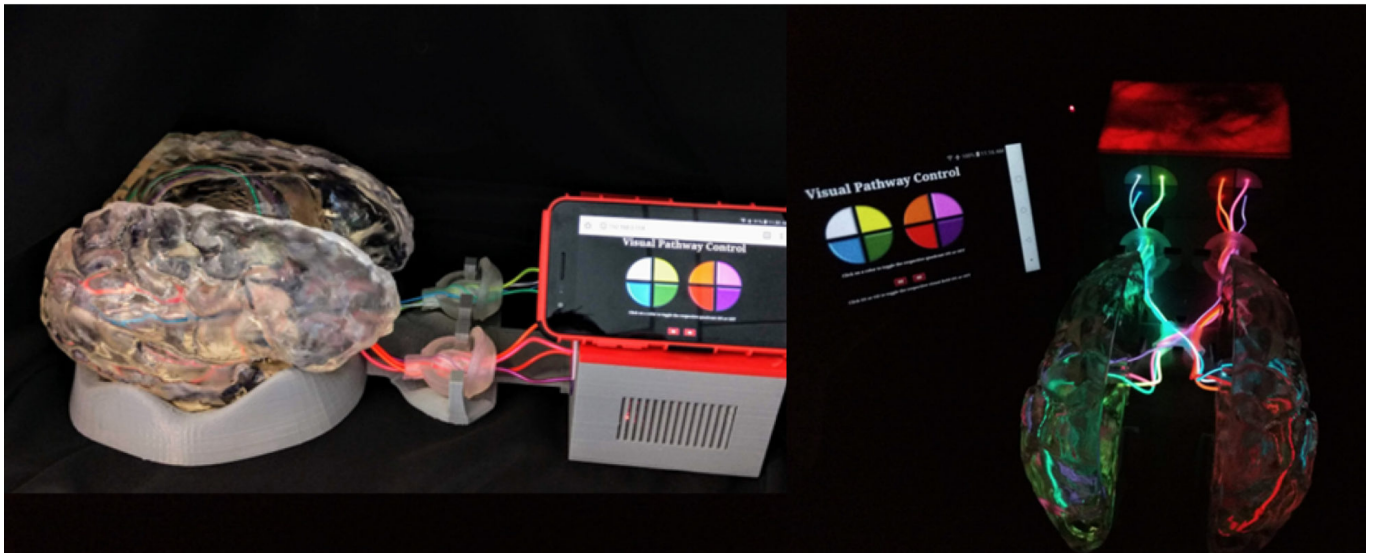


# OPTOMETRIC EDUCATION

The Journal of the Association of Schools and Colleges of Optometry

Volume 46, Number 2  
Winter-Spring 2021



Butterfly-Shaped Pattern Dystrophy: an Observational Teaching Case Report

Assessment of the Utility of 3D-Printed Interactive Models in the Vision Science Classroom

Sleep Irregularity and Academic Performance

Faculty Development to Improve Teaching Skills of Optometric Educators: Experiences of a Healthcare Organization

Student Satisfaction with an Objective Structured Clinical Examination in Optometry

Student Perceptions of Cultural Competency

Amelanotic Choroidal Melanoma: a Teaching Case Report

Does Self-Regulated Test Duration Correlate with Vision Science Test Score in First-Year Optometry Students?

## ALSO INSIDE

Editorial: Unforeseen Outcomes of Remote Learning

Invitation to Participate: Call for Papers for Theme Edition on Diversity and Cultural Competence in Optometry (Deadline extended!)

Industry News

# Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)

## Table of Contents

### Articles

---

[Butterfly-Shaped Pattern Dystrophy: an Observational Teaching Case Report](#)

[Sleep Irregularity and Academic Performance](#)

[Assessment of the Utility of 3D-Printed Interactive Models in the Vision Science Classroom](#)

[Student Perceptions of Cultural Competency](#)

[Student Satisfaction with an Objective Structured Clinical Examination in Optometry](#)

[Does Self-Regulated Test Duration Correlate with Vision Science Test Score in First-Year Optometry Students?](#)

[Faculty Development to Improve Teaching Skills of Optometric Educators: Experiences of a Healthcare Organization](#)

### Features

---

[Call for Papers for Theme Edition: Diversity and Cultural Competence in Optometry](#)

[Unforeseen Outcomes of Remote Learning](#)

[Industry News](#)

