



# An Ophthalmology Virtual Externship during the COVID-19 Pandemic: A Pilot Study

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## Abstract

**Background** The evolution of medical school curricula, characterized by truncated preclinical periods and reduced emphasis on ophthalmology, presents formidable obstacles to early exposure for aspiring medical students. The constraints imposed by the coronavirus disease 2019 pandemic further exacerbated the limitations on opportunities, compelling the implementation of innovative initiatives aimed at augmenting students' ophthalmology education through virtual means.

**Purpose** This article assesses the impact of an Ophthalmology Virtual Externship (OVE) on medical students' knowledge, interest, confidence, and seeking mentorship in ophthalmology.

**Materials and Methods** A total of 76 students voluntarily participated in the program. The OVE encompassed four virtual sessions, facilitated by 4th year medical students employing a near-peer mentorship framework. The initiative was tailored for 2nd and 3rd year medical students and was conducted under the supervision of a faculty member. All participating students completed both pre- and postexternship surveys utilizing a 7-point Likert scale to gauge their levels of interest, confidence, and inclination toward mentorship opportunities in the field of ophthalmology. Furthermore, assessments of ophthalmology knowledge were administered prior to and subsequent to the externship participation. The degree of satisfaction derived from the OVE experience was also evaluated.

**Results** Participation in the OVE significantly elevated confidence in knowledge ( $p < 0.001$ ) and mentorship interest ( $p = 0.029$ ). Ophthalmology knowledge test scores also notably improved post-OVE across all participants, irrespective of prior experience ( $p < 0.001$ ), with the most significant increase observed among 2nd and 3rd year students ( $p < 0.0001$ ). After OVE participation, 73% of students expressed intent to pursue ophthalmology opportunities, including mentorship or research. The OVE received an average Likert score of 6.35 out of 7 for student satisfaction.

## Keywords

- ▶ virtual externship
- ▶ ophthalmology
- ▶ confidence
- ▶ mentorship

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**Conclusion** The OVE serves as a virtual learning instrument beneficial for 2nd and 3rd year students with a proclivity for ophthalmology, offering a means to circumvent curriculum-related constraints. Moreover, given the decline in formal ophthalmic education, our study contributes to future research assessing the effectiveness of an OVE in addressing ophthalmic knowledge gaps among all medical students.

Traditionally, across diverse medical disciplines, clinical opportunities have manifested in the form of externships, offering medical students a potential avenue for discovering their desired specialties and enhancing their medical knowledge.<sup>1-4</sup> The onset of the coronavirus disease 2019 (COVID-19) pandemic in 2020 introduced an array of challenges to the United States' medical education system, prompting a shift in information dissemination to students. In response, medical educators swiftly embraced contemporary teaching methodologies encompassing self-directed learning and virtual instruction. For instance, Yale Medical School introduced a "Quarantine Curriculum," employing interactive online lectures for foundational topics in psychiatric neuroscience, complemented by self-study resources.<sup>5</sup> Similarly, Imperial College of London integrated a "digital clinical placement," simulating bedside teaching through weekly interactive online cases, supplemented by webinar feedback.<sup>6</sup> At the University of Washington School of Medicine, a virtual internal medicine subinternship emerged, led by near-peer educators facilitating online case discussions and personalized independent learning plans for senior medical students.<sup>7</sup> In this swiftly evolving landscape, virtual learning has expeditiously evolved into the paradigm for contemporary medical education.

It is incumbent upon specialty leaders and educators to attract aspiring medical students to their respective domains.<sup>8,9</sup> Despite ophthalmology being a competitive field, many medical institutions are reducing the extent of ophthalmology exposure within their foundational science curricula.<sup>10-12</sup> A 2018 survey revealed that only 16% of medical schools mandated a clinical rotation in ophthalmology.<sup>8</sup> Enhancing students' engagement with ophthalmology, particularly amidst the challenges of the COVID-19 pandemic, poses an ongoing educational quandary. This has led to fewer than 50% of incoming residents meeting the ophthalmology competency standards as outlined by the Association of University Professors in Ophthalmology (AUPO).<sup>13-15</sup> In response, the Kresge Eye Institute at Wayne State University School of Medicine established the Ophthalmology Virtual Externship (OVE), designed to offer medical students enhanced learning prospects and greater familiarity with ophthalmology. This pilot study was primarily conducted to assess the impact of the OVE, indicating a noteworthy elevation in medical students' knowledge, confidence, and propensity to seek mentorship within ophthalmology. Additionally, as a secondary outcome the study explored the perspective of 4th year medical students serving as junior professors in the program, revealing an enjoyable experience

coupled with an augmentation of teaching skills and ophthalmology expertise.

