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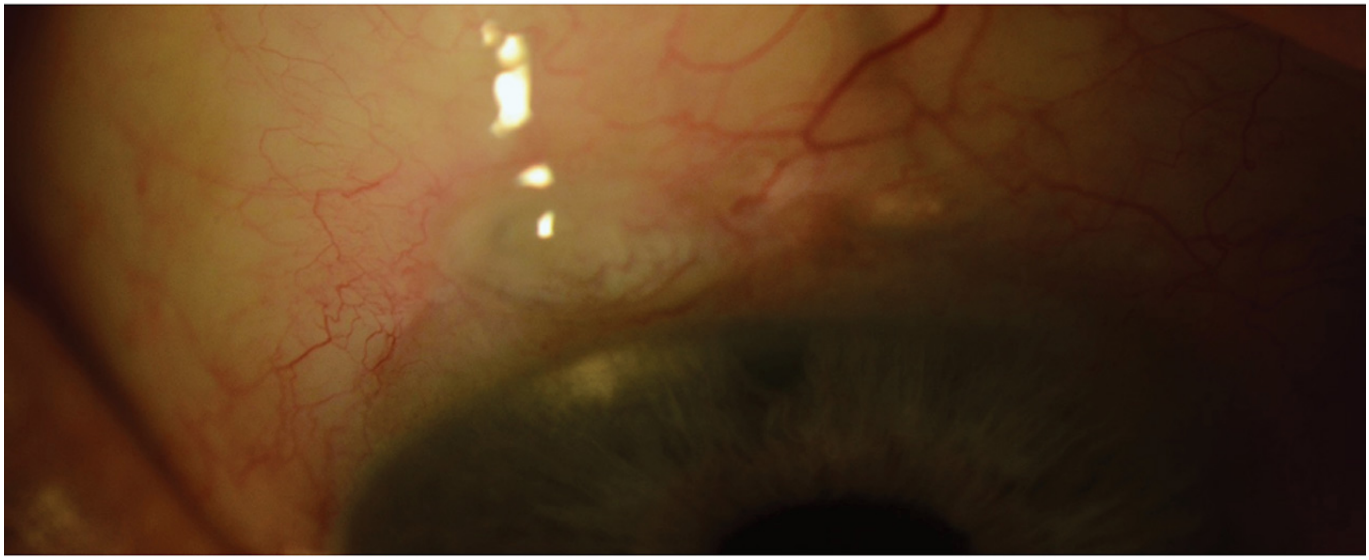

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PEER REVIEWED

Application of an Online Homework Tool in Optometry for Geometric Optics Improves Exam Performance

Varuna Kumaran, MS, B.Optom, Krishna Kumar, B.Optom, MPhil, PhD, and Naveen Mahesh, B.E. |
Optometric Education: Volume 45, Number 2 (Winter-Spring 2020)

Abstract

Geometric optics requires strong problem-solving skills that can be improved through practice. Due to time constraints, more practice in the classroom is not typically possible. An online homework application called Kognify (Kognify Assessment and Skill Development, PL, Chennai, Tamil Nadu, India) enables students to perform online "workouts" at their convenience. Thirty-four students used Kognify from July to September 2016 to practice problem-solving skills related to the course Geometric Optics-II (GO-II). This differed from the approach in previous semesters, during which only in-class, on-paper quizzes were used. When Kognify was used, students achieved better scores on mid-semester and comprehensive exams ($p<0.02$ in both cases) as well as in overall course performance ($p=0.005$).

Key Words: *Kognify, geometric optics, training, online, digital*

Background

Online homework has been replacing traditional paper-based homework in many fields, including chemistry, statistics, physics, accounting and mathematics; however, its impact on exam performance is ambiguous. While improvements have been observed in many studies,[1-24] other studies show little or no improvement.[25-32] Regardless, students and faculty have shown a strong preference for online homework systems.[1-32] Students receive feedback on their homework performance instantly and automatically as practice problems are completed, which lowers the burden of evaluation for faculty members.[8,15,21]

The use of technology in optometric education is becoming more common. Recently, a study compared the use of digital assessments with paper-based tests in geometric optics.[33] The creation of an online problem set for optics was also reported, but the report did not discuss its use by students.[34] There are no publications to date that describe the effectiveness of online homework systems in the field of optometry.

This research paper describes the use of an online homework system — Kognify (Kognify Assessment and Skill Development, PL, Chennai, Tamil Nadu, India) — for training students of optometry in the Geometric Optics-II (GO-II) course. In previous semesters, 15- to 30-minute paper-based quizzes were used to assess GO-II students' knowledge of the subject matter. The quizzes were conducted weekly during the 2.5- to 3-hour class periods. Each quiz assessed knowledge of the concepts that had been covered in the previous class. A teaching assistant evaluated the answer sheets within the following week. Any individual or common mistakes were discussed on a later date. This method was time-consuming but used because more practice for problem-solving and application of concepts was crucial at this early stage of learning. Students in these previous semesters felt the need for more faculty

guidance in solving problems, but extra class hours could not be allotted due to time constraints. To address these concerns, Kognify was employed in 2016.

Kognify is an online homework application.[35] Many school systems use Kognify in high school education.[35] The faculty create a database of multiple-choice questions in Kognify along with topics and objectives that can be tagged to their questions. Students can access Kognify through the Google Chrome or Firefox web browsers or an Android app for mobile use. Groups of questions are presented randomly as “workouts” that are given to students on a regular basis. Faculty can customize the number of questions in a workout, the time limit and the number of workouts per week. Faculty monitor performance in terms of accuracy and response time. A report is generated and shared with each student for every topic. Concepts are then reinforced as needed during class time via student-teacher interactions.

We tested whether Kognify would improve exam performance compared with employing regular weekly quizzes. This paper reports data that support the efficacy of Kognify in improving exam performance scores in the GO-II course in optometry.

Methods

The study was conducted at the Elite School of Optometry, Chennai, Tamil Nadu, India, which is affiliated to Birla Institute of Technology and Science, Pilani, Rajasthan, India. The study compared two groups of students. The first group took GO-II in July to December of 2015 (CO2015). CO2015 consisted of 31 students (10 males and 21 females), ages 17-19 years as of January 2015 (mean age ±SD = 18.08 years ±0.41). The second group of students took GO-II in July to December 2016 (CO2016). CO2016 consisted of 34 students (9 males and 25 females), ages 17-19 years as of January 2016 (mean age ±SD = 17.98 years ±0.5). Note that South Asian Indian optometry students are younger than their North American counterparts because optometric education is an undergraduate degree program in India. However, the syllabi for geometric optics courses do not substantially differ between the two types of programs. The syllabi for the Geometric Optics-I (GO-I) and GO-II courses taught at Elite School of Optometry, Chennai, are shown in **Appendix A**.

