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Evaluation of a simulation-based ophthalmology education workshop for medical students: a pilot project

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Abstract

Background/Aims Ophthalmology is an under-represented specialty in many medical school curriculums resulting in reduced confidence in medical students and clinicians when dealing with eye conditions. Our study evaluates the impact of a simulation-based education (SBE) workshop to train medical students in ophthalmology.

Methods Second-year medical students were invited to participate in a two-day (eight-hour) simulation-based ophthalmology workshop. Standardised patients, free-to-use simulators, and low-cost eye models were used to teach eye anatomy, physiology, pathologies, skills (slit-lamp, ophthalmoscopy etc.), and eye procedures (cataract surgery, eye lasers etc.). Learners filled questionnaires to evaluate their ophthalmology interest, confidence, and knowledge before the workshop, immediately after the workshop, and three months later. They also answered a feedback survey on the workshop's quality and usefulness immediately after the workshop.

Results Nine students, including six females and three males, participated in the workshop. Pre-workshop, learners' mean self-reported confidence in dealing with ophthalmology patients was 1.8/5 and mean self-reported interest in pursuing an ophthalmology residency was 2.6/5 on a Likert-scale-based questionnaire (on a scale of 1–5). Learners scored a mean of 8.4/15 on an ophthalmology knowledge questionnaire with fifteen questions. Post-workshop (immediate), their mean self-reported confidence was 3.4/5 ($p=0.0001$), interest in pursuing an ophthalmology residency was 3.2/5 ($p=0.022$), and score on the ophthalmology questionnaire was 13/15 ($p=0.0001$). Three months later, students' self-reported mean confidence was 3.2/5 ($p=0.0001$), the likelihood of choosing ophthalmology residency was 2.8/5 ($p=0.59$), and score on the ophthalmology knowledge questionnaire was 11/15 ($p=0.006$). The feedback survey showed that all students found the workshop relevant, comprehensive, easy to understand, and that they gained knowledge/skills applicable to their future clinical practice.

Conclusions A small group SBE ophthalmology workshop improves learners' knowledge, skills, and confidence using an approach they find interesting, with low cost and time investment.

Trial registration Not applicable.

Keywords Simulation-based education, Medical education, Simulation-based ophthalmology, Ophthalmology education

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Background/Introduction

Ophthalmic complaints are common in primary care and emergency services, affecting an estimated 5–19% and 1.5% of visits, respectively, in these settings [1]. Several studies have highlighted the lack of confidence reported by medical students and practicing clinicians when dealing with eye conditions [2–7].

Ophthalmology is an under-represented specialty in many medical school curriculums [8, 9] and it has been suggested that if undergraduate ophthalmological teaching could be made more effective, the standard of primary ocular care would improve [10].

Simulation offers a safe environment where students are allowed to repeatedly practice a range of clinical skills without putting patients at risk. In traditional teaching techniques, there is a disconnect between the classroom and the clinical environment. To bridge this gap, simulation-based education (SBE) is increasingly being used in medical education.

Studies have shown that even a short ophthalmology training schedule (mini-elective) leads to significant improvement in ophthalmology knowledge and skills for medical students [11].

Currently, there is a paucity of literature on the effectiveness of SBE in ophthalmology for medical students.

The objective of our study was to evaluate the use of SBE in the field of ophthalmology for medical students through a small group, low-cost, short-duration training workshop to increase their knowledge, skills, and interest in ophthalmology.

Methods

This was a prospective study to evaluate the use of SBE in ophthalmology through a workshop for medical students.

The study was approved by the institutional ethics review board.

Second-year medical students at the Northern Ontario School of Medicine University (NOSM U) in Thunder Bay, Ontario (total class strength of 29 students for 2022 and 26 students for 2023) were invited to participate in a two-day simulation-based ophthalmology workshop via online posters through university emails. Two such workshops were conducted for this study, one in September 2022 and the other in September 2023.