## Materials and Methods

### Virtual Externship Program and Student Enrollment

Our study received Institutional Review Board (IRB) exemption from the IRB at Wayne State University, rendering individual consent unnecessary. The OVE program was executed in May 2020 through the Zoom platform and was extended to 2nd, 3rd, and 4th year medical students enrolled at Wayne State University School of Medicine. A total of 76 students voluntarily engaged in the program.

The OVE initiative comprised four 2-hour interactive sessions, comprehensively addressing various fundamental ophthalmology subjects, including but not limited to anatomy, glaucoma, neuro-ophthalmology, oculoplastics, cornea, uveitis, pediatrics, and trauma. These sessions were led by a faculty preceptor, with 4th year medical students serving as near-peer "junior professors" delivering the lectures. The selection of junior professors was derived from the pool of medical students applying for ophthalmology in that particular year. The faculty preceptor was present throughout the teaching session, offering support to junior professors in elucidating intricate topics and supplementing each lecture with additional instructional insights. Optionally, weekly American Academy of Ophthalmology (AAO) case assignments were administered by faculty members.

### Survey and Test Design

The participants in the OVE were required to complete confidential surveys (→ **Table 1**) and take pre- and postprogram tests. The presurvey encompassed inquiries concerning students' rankings of their interests and perceived confidence in ophthalmology. Additionally, participants were queried about their previous experiences in ophthalmology and their comfort levels in pursuing mentorship opportunities. The postsurvey paralleled the presurvey, augmented by supplementary questions gauging their contentment with the externship. Optional self-study AAO case assignments were also included. Furthermore, the 4th year medical students who served as junior professors were surveyed about their teaching experiences and general satisfaction with their instructional role in the OVE.

A 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), was employed in the surveys. The tests comprised 12 questions selected from the AUPO Web site. Pre- and postexternship student performance was

**Table 1** Survey questions and knowledge-based questions<sup>a</sup>

Demographic questions
1. What year of medical school will you be in September 2020?
2. Have you previously shadowed an Ophthalmologist?
3. Have you ever participated in ophthalmology research?
4. Have you previously participated in outreach or volunteer eye care events related to ophthalmology?
5. How many ophthalmology electives have you taken? (If you are currently in an elective, please count as yes)
6. Please list any other experience in Ophthalmology prior to this Virtual Ophthalmology Externship
Confidence questions
7. I am comfortable with my understanding of basic ophthalmology <sup>a</sup>
8. I am comfortable with my understanding of clinical ophthalmology <sup>a</sup>
9. I feel knowledgeable enough to discuss eye health with patients <sup>a</sup>
Interest question
10. I am interested in Ophthalmology as a potential career specialty <sup>a</sup>
Mentor questions
11. I feel comfortable reaching out to senior students for advice regarding research in Ophthalmology <sup>a</sup>
12. I feel comfortable reaching out to senior students for advice if I consider applying to Ophthalmology residency <sup>a</sup>
Miscellaneous questions
13. What are your goals for participating in this Ophthalmology Externship?
14. As a student in this virtual externship class, I will adhere to professionalism and the honor system regarding attendance and survey completion. I will not look up or discuss the quiz answers prior to taking this 12 question quiz. I understand the results are anonymous, and this quiz is to help in my learning through the externship. I will not copy or share the quiz or externship materials
Knowledge-based questions
15. A 25-year-old female presents with sudden onset of left eye vision loss that is accompanied by pain with eye movement and reduced color vision. She reports a similar episode that occurred two years ago, along with an incidence of urinary incontinence 6 months ago. What is the patient's most likely diagnosis?
16. A 35-year-old male who has worn glasses since youth presents with new onset of multiple floaters, flashes, and a dark curtain obscuring his vision. He noticed the symptoms shortly after hitting his head four hours ago. The patient denies any loss of consciousness, confusion, nausea, or vomiting. What is the next step in management?
17. A 30-year-old female with a recent upper respiratory tract infection presents with bilateral eye redness and watery discharge. She reports that her ocular symptoms began with burning, redness, and tearing affecting her right eye two days ago, and are now affecting her left eye as of this morning. In addition to diffuse conjunctival injection, physical exam is also significant for a palpable pre-auricular node on the right. What is the most likely diagnosis?
18. A 35-year-old male with a long-standing history of asthma since childhood presents with bilateral decreased vision over several months, especially apparent while reading. The patient uses a steroid inhaler daily and has required intermittent steroid use over the past several years. What is the next best step in management for this patient?
19. The patient is a 65-year-old female on chronic immunosuppressant therapy who presents with a several-day history of right eye redness, mild pain, tearing, and blurred vision. Slit lamp examination reveals corneal dendritic ulcers. Which of the following is the most likely diagnosis?
20. Which of the following does NOT typically cause a relative afferent pupillary defect (RAPD)?
21. A 4-year-old child who wears glasses presents for his annual visit to his pediatrician. His physical exam is normal except that the red reflex cannot be observed in his left eye. As you examine the affected eye more closely, you notice a whitish appearance near the pupil. Which would most likely NOT be included in a differential diagnosis for this child?
22. What can prevent the progression of dry age-related macular degeneration (ARMD)?
23. Which of the following is/are risk factor(s) for developing primary open-angle glaucoma?
24. A 60-year-old African American female with a history of seizures, diabetes mellitus, and hypertension presents with significant abdominal pain that is associated with nausea. She also reports seeing halos around lights. On exam, her right eye is red with a fixed mid-dilated pupil. When you cover her left eye, she notes decreased vision. Which of the following is a risk factor(s) for this patient's most likely diagnosis?
25. What anatomical structures make up the angle that aqueous fluid drains through?