Both CO2015 and CO2016 had the same syllabus, and the same faculty members taught their theory classes for both the GO-I and GO-II courses. Both classes went through the university-mandated continuous assessment process during the semester. This consisted of three evaluation components (EC1, EC2 and EC3), a comprehensive exam and a practical exam. **Table 1** shows the breakdown of the total course grade. EC1 and EC3 were paper-based class assessments on topics covered for that month alone. EC2 (a mid-semester exam) and the comprehensive exam were scheduled written exams that covered topics taught up to those points. A common examination format was followed for all the semesters for EC2 and the comprehensive exam as suggested by the institution **(Table 2)**.

Table 1. Click to enlarge

Table 2. Click to enlarge

The CO2015 students were trained using frequent in-class quizzes as described above. For the CO2016 students, Kognify was used as a replacement for the in-class quizzes.

Implementation of Kognify workouts for GO-II

Each CO2016 student was given a free password-protected user account. An initial training session on use of Kognify was given at the premises on July 18, 2016. Students were invited to perform timed workouts two to five days per week from July 19 to Sept. 16, 2016. Faculty added multiple-choice questions on a regular basis and tagged the questions with their topics and learning objectives. Five to 10 questions formed a part of each workout. The questions, as well as the answer choices, were randomized. The questions reflected topics covered in the class that week (every Monday). The concepts and problem-solving techniques delivered in the class were therefore revisited through the workouts.

Table 3. Click to enlarge

Students with Android phones performed the workouts through their phones, while the rest used laptop or desktop computers. The students could log-in multiple times in each workout and had the option of re-attempting questions until they submitted the workout or the time expired. The time allotted for the workouts was liberal. Students were allowed to refer to books. Individual doubts were clarified via e-mail and WhatsApp messaging. The students were aware of their scores via the summary reports generated in their individual user accounts. Once most of the students had completed a workout, the assessment with the answer key was e-mailed to them for future reference. The students were encouraged and reminded to take these workouts, but no incentives were given to students to complete the workouts. The compliance and performance in these workouts were not considered toward the final scores in any way.

Table 4. Click to enlarge

If a student wanted a repeat workout due to absence, a power outage, accidental logout or any other reason, it was arranged for them. If the faculty felt that unusually less time was taken, or a workout was badly performed (less than 50%), a repeat workout for only those students was arranged. The repeat workouts consisted of the same assignment, but the questions and answer choices were randomized. Workouts could be repeated only once. **Table 3** provides details regarding the number of students who took repeat workouts. Before the mid-semester exam (EC2), a review workout was given for practice.

Students used Kognify from mid-July to mid-September 2016 until the comprehensive mid-semester exam (EC2), which included subject matter covered for EC1 (involving significant mathematical calculations, formulas and important concepts) **(Table 4)**. Kognify was not employed prior to the end-of-semester comprehensive exam.

The Institutional Review Board (IRB) considered the study proposal and declared it exempt from a formal IRB approval.

Statistical analysis

Data analysis and plotting of graphs were performed using the statistical package RStudio, (R version 3.3.2, The R Foundation for Statistical Computing).[36] The normality of the data distribution was tested using the Shapiro-Wilk test. First, GO-I scores for each of the classes were compared to establish a similar academic ability between the classes. The EC2 and comprehensive exam were compared for the GO-I course for CO2015 and CO2016 using the Mann-Whitney U test. Then, GO-II scores for the mid-semester exam (EC2) and final comprehensive exam for CO2015 were compared to those for CO2016

using the Mann-Whitney U one-sided test. It tested the alternative hypothesis that the GO-II scores of CO2016 were better than the GO-II scores of CO2015. A p-value of 0.05 was considered statistically significant in all analyses.

EC1 and EC3 were not separately analyzed because they were not assessed in a structured and common examination format across classes and semesters. Practical exam scores were also not compared separately.

Results

Because many scores in CO2016 were not normally distributed, nonparametric statistics were used. Normality was tested using the Shapiro-Wilk normality test for the comprehensive exam and EC2 (mid-semester exam) across all semesters. Distributions deviated from normality for the comprehensive exam (W=0.916, p=0.01209) for GO-I in CO2016. EC2 (W=0.911, p=0.009) for GO-II in CO2016 also lacked normal distributions.

The academic skills of CO2016 and CO2015 were similar, as confirmed by the absence of statistically significant difference in their GO-I scores [Mann-Whitney U test: EC2 exam (Med. diff.=0 marks, W=468.5); comprehensive exam (Med. diff.=3.50 marks, W=500.5); p>0.05 (not significant) in both the cases]. **Table 5** summarizes the means, standard deviations, medians and 95% confidence intervals for the mid-semester exam (EC2) and comprehensive exam scores in GO-I and GO-II for CO2015 and CO2016.

Table 5. Click to enlarge

Figure 1. Mid-semester exam (EC2) and comprehensive exam (Comp) Scores in Geometric Optics-I and Geometric Optics-II for CO2015 and CO2016. Click to enlarge

Figure 1 presents the box plots for scores obtained in GO-I and GO-II for both classes. Better scores are seen in the class that used Kognify compared with its CO2015 counterpart that used conventional practice methods [Table 5: Mann-Whitney U test: EC2 exam (Med. diff.=2.63 marks, W=369, p=0.0193); comprehensive exam (Med. diff.=7.31 marks, W=210, p<0.0001).

Discussion

The results of the study suggest that Kognify improved students' performance over the conventional method of weekly on-paper quizzes. This is evident from the performance of the CO2016 students on their GO-II exams, which was much better when compared with the performance of the CO2015 students.

Concepts and problem-solving skills acquired in the GO-I and GO-II courses lay a strong foundation for other subjects such as visual optics, contact lenses, optometric optics, dispensing optics and low vision aids. Thus, reviewing concepts and practicing solving problems are essential. Remote faculty interaction with Kognify makes these goals achievable outside of time-constrained classroom hours. Apart from setting up the workouts and reviewing performance reports daily or weekly, faculty communicate with students individually about needed areas of improvement via email, SMS and WhatsApp. This further reduces dependency on additional teaching staff, who may instead be trained to set up Kognify workouts

and analyze students' performance.