### Sponsors

---

VSP Global Innovation Center

Essilor

Alcon

---

# Articles

## PEER REVIEWED

# Butterfly-Shaped Pattern Dystrophy: an Observational Teaching Case Report

*Hyoung I. Lho, OD, An T. Hoang, OD, Erika M. Perzan, OD, FAAO, ABCMO, and Kelsey D. Smith, OD |  
Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

### **Abstract**

*Butterfly-shaped pattern dystrophy (BSPD) is one of five subtypes of macular pattern dystrophy. BSPD is a heterogenous macular condition affecting the retinal pigment epithelium layer of the macula. This paper presents an observational teaching case report on BSPD to the Doctor of Optometry involved in clinic-based training of fourth-year optometric interns and externs and residents. Practical knowledge of BSPD is relevant to the optometrist because BSPD is a rarely encountered type of macular disease that can often be managed appropriately with observation in an optometric setting. Trainees should be instructed how to differentiate retinal findings that require referral and those that usually do not. The case report reviews the natural history of stable BSPD throughout a 12-year period. It also reviews practical applications for teaching, utilization of readily available technologies, genetic test recommendations and appropriate management.*

**Key Words:** *butterfly-shaped pattern dystrophy, pattern dystrophy of macula, pigmentary retinal dystrophy (H35.52)*

### **Background**

This teaching case report involves one of five pattern dystrophies of the retinal pigment epithelium (RPE), which share several characteristics. Typically, they are inherited in autosomal dominant fashion, heterogenous in presentation, associated with little or no vision loss, and characterized by lipofuscin deposits in the RPE. They can show variability with time, and fluorescein angiography can help distinguish the subtypes.<sup>1-5</sup> The five pattern dystrophy subtypes of the macula are: butterfly-shaped pattern dystrophy (BSPD), vitelliform dystrophy of the fovea, fundus flavimaculatus, reticular dystrophy of the pigment epithelium and fundus pulverulentus.<sup>2,3,4</sup> Signs of these five pattern dystrophies may be evident in the first decade of life,<sup>5</sup> and most patients are asymptomatic into middle age.<sup>2</sup>

This case discusses a stable, bilateral presentation of BSPD. The patient is a 68-year-old African American female who has been a Veterans Health Administration (VHA) eye clinic patient for 12 years. BSPD is a rare, bilateral condition characterized by a buildup of yellow, orange or gray pigmented material in a butterfly-shaped pattern within the RPE of the macula.<sup>1,6,7</sup> The butterfly shape may also be described as linear, stellate, branching or shaped like a letter.<sup>7,8</sup>

BSPD has a rare incidence and prevalence per a 1991 study. The study spanned 18 years in Northern France and included approximately 4 million people. Researchers found three patients with BSPD out of 1,660 patients known to have inherited retinal dystrophies. This gives a cumulative incidence of 0.000415% of residents having any inherited retinal dystrophy in that time period. (Cumulative incidence

= number of events/population size.) Additionally, this gives a prevalence for BSPD of 0.00000075% among all of the study subjects and 0.001807%<sup>9</sup> among the 1,660 study subjects with a pattern dystrophy. (Prevalence = number of cases/population size.)

## Purpose

The intended audience for this teaching case report is the Doctor of Optometry involved in training fourth-year interns and externs and residents in a clinical or academic setting. The case provides an example of how to approach a rare diagnosis with a trainee, how to gather the pertinent objective data to monitor the condition, when to refer the case for co-management with a retina specialist and how to educate the patient about the impact of the diagnosis on the patient and his or her family members.

## Student Discussion Guide

### *Case description*

A 68-year-old African American female presented for a routine comprehensive eye exam in 2019. Previously, in 2007 and 2010, the patient had undergone teleretinal screening. Her first known eye exam at a VHA facility was in 2012. Subsequent exams occurred in 2014, 2016, 2017, 2018 and 2019.