(Continued)

**Table 1** (Continued)

26. A 28-year-old patient with no past medical history presents to your clinic with eye irritation. He has a swelling as pictured below. Which of the following is the most appropriate treatment?

Note: Survey questions and knowledge based test (questions derived from Association of University Professors in Ophthalmology [AUPO]) completed by medical student participants.

<sup>a</sup>Measured on a 7-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree).

juxtaposed, forming the quantitative assessment of the virtual externship's impact on students' learning.

### Data Collection and Analysis

The data were presented as mean values  $\pm$  standard deviation. Statistical analyses were conducted using IBM SPSS Statistics (Version 25.0, IBM Corp., Armonk, NY). The unpaired Student's *t*-test was employed for the juxtaposition of continuous variables within two groups. Statistical significance was achieved at a threshold of  $p < 0.05$ . The chi-square test of independence was applied to evaluate differences in categorical variables, and Spearman's rank correlation was utilized to quantify the strength of association among ranked variables.

## Results

### Demographic Information

A total of 76 medical students actively engaged in the OVE, ultimately completing both a presurvey and a pretest, while 70 successfully concluded the postsurvey, and 64 accomplished the posttest. The surveys encapsulated information about the participants' academic year within medical school and any pertinent prior exposure to ophthalmology before their participation in the OVE. Out of the initial cohort of 76 surveyed students, the distribution included 1 first-year student, 25 second-year students, 38 third-year students, and 12 fourth-year students. A notable 33 (43%) students had previously shadowed an ophthalmologist, while 26 (34%) had participated in ophthalmology research endeavors. Furthermore, 45 (59.21%) participants had actively engaged in volunteer or outreach activities connected to ophthalmology, and 9 (12%) had prior exposure to ophthalmology electives. Additionally, students reported other experiences including involvement in interest groups, scribing, journal clubs, workshops, and resident buddy programs.

### The Impact of the OVE on Interest, Confidence, and Seeking Mentorship in Ophthalmology

The participants of the OVE were administered pre- and postexternship surveys, aimed at gauging their self-assessed confidence in ophthalmological knowledge, their level of interest in the field, and their comfort in seeking mentorship for guidance. To comprehensively evaluate the impact of the OVE on students' overall confidence, interest, and comfort, an independent samples *t*-test was employed to contrast the pre- and postsurvey outcomes. The analysis revealed a noteworthy increase in confidence regarding ophthalmological knowledge ( $3.842 \pm 1.510$  vs.  $5.619 \pm 0.852$ ,  $p < 0.001$ ). However, this change was not mirrored in students' interest in the field of ophthalmology ( $p = 0.480$ ) or in seeking mentorship ( $p = 0.085$ ) (► **Table 2**).

An additional analysis, utilizing an independent samples *t*-test, was undertaken to investigate potential associations between prior ophthalmology experiences and discrepancies in students' pre- and postsurvey outcomes. Prior shadowing emerged as significantly linked with a notable elevation in confidence ( $4.110 \pm 1.440$  vs.  $5.440 \pm 1.286$ ,  $p < 0.001$ ), interest ( $5.630 \pm 1.040$  vs.  $6.480 \pm 0.854$ ,  $p < 0.001$ ), and comfort seeking mentorship ( $5.530 \pm 1.180$  vs.  $6.100 \pm 1.070$ ,  $p = 0.003$ ).