Kognify provides instant feedback, a feature of great benefit to students and teachers, as with other online homework systems.[8,15,21,27,39-41] In addition, Kognify provides a summary report of student performance across all topics covered. Feedback from Kognify coupled with off-line comments from faculty increased student motivation to study, as reported by students during informal conversations with faculty.

Kognify also helps to build rapport between faculty and students. Students who were generally hesitant to seek help in the classroom were given a platform from which to reach out to faculty or peers on a regular basis. Such benefits of online homework systems have been reported previously as well.[4,5]

Adoption of Kognify for the current study went smoothly except for a couple of instances. One student forgot her password and it had to be reset. Also, despite several reminders, 50% of the students (17 of 34) missed one or more workouts. One student didn't use the system fully due to health issues and completed only 9 of the 27 workouts. Students who missed two or fewer workouts had better scores on the mid-semester (EC2) and comprehensive exams, but this negative correlation is weak (p=-0.24, Spearman's rank correlation) **(Figure 2)**. Many factors influence performance on exams; therefore, additional studies can be conducted to identify the population, based on skill and motivation level, that will benefit most from online homework.

Figure 2. Scatter plot showing Geometric Optics-II mid-semester exam (EC2) scores for batch CO2016 vs. number of Kognify workouts missed. Click to enlarge

In the current study, the students were given the liberty of multiple logouts and repeat tests. Although encouraged to take workouts without any help, they had the opportunity to re-learn a concept and re-do a question. Each student has a different learning strategy, which can influence performance on exams. Future studies can evaluate the effect of study habits (e.g., average time spent on workouts, number of repeat attempts and performance on online workouts) on final exam performance, as has been done elsewhere.[43-45]

The students were initially highly motivated to perform the Kognify workouts, but participation dropped over the weeks. With the burden of other subjects and activities, they needed more reminders to complete their tasks. Nevertheless, the minimum compliance was 61% (21 of 34 students participated across all workouts). To make students more participative, timely completion of Kognify workouts and scores in the workouts can be considered in determination of final grades, as suggested elsewhere.[46-48] Further, if students bear the cost of the Kognify subscription, better compliance may be expected. Dedication and motivation level of faculty members, teaching assistants and students are important to the success of online homework systems, as reported earlier.[4,13,49]

Although this study took a quasi-experimental approach, it can pave the way for future prospective, randomized, controlled studies. A questionnaire to gauge students' satisfaction with Kognify would be useful in the future.

Conclusion

This study suggests that online homework systems such as Kognify can be effective in training optometry students in problem-solving skills for geometric optics courses. Kognify can be useful for students facing qualifying exams, fellowship exams and board exams. As experienced in this study, Kognify can help faculty to plan classroom time to review concepts taught earlier and to clarify student

questions before proceeding to the next lecture. It can also help students better understand the concepts with well-planned workouts that can be used anywhere, anytime.

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References

1. Bartlett JE, Reynolds KA, Alexander MW. A tool for online learning. Journal of Online Learning. 2000;11(3-4):22-24.
2. Dufresne RJ, Mestre J, Hart DM, Rath KA. The effect of web-based homework on test performance in large enrollment introductory physics courses. Journal of Computers in Mathematics and Science Teaching. 2002;21(3):229-251.
3. Arasasingham RD, Taagepera M, Potter F, Martorell I, Lonjers S. Assessing the effect of web-based learning tools on student understanding of stoichiometry using knowledge space theory. J Chem Educ. 2005;82(8):1251-1262.
4. Arasasingham RD, Martorell I, McIntire TM. Online homework and student achievement in a large enrollment introductory science course. J Coll Sci Teach. 2011;40(6):70-79.
5. Richards-Babb M, Drelick J, Henry Z, Robertson-Honecker JR. Online homework, help or hindrance? What students think and how they perform. J Coll Sci Teach. 2011;40(4):81-93.
6. Gaffney MA, Ryan D, Wurst C. Do online homework systems improve student performance? Advances in Accounting Education. 2010;11:49-68.
7. Wooten T, Dillar-Eggers J. An investigation of online homework: required or not required? Contemp Issues Educ Res. 2013;6(2):189-198.
8. Burch KJ, Kuo YJ. Traditional vs. online homework in college algebra. Mathematics and Computer Education. 2010;44(1):53-63.
9. Arora M, Rho Y, Masson C. Longitudinal study of online statics homework as a method to improve learning. J STEM Educ. 2013;14(1):36-44.
10. Chak SC, Fung H. Exploring the effectiveness of blended learning in cost and management accounting: an empirical study. New Media, Knowledge Practices and Multiliteracies. 2015;13:189-203.
11. Lazarova K. The role of online homework in low-enrollment college introductory physics courses. J Coll Sci Teach. 2015;44(3):17-21.
12. Palocsay SW, Stevens SP. A study of the effectiveness of web-based homework in teaching undergraduate business statistics and decision sciences. Journal of Innovative Education. 2008;6(2):213-232.
13. Halcrow C, Dunnigan G. Online homework in Calculus I: friend or foe? Problems, resources, and issues in mathematics undergraduate studies. 2012;22(8):664-682.
14. Taraban R, Anderson EE, Hayes MW, Sharma MP. Developing on-line homework for introductory thermodynamics. Journal of Engineering Education. 2005;94(3):339-342.
15. Zerr R. A quantitative and qualitative analysis of the effectiveness of online homework in first-semester calculus. Journal of Computers in Mathematics and Science Teaching. 2007;26(1):55-73.
16. Cuadros J, Yaron D, Leinhardt G. “One firm spot”: the role of homework as lever in acquiring conceptual and performance competence in college chemistry. J Chem Educ. 2007;84(6):1047-1052.
17. Gebru MT, Phelps AJ, Wulfsberg G. Effect of clickers versus online homework on students’ long-term retention of general chemistry course material. Chemistry Education Research and Practice.