The small group (limited to five participants) workshop was conducted over a weekend (Saturday and Sunday), from 8 am to 12 noon on both days, at the 'Eye Exam and Laser Room' and the 'Operating Room' at Thunder Bay Regional Health Sciences Centre by a local ophthalmologist (VB) and a simulation-based medical education expert (SB).

Inclusion criteria were second-year medical students at NOSM U who were willing and available to attend the workshop on both days and complete pre-and post-workshop questionnaires.

The medical students were provided with a schedule of the workshop including the location, timings, and what to expect on the days of the workshop via email two weeks before the workshop. The students were also required to fill an online pre-workshop questionnaire with their demographic details (age, sex), any prior experience in ophthalmology, and any prior experience of SBE. The questionnaire also included the students' self-reported confidence in their ophthalmology knowledge and skills (1 = no confidence at all; and 5 = very confident), and the likelihood of them choosing ophthalmology as a specialty for residency (1 = very unlikely; and 5 = almost certain) on a Likert-based scale. Students were also required to answer 15 multiple-choice questions to assess their baseline ophthalmology knowledge. (Supplement I)

The workshop included the following:

1. An overview of the workshop, basic eye anatomy and physiology, common eye pathologies, and theory of the skills that would be taught using a PowerPoint presentation.
2. Vision assessment using standardized vision charts with and without a pin-hole on standardized patients (SPs).
3. Pupil assessment including light reflex (direct, consensual, swinging flashlight test) and accommodation reflex testing on SPs.
4. Slit-lamp examination on SPs with un-dilated and dilated pupils.
5. Direct ophthalmoscopy, indirect ophthalmoscopy (20 D lens), and slit lamp biomicroscopy (90 D lens) on SPs with dilated pupils.
6. Intraocular pressure measurement on SPs using the iCare tonometer (iCare Inc.) and the Goldmann applanation tonometer.
7. Retinoscopy for refractive error assessment on SPs with dilated pupils and use of a retinoscopy simulator (https://www.aao.org/education/interactive-tool/retinoscopy-simulator) to learn and practice the basic principles of retinoscopy.
8. Ocular motility assessment (ductions, versions) on SPs and use of a strabismus simulator (https://www.aao.org/education/interactive-tool/strabismus-simulator) as an interactive tool to practice basic strabismus evaluation.
9. Use of eye models to teach basic eye anatomy and allow students to experience and practice eye procedures.

– Laser capsulotomy eye model (https://www.simuleye.com/products/p/simuleye-yag).

- Laser iridotomy eye model (https://www.simuleye.com/products/p/simuleye-lpi).
- Eye model for phacoemulsification cataract surgery (https://simulatedocularsurgery.com/products#!/Phaco-–-hard-lens-price-per-pack-of-8-eyes/p/213476580/category=0).
- Eye model for strabismus surgery (https://www.wrighteyecare.com/product/strab-lab-model-eyes/).

At the end of the second day, students completed the post-workshop questionnaire. Multiple choice questions were used again to assess their ophthalmology knowledge gained. Likert-based questions were used again to evaluate the learners' self-reported confidence in the assessing patients with ophthalmological conditions and the likelihood of choosing ophthalmology as a specialty for residency. (Supplement I)

The students were also asked to complete a feedback survey to provide insight into their experience of attending the workshop. This survey included questions (Likert scale-based: 1 = strongly disagree; and 5 = strongly agree) related to the workshop's objectives & content, facilitator, time management, whether they found it valuable, gained knowledge/skills that they will be able to apply to their future clinical practice, and whether the workshop increased their interest in the field of ophthalmology. Open-field questions were used to find out what they liked best and least about the workshop as well as for suggestions for improvement. The survey also included questions regarding their views on the inclusion of such workshops and other simulation-based activities in their medical school curriculum. (Supplement II)

Students' ophthalmology knowledge retention was re-assessed 3 months after the workshop using an online multiple-choice questionnaire. They were also asked about their self-reported confidence in the field and the likelihood of them choosing an ophthalmology residency again at this 3-month mark. (Supplement I)

Pre- and post-training scores were compared using paired t-tests. For the free text questions of the feedback survey, a descriptive analysis was conducted. A significance level of $p < 0.05$ was assumed for all tests.