Likewise, research experience was significantly linked with heightened confidence ( $4.320 \pm 1.500$  vs.  $5.350 \pm 1.347$ ,  $p < 0.001$ ) and interest ( $5.720 \pm 1.070$  vs.  $6.510 \pm 0.800$ ,  $p < 0.001$ ). However, there was no significant association with comfort seeking mentorship ( $p = 0.081$ ).

Furthermore, outreach experience demonstrated a significant connection with an elevation in confidence ( $4.230 \pm 1.570$  vs.  $5.010 \pm 1.412$ ,  $p = 0.002$ ) and interest ( $5.470 \pm 1.120$  vs.  $6.370 \pm 0.823$ ,  $p < 0.001$ ), though not with a surge in comfort related to seeking mentor relationships ( $p = 0.276$ ) (► **Table 3**).

Furthermore, a comparative analysis of pre- and postsurvey outcomes was executed, stratified by the year of medical school, employing independent samples *t*-tests. Regarding

**Table 2** Independent samples comparison of confidence, interest, and mentorship in all students pre- versus postsurvey

	Presurvey (n = 76) Mean $\pm$ SD	Postsurvey (n = 70) Mean $\pm$ SD	p-Value <sup>a</sup>
Confidence	3.842 $\pm$ 1.510	5.619 $\pm$ 0.852	< 0.001
Interest	6.066 $\pm$ 0.998	5.943 $\pm$ 1.102	0.480
Mentorship	5.579 $\pm$ 1.329	6.000 $\pm$ 0.921	0.085

Abbreviation: SD, standard deviation.

<sup>a</sup>p-Value based on Brunner–Munzel test.

**Table 3** Independent samples comparison of prior ophthalmology experience and change in presurvey versus postsurvey results

Prior ophthalmology experience		Presurvey (n = 76) Mean ± SD	Postsurvey (n = 70) Mean ± SD	p-Value <sup>a</sup>	Effect size (Cohen's d)
Shadowing	Confidence	4.110 ± 1.440	5.440 ± 1.286	< 0.001	0.961
	Interest	5.630 ± 1.040	6.480 ± 0.854	< 0.001	0.885
	Mentorship	5.530 ± 1.180	6.100 ± 1.070	0.003	0.503
Research	Confidence	4.320 ± 1.500	5.350 ± 1.347	< 0.001	0.716
	Interest	5.720 ± 1.070	6.510 ± 0.800	< 0.001	0.806
	Mentorship	5.630 ± 1.270	6.040 ± 0.919	0.081	0.349
Outreach	Confidence	4.230 ± 1.570	5.010 ± 1.412	0.002	0.937
	Interest	5.470 ± 1.120	6.370 ± 0.823	< 0.001	0.525
	Mentorship	5.650 ± 1.250	5.870 ± 1.104	0.276	0.185

Abbreviation: SD, standard deviation.  
<sup>a</sup>p-Value based on Brunner–Munzel test.

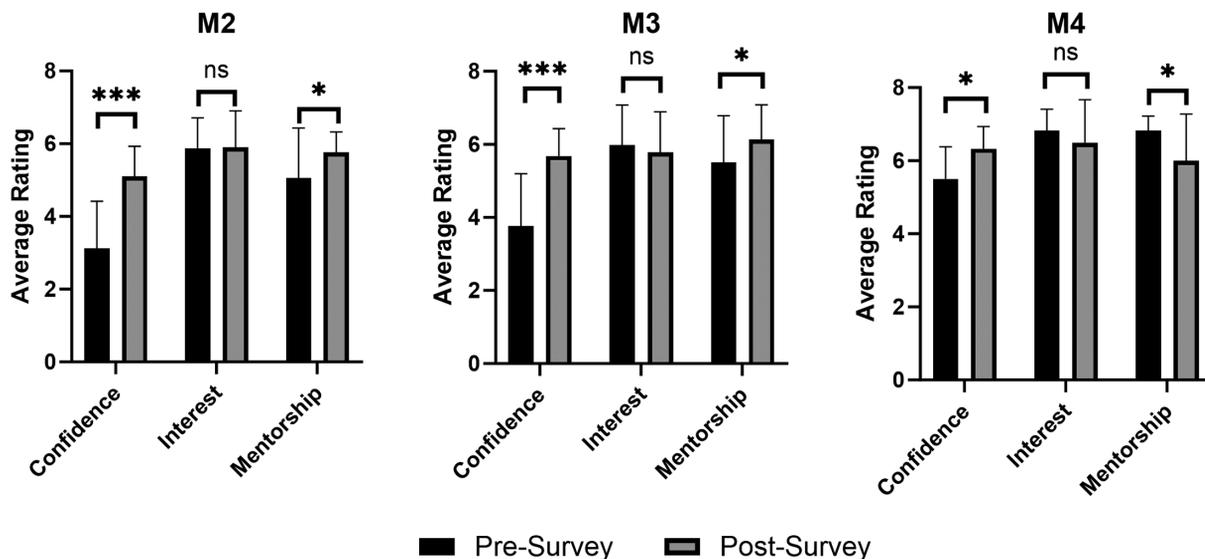
the augmentation of confidence in ophthalmology knowledge, 2nd year students ( $3.120 \pm 1.298$  vs.  $5.095 \pm 0.838$ ,  $p < 0.001$ ), 3rd year students ( $3.772 \pm 1.425$  vs.  $5.685 \pm 0.745$ ,  $p < 0.001$ ), and 4th year students ( $5.500 \pm 0.882$  vs.  $6.333 \pm 0.603$ ,  $p = 0.013$ ) all exhibited significant associations with an increase in confidence. However, none of the academic years displayed a significant association with heightened interest. Notably, 2nd year students ( $5.060 \pm 1.372$  vs.  $5.762 \pm 0.562$ ,  $p = 0.034$ ) and 3rd year students ( $5.513 \pm 1.271$  vs.  $6.135 \pm 0.948$ ,  $p = 0.019$ ) demonstrated a substantial increase in comfort related to seeking mentorship (→ Fig. 1).