2012;13:325-329.
18. Dufresne R, Mestre J, Doorn D, Janssen S, O'Brien M. Student attitudes and approaches to online homework. International Journal for the Scholarship of Teaching and Learning. 2010;4(1)1-19.
19. Harris H. Electronic homework management systems: review of popular systems. J Chem Educ. 2009;86(6):691.
20. Fynewever H. A comparison of the effectiveness of web?based and paper?based homework for general chemistry. Chem Educ. 2008;13:264.
21. Malik K, Martinez N, Romero J, Schubel S, Janowicz PA. Mixed-methods study of online and written organic chemistry homework. J Chem Educ. 2014;91(11):1804-1809.
22. Richards?Babb M, Jackson JK. Gendered responses to online homework use in general chemistry. Chemistry Education Research and Practice. 2011;12(4):409?419.
23. Freasier B, Collins G, Newitt P. A web-based interactive homework quiz and tutorial package to motivate undergraduate chemistry students and improve learning. J Chem Educ. 2003;80(11):1344-1347.
24. Ichinose C. Students' perceptions when learning mathematics online: a path analysis. Journal of the Research Center for Educational Technology. 2010;6(2):78-93.
25. Fisher L, Holme T. Using web-based databases in large-lecture chemistry courses. Chem Educ. 2000;5(5):269-276.
26. Chamala R, Ciochina R, Grossman R, Finkel R, Kannan S, Ramachandran P. EPOCH: An organic chemistry homework program that offers response-specific feedback to students. J Chem Educ. 2006;83(1):164-169.
27. Cole RS, Todd JB. Effects of web?based multimedia homework with immediate rich feedback on student learning in general chemistry. J Chem Educ. 2003;80:1338?1343.
28. Bonham S, Beichner R, Deardorff D. Online homework: does it make a difference? Phys Teach. 2001;39:293?296.
29. Bonham SW, Deardorff DL, Beichner RJ. Comparison of student performance using web and paper-based homework in college-level physics. Journal of Research in Science Teaching. 2003;40(10):1050-1071.
30. Cheng KK, Thacker B, Cardenas RL, Crouch C. Using an online homework system enhances students' learning of physics concepts in an introductory physics course. American Journal of Physics. 2004;72:1447?1453.
31. Demirci N. Developing web-oriented homework system to assess students' introductory physics course performance and compare to paper-based peer homework. Turkish Online Journal of Distance Education. 2006;7(3):105-119.
32. Humphrey RL, Beard DF. Faculty perceptions of online homework software in accounting education. Journal of Accounting Education. 2014;32(3):238.
33. Fecho GM, Althoff J, Hardigan P. Assessing student performance in geometrical optics using two different assessment tools: tablet and paper. Optometric Education. Fall 2016;42(1).
34. Kollbaum PS, Jackson JM, Koh B. Development of an adaptable online optometric quiz site [Internet]. Proceedings of the American Academy of Optometry 91st Annual meeting; 2012 Oct 24-27; Phoenix (AZ); [cited 2017]. Program No. 125460. Available from: https://www.aaopt.org/detail/knowledge-base-article/development-adaptable-online-optometric-quiz-site
35. Kognify [Internet]. Kognify assessment and skill development private limited, Chennai, Tamil Nadu, India; c2016. [Cited 2016]. Available from: https://www.kognify.com
36. R Development Core Team (2016). R: A language and environment for statistical computing. [Internet]. Vienna, Austria. Available from: https://www.R-project.org
37. Brewer D, Becker K. Online homework effectiveness for underprepared and repeating college algebra students. Journal of Computers in Mathematics and Science Teaching. 2010;29(4):353-371.
38. Pundak D, Maharshak A, Rozner S. Successful pedagogy with web assignments checker. Journal

of Educational Technology Systems. 2004;33(1):67-80.
39. Liberatore MW. Improved student achievement using personalized online homework for a course in material and energy balance. Chem Eng Educ. 2011;45(3):184-190.
40. Axtell M, Curran E. The effects of online homework in a university finite mathematics course. In: Larsen S, Marrongelle K, editors. Proceedings of the 14th Annual Conference on Research in Undergraduate Mathematics Education; 2011 Feb 24-27; Portland (OR). (4):20-23.
41. Carpenter J, Camp B. Using a web-based homework system to improve accountability and mastery in calculus. Proceedings of the 2008 ASEE Annual Conference and Exposition; 2008 Jun 22-25; Pittsburgh (PA); [cited 2008]. Available from: https://peer.asee.org/4426
42. Brewer DS. The effects of online homework on achievement and self-efficacy of college algebra students [dissertation]. [Logan (UT)]: Utah State University; 2009. 228p. Available from: https://digitalcommons.usu.edu/etd/407
43. Bowman CR, Gulacar O, King DB. Predicting student success via online homework usage. Journal of Learning Design (Science Education). 2014;7(2):47-61.
44. Richards-Babb M, Curtis R, Georgieva Z, Penn JH. Student perceptions of online homework use for formative assessment of learning in organic chemistry. J Chem Educ. 2015;92(11):1813-1819.
45. Mitchell JC, Mitchell JE. Using web-based homework to teach principles of microeconomics: A preliminary investigation. American Journal of Business Education. 2017;10(1):9-16.
46. Parker LL, Loudon GM. Case study using online homework in undergraduate organic chemistry: results and student attitudes. J. Chem. Educ. 2013;90(1):37-44.
47. Walvoord BE, Anderson VJ. Effective grading: A tool for learning and assessment in college. 2nd ed. San Francisco: Jossey?Bass; 2010.
48. Cannonier C, Chen DC, Smolira J. The effect of a homework grade cap in an introductory finance class [Internet]; c2015 [cited 2015 Aug 24]. Available from: https://ssrn.com/abstract=2652425
49. Chan SH, Song Q, Rivera LH, Trongmateerut P. Using an educational computer program to enhance student performance in financial accounting. Journal of Accounting Education. 2016;36:43-64.

Disclaimer

Naveen Mahesh is the founder of Kognify Assessment and Skill Development, PL. While he was instrumental in providing the idea for this study, he was not involved in the data collection and analyses for the study. Execution of the study, including creation of the questions database and collection and analyses of data, was independent of any influence from the Kognify company. Varuna Kumaran and Dr. Krishna Kumar had no financial agreement with Kognify Assessment and Skill Development, PL, to conduct this study.

Appendix A. Click to enlarge

Varuna Kumaran [varuna_p@yahoo.com] is a visiting faculty member at the Elite School of Optometry, Chennai, Tamil Nadu, India, and has been teaching geometric optics since 2014. She is also a visiting faculty member and involved with research projects at other optometry schools.

Dr. Kumar is the Principal at the Elite School of Optometry, Chennai, Tamil Nadu, India, and has various publications to his credit. He specializes in the areas of low vision aids and occupational optometry.

