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Evaluation of an Instructional Video and Simulation Model for Teaching Slit Lamp Examination to Medical Students

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Abstract

Purpose This article assesses the efficacy of an instructional video and model eye simulation for teaching slit lamp exam to medical students as compared to traditional preceptor teaching.

Methods First through 4th year students from the University of California, San Francisco School of Medicine were recruited via email to participate in the study. Students were randomized into two groups. The experimental "model eye" group watched an instructional video on slit lamp exam, spent 10 minutes practicing on the model eye, then practiced for 25 minutes with a student partner. The control "preceptor teaching" group received 25 minutes of in-person preceptor teaching on slit lamp exam, then spent 25 minutes practicing with a student partner. Students were objectively assessed by a blinded grader who scored their examination skills with a 31-item checklist. Qualtrics surveys that measured student perceptions were distributed before and after the intervention.

Results Seventeen medical students participated in the study. Students in the model eye group achieved higher mean objective assessment scores than students in the preceptor teaching group on skills relating to slit lamp set up (1.75, standard deviation [SD] = 0.50 and 1.50, SD = 0.80 out of 2 points, $p = 0.03$) and on the total score (1.69, SD = 0.6 and 1.48, SD = 0.8 out of 2 points, $p < 0.01$). Both groups reported a significant increase in their understanding of what a slit lamp is used for ($p < 0.01$) and in their confidence using a slit lamp ($p < 0.01$). All students felt their skills improved with the workshop, 94% found the workshop to be useful, and 88% enjoyed the workshop, with no intergroup differences on these metrics.

Conclusion An instructional video combined with a simulation model is as effective as traditional preceptor teaching of the slit lamp exam. Such a teaching module may be considered as an adjunct to traditional methods.

Keywords
- medical student education
- slit lamp
- video-based learning
- simulation

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The slit lamp examination is an essential diagnostic skill for ophthalmology residents[1] and an important teaching tool for medical students. Many medical students first encounter the slit lamp during their third-year clinical rotations. However, teaching the exam to students at this time can be challenging. Clinicians have limited time dedicated to teaching. Fast-paced care schedules with insufficient teaching time is a frequently cited barrier to outpatient medical education by both students and staff.[2] In addition, students receive relatively low exposure to ophthalmic conditions in their medical school curriculum,[3,4] and in most schools, clinical rotations in ophthalmology are not required.[5] Finally, the complexity of the slit lamp apparatus itself poses a barrier as it requires a significant amount of hands-on instruction and an additional person on whom to practice. In a study of recent medical school graduates, slit lamp examination was among those core clinical skills laid out by the International Council of Ophthalmology that students had not obtained competency in.[4] These challenges call for innovative ways to augment traditional teaching of slit lamp exam to medical students, such as electronic learning (e-learning) and the use of simulation models.

Methods of e-learning—the delivery of learning through digital resources—have grown rapidly within medical education, especially since the coronavirus disease 2019 pandemic.[6] Studies that compare e-learning to traditional face-to-face learning in medicine have found the teaching methods to be comparable in efficacy.[7–12] Within ophthalmology, the limited number of studies that compare these teaching methods generally favor e-learning. In the preclinical period, e-learning was found to enhance both student satisfaction and examination technique compared to traditional lectures.[13] A flipped classroom learning model with self-administered videos was found to enhance satisfaction, examination performance, and knowledge retention.[14] On ophthalmology clinical rotations, incorporating interactive Web-based teaching modules enhanced academic performance compared to traditional hospital-based teaching[15]. Finally, teaching the fundoscopic exam to medical students via a flexible e-learning video led to better diagnostic accuracy and higher cognitive activity compared to face-to-face teaching.[16] Together, this work highlights the potential for e-learning to supplement traditional teaching in ophthalmology.

