

A validated audio-visual educational module on examination skills in ophthalmology for undergraduate medical students in the COVID-19 season - An observational longitudinal study

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Purpose: The aim of this study was to assess the impact of an audio visual (AV) teaching module on basic torchlight examination of the eye and direct ophthalmoscopy for undergraduate medical students.

Methods: This observational longitudinal study was done on 33 consecutive medical interns during their Ophthalmology posting from December 2019 to March 2020 at a medical college in South-India. An AV-module was created using animation graphics, narratives, demonstrations on normal individuals and on patients with positive signs. All interns had a pretest consisting of Multiple-choice questions, (MCQs) and an Objective Structured Clinical Examination (OSCE) on torchlight examination and direct ophthalmoscopy (DO). They were then shown the 20-minute AV-module. A posttest was performed immediately and after one week. **Results:** The mean pretest MCQ score was 5.84 ± 1.98 . It improved to 8.81 ± 1.15 in the immediate posttest and 8.87 ± 1.66 in the one-week posttest. The mean pretest OSCE score was 12.21 ± 3.39 . It improved to 23.21 ± 3.39 in the immediate posttest and 23.90 ± 3.7 in the one-week posttest. Using Generalized Estimating Equation, MCQ score improved by 2.97 units and 3.03 units and the OSCE score improved by 11 units and 11.69 units in the immediate posttest and one-week posttest respectively when compared to the pretest corresponding to the MCQ score and OSCE score ($p < 0.001$).

Conclusion: AV teaching modules-for torchlight examination and DO has a significant benefit in improving knowledge and skill in undergraduate medical students. These significant results have the great translatory capacity in the current COVID-19 pandemic, where physical demonstrations involving close proximity and groups of students are highly risk prone.

Key words: Audio-visual teaching module, COVID-19, direct ophthalmoscopy, torchlight examination, undergraduate medical students

Ophthalmic presentations are common within primary care settings, constituting nearly 20% of emergency and 2–19% of general practice consultations.^[1] Ophthalmic medical student education is the cornerstone for improving global eye health care.^[2] It is therefore critical that young doctors should be equipped with skills to effectively diagnose common ophthalmic conditions upon graduation. Medical students spend considerably less time in Ophthalmology as compared to other mainstream clinical subjects. Most MBBS (Bachelor of Medicine and Bachelor of Surgery) interns and medical students do not show high levels of confidence in basic ophthalmological clinical skills and knowledge.^[3] Standards adopted by the Association of University Professors in Ophthalmology and endorsed by the American Academy of Ophthalmology and the International Council of Ophthalmology recommend that all graduating medical students in the United States be able to recognize key abnormalities of the ocular fundus using a direct ophthalmoscope.^[4] Despite these standards, direct ophthalmoscopy is performed infrequently and often

inaccurately by interns. Studies have shown that direct ophthalmoscopy is performed poorly and is often avoided due to lack of adequate training and low self-confidence.^[5] One of the fundamental problems in teaching direct ophthalmoscopy is that the student cannot see what the teacher sees and vice versa.^[3] Therefore, direct ophthalmoscopy may be well suited for video-based instruction, particularly if videos enable the student to see what the examiner sees when performing direct ophthalmoscopy. Torchlight examination is a very important step in the examination of the eye. This simple inexpensive test has the advantage of portability making it a huge asset to the clinical ophthalmological exam. The correct techniques of tests done with torchlight are crucial in the screening and diagnosis of vision-threatening diseases and ocular morbidity that is highly prevalent in communities. Hence, if increasing

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the exposure of ophthalmology for medical students becomes difficult to fit in their existing curriculum, a system where the focus is towards maximizing their efficacy in the limited period of their ophthalmology posting needs to be worked out on. This new system should focus on improving the efficiency of teaching rather than investing a greater share of teaching time.^[6] Many studies have shown that students tend to retain more information and understand things better when taught using multimedia learning tools in the form of audio, video and visual images.^[7] As far as the acquisition of the practical clinical skills of torchlight examination of the eye and direct ophthalmoscopy examination of the eye mediated by multimedia tools is concerned, the existing literature is scarce. Hence, there is a need for high-quality videos that include graphics to highlight relevant points, provide realistic visualization of the examiner's view, and animation to emphasize the importance of technique and sound observation. A review of YouTube videos has failed to address these issues adequately.^[8] The aim of this study was to assess the impact of an AV teaching module created by the authors -on basic torchlight examination of the eye and direct ophthalmoscopy on medical interns posted in ophthalmology. We chose the time point of the internship, because graduates would be going into service obligations in remote communities and translate into a diagnostic benefit in the remote communities of their service following the MBBS program.