Naveen Mahesh is Managing Trustee with Headstart Learning Centre International, Tamil Nadu, India. He is a serial entrepreneur and has founded many successful initiatives such as Headstart Learning Centre (IGCSE School), Explorers Basketball Club, Militvaa (entrepreneurship challenge), Karthavyam (public problem-solving diploma), Elina (integrated services for special education), Beyond 8 (ecosystem

for continuous learning) and Kognify (learning with understanding). Mr. Mahesh spent many years in the United States before becoming interested in education and learning in India. What he initially started as learning experiments in schools 15 years ago has become a habit of innovation in education redesign. He is passionate about getting schools to meet the global capacity challenge using emerging innovations and dynamic solutions.

PEER REVIEWED

Assessment of Competency Following Use of Eyesi Indirect Ophthalmoscope Simulators Within a First-Year Optometric Curriculum

Raymond H. Chu OD, MS, FAAO, Edeline J. Lu, OD, FAAO, and John Lee, OD, FAAO | Optometric Education: Volume 45, Number 2 (Winter-Spring 2020)

Abstract

This study evaluates the effectiveness of using the Eyesi Indirect Ophthalmoscope (VRmagic Holding AG, Mannheim, Germany) simulator in training first-year optometry students to perform binocular indirect ophthalmoscopy (BIO). During the spring quarter of the 2015-2016 academic year, first-year optometry students completed Tiers A and B of the Eyesi curriculum. At the start of the fall quarter of the second year, students were assessed before and after traditional faculty-led BIO instruction. The vast majority of students did not demonstrate competency following training with the Eyesi Indirect Ophthalmoscope ($p<0.001$). After traditional instruction, student performance was no different compared to previous years ($p=0.283$). As a standalone instruction method, the Eyesi Indirect Ophthalmoscope was not an effective way to teach students to perform the BIO technique to a competent level. Based on our work and the work of others, the Eyesi Indirect Ophthalmoscope is best utilized as an adjunct to traditional teaching methods, as an individualized remediation program, or as a way for clinicians to maintain skills.

Key Words: *binocular indirect ophthalmoscopy, simulation, optometric education, virtual reality, fundus examination*

Background

Healthcare education has historically operated under the adage of, “See one, Do one, Teach one,” a phrase coined after Halsted’s depiction of early surgical residency training.[1] In reality, Duvivier et al. found that medical students require repetitive practice to reach competency.[2] For optometry students, competent operation of the binocular indirect ophthalmoscope is a skill that requires many hours of practice. Binocular indirect ophthalmoscopy (BIO) is a difficult skill because it requires knowledge of anatomy, proper alignment of the optics and fine motor dexterity, all while navigating an inverted retinal image. Traditionally, students reach competency through classroom instruction, hands-on laboratory sessions with faculty and many hours of practice with peers.

Ericsson et al. hypothesized the path to mastery was not solely based on the amount of time spent practicing, but the amount of practice time devoted to targeting specific aspects of performance, which he termed deliberate practice.[3] Deliberate practice requires students to:

1. break the task down to the individual skills required to become competent
2. engage in tasks that provide immediate feedback on performance
3. persevere with increasingly more challenging tasks until the intended cognitive or psychomotor skills are achieved

Figure 1. Depiction of what the user sees in the Eyesi Indirect Ophthalmoscope headset.[7] Click to enlarge

Figure 2. Students using the Eyesi Indirect Ophthalmoscope. Click to enlarge

The use of simulations in healthcare education has increased due to concerns for patient safety, necessity of exposing students to rare clinical scenarios and a need for repeated practice of clinical skills within a standardized experience. Issenberg et al. defined simulation-based medical education (SBME) as an individualized learning opportunity for students to acquire and practice clinical?skills in an environment that imitates real patient encounters, anatomic regions or representative clinical tasks.[4] High-fidelity medical simulations facilitate learning through timely feedback and engagement in activities that reinforce and challenge the student, contain well-defined learning objectives and are representative of clinical practice. McGaghie et al. performed a meta-analysis and concluded that SBME with deliberate practice was superior to traditional clinical medical education in achieving skill acquisition.[5] Hayden et al. found that incorporating high-quality simulation experiences could replace up to half of traditional clinical education opportunities with no deleterious effect on outcomes.[6] Advances in virtual reality have provided more realistic and immersive environments for SBME. The Eyesi Indirect Ophthalmoscope is a high-fidelity virtual reality simulator for training of the BIO skill. When wearing the Eyesi headset, the student is able to view a binocular rendering of the anatomical structures of the retina **(Figures 1 and 2)**. The Eyesi curriculum contains four modules designed for students to independently learn basic BIO navigation and documentation and visualize common pathologies such as age-related macular degeneration and diabetic retinopathy.[7]

During the spring quarter of the 2015-2016 academic year, first-year students were tasked to complete Tiers A and B within the Eyesi Indirect Ophthalmoscope curriculum. The purpose of this study was to evaluate whether these students were able to perform BIO to a competent level following 10 weeks of independent study with the Eyesi Indirect Ophthalmoscope.

Methods

Previous class-year instruction

Figure 3. Scoring rubric for the Posterior Pole Mini Proficiency (PPMP) and the Pre-Lab Mini Proficiency (PLMP). Click to enlarge

For the three previous academic years (2013-14, 2014-15, and 2015-16), the BIO skill was first introduced to students in the Ocular Health Procedures I course in the fall quarter of their second year. In this course, students received a total of four hours of lecture (two hours of lecture per week) along with six hours of laboratory instruction (three hours per week) on the BIO skill. In addition, students were provided with after-hours practice sessions staffed by third-year optometry teaching assistants seven days a week for three hours each session. During the third week, students were administered the Posterior Pole Mini Proficiency (PPMP), which was used to evaluate their competency in obtaining full views of the posterior pole of the retina. **Figure 3** shows the rubric in which students were evaluated with a total of 10 points possible and requiring a minimum score of 7.5 points to have demonstrated competency.

Introduction of the Eyesi BIO simulators

During the spring quarter of the 2015-2016 academic year, first-year optometry students were tasked with completing Tiers A and B within the Eyesi curriculum in the Optometric Clinical Services I course. The intent of placing the simulators in the first-year curriculum, prior to traditional instruction, was to reduce the need for faculty instruction on the BIO skill.

Students completed an online learning module and a hands-on demonstration designed to familiarize them with basic handling of the simulators. In addition, students reviewed an online video tutorial on how the BIO skill is performed on a live patient and were allocated three hours of practice time every other week for a 10-week period to complete the tiers of the Eyesi Indirect Ophthalmoscope curriculum.