Results

Nine (6 female, 3 male) second-year NOSM U medical students participated in the study, five in the workshop held in 2022 and four in the one held in 2023. The mean age of students was 27.1 ± 6.3 years.

Four out of the nine students (44%) had some previous ophthalmology training or experience in the form of an observership, research, or short clinical sessions with physicians. Four (44%) students had exposure to simulation-based educational activities (other than ophthalmology) in medical school in the past.

Pre-workshop, learners' self-reported confidence in dealing with ophthalmology patients was 1.8 ± 0.8 out of 5, and self-reported interest in pursuing an ophthalmology residency was 2.6 ± 1.5 out of 5. Pre-workshop, learners scored a mean of 8.4 ± 3.6 out of 15 on an ophthalmology knowledge questionnaire.

Post-workshop (immediate), their self-reported confidence was 3.4 ± 0.5 ($p = 0.0001$), interest in pursuing ophthalmology residency was 3.2 ± 1.5 ($p = 0.022$), and their score on the ophthalmology questionnaire was 13 ± 2.2 ($p = 0.0001$).

Three months post the workshop, students' self-reported confidence was 3.2 ± 0.4, the likelihood of choosing an ophthalmology residency was 2.8 ± 1.6, and the mean score on the ophthalmology knowledge questionnaire was 11 ± 3.2.

The difference between learners' self-reported confidence three months after the workshop was found to be statistically significant/higher ($p = 0.0001$) compared to their pre-workshop confidence and not statistically different ($p = 0.1690$) when compared with their confidence immediately after the workshop.

The learners' interest in pursuing an ophthalmology residency three months after the workshop was not statistically different compared with their interest before ($p = 0.5943$) and immediately after the workshop ($p = 0.1038$).

Learners' scores on the ophthalmology questionnaire three months after the workshop were statistically higher compared to their scores before the workshop ($p = 0.0060$) and significantly lower compared to their scores immediately after the workshop ($p = 0.0104$). (Table 1)

The responses to the feedback survey (immediate post-workshop) are shown in Table 2. All learners felt that the learning objectives of the workshop were clear (4.9/5)

Table 1 Learner confidence, interest, and knowledge pre- and post-workshop

	A: Pre-workshop (Mean ± SD)	B: Post-workshop (Mean ± SD)	C: 3 months post-workshop (Mean ± SD)	A vs. B *p* value	A vs. C *p* value	B vs. C *p* value
Learner confidence	1.8 ± 0.8/5	3.4 ± 0.5/5	3.2 ± 0.4/5	0.0001	0.0001	0.1690
Learner interest	2.6 ± 1.5/5	3.2 ± 1.5/5	2.8 ± 1.6/5	0.022	0.5943	0.1038
Learner knowledge	8.4 ± 3.6/15	13 ± 2.2/15	11 ± 3.2/15	0.0001	0.0060	0.0104

Table 2 Results of learner feedback survey

Questions	Score (out of 5)
WORKSHOP RELATED (1 = strongly disagree, 5 = strongly agree)	
1. The learning objectives of the workshop were clear.	4.9 ± 0.3
2. The learning objectives of the workshop were met.	5 ± 0
3. The workshop content was relevant.	4.8 ± 0.4
4. The workshop content was comprehensive.	4.8 ± 0.4
5. The workshop content was easy to understand.	4.9 ± 0.3
FACILITATOR RELATED (1 = strongly disagree, 5 = strongly agree)	
1. The main facilitator (ophthalmology) was knowledgeable.	5 ± 0
2. The main facilitator (ophthalmology) was effective in providing learning on the workshop topics.	5 ± 0
3. The facilitators were well prepared.	4.9 ± 0.3
4. The facilitators were responsive to participant questions.	4.9 ± 0.3
TIME-RELATED QUESTIONS (1 = strongly disagree, 5 = strongly agree)	
1. There was enough time to learn and practice ophthalmology skills.	4.4 ± 0.9
2. There was adequate time for discussion.	4.9 ± 0.3
OTHERS (1 = strongly disagree, 5 = strongly agree)	
1. You gained knowledge and skills that you will be able to apply later on in clinical practice.	5 ± 0
2. This workshop built or increased my interest in the field of ophthalmology?	4.3 ± 0.9
3. The simulation-based ophthalmology workshop should be offered again next year.	4.9 ± 0.3
4. In your opinion, should simulation-based activities be included in your medical school curriculum?	5 ± 0
EDUCATIONAL VALUE (1 = no educational value, 5 = very valuable educational experience)	
1. Please rate the overall educational value of this workshop.	4.9 ± 0.3