**The Impact of the OVE on Students' Knowledge in Ophthalmology**

Students underwent a comprehensive assessment of their ophthalmology knowledge through a 12-question pre- and posttest evaluation. Out of the initial cohort of 76 students

who participated in the test, 64 completed both the pre- and posttests following their engagement in the OVE. To explore potential associations between prior ophthalmology exposure—encompassing research, shadowing, and outreach/volunteering—and attaining a score above 70%, a chi-square test of independence was executed on the pretest outcomes. Specifically, prior shadowing (chi-square [1, N = 76] = 6.720,  $p = 0.010$ ) and research experience (chi-square [1, N = 76] = 9.520,  $p = 0.002$ ) exhibited a statistically significant correlation with scores surpassing 70%. However, no substantial association was found between prior outreach experience and achieving scores above 70% ( $p = 0.407$ ) (→ Table 4).

A Spearman's rank correlation analysis was undertaken to elucidate the relationship between a student's current academic year and their pretest performance. Evidently, a moderately positive correlation emerged ( $\rho [74] = 0.488$ ,  $p < 0.001$ ).



**Fig. 1** Comparison of pre- and postexternship interest, confidence, and seeking mentorship in ophthalmology in 2nd, 3rd, and 4th year medical students. ns, not significant. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

**Table 4** Association of prior ophthalmology exposures with scoring above 70% on for OVE participants

Experience	Exposure ( <i>n</i> = 76)		<i>p</i> -Value <sup>a</sup>
	Yes	No	
Shadowing	33	43	0.010
Research	26	50	0.002
Outreach	45	31	0.407

Abbreviation: OVE, Ophthalmology Virtual Externship.

<sup>a</sup>Chi-square continuity corrected *p*-values.

**Table 5** Independent samples comparison of ophthalmic knowledge (KBQ) in all students pre- versus posttest

	Pretest ( <i>n</i> = 76) Mean ± SD	Posttest ( <i>n</i> = 64) Mean ± SD	<i>p</i> -Value <sup>a</sup>
KBQ (15–26)	6.800 ± 2.040	9.450 ± 2.130	< 0.001

Abbreviations: KBQ, Knowledge-Based Questions; SD, standard deviation.

Note: Means represent number correct out of 12.

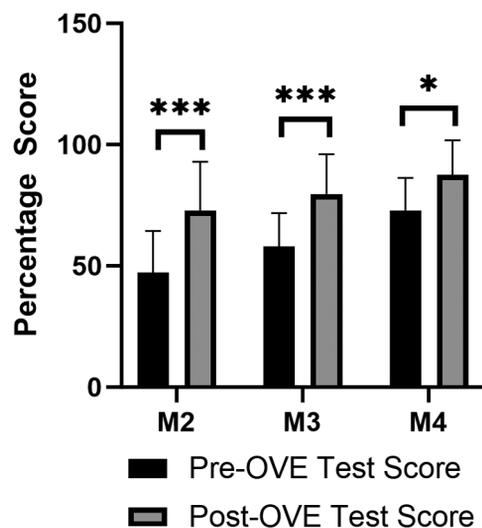
<sup>a</sup>*p*-Value based on Brunner–Munzel test.