The ongoing COVID-19 (coronavirus disease 2019) pandemic has impacted medical education globally.^[9] As social distancing is the most effective preventive strategy for COVID-19, until a vaccine for the same is found, students are refrained from gathering in lecture halls for academic sessions.^[10] In such a situation, there is all the more a need for a transition from classroom-based teaching or bedside clinics towards a safer platform without any compromise on learning the basic critical skills in the examination of the eye. Thus, AV teaching modules can be of great help in this situation, where there can be learning without any compromise on safety and social distancing.

Methods

This observational longitudinal study was conducted in the Department of Ophthalmology at a Medical college in Southern India. The subjects were 33 consecutive medical interns posted in Ophthalmology from 16th December 2019 to 23rd March 2020. The study received Institutional Review Board and Research Ethics Committee clearance (IRB NO. 11590) & was conducted according to the tenets of the declaration of Helsinki. The AV teaching module aimed at making medical interns perform basic torchlight examination of the eye like the swinging flashlight test, ROPLAS (Regurgitation On Pressure over the Lacrimal Sac) test, assess the Anterior Chamber Depth (ACD), examination of the cornea, lens and perform Distant Direct Ophthalmoscopy (DDO), Direct Ophthalmoscopy (DO) along with evaluation of the optic disc margin, neuro-retinal rim, cup disc ratio using the prescribed techniques. The module also aimed at making medical interns identify abnormal findings like Relative Afferent Pupillary Defect (RAPD) and interpret its grade, shallow anterior chamber, positive ROPLAS, type of corneal scar, grade of cataract, abnormal DDO reflex, papilledema, optic atrophy, and glaucomatous cupping.

Preparatory phase

Prior to the study, the investigators prepared a script which included the list of eye examination techniques that the study focussed on and a detailed step by step construct of each of the tests as shown in Table 1. This was followed by collecting subjects with abnormal eye findings, i.e., RAPD grade 2 and 3, shallow anterior chamber, positive ROPLAS, corneal scar, Mature and immature cataract, glaucomatous disc, papilledema, optic atrophy and normal. A video recording of the various eye tests on a smart-phone and a digital camera were done. Software analysts were called over to our institute and were shown these videos with a clear and concise narration of these clinical examination techniques as scripted. Real-time anatomy like using the human skull for a demonstration of the ROPLAS test was used. Using the concept and the script, a voice-over of the senior-most investigator of the study was lent for the proposed AV module. Series of editing then followed to fit in the videos with the voice over. The content of the AV module was validated by 2 qualified ophthalmologists who were actively involved in teaching undergraduate medical students.

Execution phase

All Medical interns posted in Ophthalmology for a 1-week period from December 2019 to March 2020 were included in the study. Assessment modules were created using a picture-based MCQ to assess knowledge and a validated OSCE to test clinical skills. The content was validated to ensure the assessment tool was aligned with the objectives. All interns had a pre-exposure standardized manned OSCE to measure torchlight and direct ophthalmoscopy examination skills. A picture and video-based MCQs were administered to measure knowledge of the objectives mentioned above. The AV teaching module was displayed to the students on day 1 of the internship posting in Ophthalmology after the pretest. This module was approximately for duration of 20 minutes. It consisted of 5 videos that illustrated an audio-visual presentation of the swinging flashlight test and different grades of RAPD along with normal pupillary reflex, assessment of anterior chamber depth showing shallow and a normal anterior chamber, demonstration of the ROPLAS test showing a positive and negative ROPLAS, examination of the cornea and the lens showing normal cornea and lens along with different grades of corneal scars and mature and immature cataract, direct ophthalmoscopy demonstrating the technique of distant direct ophthalmoscopy showing normal red reflex, dim red reflex, white reflex in the pupillary area and direct ophthalmoscopy showing normal disc, glaucomatous disc, optic atrophy and papilledema. Each video had two parts. The first part provided a descriptive animation with a transcript detailing the precise technique of examination, positive and negative test results. The second half included live-recorded demonstrations of real patients with normal and abnormal test results.

