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The use of simulation and innovative technology to enhance teaching and clinical training is a common trend in higher education. Training using simulation has been reported in medical and allied health disciplines, but few publications exist in optometry. In this report, we present a teaching model implementing the 3D Eyesi Binocular Indirect Ophthalmoscope simulator (VRmagic, Germany) that has yielded positive learning and teaching outcomes.

**Utilization of a BIO Simulation System**

Binocular indirect ophthalmoscopy (BIO) is an essential optometric skill that students must master in order to detect sight-threatening conditions such as retinal detachment and diabetic retinopathy. It is a constant challenge for clinical educators to provide immediate, constructive and rich feedback to students performing BIO because the retina cannot be viewed simultaneously by student and educator without one-on-one supervision using a teaching mirror or utilizing imaging equipment (e.g., BIO video camera). Hence, it is difficult for students to improve their BIO skills efficiently and effectively, especially if unsupervised. In addition, students are exposed to only a couple of practice patients with a limited range of retinal conditions when learning the technique. All these factors have made student learning of BIO less enjoyable and engaging.

With a head-mounted display, a model head and two lenses, the Eyesi BIO simulator provides a realistic 3D experience and operates exactly like a real ophthalmoscope. Exact alignment of the laser light source and the lens has to be achieved before a retinal view can be obtained. A camera system tracks the position of the student's head and lens relative to the model head. The software offers training on four different tiers of complexity, which are appropriate for different year levels of our four-year Doctor of Optometry postgraduate program. The live interactive training program provides students with high-quality, comprehensive and instant feedback on their BIO technique as the examined retina is recorded and the retina currently being examined is displayed on the screen in real time. In addition, aspects of the technique such as efficiency, accuracy, thoroughness of the findings and diagnoses of a wide range of retinal pathologies can be evaluated by the computer.

We have enhanced the BIO learning experience for students using the simulator as a teaching and revision tool. In the second year of our program, after receiving the didactic lecture on how to perform BIO, all students attend standard practical classes to learn the technique. Prior to using the simulator, all second-year students need to pass an online orientation course to ensure familiarity with the technology. Then they are assigned to work in groups of three to use the BIO simulator for six two-hour self-directed sessions for the year. A final-year student is allocated to provide peer trouble-shooting advice and critique only for the first session. In the third year, students again have access to the simulator for six two-hour self-directed sessions, but on an individual basis. It is expected that by the end of the third year, students should have completed the first two tiers of the simulator training program.

**Assessment of Benefits and Drawbacks**

We obtained ethics approval to conduct anonymous surveys over a two-year period to assess students' perception of this technology. A total of 104 students were surveyed (response rate 46%), and 90-100% strongly agreed or agreed that the technology: (i) is a highly valued and useful learning tool, (ii) contributes to them being more confident, competent and proficient in performing BIO, and (iii) improves their stability, orientation and alignment when examining the retina on a real patient.

In our opinion, the implementation of a technology-enhanced learning environment has provided students with a deeply interactive and immersive learning experience. Our observations demonstrate that integration of the BIO simulator into our OD program has improved students' clinical examination and reasoning skills and concurrently minimized the range and variability in clinical performance. We hypothesize that well-structured self-directed BIO simulator sessions in the second and third year have allowed students to achieve technical competency earlier, which then enabled clinical educators to concentrate on the translation of the technique to a real patient in the clinical setting in later years.

Use of the BIO simulator has also led to reduction in teaching workload because the need for intensive one-on-one BIO technique introduction and refinement with clinical educators is minimized, particularly in the early stages. Increased student interaction and engagement has been achieved by working with same and different year-level peers.

Despite the positive outcomes, the BIO simulator does have drawbacks. It supplements, but still does not replace conventional practical classes. Certain aspects of the technique such as patient instructions, manipulating the patient's lids and head, and altering chair height cannot be taught and evaluated properly using this technology. How the simulator generates a final score based on its assessment criteria remains to be understood. Large class sizes require multiple simulators, and service and repairs are currently available only in Germany.

**Considerations for the Future**

We anticipate that improved in-situ feedback and assessment mechanisms will translate to increased proficiency and efficiency when students perform BIO on real patients in clinic in later years. Additional studies are warranted to evaluate the efficacy of the BIO simulator in improving student-perceived proficiency and confidence. Furthermore, the suitability of the BIO simulator to be used as an examination tool in clinical competency examinations remains to be explored.



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