and met (5/5). All learners felt that the workshop was relevant (4.8/5), comprehensive (4.8/5), easy to understand (4.9/5), and that they gained knowledge/skills that they will be able to apply to their future clinical practice (5/5). They found the facilitator to be knowledgeable (5/5), effective in providing learning on the workshop topics (5/5), well-prepared (4.9/5) and responsive to participant questions (4.9/5). They agreed that there was adequate time for discussion (4.9/5). As for there being enough time to learn and practice ophthalmology skills during the workshop, the mean score of the participants was 4.4/5 with two students rating it neutral. The overall educational value of the workshop was rated 4.9/5. All students agreed that the simulation-based ophthalmology workshop should be offered again next year (4.9/5) and that simulation-based activities should be included in the medical school curriculum (5/5).

A selection of students' quotes in response to the open-ended questions in the survey are listed below.

When the learners were asked what they liked best about the workshop, they responded with–

- "surgical simulations",
- "small group size maximizing time with equipment",
- "excellent facilitator feedback throughout",
- "applying tests to real life pathologies",
- "increase of confidence level",
- "hand-on opportunities",
- "ability to ask questions at any point",
- "very comfortable learning environment", and
- "practical component".

When asked what they liked least about the workshop, they responded with–

- "would like more hands-on with the equipment to further increase familiarity", and
- "would have liked more time to practice the skills that we learned, particularly the surgical skills".

When asked about the overall experience, comments, and suggestions for improvements, the responses received were as follows-

- "My overall experience was great. This workshop expanded on most of the ophthalmology concepts taught in the first year and gave insight into the common exams/procedures that I found very useful",
- "This was a very comfortable learning environment, with lots of positive reinforcement and I felt there was a lot of valuable information covered that was also tailored to the group. Explanations of procedures and conditions were very clear, and there was good use of group participation. I liked the combination of a standardized patient as well as the use of models. An improvement could be to hold a refresher session in a few months with some case studies and hands-on with the equipment.",
- "I honestly wish that more of my classmates attended. Something that I think would get them

interested would be to state that this is for ANYONE, regardless of what specialty of medicine you would like to go into.",

- "I would strongly advocate running this for future years to come! This was a fantastic workshop and I truly feel like I learned so much",
- "Excellent workshop especially since this material is not covered in our course material."

There was no attrition of participants in our study and all learners participated in pre- and post-surveys.

Discussion

Our study shows that providing ophthalmology exposure and training to medical students through low-cost, short-duration simulation-based education, has the potential to improve learner knowledge, skills, confidence, and interest; in a learning environment that students find comfortable and enjoyable.

The International Council of Ophthalmology (ICO) recommends forty to sixty hours (or 5 to 8 days) of exposure to ophthalmology in medical schools which should cover the basic skills and knowledge of ophthalmology to provide primary eye care, teach the recognition of the ocular manifestations of systemic disease, and when to refer to an ophthalmologist [12]. However, a survey of US and Canadian medical schools done in 2012–2013 showed that ophthalmology is under-represented in many medical school curriculums [9]. This may result in a lack of confidence in clinicians when dealing with eye conditions. A survey revealed that 80% of Canadian family medicine residents felt either 'somewhat comfortable' or 'uncomfortable' when evaluating and managing ophthalmologic emergencies [13]. It has been suggested that optimizing ophthalmic medical student education will lead to improved primary ocular care [10]. However, in most medical school programs, it is often difficult to find time and resources to incorporate extra hours into the already busy curriculum. There is evidence that short training in the specialty leads to a significant improvement in medical students' ophthalmology knowledge and skills [11]. This suggests a clear need for educating medical students in ophthalmology while addressing limited time, cost, and human resources.