An independent samples *t*-test was undertaken to analyze the disparity in ophthalmic knowledge before and after the OVE. The outcomes distinctly revealed a substantial enhancement in ophthalmic knowledge subsequent to OVE participation (6.800 ± 2.040 vs. 9.450 ± 2.130, *p* < 0.001) among the entirety of the medical student cohort (►Table 5).

To elucidate potential disparities in the performance of medical students across different years of study on the Knowledge-Based Questionnaire, independent samples *t*-tests were conducted to contrast their scores before and after the OVE program. The 2nd year students exhibited a substantial score augmentation (5.680 ± 2.056 vs. 8.750 ± 2.403, *p* < 0.001), as did the 3rd year students (6.947 ± 1.676 vs. 9.559 ± 1.972, *p* < 0.001), and 4th year students (8.750 ± 1.603 vs. 10.500 ± 1.716, *p* = 0.022). This

collective evidence underscores a notable increase in scores across all academic levels subsequent to their participation in the OVE program (►Fig. 2).

A chi-square test of independence was conducted to assess the association between pretest and posttest outcomes for individual questions. Globally, students exhibited statistically significant improvements in their performance on 9 out of the 12 knowledge-based questions. Questions 1, 10, and 11 did not yield statistically significant differences (*p* > 0.050). These questions encompassed topics in neuro-ophthalmology, glaucoma, and general ophthalmology, respectively. The questions manifesting the most substantial shifts were Q8 and Q9 (*p* < 0.001), which exhibited the most pronounced deficits in the pretest. These two questions pertained to different domains, specifically retina and glaucoma. The remaining questions, Q1 to 7 and Q12, all demonstrated statistically significant enhancement (*p* < 0.050) (►Table 6).



**Fig. 2** Comparison of test scores pre- and postexternship in 2nd, 3rd, and 4th year medical students. ns, not significant. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.0001.

### Satisfaction of the OVE

Medical students indicated a robust level of satisfaction with the OVE, recording an average Likert score of 6.35 out of 7 (►Table 7). Notably, the spectrum of satisfaction scores exhibited variability across different academic years, with 2nd year students reporting the lowest score (6.21) and 4th year students attaining the highest (6.56). When stratified by ophthalmology exposure, students who had undergone all three ophthalmology experiences reported an aggregated satisfaction rating of 6.44, while those without any prior experience registered a score of 6.24.

A noteworthy 87% of participants expressed appreciation for the virtual format employed in the externship, attributing to it an augmentation of their comprehension of ophthalmic disease processes. Pertaining to the quality of lectures, students bestowed an average rating of 6.37 out of 7, signaling a high level of approval for the educational content delivered.

**Table 6** Pre- and postsurvey knowledge-based questions (Q1–12): results for OVE participants

Question	Pre, n = 76, Post, n = 64		p-Value <sup>a</sup>
	Correct responses (%)		
1	87	89	0.950
2	86	98	0.016
3	66	86	0.011
4	68	84	0.046
5	66	89	0.002
6	45	66	0.021
7	37	63	0.004
8	30	75	< 0.0001
9	11	67	< 0.0001
10	54	64	0.130
11	53	67	0.150
12	79	97	0.004

Abbreviation: OVE, Ophthalmology Virtual Externship.

<sup>a</sup>Chi-square continuity corrected *p*-value.

**Table 7** Satisfaction ratings among student participants

Category	Satisfaction rating Mean ± SD
Overall satisfaction (all classes)	6.35 ± 0.326
2nd year satisfaction	6.21 ± 0.372
3rd year satisfaction	6.36 ± 0.373
4th year satisfaction	6.56 ± 0.291
Students with all 3 experiences	6.44 ± 0.304
Students with no experiences	6.29 ± 0.547
Quality of lectures	6.37 ± 0.383

Abbreviation: SD, standard deviation.

Note: Measured on a 7-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree).

### The Experience and Satisfaction of the OVE in Junior Professors

All 12 fourth year students selected as junior professors successfully completed the Junior Professor Survey (► **Supplementary Table S1** [available in the online version]). Among them, 50% of junior professors acknowledged that this engagement marked their inaugural experience in delivering lectures to 2nd and 3rd year medical students. The junior professors were queried on aspects encompassing the impact of the externship on their instructional acumen, comfort level in virtual presentation, and perceived program advantages. Following their participation in the OVE, their confidence in conducting subsequent virtual lectures exhibited a statistically significant enhancement, rising from a mean of 5.0 to 6.33 out of 7 ( $p < 0.001$ ). Moreover, a substantial 70% of participants expressed strong agreement in the

notion that their teaching skills improved through their involvement in the externship.