All the interns had an immediate standardized manned OSCE and a picture & Video based MCQ questionnaire similar to that of the pre-exposure test in torchlight and DO examination following the AV module. Following this, they were posted in various areas of ophthalmology using a weekly existing protocol, which includes equal rotations in outpatient clinics, operation theatre, casualty and outreach field visits. A logbook with a prefixed number

Table 1: Steps of the basic eye examination techniques**Swinging flash light test^[11]**

Switch off the room lights and ask the patient to look up or at a distant object
 Torch light is shone on one eye for 3 seconds taking care that it doesn't fall on the other eye and is quickly shifted back and forth stopping at each eye for 3 seconds. This is done for 3-4 cycles
 Normal pupil - initial constriction followed by dilatation within the 3 seconds period
 Grade 1 RAPD - a weak initial constriction with greater redilatation
 Grade 2 RAPD - initial stall and greater redilatation
 Grade 3 RAPD - immediate pupillary dilatation
 Grade 4 RAPD - immediate pupillary dilatation following prolonged illumination of the good eye for 6 sec
 Grade 5 RAPD - immediate pupillary dilatation with no secondary constriction

Regurgitation On Pressure over Lacrimal Sac (ROPLAS) test^[12]

Trace the inferior orbital rim and proceed medially and superiorly till you reach the anterior lacrimal crest
 Rotate the index finger behind the crest and apply pressure on the sac area in an upward and medial direction
 Look for any discharge from the punctum
 Absence of any discharge - Normal NLD; Fluid or mucoid regurgitation from the punctum - Positive ROPLAS

Assessment of Anterior Chamber Depth (ACD)^[13]

A torch light is shone from the temporal aspect of the iris parallel to it
 Normal ACD- If the entire iris is illuminated
 Shallow ACD- Nasal iris is not illuminated

Examination of the cornea and lens

Lift the upper lid and shine light on the cornea in different directions. The normal cornea is clear
 Corneal scars: Nebula- mild opacity through which iris details can be seen
 Macula- denser opacity through which iris can be seen but details cannot be made out
 Leucoma- dense white opacity obscuring view of the iris
 Ask the patient to look up and shine the bright spot of the torch light into the pupil and observe the colour of the lens
 Normal- grey colour, Immature cataract- greyish white opacity, Mature cataract- Pearly white opacity

Direct Ophthalmoscopy (DO)^[14]

This test is best done in a dimly lit room. Ensure the patient's eyes are steady by giving a fixation target.
 Use your right hand and right eye to examine the patient's right eye and vice versa for the left eye
 Gently place your other hand on the brow, which helps to steady yourself and also helps to elevate the upper eyelid. For Distant Direct Ophthalmoscopy (DDO), shine the light of the direct ophthalmoscope at the pupil standing at a distance of 33 cm or 1 foot in front of the patient and observe the red reflex.
 Rich red glow - Clear media
 Black opacities within the red glow - Immature Cataract
 White reflex - Retinoblastoma, Mature cataract, Retinal detachment
 Next, keeping the direct ophthalmoscope dial at zero and with the biggest wide spot, go 15 degrees off axis ensuring that the patient is maintaining fixation.
 If you see any blood vessel, follow the blood vessel because all blood vessels reach the optic disc.
 On examining the optic disc, examine the disc margins, neuro-retinal rim (NRR) and the Cup Disc Ratio (CDR)
 Disc margins - Clear (normal), Blurred (suggestive of disc oedema, if bilateral then suggestive of papilledema seen in raised intra cranial tension)
 NRR - Pink (normal), Pale (Optic atrophy)
 CDR- 0.3-0.4:1 (normal), >0.5:1 (suspicious of glaucoma)

of torchlight and direct ophthalmoscopy examinations that need to be completed, as field practice, was maintained and monitored by the faculty in charge of the rotation. At the end of the 1-week posting in ophthalmology, the interns underwent the final picture & video-based questionnaire and a manned OSCE in torchlight and DO examination. The assessment of OSCE pretest, immediate posttest and 1-week posttest were done by the same investigator for all the 33 students. All interns were given a feedback form after the one-week posttest which had questions graded on the Likert scale. The MCQs comprised of 10 questions and were allotted 1 point each for the total of 10-points. The OSCE had five stations namely RAPD (8 points), ROPLAS (4 points), Anterior chamber depth assessment (5 points), cornea and lens examination (5 points) and direct

ophthalmoscopy (8 points), thus amounting to a total of 30 points for OSCE [Table 2] (OSCE Scoring Sheet used for assessment is attached in Supporting Material).