At the 2019 eye exam, the patient reported no ocular or visual complaints. Known family ocular history was unremarkable. The patient's ocular history included moderate dry eye syndrome with blepharitis in both eyes, chronic allergic conjunctivitis and uncontrolled type 2 diabetes mellitus (T2DM) that was diagnosed in 2007. The patient had been taking insulin since 2015, and there was no known retinopathy in either eye. BSPD in both eyes had been originally diagnosed as "pattern dystrophy" in 2007 via teleretinal imaging. The patient's ocular history also included moderate hypertensive retinopathy in both eyes, refractive error in both eyes and nuclear cataracts in both eyes. Medical history included benign hypertensive heart disease and chronic renal disease stage 3, T2DM on insulin, multiple-type hyperlipidemia, obesity and essential hypertension. Known drug allergies included codeine, influenza [vaccine] and metformin. Active medications included amlodipine 10-mg tablet QD for blood pressure, carboxymethylcellulose 1% (Refresh Liquigel) 1gtt in each eye TID for dry eyes, cholecalciferol (vitamin D3) 1,000-IU tablet QD for vitamin D supplementation, glimepiride 4-mg tablet every morning with food for diabetes, hydrochlorothiazide one half of a 25-mg tablet QD as needed for blood pressure, human insulin 100 unit/mL injection 35 units subcutaneously QD for diabetes, losartan one half of a 100-mg tablet QD for blood pressure, and simvastatin 80-mg tablet QHS for cholesterol.

Also at the 2019 visit, the patient's best-corrected visual acuity was 20/25- in the right eye and 20/25+ in the left eye with near visual acuity of 20/20 (both eyes). All entrance tests and anterior segment slit lamp examination findings were stable, unremarkable and age-appropriate in both eyes. Specific tests performed included extraocular muscle motilities, confrontation visual fields, pupil testing, manifest refraction and dilated fundoscopic examination with 20D and 66D lenses. Amsler grid testing with best near correction was full in each eye. Posterior segment examination with dilation showed mild arterial/venous (A/V) crossing changes with attenuated vessels and an A/V ratio of 1:2 OU. The peripheral retina was unremarkable. Macular findings were stable and significant for the presence of BSPD in both eyes overlying a two-disc-diameter area. The appearance of the butterfly-shaped patterns in 2019 was stable when compared with the 2007 and 2017 retinal photographs (**Figures 1-4**). The quality of the 2019 photographs was degraded by media blur from the cataracts. Only the 2007 and 2017 retinal images are included in the case report.



**Figure 1. 2007:** Mydriatic fundus photography of the posterior pole of the right eye, including optic nerve, macula and major retinal vessels. The area of butterfly-shaped pattern dystrophy is circled. [Click to enlarge](#)



**Figure 2. 2007:** Mydriatic fundus photography of the posterior pole of the left eye, including optic nerve, macula and major retinal vessels. The area of butterfly-shaped pattern dystrophy is circled. [Click to enlarge](#)



**Figure 3. 2017:** Mydriatic fundus photography of the posterior pole of the right eye, including optic nerve, macula and major retinal vessels. The area of butterfly-shaped pattern dystrophy is circled. [Click to enlarge](#)



**Figure 4. 2017:** Mydriatic fundus photography of the posterior pole of the left eye, including optic nerve, macula and major retinal vessels. The area of butterfly-shaped pattern dystrophy is circled. [Click to enlarge](#)

Reliable optical coherence tomography (OCT) macular cube 512 x 128 and HD five-line raster scans [Zeiss Cirrus 400 spectral domain (SD) OCT] obtained in 2019 showed intact foveal contours in both eyes with no subretinal fluid (**Figures 5-8**). The scans were remarkable for macular thinning and showed subtle subfoveal disruption in both eyes with ellipsoid zone loss. Central subfield thickness measured 204  $\mu\text{m}$  OD and within average ranges at 223  $\mu\text{m}$  OS; cube volume was decreased at 8.7  $\text{mm}^3$  OD and 8.4  $\text{mm}^3$  OS. Cube average thickness was decreased at 245  $\mu\text{m}$  OD and 240  $\mu\text{m}$  OS.



**Figure 5. 2019:** OCT scan (Zeiss Cirrus SD-OCT 400) of the right eye showing macular thinning and volume loss. [Click to enlarge](#)



**Figure 6. 2019:** OCT scan (Zeiss Cirrus SD-OCT 400) of the left eye showing macular thinning and volume loss. [Click to enlarge](#)



**Figure 7. 2019:** OCT five-line raster scan (Zeiss Cirrus SD-OCT 400) through the fovea of the right eye showing loss of ellipsoid zone. [Click to enlarge](#)



**Figure 8. 2019:** OCT five-line raster scan (Zeiss Cirrus SD-OCT 400) through the fovea of the left eye showing loss of ellipsoid zone. [Click to enlarge](#)

The patient was scheduled to return in one year for a comprehensive exam with OCT imaging of the maculae and fundus photographs of both eyes. The plan included continued progression analysis of macular thickness via OCT scans and to obtain baseline fundus autofluorescence imaging. Obtaining an electroretinogram (ERG) and electro-oculogram (EOG) could also be illustrative. In pattern dystrophies, expected findings would be abnormal pattern ERG, normal flash ERG and abnormal EOG.<sup>10</sup>

The findings of stable hypertensive retinopathy and stable BSPD were discussed with the patient. She was counseled on lifestyle management of diabetes, cardiovascular risk factors and hypertension. The importance of avoiding smoking, maintaining a heart healthy diet and managing all systemic health conditions per the advice of her primary care provider were discussed.