Students' perspectives were also solicited concerning their overall contentment with the OVE and their roles as junior professors. Impressively, 83% of respondents strongly concurred that the process of preparing lectures contributed to their comprehension of ophthalmic diseases and their underlying pathophysiology. An overwhelming majority (83%) expressed strong agreement with the proposition that the OVE could serve as a valuable supplement to the medical school curriculum. Notably, all participants were unanimous in their view that the conception of analogous programs for other medical specialties would yield positive outcomes.

### Discussion

Externships provide students with a valuable avenue to broaden their knowledge base, explore their interests, and initiate the development of the necessary confidence for pursuing a specialized medical career<sup>1–4</sup>. The advent of the COVID-19 pandemic necessitated the adoption of virtual platforms for sustaining clinical medical education. In response, the Kresge Eye Institute at Wayne State University School of Medicine introduced the OVE program, aiming to facilitate medical students' engagement with ophthalmology. To the best of the authors' knowledge, this study represents the pioneering effort in investigating the impact of a virtual externship within the field of ophthalmology. The present study demonstrates that participation in the OVE program significantly enhances students' knowledge, confidence, and propensity to seek mentorship in ophthalmology.

Overall, students exhibited a high level of satisfaction with the virtual externship, with an average score of 6.35 out of 7. This satisfaction was substantiated by their sustained engagement in ophthalmology activities over an extended period. Six weeks post the virtual externship, students reported active involvement in ophthalmology research, mentorship seeking, and enrollment in webinars and elective courses. Remarkably, this heightened satisfaction was attained without impinging upon the demands of their medical school curriculum, a notable achievement given the compressed timelines of preclinical years and rigorous clerkship schedules for medical students.<sup>16,17</sup> In this context, the virtual externship presents an efficient and gratifying avenue to introduce students to ophthalmology, especially considering the constraints posed by abbreviated summers and intensive academic calendars.

Students expressed a preference for the interactive format of the virtual externship over traditional in-person lectures and prerecorded online sessions. Such insights hold significance as medical education progressively integrates technological advancements.<sup>18,19</sup> The merits of the virtual platform encompass the flexibility it offers in terms of students' preferred learning environments, streamlined interactions through features like group chats for real-time anonymous questioning, and the stimulation of interactive digital resources to facilitate effective learning.<sup>20,21</sup> These attributes align

with the evolving landscape of medical education and its growing reliance on technology.

Of note, there was no significant change between pre- and postexternship interest ratings. This is likely due to the self-selective nature of the externship. Participation was optional and likely fueled by prior interest in the field. Additionally, high interest levels preexternship was expected for the 4th year students as they were applying to ophthalmology residency that year.

Within the current framework of medical school curricula, the exposure of students to ophthalmology remains notably restricted.<sup>8</sup> This constraint likely contributes to the discernibly modest confidence scores evident in the preliminary survey. The OVE initiative systematically addresses a multitude of ophthalmology competencies as delineated by the guidelines set forth by the AUPO<sup>13-15</sup>; these competencies are deemed imperative for prospective physicians' comprehension and adept management. Through our investigation, we have substantiated that active engagement in the OVE engenders a marked enhancement in confidence levels pertaining to ophthalmological knowledge. Furthermore, a statistically significant increase in examination scores spanning all academic years was observed post-OVE participation. This evidence collectively attests to both an objective augmentation in familiarity with ophthalmology and a subjective elevation in students' proficiencies.

Furthermore, to the best of our knowledge, this study represents the inaugural effort to elucidate the diverse effects of preceding student experiences on their holistic ophthalmic knowledge, along with their subjective sense of comfort and confidence in their capabilities. As anticipated, students with previous involvement in shadowing, research, and/or outreach exhibited elevated presurvey and test scores. Nonetheless, a notable discovery emerged: all students, irrespective of prior experience, exhibited comparable enhancements in both ophthalmic knowledge and their subjective confidence in the field subsequent to their participation in the OVE. The outcomes of our study substantiate the efficacy of a condensed, 1-month virtual program such as the OVE, which operates beyond the confines of the conventional medical school curriculum, in fortifying students' grasp of ophthalmological principles and bolstering their self-assurance within a compressed timeframe.