The continuous variables, which include- the MCQ and OSCE scores were represented statistically as mean with standard deviation. The change in MCQ and OSCE scores over time were analyzed statistically using Generalised estimating Equations (GEE) with an exchangeable correlation structure and *P* value for the same was determined. All analysis was done by SPSS 21 Version.

Results

Thirty-three medical interns (20 women and 13 men) at a Medical college in Southern India were recruited for the

study. Their mean age was 23.5 ± 0.8 . The mean MCQ score in the pretest was 5.84 (SD = 1.98), immediate posttest was 8.81 (SD = 1.15) and one-week posttest was 8.87 (SD = 1.66). The change of knowledge during the course of the study is shown in Fig. 1a. The mean OSCE score in the pretest was 12.21 (SD = 4.97), for immediate posttest was 23.21 (SD = 3.39) and for one-week posttest was 23.90 (SD = 3.70). The change in skill during the course of the study is shown in Fig. 1b. The mean scores in the various OSCE stations is depicted in Table 2. The comparison of the overall Percentage obtained in the individual OSCE stations in the pretest and one-week posttest is shown in Fig. 2a. The percentage increase in the performance in the individual OSCE stations is shown in Fig. 2b. The percentage increase from pretest to one-week posttest at the various OSCE stations were 69.83%, 143.58%, 99.98%, 47.33% and 211.26% for RAPD, ROPLAS, Anterior chamber depth, Cornea and lens and direct ophthalmoscopy stations respectively.

The change in the performance of students in MCQs and the individual OSCE stations in the immediate posttest and one-week posttest when compared to the pretest was assessed using Generalised Estimating Equation (GEE) as shown in Table 3. The feedback form for the AV module was evaluated based on a 5 point Likert scale with values 1 (strongly disagree) to 5 (strongly agree). The responses of students based on the 5-point Likert scale for the contents of the module is shown in Fig. 3.

Discussion

The limited medical undergraduate curriculum time has resulted in an increased focus towards acquiring more knowledge and skills in subjects like Medicine and Surgery.^[15] As a result, students get limited opportunities to get sufficient experience in subspecialties like Ophthalmology. Ophthalmic skills are challenging to learn and require a lot of practice to master. Thus, it is difficult to become fully competent in performing basic tests in ophthalmology given the short time frame dedicated towards this speciality. With the current COVID-19 pandemic in the country, there is little scope for medical students in the coming year to master these skills. Therefore, powerful and precise AV technology is the need of the hour in ensuring that the current group of medical students are proficient in their examination skills.

In an attempt to fill this gap, we believe that the AV teaching tool created with its series of animated & real-time videos will have a huge impact on our country. The module consists of 5 videos with an explanation and demonstration of the important torchlight examination skills of the eye that are crucial in the diagnosis of diseases that can lead to irreversible visual loss and other common aetiologies of avoidable blindness. These included assessment of the pupillary light reflex and swinging flashlight test to check for RAPD, Anterior chamber depth assessment, the examination of the cornea and lens, ROPLAS test and direct ophthalmoscopy. These clinical skills help

Table 2: Mean scores at the various OSCE stations

OSCE station	Mean (SD)		
	Pretest	Immediate posttest	One-week posttest
RAPD (out of 8 points)	3.818 (1.667)	6.015 (1.518)	6.485 (1.296)
ROPLAS (out of 4 points)	1.424 (1.611)	3.742 (0.356)	3.470 (0.983)
ACD (out of 5 points)	2.379 (1.883)	4.576 (0.969)	4.758 (0.435)
Cornea and lens (out of 5 points)	3.106 (1.55)	4.606 (0.634)	4.576 (0.6746)
DO (out of 8 points)	1.485 (1.349)	4.273 (1.729)	4.621 (1.541)

