

A Comparison of Knowledge Acquisition and Perceived Efficacy of a Traditional vs Flipped Classroom–Based Dermatology Residency Curriculum

Lauren N. Pontius, MD; Joanna Hooten, MD; Erin Lesesky, MD; Caroline Rao, MD; Matilda Nicholas, MD, PhD; Rebecca Bialas, MD; Beiyu Liu, PhD; Cynthia L. Green, PhD; Amber Reck Atwater, MD

PRACTICE POINTS

- There was not a significant difference in dermatology resident factual quiz scores when comparing flipped vs traditional classroom teaching sessions.
- There was a significant difference between the flipped vs traditional teaching models, with dermatology residents favoring the flipped classroom, for co-resident lecture participation and individual and co-resident enjoyment of the lecture.
- Residents also perceived that the flipped classroom sessions were more efficient, better prepared them for boards, and better prepared them for clinical practice.

Flipped and traditional classroom models were compared in the Duke University Medical Center (Durham, North Carolina) dermatology residency program for the 2014-2015 academic year. The residents participated in 12 lectures—6 traditional and 6 flipped—that were paired for similar content. Each lecture was followed by a survey comprised of 10 factual questions and 10 perception questions. Generalized linear regression models were used to study the differences in quiz scores between the 2 classroom models after adjusting for other baseline covariates. There was not a significant difference in mean factual quiz scores between the two classroom models. Results indicated significant perception differences in favor of the flipped classroom model, such as participation ($P < .001$), enjoyment ($P = .038$ and $P = .026$), efficiency ($P = .033$), and boards ($P = .050$) and clinical preparedness ($P = .034$).

Cutis. 2020;105:36-39.

The ideal method of resident education is a subject of great interest within the medical community, and many dermatology residency programs utilize a traditional classroom model for didactic training consisting of required textbook reading completed at home and classroom lectures that often include presentations featuring text, dermatology images, and questions throughout the lecture. A second teaching model is known as the flipped, or inverted, classroom. This model moves the didactic material that typically is covered in the classroom into the realm of home study or homework and focuses on application and clarification of the new material in the classroom.¹ There is an emphasis on completing and understanding course material prior to the classroom session. Students are expected to be prepared for the lesson, and the classroom session can include question review and deeper exploration of the topic with a focus on subject mastery.²

In recent years, the flipped classroom model has been used in elementary education, due in part to the influence of teachers Bergmann and Sams,³ as described in their book *Flip Your Classroom: Reach Every Student in Every Class Every Day*. More recently, Prober and Khan⁴ argued for its use in medical education, and this model has been utilized in medical school curricula to teach specialty subjects, including medical dermatology.⁵

Given the increasing popularity and use of the flipped classroom, the primary objective of this study was to determine if a difference in knowledge acquisition and resident perception exists between the traditional and flipped classrooms. If differences do exist, the secondary aim was to quantify them. We hypothesized that the

From Duke University Medical Center, Durham, North Carolina.

The authors report no conflict of interest.

Correspondence: Amber Reck Atwater, MD, Duke University Hospital, Department of Dermatology, 5324 McFarland Rd #210, Durham, NC 27707 (amber.atwater@duke.edu).

flipped classroom actively engages residents and would improve both knowledge acquisition and resident sentiment toward the residency program curriculum compared to the traditional model.

Methods

The Duke Health (Durham, North Carolina) institutional review board granted approval for this study. All of the dermatology residents from Duke University Medical Center for the 2014-2015 academic year participated in this study. Twelve individual lectures chosen by the dermatology residency program director were included: 6 traditional lectures and 6 flipped lectures. The lectures were paired for similar content.