As in many other Canadian medical schools [14, 15], in NOSM U learners have limited clinical ophthalmology exposure with no compulsory/mandatory clinical rotation in ophthalmology during medical school. This probably results in reduced interest in pursuing the specialty and also limits the clinical skills of future general/family/emergency physicians regarding the treatment of common eye conditions. Only 5% NOSM U graduates choose sub-specialties such as ophthalmology, dermatology, and plastic surgery [16], which may add to the existing ophthalmology workforce shortages in Canada in the future [17]. A survey-based study done at a Canadian medical school revealed that students have a more favorable opinion of ophthalmology if they have had previous exposure to the field. It further emphasized that exposure to ophthalmology in the formative years improves students' interest in the field as well as helps them decide if they want to pursue a career in the specialty [17].

Through our short-duration, low-cost workshops, we have tried to meet this gap by providing training in ophthalmology in simulation form. SBE provides learning experiences in an era where access to clinical/patient encounters is limited. Using simulation-based education in healthcare allows individuals to gain knowledge, practice repeatedly/deliberately with expert feedback, make mistakes, learn from their mistakes without feeling undue pressure and gain confidence/competence without putting patients at risk, in a comfortable learning environment which arouses interest [18]. Ophthalmology training benefits from SBE at both undergraduate and postgraduate levels and simulation has become a new tool in ophthalmology to achieve better results in medical and surgical procedures as well as in improving outcomes and quality of care [18, 19]. Cook et al. conducted a meta-analysis comparing technology-enhanced simulation training for medical professionals with no intervention. They found that the simulation training was consistently and positively associated with large effects for outcomes of knowledge, skills, and behaviors of medical professionals and moderate effects for patient-related outcomes [20]. However, there is limited literature available on the use of SBE for medical students [21–23].

We have described the components of our SBE workshop in this article to show that a short-duration, low-cost program with excellent learner feedback can be implemented by other institutions interested in providing ophthalmology SBE. In terms of commitments and resources, it is not as onerous as a clinical rotation in ophthalmology and is easily reproducible. Also, we used standardized patients, free-to-use simulators, and low-cost eye models for our workshop to allow it to be more accessible to all institutions in contrast to some expensive simulators available on the market [22].

When designing a SBE workshop for medical students, the learners' training level, the facilitators' experience, knowledge/skills and motivation, as well as the goals of the training should be considered [24]. For our workshop, we targeted second-year medical students at NOSM U, as they have some theoretical knowledge of ophthalmology through lectures in their first year, but have still not completed their clinical rotations and made their choice of residency specialties, which happens in the third and fourth year. This also allows interested students to further explore ophthalmology through additional elective

rotations in the fourth-year. This was done based on consultations with previous students as well as faculty at NOSM U, to help learners gain knowledge and skills that they would be able to apply to their future practice as well as to increase their interest in pursuing ophthalmology. We wanted to keep learners' participation voluntary, to avoid burdening them with additional training and to ensure that they were self-motivated to participate in and learn from our workshop. We involved an ophthalmologist and a simulation medical education expert in the creation, design, and scheduling of the workshop. Involved, interested, and motivated faculty can offer their expertise and serve as role models and mentors to the learners [1]. Our group size was limited to 4–5 to allow for maximal individual learner attention as well as time and resources for practice. Learners practiced in groups of 2–3 aiding each other to allow for collaborative learning since studies have shown that learning in pairs compared with individual learning in a simulated setting leads to better skills retention [25, 26] and non-inferior skills transfer to the clinical workspace [27]. The workshop was spread over two days to allow candidates time to assimilate information, practice skills, and to avoid overloading them with information. From the feedback received, we think it may be useful to add another standardized patient and an extra hour to allow participants more time and resources to practice skills. Also, we included the performance of laser and surgical procedures, even though medical students would not be expected to know these technicalities, to arouse learner interest in the specialty. As is evident from the feedback we received, these procedures were amongst the most appreciated contents of the workshop.