The patient was educated that no treatment for BSPD is currently known and she would be notified if that were to change. She was instructed to routinely check her vision at home with the Amsler grid and why it is important. The patient verbally confirmed that she should immediately contact the eye clinic if grid changes were noted. Patient education also included a discussion on possible treatment options if her condition should progress. She was instructed to inform her immediate family members of the diagnosis so they could schedule routine comprehensive eye exams and determine whether they had a retinal pattern dystrophy.

## Educator's Guide

### Learning objectives

1. Recognize macular pattern dystrophies (BSPD, vitelliform dystrophy of the fovea, fundus

flavimaculatus, reticular dystrophy of the pigment epithelium and fundus pulverulentus)

2. Determine appropriate tools for diagnosis of macular pattern dystrophies
3. Diagnose the subset of BSPD
4. Understand appropriate management for the condition
5. Understand treatment options if complications develop
6. Deliver patient education regarding management options and prognosis
7. Deliver patient education regarding genetic testing and family counseling

#### *Key concepts*

1. Difference between common macular diseases and the rare pattern dystrophies
2. How the appearance of BSPD is different from the appearance of the other macula pattern dystrophies
3. Recommending ancillary testing to support the management of pattern dystrophy
4. Delivering clear education to the patient regarding diagnosis, treatment and management of BSPD

#### **Education Guidelines**

*Setting: academic classroom or clinical discussion after patient care*

1. Focus on the knowledge, facts, and concepts required for critical review of the case:
  - a. Is this a typical presentation of BSPD?
  - b. Can the patient make lifestyle changes to assist in management of BSPD?
  - c. How can you differentiate BSPD from the other pattern dystrophies of the macula?
  - d. What is an appropriate patient management plan?
2. Differential diagnosis:
  - a. What differential diagnoses can be considered based on the findings of the eye exam?
  - b. What is the purpose of ancillary testing in pattern dystrophy?
  - c. What knowledge gaps did this case expose for you and how will you bridge those gaps?
3. Disease management:
  - a. What are the benefits of closely monitoring this patient?
  - b. What are the drawbacks of closely monitoring this patient?
4. Patient education and communication:
  - a. How do you educate the patient on the diagnosis?
  - b. How do you educate the patient on the prognosis?
  - c. What sequelae do you advise the patient to expect?
  - d. How do you discuss genetic testing with the patient?
  - e. How do you deliver these discussions in an empathetic manner?
5. Critical thinking:
  - a. Could patient adherence to follow-up be a complication in this case?
  - b. Could patient adherence to home monitoring be a challenge in this case?
  - c. Are you prepared now to manage a diagnosis of pattern dystrophy?

#### *Learning assessment*

1. Instructor guides a case discussion to ensure all discussion questions are considered
2. Evaluate the trainees' knowledge base by fostering discussion of the OCT scans, retinal photos, Amsler grid and pertinent exam findings
3. Evaluate knowledge base by having the trainees discuss possible differential diagnoses
4. Evaluate clinical-thinking skills with a literature review and follow-up discussion (The literature review can be conducted informally by the trainees or formally with the intent to produce a case study paper, case study manuscript or poster)

## Discussion

### *Clinical presentation and differential diagnosis*

Pattern dystrophies of the RPE tend to share several characteristics. Typically, they are inherited in autosomal dominant fashion, heterogenous in presentation, associated with little or no vision loss, and characterized by lipofuscin deposits in the RPE. They can show variability with time, and fluorescein angiography can help distinguish the subtypes.<sup>1-5</sup> Signs of the macular pattern dystrophies may be evident in the first decade of life,<sup>5</sup> and most patients are asymptomatic into middle age.<sup>2</sup> The physical appearance of pattern dystrophies and BSPD can progress with time, appear as different patterns between eyes, and display different patterns among family members.<sup>7,8</sup> The pattern may vary in presentation at subsequent exams and change in appearance to more closely resemble a different pattern dystrophy of the macula. Family members of patients with BSPD who are initially free of clinical signs of the condition may develop a pattern dystrophy over time.<sup>4,7</sup>