Survey Administration—Each resident was assigned a unique 4-digit numeric code that was unknown to the investigators and recorded at the beginning of each survey. The residents expected flipped lectures for each session and were blinded as to when a traditional lecture and quiz would occur, with the exception of the resident providing the lecture. Classroom presentations were immediately followed by a voluntary survey administered through Qualtrics.⁶ Consent was given at the beginning of each survey, followed by 10 factual questions and 10 perception questions. The factual questions varied based on the lecture topic and were multiple-choice questions written by the program director, associate program director, and faculty. Each factual question was worth 10 points, and the scaled score for each quiz had a maximum value of 100. The perception questions were developed by the authors (J.H. and A.R.A.) in consultation with a survey methodology expert at the Duke Social Science Research Institute. These questions remained constant across each survey and were descriptive based on standard response scales. The data were extracted from Qualtrics for statistical analysis.

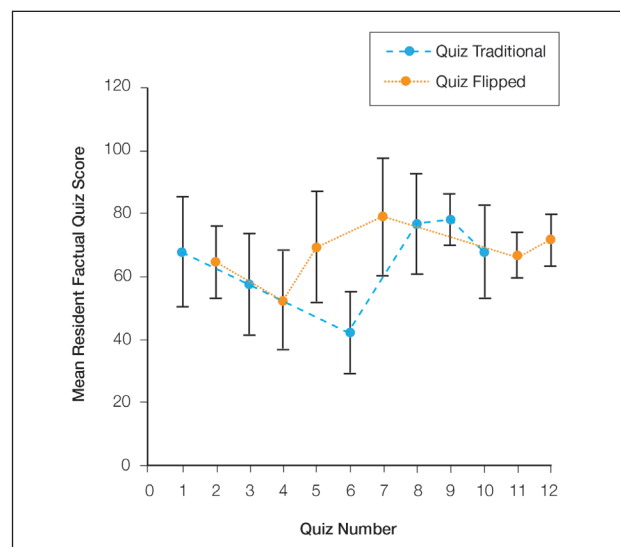
Statistical Analysis—The mean score with the standard deviation for each factual question quiz was calculated and plotted. A generalized linear mixed model was created to study the difference in quiz scores between the 2 classroom models after adjusting for other covariates, including resident, the interaction between resident and class type, quiz time, and the interaction between class type and quiz time. The variable resident was specified as a random variable, and a variance components covariance structure was used. For the perception questions, the frequency and percentage of each answer for a question was counted. Generalized linear mixed models with a Poisson distribution were created to study the difference in answers for each survey question between the 2 curriculum types after adjusting for other covariates, including scores for factual questions, quiz time, and the interaction between class type and quiz time. The variable resident was again specified as a random variable, and a diagonal covariance structure was used. All statistical analyses were carried out using SAS software package version 9.4 (SAS Institute) by the Duke University

Department of Biostatistics and Bioinformatics. $P < .05$ was considered statistically significant.

Results

All 9 of the department's residents were included and participated in this study. Mean score with standard deviation for each factual quiz is plotted in the Figure. Across all residents, the mean factual quiz score was slightly higher but not statistically significant in the flipped vs traditional classrooms (67.5% vs 65.4%; $P = .448$) (data not shown). When comparing traditional and flipped factual quiz scores by individual resident, there was not a significant difference in quiz performance ($P = .166$) (data not shown). However, there was a significant difference in the factual quiz scores among residents for all quizzes ($P = .005$) as well as a significant difference in performance between each individual quiz over time ($P < .001$) (data not shown). In the traditional classroom, residents demonstrated a trend in variable performance with each factual quiz. In the flipped classroom, residents also had variable performance, with wide-ranging scores ($P = .008$) (data not shown).

Each resident also answered 10 perception questions (Table 1). When comparing the responses by quiz type (Table 2), there was a significant difference for several questions in favor of the flipped classroom: how actively residents thought their co-residents participated in the lecture ($P < .001$), how much each resident enjoyed the session ($P = .038$), and how much each resident believed their co-residents enjoyed the session ($P = .026$). Additionally, residents thought that the flipped classroom sessions were more efficient ($P = .033$), better prepared them for boards ($P = .050$), and better prepared them for clinical practice ($P = .034$). There was not a significant difference in the amount of reading and



Mean resident scores for each factual quiz. There were 12 quizzes total: 6 for traditional classroom lectures and 6 for flipped classroom lectures. Error bars indicate standard deviation.