Simulation models are an effective tool for students to improve their clinical skills in a risk-free environment[17–19] and are increasingly used within ophthalmology.[20] A 2020 systematic review of simulation-based training tools for technical and nontechnical skills within ophthalmology found that while virtual reality simulators and wet-lab models have been widely studied and have strong validity evidence, the use of synthetic dry-lab models in ophthalmology was limited compared to other surgical specialties.[21] Those studies that have been published focus mostly on corneal foreign body removal,[22–24] direct fundoscopy,[25,26] and indirect fundoscopy.[27–29] There are limited descriptive studies of simulation models for slit lamp examination,[30,31] which demonstrate the potential of dry-lab simulation models for slit lamp training. However, there is a need to formally access their efficacy.

To our knowledge, there are no reports looking at e-learning along with simulation models as a method for teaching the slit lamp examination to medical students. The aim of our study is to assess the efficacy of an instructional video and model eye simulation for teaching the slit lamp exam to medical students as compared to traditional preceptor teaching.

Methods

Approval from the University of California, San Francisco (UCSF) Institutional Review Board and Committee for Human Subjects Research was obtained for this study. The study was conducted in accordance with the tenets of the Declaration of Helsinki.

Participants

First through 4th year medical students from the UCSF School of Medicine were recruited via email to participate in the study. Students were excluded from participating if they had completed any clinical rotation, elective, or sub-internship in ophthalmology, or if they had used a slit lamp in the past. Students who had shadowed in ophthalmology or had watched someone else use a slit lamp through a teaching scope were allowed to participate. Student participants who completed all elements of the study received a $10 coffee gift card. Preceptors and graders for the study consisted of UCSF ophthalmology and optometry residents, ophthalmology attendings, and optometrists who were also recruited and asked to volunteer via email.

Design of Study Materials

On reviewing the literature, we did not find an applicable module for teaching slit lamp examination, and so we created our own instructional video and model eye simulation.

Our 22-minute instructional video (available at https://ucsf.box.com/v/SlitLampVideo), incorporated annotated pictures and figures, recorded demonstrations of skills, and narration. It is divided into three blocks of educational content, outlined in ►**Table 1**. The first block, "Slit Lamp Set Up," explains proper positioning of the patient and clinician on the slit lamp. The second block, "Slit Lamp Mechanics," explains how to operate the slit lamp and adjust each of its components (brightness, magnification, beam height/width, etc.). The third block, "Eye Exam Skills," reviews basic eye anatomy and provides a systematic way to examine the anterior segment of the eye, indicating which settings on the slit lamp are used to best visualize each anatomic structure. We created two versions of the instructional video, a comprehensive video and a modified version with only those steps that could be performed on the model eye (as noted in ►**Table 1**). The videos were designed in PowerPoint and recorded with voice-over narration in MP4 format.

Table 1 31-item checklist of slit lamp skills divided into three blocks

Block 1: Slit lamp set up	Block 2: Slit lamp mechanics	Block 3: Eye exam skills
Wash/sanitize hands	Turn on slit lamp	Correctly focus on lids/lashes[a]
Clean equipment	Unlock slit lamp	Correctly focus on conjunctiva/sclera
Adjust height of examiner's chair	Adjust oculars to pupillary distance	Correctly focus on cornea
Align oculars with examiner's eyes	Start with dominant hand on joystick	Correctly focus on anterior chamber
Adjust height of patient's chair	Examine patient's right eye first, followed by the left eye[a]	Correctly focus on iris
Ask patient to lean forward/chin in rest/forehead in top strap[a]	Adjust coarse focus	Correctly focus on lens
Line patient's eyes (lateral canthus) to black marking	Adjust fine focus	Adjusts beam height to pupil height
Instruct patient to hold handles[a]	Move slit beam up or down	Read measurement
	Adjust brightness	Pull slit lamp back before moving it laterally
	Adjust beam height	Switch arm to other side
	Adjust beam width	
	Adjust magnification	
	Switch to cobalt blue light	

[a]Skills that students are unable to perform on the model eye.