In Tier A **(Figure 4)**, students were taught the basic handling of the indirect ophthalmoscope as well as how to maneuver to obtain the desired views. They were tasked to obtain a view of the retina (starting with posterior pole) and to move the viewfinder crosshairs over geometric shapes within the retinal image **(Figure 5)**. In Retina Screening, students learned the location of anatomical structures within the retina by searching for and placing the viewfinder crosshairs over specific anatomical structures. In Retina Documentation, students were tasked to find and document the location, orientation and size of abstract objects in order to understand the true location of the inverted images (Figure 5). At the end of each training case, students were provided a report card on how well they completed the task **(Figure 6)**.

In Tier B **(Figure 7)**, students were provided with images of normal retinas from various cases. They worked through the teaching and exam modes, which tasked them to identify anatomical features and classify characteristics of healthy retinas. Students who needed additional time to complete the tiers were provided access to the simulators during non-scheduled hours. The instructor of record of the Optometric Clinical Services I course evaluated the students' progress via the online portal to ensure all students completed the assigned tiers by the end of the spring quarter.

Figure 4. Description of Tier A within the Eyesi Indirect Ophthalmoscope simulator curriculum.[7] Click to enlarge

Figure 5. Example of abstract objects in Tier A.[7] Click to enlarge

Figure 6. Example of end-of-case feedback report to the student. Click to enlarge

Figure 7. Description of Tier B within the Eyesi Indirect Ophthalmoscope simulator curriculum.[7] Click to enlarge

After the summer break, the students (now second-year) were enrolled in the Ocular Health Procedures I course during the fall quarter of the 2016-2017 academic year. At the start of the fall quarter, the students were administered a Pre-Lab Mini Proficiency (PLMP) prior to receiving any laboratory instruction on the BIO skill. The PLMP was identical to the PPMP, and the same rubric was used for grading (Figure 3). Students then received the same traditional BIO instruction and practice sessions as described above for previous classes, including taking the PPMP during the third week.

Data collection and analysis

The mean scores on the PPMP for the three previous class years were compared to the mean score of the 2016-2017 class using ANOVA. Also, the mean score on the PLMP exam for the 2016-2017 class was compared to its mean score on the PPMP using a paired t-test. The percentage of students who demonstrated competency (at least 7.5 of 10 points) on the PPMP (and PLMP for the 2016-2017 class) was recorded for the four classes.

Results

During the spring quarter of the first-year, 99 students completed Tiers A and B within the Eyesi curriculum. During the subsequent fall quarter, the students were enrolled in the Ocular Health Procedures 1 course where 5% of the class reached competency (defined as a minimum score of 7.5 out of 10 points on the PLMP). The mean score for the class was 2.46±2.08 on the PLMP **(Table 1)**.

Table 1. Click to enlarge

After instruction and practice, students took the PPMP where the 2016-2017 class achieved a mean score of 8.55±1.94 (paired t-test $p<0.001$) and 82.82% of the class reached competency. Based on ANOVA, with statistical significance set at a p-value less than 0.05, the PPMP score was not statistically different ($p=0.283$) from the scores of the previous classes.

Discussion

Based on the comparison of the PLMP score to the PPMP score, as a standalone instruction method for teaching the BIO skill, the EyeSi curriculum was not able to teach students to obtain a full, in-focus and stable view of the posterior pole to a competent level. These results differ from previous reports in which a positive learning outcome was associated with the incorporation of the EyeSi Indirect Ophthalmoscope.[8-13] Rai et al. found that novice ophthalmology residents who received instruction through the EyeSi Indirect Ophthalmoscope outperformed their colleagues who had received traditional BIO training with didactic lecture and practicing BIO under supervision.[12] This conclusion was based on the residents' performance score derived from the EyeSi Indirect Ophthalmoscope, which factored in accurate documentation, amount of retina visualized, elapsed time and the ability of the residents to identify and maintain views of posterior segment structures. However, it is likely that the familiarization of training on the simulators had an effect on performance scores because the conventional training group also had improvement in performance following an opportunity to receive training on the simulators. Anderson et al. reported a greater number of students achieving a 100% score in visualizing the mid-periphery and posterior pole with their BIO assessment when they were assigned to complete Tier A of the EyeSi curriculum as a supplement to traditional faculty-led instruction.[11] In their subsequent course administration, a portion of Tier A was assigned to the students prior to the course, similar to our course design. Anderson et al. observed that student learning had been accelerated. As a result, to better challenge and further assess students' BIO ability, they altered their assessment to include full views in nine peripheral locations.[11] In our study, the timing of the PPMP was the same as in previous course administrations; therefore, we were unable to assess whether the students' competency in BIO had been accelerated.

Issenberg et al. identified feedback as the single most important feature of simulation-based medical education.[4] After completing Tiers A and B of the EyeSi curriculum (Figure 4 and 7), students learned to obtain views of the retina with the indirect ophthalmoscope. However, the limitation of the EyeSi curriculum was its inability to provide feedback on the other dimensions of the PLMP rubric (Figure 3), such as hand-washing, ability to hold a full view for at least three seconds, manipulation of a patient's lids and lashes and adjustment variables such as chair height and patient fixation angles.

Limitations

A limitation of our study was the timing of the PLMP. Students' skills were subject to degradation over the summer break. It is possible that a larger proportion of students would have passed the PLMP if it had been administered at the conclusion of the spring quarter of their first-year. Although the instruction of the BIO skill was similar across each course administration, the cohorts of students were different, which could have affected the outcome of our study.

Conclusion

The EyeSi Indirect Ophthalmoscope is a high-fidelity simulator that provides a realistic student training experience, opportunity for continuous practice, tracking of skill acquisition and introduction to a wide array of common and rare vitreoretinal pathology. The simulator adopts the principles of deliberate practice, which may accelerate competency attainment and assist in reducing the achievement gap between students' performance. Cham and Cochrane hypothesized that introduction of the EyeSi Indirect Ophthalmoscope would help students reach technical competency sooner, which would reduce teaching workloads by minimizing the need for intensive faculty-led instruction on the BIO procedure.[13] Based on our work and the work of Anderson et al. and Rai et al., the EyeSi Indirect Ophthalmoscope is best utilized as an adjunct to faculty-led instruction, not as a replacement for faculty instruction.[11,12] Additional applications for the EyeSi Indirect Ophthalmoscope simulator may be as a tool to reduce erosion of skill over time, to simulate clinical decision-making (Eyesi curriculum Tiers C and D) and to reduce the rigors and consequences associated with repeated dilations on one another.