We evaluated the effectiveness of our workshop training using level 1 and level 2 of Kirkpatrick's four-level training evaluation model [28].

- Level 1 – Perception: Measuring the participant's reaction using the feedback survey.
- Level 2 – Learning: Measuring acquisition of knowledge and skills. We administered pre- and post-surveys to gauge student learning.

It is not surprising that the provision of additional training in ophthalmology increased the knowledge of medical students as well as their interest in the field of ophthalmology, as has been demonstrated in other studies as well [11]. We could not evaluate the third level of Kirkpatrick's model which indicates a behavior change in which the participants apply what they have learnt during a training workshop to the real world, but we could demonstrate an increase in self-reported confidence in dealing with ophthalmology patients immediately after the workshop which was maintained even three months later.

Our study also showed that time causes a loss of knowledge gained, as was demonstrated by our learner scores on the ophthalmology questionnaire in the 3-month post-workshop survey. Therefore, we recommend "top-up" sessions in the future to maintain and further build on the gains achieved. This is in line with the evidence in the literature which indicates that repeating teaching over time produces more durable learning [11]. Medical students need to be exposed to SBE repeatedly to be able to deliver clinical treatment competently [29]. However, learners still reported higher confidence in dealing with ophthalmology patients even 3 months after the workshop compared to their pre-workshop levels, which is further evidence of the effectiveness of SBE.

Our study has a few limitations. First, our pilot study had a small sample size of only nine participant learners. However, even with the small number, we were able to show statistically significant results with clear themes supporting the use of SBE in medical student ophthalmology training. Second, as participation in the study was voluntary, there may have been a selection bias - including only those medical students who were interested in learning ophthalmology skills as well as those interested in simulation. It will be interesting to see if there is any change in the results if all medical students were made to attend the workshop. Finally, every medical school curriculum, schedule, and priorities are different and the same SBE solution may not be a good fit everywhere. However, we believe that our basic, short-duration, low-cost program can be easily modified to allow it to be implemented at other institutions and be beneficial for medical student learning.

Conclusions

Our study shows that a small group SBE ophthalmology workshop provides learners with an opportunity to obtain practical and hands-on experience to improve learner knowledge, skills, and confidence. It can also increase learner interest in ophthalmology. This is especially important for those medical students who do not undergo mandatory, structured ophthalmology clinical rotations during their medical school training. We have described the components and design of our workshop, which can be customized and implemented by other institutions based on their local needs. Simulation-based ophthalmology education has the potential to produce well-trained clinicians and improve primary ocular care with low cost and time investment.

Abbreviations

SBE	Simulation-based education
NOSM U	Northern Ontario School of Medicine University
SPs	Standardized patients
ICO	International Council of Ophthalmology

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-06712-y.

Supplementary Material 1

Supplementary Material 2

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Author contributions
VB and SB both were involved in the conception, design and conduct of the study. Both VB and SB analyzed and interpreted the survey data. VB and SB both contributed to the writing, revising and approval of the submitted manuscript.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the institutional ethics review board of Thunder Bay Regional Health Sciences Centre (TBRHSC) on 26-04-2022. We obtained informed consent to participate from all the participants.

Consent for publication
Not applicable.

Competing interests
Dr. Bansal receives grant funding from the Northern Ontario Academic Medicine Association (NOAMA). Dr. Bhambhwani receives research grant support from the Northern Ontario Academic Medicine Association (NOAMA) and Orbis Canada. He has received research support from iCare Inc and Eyenuk Inc and honorariums from Roche Inc and Bayer Inc in the past.

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