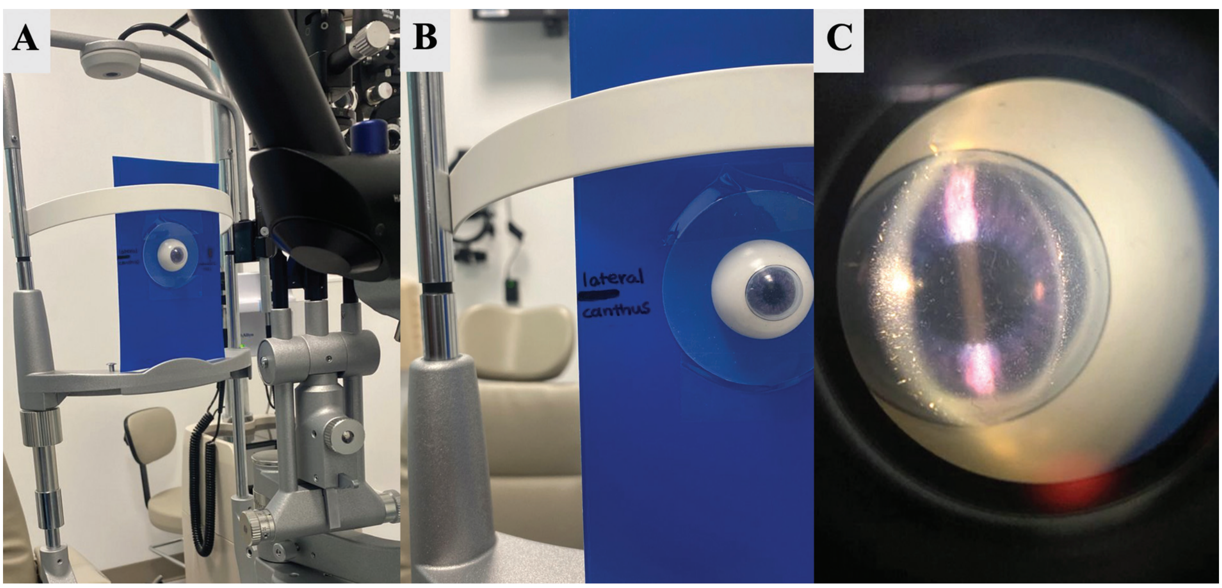

Fig. 1 (A) The surgical simulation eye used in the model eye group, positioned against the head rest and chin rest of the slit lamp. (B) The lateral canthus marking on the model eye, aligned with the canthus alignment marker on the slit lamp. (C) A close-up view of the surgical simulation eye.

For the model eye, we used a synthetic surgical simulation eye (PS-016, Phillips Studio, Bristol, U.K.) taped to a 6×4 inch rectangle cut from a plastic folder (►**Fig. 1A**). A line labeled as the lateral canthus was drawn on each plastic backing (►**Fig. 1B**). The model eye can be placed against the chin rest and forehead rest, and by aligning the lateral canthus to the canthus alignment marker on the slit lamp, it can be used to practice the examination. The simulation eye is a good epressentation of a true eye, with a corneal thickness and anterior chamber (►**Fig. 1C**).

We piloted the instructional video and model eye simulation on several medical students who were not study participants before implementing it on the study day.

Study Design

The study was performed at the Wayne and Gladys Valley Center for Vision on August 14, 2022. All participants were required to pass a daily health screener within 4 hours of entering the building and to wear a mask, as per the UCSF policy at that time.