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References

1. Cameron JL. William Stewart Halsted. Our surgical heritage. Ann Surg. 1997;225(5):445-458.
2. Duvivier RJ, van Dalen J, Muijtjens AM, Moulaert VR, van der Vleuten CP, Scherpbier AJ. The role of deliberate practice in the acquisition of clinical skills. BMC Medical Education. 2011;11(1):101. doi:10.1186/1472-6920-11-101
3. Ericsson KA. Deliberate practice and acquisition of expert performance: a general overview. Acad Emerg Med. 2008;15(11):988-994. doi:10.1111/j.1553-2712.2008.00227.x
4. Issenberg SB, McGaghie WC, Petrusa ER, Lee Gordon D, Scalese RJ. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Med Teach. 2005;27(1):10-28. doi:10.1080/01421590500046924
5. McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence: Acad Med. 2011;86(6):706-711. doi:10.1097/ACM.0b013e318217e119
6. Hayden JK, Smiley RA, Alexander M, Kardong-Edgren S, Jeffries PR. The NCSBN National Simulation Study: a longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. Journal of Nursing Regulation. 2014;5(2):S3-S40. doi:10.1016/S2155-8256(15)30062-4
7. VRmagic Holding AG. Eyesi indirect ophthalmoscope. Eyesi Indirect Ophthalmoscope – VRmagic [accessed 2017 Dec 18]. Available from: https://www.vrmagic.com/fileadmin/downloads/simulator_brochures/Eyesi_Indirect_Brosch%C3%BCre_170926_EN_WEB.pdf
8. Leitritz MA, Ziemssen F, Suesskind D, et al. Critical evaluation of the usability of augmented reality ophthalmoscopy for the training of inexperienced examiners. Retina (Philadelphia, Pa). 2014;34(4):785-791. doi:10.1097/IAE.0b013e3182a2e75d
9. Singh P, Deuchler S, Schaefer H, Fassbender S, Kohnen T, Koch FH. Indirect ophthalmoscopy: training with conventional hardware versus the Eyesi indirect ophthalmoscopy simulator. Invest Ophthalmol Vis Sci. 2014;55(13):279.
10. Chou J, Kosowsky T, Payal AR, Gonzalez Gonzalez LA, Daly MK. Construct and face validity of

the EyeSi indirect ophthalmoscope simulator. Retina. 2017;37(10):1967-1976.
11. Anderson HA, Giannoni AG, Berntsen DA. Student performance and perceptions following incorporation of Eyesi indirect simulators into the optometric curriculum. Optometric Education. 2017 Winter-Spring;42(2).
12. Rai AS, Rai AS, Mavrikakis E, Lam WC. Teaching binocular indirect ophthalmoscopy to novice residents using an augmented reality simulator. Can J Ophthalmol. 2017;52(5):430-434. doi:10.1016/j.jcjo.2017.02.015
13. Cham KM, Cochrane, A. Educator's Podium. Using technology to enhance student learning and clinical teaching outcomes. Optometric Education. 2017 Winter-Spring;42(2).

Dr. Chu [rchu@ketchum.edu] is an Associate Professor and the Associate Dean of Academic Affairs at the Southern California College of Optometry at Marshall B. Ketchum University. He is a Diplomate in the Optometric Education Section of the American Academy of Optometry.

Dr. Lu is an Assistant Professor with clinical and laboratory teaching responsibilities in the Primary Care/Ocular Disease services at the Southern California College of Optometry at Marshall B. Ketchum University.

Dr. Lee is an Assistant Professor at the Southern California College of Optometry at Marshall B. Ketchum University. His primary teaching responsibilities are in clinical education and primary care optometry. He is also the Assistant Chief of the Jarnigan Primary Care Service at Ketchum Health.

Features

Editorial

Students Increasingly Affected by Anxiety, Depression

Aurora Denial, OD, FAAO | Optometric Education: Volume 45, Number 2 (Winter-Spring 2020)

Aurora Denial, OD, FAAO

Anxiety and depression are apparently on the rise among students at various education levels. The Pew Research Center reported in 2019 that 70% of teens say anxiety and depression are major concerns among their peers.[1] According to the American College Health Association's National College Health Assessment II, in 2016 nearly two-thirds of college students reported anxiety, which was an increase of 50% over the previous five years.[2]

Depression and anxiety seem to be on the rise among graduate healthcare students as well, including optometry students. I've had informal discussions with colleagues in a variety of healthcare professions, and all report seeing an increase in student anxiety and depression at their institutions. Published data support these impressions. A meta-analysis by Quek et al. showed a high prevalence of anxiety among medical students globally, ranging from 29.2% to 38.7% compared with 3% to 25% in the general population.[3] According to data collected for a study done by The Ohio State University, 17% of incoming students in seven disciplines (dentistry, medicine, nursing, optometry, pharmacy, social work and veterinary medicine) reported moderate to severe depressive symptoms, 14% reported moderate to severe anxiety, and 6% reported suicidal ideation."[4] Risk factors or predictors for anxiety and depression identified by the researchers included lack of sleep, lifestyles behaviors, general health, perceived lack of control and stress.[4]

Defining Anxiety and Depression

Anxiety as defined by the American Psychological Association (APA)[5] is "an emotion characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure. People with anxiety disorders usually have recurring intrusive thoughts or concerns. They may avoid certain situations out of worry. They may also have physical symptoms such as sweating, trembling, dizziness or a rapid heartbeat." The APA[6] characterizes depression as "more than just sadness" and states "People with depression may experience a lack of interest and pleasure in daily activities, significant weight loss or gain, insomnia or excessive sleeping, lack of energy, inability to concentrate, feelings of worthlessness or excessive guilt and recurrent thoughts of death or suicide."

Why are Students Struggling to Cope?

Why do we have a generation of students who seem to have very little ability to cope with stress? Certainly healthcare education is academically and emotionally challenging. In graduate health programs, students must master a large quantity of information, develop clinical skills, pass formalized tests and deal with difficult emotional topics and patient scenarios. Additionally, students at the graduate level are often living on their own, dealing with financial issues and having to adjust to a prescribed academic schedule. It is not surprising that the stress inherent in graduate education may worsen pre-existing mental health issues.