TABLE 1. Perception Questions Defined

Question Number	Perception Question
11	How much of the required reading did you complete prior to today's didactics lecture?
12	How active were you in participating in today's lecture?
13	How active were your co-residents in participating in today's lecture?
14	How enjoyable was today's session?
15	How enjoyable do you think your co-residents found today's lecture?
16	How efficient was today's session?
17	How effective was today's curriculum structure?
18	How helpful was today's session for increasing my knowledge on the topic?
19	How helpful was today's session for preparing for the dermatology boards?
20	How helpful was today's session for preparing for clinical dermatology practice?

preparation residents did for class ($P=.697$), how actively the residents thought they participated in the lecture ($P=.303$), the effectiveness of the day's curriculum structure ($P=.178$), or whether residents thought the lesson increased their knowledge on the topic ($P=.084$).

Comment

The traditional model in medical education has undergone changes in recent years, and researchers have been looking for new ways to convey more information in shorter periods of time, especially as the field of medicine continues to expand. Despite the growing popularity and adoption of the flipped classroom, studies in dermatology have been limited. In this study, we compared a traditional classroom model with the flipped model, assessing both knowledge acquisition and resident perception of the experience.

There was not a significant difference in mean objective quiz scores when comparing the 2 curricula. The flipped model was not better or worse than the traditional teaching model at relaying information and promoting learning. Rather, there was a significant difference in quiz scores based on the individual resident and on the individual quiz. Individual performance was not affected by the teaching model but rather by the individual resident and lecture topic.

These findings differ from a study of internal medicine residents, which revealed that trainees in a quality-improvement flipped classroom had greater increases in knowledge than a traditional cohort.⁷ It is difficult to make direct comparisons to this group, given the difference in specialty and subject content. In comparison, an emergency medicine program completed a cross-sectional cohort study of in-service examination scores

in the setting of a traditional curriculum (2011-2012) vs a flipped curriculum (2015-2016) and found that there was no statistical difference in average in-service examination scores.⁸ The type of examination content in this study may be more similar to the quizzes that our residents experienced (ie, fact-based material based on traditional medical knowledge).

The dermatology residents favored the flipped curriculum for 6 of 10 perception questions, which included areas of co-resident participation, personal and co-resident enjoyment, efficiency, boards preparation, and preparation for clinical practice. They did not favor the flipped classroom for prelecture preparation, personal participation, lecture effectiveness, or knowledge acquisition. They perceived their peers as being more engaged and found the flipped classroom to be a more positive experience. The residents thought that the flipped lectures were more time efficient, which could have contributed to overall learner satisfaction. Additionally, they thought that the flipped model better prepared them for both the boards and clinical practice, which are markers of future performance.

These findings are consistent with other studies that revealed improved postcourse perception scores for a quality improvement emergency medicine-flipped classroom. Most of this group preferred the flipped classroom over the traditional after completion of the flipped curriculum.⁹ A neurosurgery residency program also reported increased resident engagement and resident preference for a newly designed flipped curriculum.¹⁰

Overall, our data indicate that there was no objective change in knowledge acquisition at the time of the quiz, but learner satisfaction was significantly greater in the flipped classroom model.