Table 2 Baseline characteristics of students in the model eye and preceptor teaching group

	Model eye ($N = 8$)	Preceptor teaching ($N = 9$)	p-Value
Sex (N, %)			
Female	4 (50)	5 (55)	0.20
Male	4 (50)	3 (33)	
Nonbinary	0	1 (11)	
Medical school year (N, %)			
MS1	2 (25)	1 (11)	0.59
MS2	3 (38)	4 (44)	
MS3	2 (23)	1 (11)	
MS4	1 (13)	3 (33)	
Participation in ophthalmology-related activities prior to this workshop (N, %)	4/8 (50)	2/9 (22)	0.095

Students were randomized into two groups. The experimental "Model Eye" group watched our instructional video on slit lamp exam, spent 10 minutes practicing the exam on the model eye in pairs, then practiced for 25 minutes with a student partner. During the 10-minute model eye practice, students used the PowerPoint version of the model eye video as a guide. During the 25-minute practice period, students in the model eye group could refer to the PowerPoint version of the instructional video. The control "Preceptor Teaching" group received 25 minutes of in-person preceptor teaching on slit lamp exam, then spent 25 minutes practicing with a student partner. The preceptor-to-student ratio was 1:2 and one group of 1:3. The three preceptors, consisting of UCSF ophthalmology and optometry residents with previous experience in teaching slit lamp exam, were given a list of teaching points (►**Supplementary Material S1** [available in the online version]) to cover and a copy of the instructional video to watch ahead of time to ensure that their instruction covered the same material as our instructional video.

Data Collection and Analysis

After their 25-minute practice period, each student performed a complete slit lamp exam on another student. Their exam was assessed by one of three blinded graders (an ophthalmology attending or an optometrist). Examination skills were scored with a 31-item checklist (►**Table 1**) on a 0 to 2 grading scale, where 0 = did not perform skill or failed to perform correctly after two attempts, 1 = performed skill correctly after one attempt, and 2 = performed skill correctly on first attempt. Scores were anonymous. Additionally, we gathered demographic information and assessed student perceptions with 5-point Likert scale questions by distributing Qualtrics surveys before and after the intervention. Surveys can be seen in their entirety in ►**Supplementary Material S2** (available in the online version). Objective assessment scores and survey responses were reported as means with standard deviations (SDs) as appropriate. The data was statistically analyzed with t-tests of sample means. Paired t-tests were used for pre- and poststudy survey analysis. A p-value of < 0.05 was considered statistically significant.

Results

►**Table 2** summarizes the baseline characteristics of students in the model eye and preceptor teaching group. A total of 17 students, 8 in the model eye group and 9 in the preceptor teaching group, participated in the study. Three students (18%) were MS1s, 7 (41%) were MS2s, 3 (18%) were MS3s, and 4 (24%) were MS4s. Six students (35%) had participated in ophthalmology-related activities prior to the study, the two most common being clinical shadowing and ophthalmology research. There were no statistically significant differences in age, sex, or previous ophthalmology experience between the two groups.

Objective performances of the model eye and preceptor teaching groups are shown in ►**Fig. 2**, scored on a 0 to 2 scale. Students in the model eye group scored significantly higher than students in the preceptor teaching group on skills relating to slit lamp set up (1.75, SD = 0.50 and 1.50, SD = 0.80, $p = 0.03$) and on the total score (1.69, SD = 0.6 and 1.48, SD = 0.8, $p < 0.01$). Students in the model eye group also trended higher than students in the preceptor teaching group on skills relating to slit lamp mechanics (1.83, SD = 0.5 and 1.68, SD = 0.6, $p = 0.06$) and on eye exam skills (1.46, SD = 0.8 and 1.21, SD = 0.9, $p = 0.05$), but these differences were not statistically significant.

►**Fig. 3** compares the objective performance of students with and without previous ophthalmology experience. Students with previous ophthalmology experience scored significantly higher than students without ophthalmology experience on skills relating to eye exam (1.51, SD = 0.8 and 1.23, SD = 0.9, $p = 0.04$) and on the total score (1.66, SD = 0.6 and 1.52, SD = 0.8, $p = 0.04$). The objective performance of students in their preclinical years (first and second year) was not significantly different than the performance of students in their clinical years (third and fourth year) across any individual question block or the total score.