Given that each interactive lecture within the virtual externship was delivered by a 4th year medical student, an avenue emerged for 2nd and 3rd year medical students to establish a near-peer mentorship dynamic with their 4th year counterparts who shared an interest in ophthalmology. Near-peer tutoring initiatives have demonstrated their efficacy in enhancing knowledge and skills for both mentors and mentees, offering a low-stress educational milieu.<sup>22-24</sup> Subsequent to the externship, students conveyed increased ease in seeking mentorship and guidance from senior medical students, as indicated by notably elevated scores on questions related to mentorship-seeking subsequent to OVE participation. The establishment of mentor-mentee relationships between students and their seasoned peers assumes significance in nurturing interest and commitment

to specific medical disciplines.<sup>25-27</sup> Notably, there was a noteworthy decline in mentorship-seeking ratings among 4th year students following their participation in the OVE. This occurrence may be attributed to the fact that 4th year students were in the process of applying for ophthalmology residencies shortly after the OVE experience.

In aggregate, the junior professors expressed high levels of satisfaction with the program. They conveyed a positive experience as junior professors, expressed a willingness to participate again, and showed enthusiasm for recommending the program to those with an interest in ophthalmology. This elevated satisfaction is particularly noteworthy as the efficacy of the virtual externship hinged upon the active involvement of these junior professors. Positioned as intermediaries between learners and faculty, junior professors assume a pivotal role by bridging the gap between the student perspective and established faculty, thus fostering a more open and approachable academic discourse.<sup>28</sup> Furthermore, the act of preparing lectures emerged as a significant learning experience for junior professors. This process not only deepened their understanding of ophthalmic diseases but also bolstered their readiness for forthcoming ophthalmology rotations, thereby enhancing their ability to teach ophthalmic diseases to future patients.

The impact of the virtual format on junior professors was minimal, as indicated by their unaffected response. Moreover, their confidence in delivering virtual lectures witnessed an improvement following their participation in the virtual externship. This increased comfort with the virtual platform bears relevance in both the immediate and long-term contexts of medical education. In the short term, such proficiency becomes pertinent as students engage in virtual residency interviews, a trend accentuated during the pandemic.<sup>29</sup> Looking ahead, as medical education continues to embrace technologically advanced pedagogical methods,<sup>18,21,30</sup> the aptitude to navigate virtual platforms will undoubtedly prove advantageous.

## Limitations

The study exhibits several limitations. First, the OVE program was an elective course, resulting in a potential selection bias toward medical students with a preexisting interest in ophthalmology, as evident from our presurvey findings. Such students are likely to possess a higher degree of familiarity with the field, enhanced subject knowledge, greater confidence, and a heightened inclination to seek mentorship even before engaging in the OVE, thereby introducing a skew into our data. Second, the duration of follow-up in this study is short. A more extensive longitudinal investigation would be advantageous to ascertain the enduring impact of the virtual externship. It would be insightful to ascertain the extent to which participating students opt to pursue ophthalmology as a career, and whether the virtual externship plays a role in shaping this decision.

Third, the study incorporated 2nd, 3rd, and 4th year medical students within a singular instructional context. The distinct levels of medical knowledge among students across various stages of their medical education present potential confounds.

Subsequent research endeavors should consider segregating students by their academic years to tailor the intervention to their specific educational requirements, accounting for potential disparities in baseline knowledge. Fourth, the scope of our study is confined to ophthalmology. Exploring the impact of virtual externships on other specialties, especially those with limited coverage in medical school curricula like otolaryngology, radiology, orthopaedics, and others, would provide valuable insights into broader educational contexts.

Lastly, the study is limited by its modest sample size. Expanding the sample size would facilitate a more comprehensive assessment of the effectiveness and adaptability of an interactive virtual externship in enhancing medical student education.

## Conclusion

The virtual externship has demonstrated its efficacy through students' contentment, heightened confidence in ophthalmology, and the cultivation of mentorship relationships. Initiatives of this nature hold the potential to furnish early career exposure, a resource of immense worth for aspiring ophthalmologists. The junior professors, pivotal contributors to the virtual externship, also registered high satisfaction levels, expanding their knowledge and acquiring skills that bear prospective advantages. This hybrid format of virtual, interactive instruction has effectively fulfilled its intended purpose, offering an engaging educational experience to students amid the challenges posed by the COVID-19 pandemic. It is recommended that further examination of the OVE be undertaken to augment student learning, aligning with the progressive trajectory of technological advancements. Furthermore, our study has laid the groundwork for addressing ophthalmic knowledge disparities among all medical students, outside of the formal medical school curricula. Future research endeavors should consider investigating the feasibility of broadening the scope of ophthalmic knowledge assessment and clinical examination skills evaluation. This expansion would enable a comprehensive analysis of its impact on all medical students, thereby effectively addressing the deficiencies delineated by the AUPO guidelines.<sup>13-15</sup>

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### Conflict of Interest

None declared.

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