TABLE 2. Perception Questions: Least Squares Mean Estimates of Perception Scores and Least Squares Mean Rate Ratios for Flipped vs Traditional Classroom Models^a

Question Number	LSM		LSM Rate Ratio	P Value
	Flipped Classroom	Traditional Classroom	Flipped vs Traditional (95% CI)	
11	2.707	2.612	1.037 (0.862-1.247)	.697
12	3.728	3.487	1.069 (0.940-1.217)	.303
13	3.675	2.876	1.278 (1.138-1.435)	<.001
14	3.771	3.338	1.130 (1.007-1.267)	.038
15	3.605	3.120	1.156 (1.018-1.311)	.026
16	3.934	3.455	1.139 (1.011-1.281)	.033
17	3.755	3.487	1.077 (0.967-1.201)	.178
18	3.935	3.600	1.094 (0.988-1.212)	.084
19	3.939	3.562	1.106 (0.999-1.223)	.050
20	3.733	3.303	1.130 (1.010-1.265)	.034

Abbreviations: LSM, least squares mean; CI, confidence interval.

^aEach of the questions is considered a categorical variable and modeled using a Poisson distribution (log linear) to adjust for covariates and correlation. The LSM estimates from the models must be exponentiated to get back to the original units of the question. The difference between groups—flipped and traditional—is estimated as a rate ratio.

Limitations—This study was comprised of a small number of residents from a single institution and was based on a limited number of lectures given throughout the year. All lectures during the study year were flipped with the exception of the 6 traditional study lectures. Therefore, each resident who presented a traditional lecture was not blinded for her individual assigned lecture. In addition, because traditional lectures only occurred on study days, once the lectures started, all trainees could predict that a content quiz would occur at the end of the session, which could potentially introduce bias toward better quiz performance for the traditional lectures.

Conclusion

When comparing traditional and flipped classroom models, we found no difference in knowledge acquisition. Rather, the difference in quiz scores was among individual residents. There was a significant positive difference in how residents perceived these teaching models, including enjoyment and feeling prepared for the boards. The flipped classroom model provides another opportunity to better engage residents during teaching and should be considered as part of dermatology residency education.

Acknowledgments—Duke Social Sciences Institute post-doctoral fellow Scott Clifford, PhD, and Duke Dermatology residents Daniel Chang, MD; Sinae Kane, MD;

Rebecca Bialas, MD; Jolene Jewell, MD; Elizabeth Ju, MD; Michael Raisch, MD; Reed Garza, MD; Joanna Hooten, MD; and E. Schell Bressler, MD (all Durham, North Carolina).

REFERENCES

1. Lage MJ, Platt GJ, Treglia M. Inverting the classroom: a gateway to creating an inclusive learning environment. *J Economic Educ.* 2000;31:30-43.
2. Gillispie V. Using the flipped classroom to bridge the gap to generation Y. *Ochsner J.* 2016;16:32-36.
3. Bergmann J, Sams A. *Flip Your Classroom: Reach Every Student in Every Class Every Day.* Alexandria, VA: International Society for Technology in Education; 2012.
4. Prober CG, Khan S. Medical education reimaged: a call to action. *Acad Med.* 2013;88:1407-1410.
5. Aughenbaugh WD. Dermatology flipped, blended and shaken: a comparison of the effect of an active learning modality on student learning, satisfaction, and teaching. Paper presented at: Dermatology Teachers Exchange Group 2013; September 27, 2013; Chicago, IL.
6. Oppenheimer AJ, Pannucci CJ, Kasten SJ, et al. Survey says? A primer on web-based survey design and distribution. *Plast Reconstr Surg.* 2011;128:299-304.
7. Bonnes SL, Ratelle JT, Halvorsen AJ, et al. Flipping the quality improvement classroom in residency education. *Acad Med.* 2017;92:101-107.
8. King AM, Mayer C, Barrie M, et al. Replacing lectures with small groups: the impact of flipping the residency conference day. *West J Emerg Med.* 2018;19:11-17.
9. Young TP, Bailey CJ, Gupta M, et al. The flipped classroom: a modality for mixed asynchronous and synchronous learning in a residency program. *Western J Emerg Med.* 2014;15:938-944.
10. Girgis F, Miller JP. Implementation of a "flipped classroom" for neurosurgery resident education. *Can J Neurol Sci.* 2018;45:76-82.