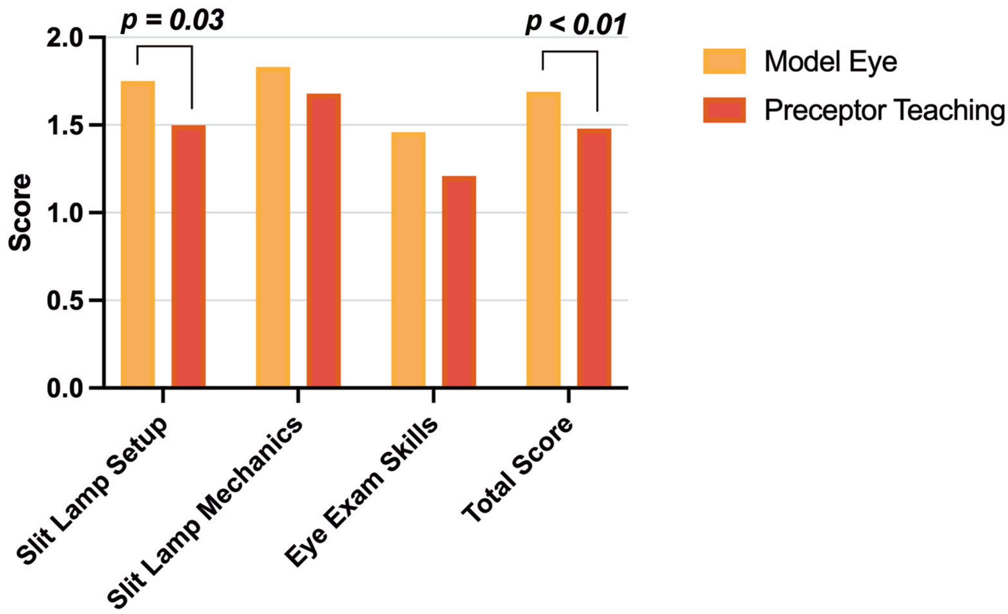

Fig. 2 Mean slit lamp exam objective assessment scores in the model eye and preceptor group. Scoring: 0 = did not perform skill or failed to perform correctly after two attempts, 1 = performed skill correctly after one attempt, and 2 = performed skill correctly on first attempt.

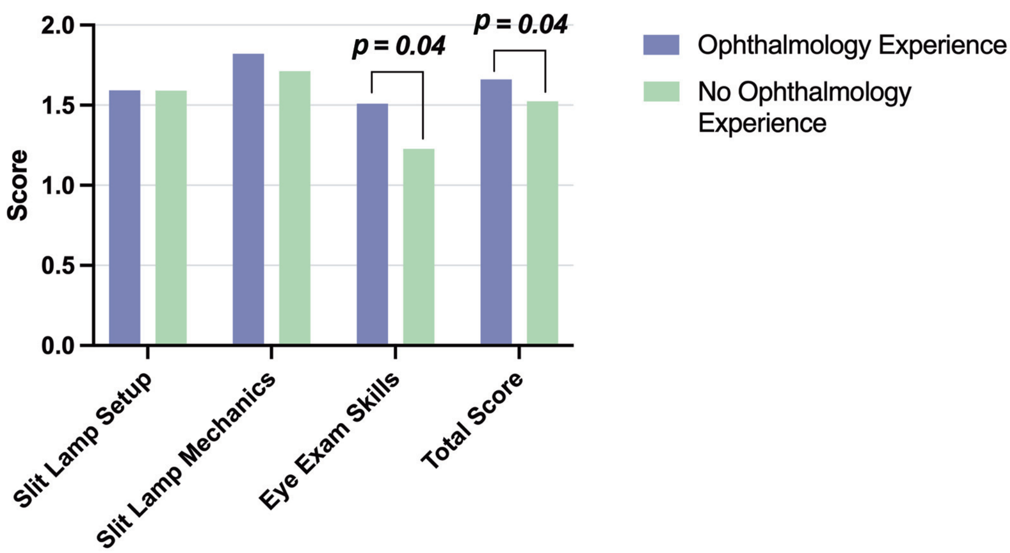

Fig. 3 Mean slit lamp exam objective assessment scores of students with and without previous experience in ophthalmology-related activities. 0 = did not perform skill or failed to perform after two attempts, 1 = performed skill correctly after one attempt, and 2 = performed skill correctly on first attempt.

