sent to all students in Cohort 1, 2 and 3. Images on this test were different than those presented in lecture and on the pretest, but covered the same diagnoses reviewed in the initial dermatology course and in the skin cancer prevention seminar review course. Participation was voluntary and students were shown the correct answers after submitting their own choices. The number of correct and incorrect answers for each student was recorded.

Statistical methods

A paired t-test was used to compare the pre and posttest scores of Cohort 2. Analysis of variance (ANOVA) was used to compare the posttest scores of all three cohorts. A chi-square test was used to compare the satisfaction scores of Cohorts 1 and 2. We used data from Cohort 2 (only cohort to have a pre and posttest) to create a forgetting curve with

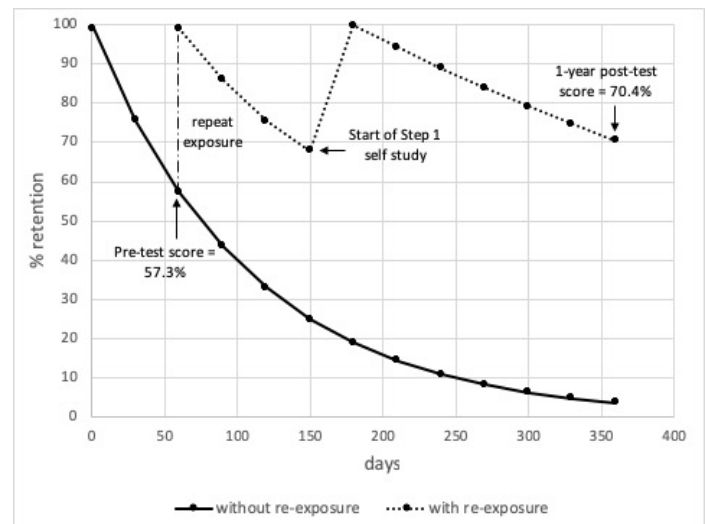


Figure 2. Forgetting curves showing estimated percent retention at thirteen months without re-exposure (solid line, <10%) to percent retention with re-exposure (dotted line, cohort 2=70.4%).

equation $R=e^{-t/S}$, where R is retrievability, S is stability of memory and t is time. We used the average pre and posttest scores of Cohort 2 as R (retrievability) at different timepoints in order to calculate S (stability) and graphed these equations over time (**Figure 2**). The S value for the first portion of the re-exposure curve is approximate, chosen to be mid-way between the S values for the non-re-exposure curve (calculated based on the pretest result) and the final portion of the re-exposure curve (calculated based on the posttest result).

Results

One hundred thirteen of approximately 124 eligible students (91%) from Cohort 2 chose to submit their pretest answers for data collection. Owing to a delay in IRB approval, we did not collect pretest data from the first forty students. For this initial subset, the pretest was administered and the session conducted identically to that of subsequent students, but answer sheets were not collected. The average score from collected pretests was 57.3%.

Fifty-four (33.5%) of 161 students from Cohort 1, 49 (29.8%) of 164 students from Cohort 2 and 71 (37.6%) of 189 students from Cohort 3 completed the image-based posttest thirteen months after the initial exposure. The mean posttest scores for Cohort 1, 2 and 3 were 68.9%, 70.4% and 73.2%, respectively. There was not a statistically significant difference between the posttest performance of Cohorts 1, 2 or 3 ($P=0.84$), (**Table 1**). Although Cohort 2 improved their average score by 13.1% between their pre and posttest, this difference was not significant ($P=0.19$). Post-seminar surveys showed that 59.3% of Cohort 1 and 91.8% of Cohort 2 agreed or strongly agreed that the second exposure (traditional didactic style for Cohort 1 and interactive style for Cohort 2) was valuable for learning ($P=0.00014$)

Discussion

Medical schools are increasingly incorporating interactive teaching and repeat exposure into their curricula, but data on these different teaching strategies has been mixed in regard to learning outcomes [4-5, 12, 17-18]. Our study showed that

medical students had long-term retention of dermatologic knowledge irrespective of teaching style or the addition of an in-class review session spaced 2-3 months after the initial exposure. Students significantly preferred an interactive as opposed to didactic re-exposure. These findings suggest that active learning and spaced in-class review of content, while popular, do not necessarily provide additional long-term benefit to students over traditional lecture and self-review.

Our findings are in agreement with previous studies that found an interactive teaching approach did not significantly improve retention over traditional didactic teaching [6-8, 10-11]. In a study in which active learning showed improved student retention of class materials, the interval between lesson and assessment was only two weeks [19]. This suggests that active learning is beneficial, but is not necessarily better than traditional didactic learning.

Despite active and passive learning having similar rates of long-term retention, students perceived the interactive session to be a more valuable learning experience. Many studies have similarly found that active learning led to greater learner satisfaction but that knowledge and skills gained was similar to the control group [6-12]. We therefore recommend incorporating interactive teaching into dermatology curricula, not with the goal of increasing long-term retention, but rather to increase learner satisfaction.

Although re-exposure to material is essential for long-term knowledge retention [14-16, 20], our data suggests that a structured in-class review did not provide additional long-term benefit to students compared to self-review alone. The difference in rate of retention between students who relied on self-review alone versus students who had a formal in-class review in addition to self-review was not statistically significant ($P=0.84$). This is an important point given dermatology course directors are often given a limited amount of time to teach medical students. Based on our data and the forgetting curve equation by Hermann Ebbinghaus ($R=e^{-t/S}$), if medical students did not review the material between the pre-test and the post-test we would have expected them to retain less than 10% of their knowledge thirteen months after their initial exposure (**Figure 2**).

All our cohorts had some form of repeat exposure, and all scored significantly higher than the estimated retention rate on their one-year posttest. Therefore, whereas repeat exposure to material is essential for long-term retention, dermatology course directors should not feel compelled to incorporate spaced repetition preclinically since students appear to obtain the greatest gains from USMLE self-study.

There are several potential limitations of our study. The calculated forgetting curves assume that at the time of the teaching interventions, students grasped 100% of the material. Our study also assumes that all students independently reviewed dermatology in preparation for their USMLE test between the re-exposure and the one-year posttest. In addition, the satisfaction survey and one-year posttest were voluntary and thus may have been influenced by selection bias.

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Conclusion

In conclusion, we recommend incorporating interactive teaching into dermatology courses to increase learner satisfaction. However, interactive teaching does not appear to have beneficial long-term effects over traditional didactic teaching. In addition, repeat exposure to material is important but self-review of dermatology alone is sufficient for medical students to have long-term retention of the visual features of common skin lesions.

Potential conflicts of interest

Dr. Allison R. Larson served as a one-time advisory board member for Sanofi Genzyme in 2019. She has no conflicts of interest relevant to this work.