Most reports of BSPD in the literature emphasize its rare occurrence and typically benign natural course. However, reports of geographic atrophy and choroidal neovascular membrane (CNVM) have been published.<sup>2,13,14</sup> Conversion to CNVM occurs infrequently.<sup>13,14</sup> In a case of BSPD with CNVM reported in 2000, lesions spontaneously involuted and without treatment regressed to a focal, fibrotic scar with a favorable visual prognosis.<sup>13</sup> Recently, CNVM in BSPD was reported to have a therapeutic response to anti-vascular endothelial growth factor (anti-VEGF) intravitreal injections.<sup>14</sup>

Differential diagnosis for BSPD includes the four other pattern dystrophies, which are Best's vitelliform dystrophy of the fovea, Stargardt's macular dystrophy/fundus flavimaculatus, reticular dystrophy of the pigment epithelium and fundus pulverulentus. Additional differential diagnoses include central areolar choroidal dystrophy, North Carolina macular dystrophy, progressive bifocal chorioretinal atrophy, Sorbsy fundus dystrophy and dominant macular dystrophy.<sup>2,3,4,6,10,15,16</sup> These conditions can all involve the macular region, and while they have similarities with BSPD, they can be differentiated by their unique presentations.

Writing in 2013, Hannan et al. provided a useful reference for the OCT appearance of three different pattern dystrophies, including BSPD. In their BSPD cases, they described SD-OCT as revealing disruptions in the ellipsoid zone of the IS/OS (inner segment/outer segment) junction.<sup>17</sup> Writing in 2017, Kumar et al. described loss of the photoreceptor integrity line in the ellipsoid layer in the macular region.<sup>18</sup>

Currently there is no treatment for stable pattern dystrophies, although nutritional supplements have been considered,<sup>10</sup> and genetic therapies may be developed. The CTNNA1 gene has been implicated in inheritance per a 2016 study. The CTNNA1 gene, which encodes for alpha-catenin 1, is essential in maintaining RPE integrity and intercellular adhesion junctions. Defects in cadherin-based intercellular adhesion is believed to cause macular dystrophy.<sup>11</sup> The HTRA1 single-nucleotide polymorphism was also associated with pattern dystrophy and age-related macular degeneration (AMD) per a 2012 study.<sup>12</sup>

Our patient was diagnosed in her mid-50s and remains asymptomatic at age 68. She fits within the age

group and clinical presentation described in the literature. Symptoms and signs have remained stable and the presentation of BSPD in our patient has followed a benign course. She has no known family members with the condition. Our OCT findings showed loss of the ellipsoid zone consistent with what is described in the literature for similar cases.

### *Indicated tests*

Patient at-home monitoring with the Amsler grid and in-clinic OCT imaging of the macula are useful tools in ruling out CNVM. For purposes of comparison, it is advised that the same OCT macular cube scan sets are run at subsequent visits. This enables a change analysis of the macular cube 512 x128 that can be compared from two different dates. Additional tests could include automated perimetry of the central visual field, ERG, EOG and genetic testing.<sup>10</sup>

Commonly available central visual field testing options include the Zeiss Humphrey Visual Field 10-2 of the central 10 degrees of vision and the Haag-Streit Octopus 900 M-Top Scan of the central 12 degrees of vision. Expected findings on electrophysiological tests are abnormal pattern ERG, normal flash ERG and abnormal EOG.<sup>10</sup> Genetic testing can be discussed with the patient and pursued if he or she desires. BSPD was originally thought to have a complicated inheritance pattern. Autosomal dominant, autosomal recessive, and multi-factorial dominant inheritance had been proposed.<sup>5,6,15,16</sup> More recent literature identified the heterozygous missense mutation of the CTNNA1 gene as a cause of BSPD in three families. It was also discovered that an analogous mutation of CTNNA1<sup>tvrm5</sup> found in mice displayed similar phenotypic expression.<sup>11</sup>

### *Treatment of BSPD*

There is no treatment for stable pattern dystrophies. The reviewed literature emphasized the usually benign natural course of BSPD. There have been reports of geographic atrophy development. CNVM development, which would require intervention by a retina specialist, has also been reported.<sup>2,13,14</sup>

### *Case management*

Annual dilated examinations incorporating Amsler grid education, OCT imaging of the macula and serial retinal photos are indicated. Optometrists can provide further support and clinical guidance by ordering genetic testing and providing comprehensive eye exams to immediate family members. The eye doctor should deliver relevant knowledge about the patient's condition with empathy at a level the patient can comprehend. Finally, the doctor should ensure the patient understands the need for regular comprehensive exams even if he or she is asymptomatic.