Responses to 5-point Likert scale questions assessing student perceptions in the model eye and preceptor teaching groups before and after the study are summarized in ►**Table 3**. Both the model eye and preceptor teaching groups reported a significant increase in their understanding of what a slit lamp is used for ($p < 0.01$ for both groups) and in their confidence using a slit lamp ($p < 0.01$ for both groups). Both groups also reported an increase in their knowledge of eye anatomy, but these results were not significant. There was no significant difference between the model eye and preceptor teaching groups on any of these metrics. In addition, both the model eye and the preceptor teaching group felt that their skills improved with the workshop (4.75, SD = 0.4 and 4.22, SD = 0.6); both groups found the workshop to be useful (4.75, 0.4, and 4.44, SD = 0.7); and both groups enjoyed the workshop (4.25, SD = 0.7 and 4.44, SD = 0.7), also with no significant intergroup differences.

Discussion

To our knowledge, this is the first study to assess the efficacy of an instructional video and a module using a simulation eye

Table 3 Student perceptions assessed with Likert scale survey questions before and after the slit lamp workshop

	Model eye ($N = 8$)			Preceptor teaching ($N = 9$)		
	Pre	Post	*p*-Value	Pre	Post	*p*-Value
I understand what a slit lamp is used for	2.38	4.38	< 0.01	2.89	4.11	< 0.01
I feel confident at using the slit lamp	1.63	3.88	< 0.01	1.22	3.67	< 0.01
I have knowledge of basic eye anatomy	3.50	3.75	0.17	3.33	3.78	0.22
I am interested in pursuing ophthalmology as a career	3.38	3.38	N/A	2.89	3.00	0.35

Abbreviation: N/A, not available.
Note: Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree.

in teaching slit lamp examination to medical students. We found students in the model eye group scored higher than students in the preceptor group across all three blocks of assessment, with significantly higher scores on skills related to slit lamp set up and on the total score. This finding is consistent with other studies that compare e-learning and virtual learning to face-to-face teaching in ophthalmology[13–16] and may reflect the advantages of this type of instruction for technical skills. The model eye group participated in more active learning as they were able to refer to PowerPoint slides while practicing and figuring things out on their own. A video-based platform allows the learner to pause, rewind, and advance across the lesson to focus on certain aspects of the material more closely, thus tailoring their learning.[32,33] The use of text and narration over diagrams and physical demonstrations in video format can help facilitate understanding.[34] Postrecording video editing allows you to trim and arrange the lesson such that all topics are adequately covered.[35,36] Our preceptors delivered the same content as in the video over 25 minutes, and we received verbal feedback that many of them struggled with time management. A condensed video can allow for greater practice time and lead to superior performance,[37] reduce the variance inherent in clinical skills instruction,[38] and deliver a lesson that is well received by students.

Other benefits of video-based lessons include standardizing education across students within a medical school and between institutions,[39] increasing access to educational content,[40] and easily updating course content to reflect standards of practice. A disadvantage of implementing video-based learning is that it relies on students to be self-motivated enough to study independently.[40] However, studies have shown that medical students are in fact highly motivated for self-directed learning.[41] The use of video-based instruction also is limited by the technical competency of students and staff[42] and does not allow students to ask questions to the instructor in real time.[34] It will be important to assess whether these factors limit student learning and participation in future studies.