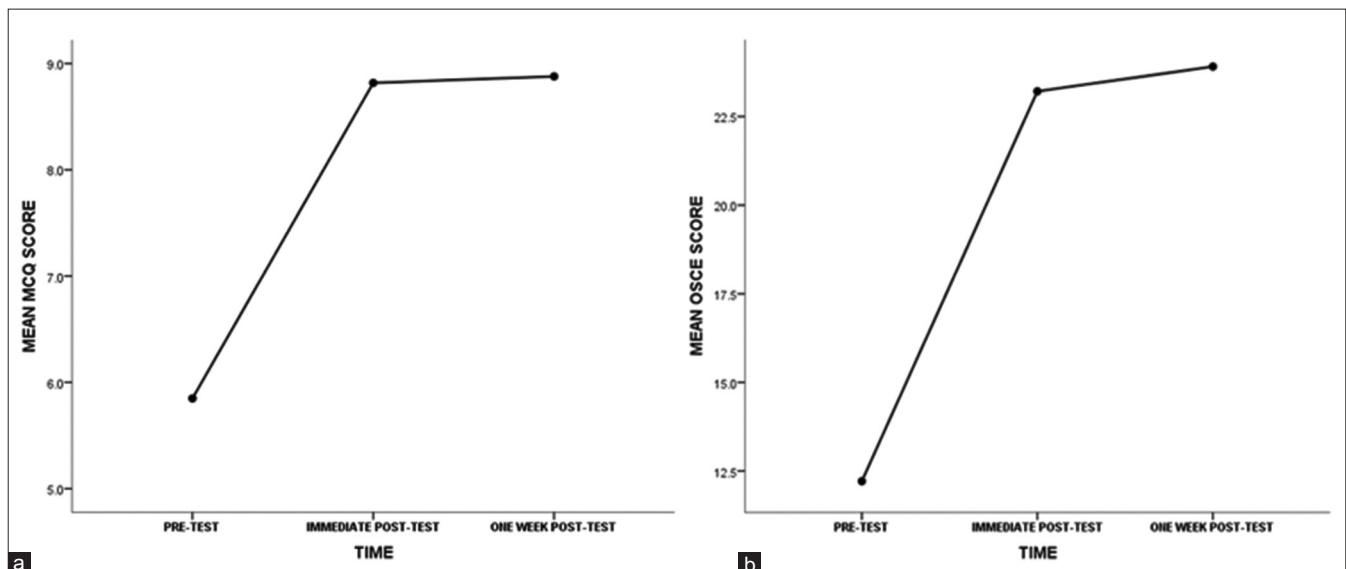


Figure 1: (a) Graph showing the increasing curve in Knowledge. (b) Graph showing the increasing curve in skills

Table 3: Change in MCQ and OSCE over time using GEE

	Immediate posttest		One-week posttest	
	B* (95% CI)	P	B* (95% CI)	P
MCQ	2.970 (2.333-3.607)	0.000	3.030 (2.361-3.700)	0.000
RAPD	2.197 (1.591-2.803)	0.000	2.667 (2.050-3.283)	0.000
ROPLAS	2.318 (1.801-2.836)	0.000	2.045 (1.496-2.595)	0.000
ACD	2.197 (1.596-2.798)	0.000	2.379 (1.753-3.005)	0.000
CORNEA AND LENS	1.500 (1.046-1.954)	0.000	1.470 (1.052-1.887)	0.000
DO	2.788	0.000	3.136 (2.538-3.735)	0.000

*B value was calculated with respect to change in scores compared to pretest

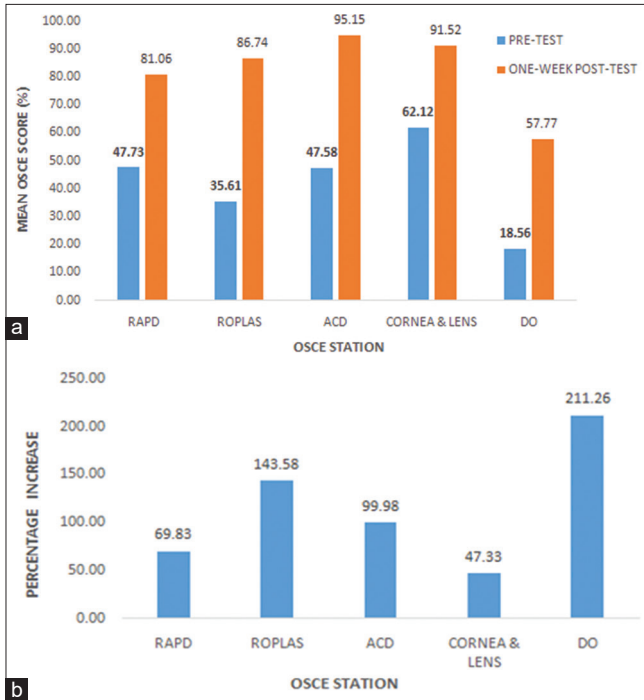


Figure 2: (a) Percentage of the mean OSCE score in the pretest and one-week posttest. (b) Percentage increase from pretest to one-week posttest in the individual OSCE stations

students to diagnose vision-threatening conditions in the eye with portable tools and will have immense translational benefit in preventing blindness especially in remote communities, which lack expensive infrastructure.