Researchers have hypothesized that academic pressure, the use of electronic devices and social media may be contributing to the rise in anxiety and depression.[2] However, previous generations all had academic pressure to succeed. Although the use of social media and electronic devices has definitely influenced this generation, I find it difficult to believe that it is significantly responsible for these trends. Have parenting styles changed so that children are no longer required to deal with small stresses that would enable them to develop coping skills? As parents are we nurturing coping skills in our children or are we solving problems for them and protecting them from any stressful situation? College environments used to prepare students both academically and emotionally for the adult world. However, students now report that in many instances there is great flexibility in college and very few consequences for underperformance.

Stress is a normal component of everyday life and definitely a component of graduate education. Should institutions screen for anxiety and depression following admission? This would allow for early identification and possible treatment. As faculty, we are all concerned about this trend.

* * * * *

ASCO posted a podcast on this topic, an interview with Jonathan Peretz, PsyD, a student wellness expert. Dr. Peretz talks about stress among students and strategies for handling it, including mindfulness and self-care and how to know when professional help is needed. Listen here.

* * * * *

References

1. Most U.S. teens see anxiety and depression as a major problem among their peers [Internet]. Washington, DC: Pew Research Center; c2020 [cited 2020 Feb 15]. Available from: https://www.pewsocialtrends.org/2019/02/20/most-u-s-teens-see-anxiety-and-depression-as-a-major-problem-among-their-peers/.
2. National College Health Assessment II, Undergraduate Student Reference Group, Executive Summary Fall 2016. Hanover, MD: American College Health Association; c2017 [cited 2020 Feb 15]. Available from: https://www.acha.org/documents/ncha/NCHA-II_FALL_2016_UNDERGRADUATE_REFERENCE_GROUP_EXECUTIVE_SUMMARY.pdf
3. Quek TT, Tam WW, Tran BX, et al. The global prevalence of anxiety among medical students: a meta-analysis. Int J Environ Res Public Health. 2019 Jul 31;16(15). pii: E2735.
4. Hoying J, Melnyk BM, Hutson E, Tan A. Prevalence and correlates of depression, anxiety, stress, healthy beliefs, and lifestyle behaviors in first?year graduate health sciences students. Worldviews Evid Based Nurs. 2020 Feb;17(1):49-59.
5. Anxiety [Internet]. Washington, DC: American Psychological Association; c2020 [cited 2020 Feb 15]. Available from: https://www.apa.org/topics/anxiety/.
6. Depression [Internet]. Washington, DC: American Psychological Association; c2020 [cited 2020 Feb 15]. Available from: https://www.apa.org/topics/depression/.

Dr. Denial [deniala@neco.edu], Editor of Optometric Education, is a Professor and Chair of the Department of Primary Care at the New England College of Optometry and a Clinical Instructor at a community health center in Boston.

Industry News

Industry News

Desiree Ifft | Optometric Education: Volume 45, Number 2 (Winter-Spring 2020)

Industry News

Ocular Allergy Drop Now Available Over the Counter

Since 2008, more than 40 million prescriptions have been written for olopatadine, the active ingredient in Alcon's Pataday prescription ocular allergy relief eye drops. Now, Pataday Once Daily Relief (olopatadine 0.2%) and Pataday Twice Daily Relief (olopatadine 0.1%) are available over the counter in the United States. Alcon secured the rights to the Rx-to-OTC switch via the FDA as part of its separation from Novartis in April 2019. The company says it will launch a robust media campaign in early March 2020 to spread the news.

Pataday Once Daily Relief and Pataday Twice Daily Relief are indicated for the temporary relief of itchy eyes due to pollen, ragweed, grass, animal hair and dander for ages 2 and older. Pataday Twice Daily Relief is also indicated for the temporary relief of red eyes.

Click here to learn more.

FDA Approves New Toric Multifocal Contact Lens

The FDA has granted CooperVision Inc. approval for its new Biofinity toric multifocal contact lenses. The lenses combine the optical designs of the company's Biofinity toric and Biofinity multifocal to provide patients with correction of both astigmatism and presbyopia.

CooperVision plans to make the lenses available to U.S. eyecare professionals later in 2020, and lens parameters and other details will be made public in the coming months.

Blog Post Breaks Down Recent Studies Evaluating the Value of ERG Technology

Diopsys Inc. has posted a round-up of recent studies highlighting the value of electroretinography (ERG) technology in the management of various ocular diseases. The blog post notes that ERG has become much more user-friendly than it had been in the past and can be carried out in the eyecare office in less than 10 minutes.

Visitors to the blog can also download a free ERG eBook, “A Game-Changer in Diabetic Retinopathy,” by Steven M. Silverstein, MD.

Free eBook Aims to help ECPs Find Their Unique Strengths and Leverage Them for Success

HOYA is offering eyecare practitioners (ECPs) a free eBook, “The Power of the ECP: Leveraging Your Unique Strengths to Impact Patients and the Industry.” The book explains common strengths that serve as the foundation of success for ECPs. It provides advice for individual ECPs on how to identify their unique strengths and build upon them by embracing technology, building an online presence, educating patients, and more.

New Program Exposes Optometry Students to Real-World Perspectives

Mentor MatchUP, a new program designed by Luxottica Eye Care to connect second-year optometry students with local doctors, kicked off at Salus University in February 2020. The six-session program enhances classroom learning with real-world perspective from working optometrists.

Mentor MatchUP allows for structured learning on topics essential to students’ long-term success in the field of optometry. The program is a combination of virtual and in-person meetings to accommodate the busy schedules of both students and doctors.

Luxottica plans to expand the program to other schools in spring 2020. Those interested in learning when Mentor MatchUP is coming to their school can sign up for Mentor MatchUP updates.

Announcement

Call for Papers for Theme Edition: Diversity and Cultural Competence in Optometry

Desiree Ifft | Optometric Education: Volume 45, Number 2 (Winter-Spring 2020)

The population continues to become more diverse, and optometry must be able to meet the cultural, ethnic, racial, gender and linguistic needs of patients. *Optometric Education* is inviting authors to submit scholarly papers addressing related themes such as diversity, cultural competency, gender issues and cultural awareness.

The deadline to submit papers for this theme edition is March 30, 2021

For more information, e-mail journal Associate Editor Keshia S. Elder, OD, MS, FAAO, or journal Editor Aurora Denial, OD, FAAO.

Industry News

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