Our success with teaching the slit lamp exam using a model eye may reflect the benefits of using dry-lab models in clinical training. The model eye set up we constructed is simple, portable, and reusable. It gives students the opportunity to perform the exam without the risk and inconvenience of performing the exam on a volunteer. This additional hands-on practice is necessary to reduce the competency gap between the “see one, do one” model in medical education.[43] Limitations of the model eye are that it is not suitable for all components of the slit lamp exam, it does not perfectly replicate the human eye or demonstrate eye pathology, and it does not build on students' interpersonal skills.[23]

Students in both the model eye and preceptor group enjoyed their experience and found the workshop to be useful. Studies that compare medical student satisfaction between video-based learning and face-to-face instruction vary overall, with some favoring e-learning,[13,42,44] some traditional teaching,[7] and others showing no difference.[12,45] Students who prefer video-based learning perceive better content organization, breadth of teaching, accessibility, and quality of instruction, whereas students who prefer face-to-face learning appreciate the group interactions and capacity for rapport building.[42,46] Future studies may explore which specific components of the model eye and preceptor group experiences students find to enhance or detract from their learning. Mixed methods of didactic and self-learning are best. Virtual learning is most effective if used prior to bedside teaching[47] and the combination of e-learning with traditional teaching leads to better learning outcomes than traditional teaching alone.[48] Therefore, offering students the instructional video and practice with model eye in preparation for preceptor instruction where they can ask questions and get guidance on ophthalmology rotations may be an effective strategy.

Students with previous experience in ophthalmology-related activities, such as clinical shadowing and ophthalmology research, scored significantly higher on questions relating to eye exam skills and on the total score than students without previous ophthalmology experience. Of note, while not statistically significant, there was a trend for more students in the model eye group to have participated in ophthalmology-related activities prior to the workshop which may have affected model eye group results. There was no difference in objective scores between 3rd and 4th year students compared to 1st and 2nd years, reinforcing that this difference is specific to clinical ophthalmology exposure rather than general clerkship experience. These findings are consistent with literature that demonstrates the benefits of preclinical exposure to ophthalmology in improving students' clinical and surgical competence, as well as their understanding of ophthalmology as a career.[49]

This study is limited by a small sample size, single institution design, interpreceptor variability, difference in "hand-on" practice time between the groups, observer bias, and selection bias among participants. Students who volunteered to participate may have had a higher interest in ophthalmology than the general student population and both groups had some students with previous ophthalmology experience, which may have affected study results, especially given the small size of the groups. Validating the efficacy of the model eye and instructional video with a larger number of medical students and involving students naive to any ophthalmology experience will be an important future direction. Another possible confounder is the model eye group had more time for "hand-on" practice (10 minutes on model eye and 25 minutes with their partner vs. 25 minutes with partners in the preceptor group). While this was done to ensure an equal amount of time for both groups to practice on another person, the additional "hands-on" practice for the model eye group may have contributed to the difference between the two groups. The instruction of students in the preceptor teaching group was not recorded and while preceptors were given a checklist of skills to cover and a copy of the instructional video to watch ahead of time, we were unable to compare teaching points made by the preceptor to those made in the video or assess the variability between preceptor instruction on the study day. Some preceptors may have talked more than others and potentially demonstrated less. If performing the study on a larger scale, preceptors could be coached in what/how to teach to ensure video content and preceptor teaching are truly equal in the material, allowing better comparison of the teaching methods. Each student was assessed by only one blinded grader. In future studies, assessment by more than one grader could help mitigate observer bias. Strengths of this study include its randomized design and the use of both objective assessment with blinded graders as well as subjective assessment questions.

This study demonstrates that an instructional video combined with a simulation model is as effective as traditional preceptor teaching of the slit lamp exam. Such a teaching module can be a useful adjunct to traditional teaching methods. Future directions include validation of the study on a larger student population and assessing the feasibility of implementation.

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Conflict of Interest
None declared.

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