The assessment of students at the start of the Ophthalmology posting was done using MCQs to judge their theoretical knowledge and OSCE to check their clinical skills in the performance of the various eye tests. The mean MCQ pretest score which was 5.84, improved to 8.81 and 8.87, thereby showing a 51.02% and 52.05% increase in their scores in the immediate posttest and one-week posttest respectively. The mean OSCE pretest score which was 12.21, improved to 23.21 and 23.90, thereby showing a 90.07% and 95.82% increase in their performance in the immediate posttest and one-week posttest respectively.

The percentage increase from pretest to one-week posttest at the various OSCE stations ranged from 47.33% to 211.26%, the maximum increase being seen in the direct ophthalmoscopy

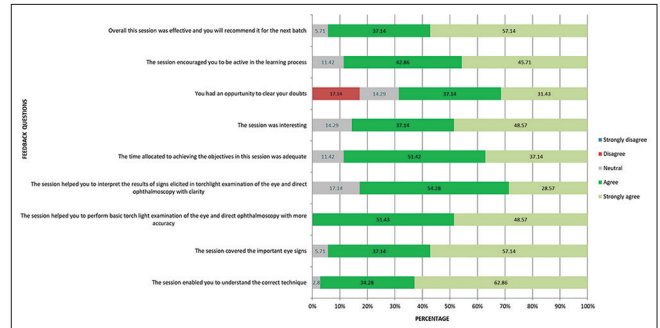


Figure 3: Graph showing the response of students based on the 5-point Likert scale for the questions in the feedback form

and ROPLAS stations. All of the above results were found to be statistically significant ($p < 0.001$). Thus, the AV tool was useful in improving the knowledge and practical skills.

The Feedback on the Likert scale as shown in Fig. 3 indicated a more than 80% agreement in themes ranging from the clarity of understanding, holistic coverage, confidence in performance and interpretive abilities of the students. There was good agreement in terms of the ideal time duration of the AV module and the interest is stimulated. Only 30% of students felt the need for a resource person to answer doubts. This is an inevitable limitation of any exclusive AV teaching module. However, it is encouraging to note that 70% of students were self-sufficient even in this respect.

This innovative AV teaching tool is an attempt to address the barriers in the existing system responsible for the gaps in the acquisition of the basic skills in ophthalmology. This teaching tool can have many benefits. It is a standardised resource, thereby, ensuring that students are provided with equally consistent learning that can address their learning needs. Other modes of teaching these practical skills require staff, staff time, equipment and an adequate learning space all of which are taken care of with this teaching tool. Amidst the COVID-19 season, with concerns regarding safety and social distancing as well as with a decrease in patient load in hospitals, this AV teaching module can keep the medical education process going.^[10] It can also be used in conjunction with the existing teaching system for their better understanding as this involves both video and audio mediums. We created this tool specifically for the basic torch light tests of the eye and direct ophthalmoscopy technique keeping in mind that these are the basic tests, which can be of benefit to medical students once they are posted in various peripheral hospitals after competition

of their MBBS as well for those students who plan to pursue as general practitioners. These skills can help them pick up conditions like a relative afferent pupillary defect (RAPD), blocked ducts (ROPLAS positive), shallow anterior chamber of the eye (Primary angle-closure suspects), corneal ulcer, Mature cataract, papilledema, glaucomatous discs, white reflex in the pupillary area in a child all of which need a prompt referral to an ophthalmologist which can be vision-saving due to the timely diagnosis and timely referral.

The drawback of this tool is the cost involved in creating these animation videos. However, this is a one-time investment and this validated AV Module could have powerful translational implications in the present COVID-19 crisis, in sustaining competence in clinical skills amongst medical students. The 1-week outcome measures only evaluate the primary levels of Kirkpatrick's model of learning.^[16] A longer follow up would be required in assessing clinical competence in work place based practice over a period of time. This is a scope for further study.

Conclusion

AV teaching modules for torchlight examination and DO can significantly improve ophthalmology knowledge and skill in undergraduate medical students. Our results have a direct practical application in the current COVID-19 pandemic, where physical demonstrations involving close proximity and groups of students have the potential risk of infection.

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Conflicts of interest

There are no conflicts of interest.

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