### **Conclusion**

BSPD is a rare, bilateral condition that can be conservatively managed by the optometrist with annual dilated exams, OCT imaging of the macula and retinal photos. The patient participates in management with at-home Amsler grid monitoring. If CNVM develops, the patient should be promptly referred to a retina specialist to discuss treatment options, which may include anti-VEGF injections or careful monitoring. The diagnosis of BSPD is mainly clinical and can be supported with genetic testing if pursued by the patient or clinician. The patient should understand that this rare condition usually has minimal impact on vision, but severe outcomes can occur. The patient should be informed that BSPD can be inherited and that primary family members should be examined for signs of macular pattern dystrophy. The optometrist can educate the patient on how macular pattern dystrophy is different from AMD and other maculopathies. This topic is relevant in an optometric clinical training environment to guide the trainee in appropriate treatment and management decisions, specifically when to retain the patient and when to refer to a retina specialist for co-management.

## References

1. Zhang K, Garibaldi DC, Li Y, Green WR, Zack DJ. Butterfly-shaped pattern dystrophy: a genetic, clinical, and histopathological report. *Arch Ophthalmol*. 2002 Apr;120(4):485-90. doi: 10.1001/archophth.120.4.485. PMID: 11934323.
2. Esteves F, Dolz-Marco R, Hernández-Martínez P, Díaz-Llopis M, Gallego-Pinazo R. Pattern dystrophy of the macula in a case of steinert disease. *Case Rep Ophthalmol*. 2013 Sep 21;4(3):129-33. doi: 10.1159/000355385. PMID: 24163680; PMCID: PMC3806677.
3. Agarwal A. *Gass' atlas of macular diseases*. 5th ed. Philadelphia(PA): Elsevier/Saunders; 2012. p239-436.
4. Agarwal A, Patel P, Adkins T, Gass JD. Spectrum of pattern dystrophy in pseudoxanthoma elasticum. *Arch Ophthalmol*. 2005 Jul;123(7):923-8. doi: 10.1001/archophth.123.7.923. PMID: 16009832.
5. Prensky JG, Bresnick GH. Butterfly-shaped macular dystrophy in four generations. *Arch Ophthalmol*. 1983 Aug;101(8):1198-203. doi: 10.1001/archophth.1983.01040020200005. PMID: 6882245.
6. Deutman AF, van Blommestein JD, Henkes HE, Waardenburg PJ, Solleveld-van Driest E. Butterfly-shaped pigment dystrophy of the fovea. *Arch Ophthalmol*. 1970 May;83(5):558-69. doi: 10.1001/archophth.1970.00990030558006. PMID: 5442145.
7. Watzke RC, Folk JC, Lang RM. Pattern dystrophy of the retinal pigment epithelium. *Ophthalmology*. 1982 Dec;89(12):1400-6. doi: 10.1016/s0161-6420(82)34632-1. PMID: 6984500.
8. Gutman I, Walsh JB, Henkind P. Vitelliform macular dystrophy and butterfly-shaped epithelial dystrophy: a continuum? *Br J Ophthalmol*. 1982 Mar;66(3):170-3. doi: 10.1136/bjo.66.3.170. PMID: 7066268; PMCID: PMC1039746.
9. Puech B, Kostrubiec B, Hache JC, François P. Epidémiologie et prévalence des principales dystrophies rétinienne héréditaires dans le Nord de la France [Epidemiology and prevalence of hereditary retinal dystrophies in the Northern France]. *J Fr Ophtalmol*. 1991;14(3):153-64. French. PMID: 1918822.
10. Michaelides M, Hunt DM, Moore AT. The genetics of inherited macular dystrophies. *J Med Genet*. 2003 Sep;40(9):641-50. doi: 10.1136/jmg.40.9.641. PMID: 12960208; PMCID: PMC1735576.
11. Saksens NT, Krebs MP, Schoenmaker-Koller FE, et al. Mutations in CTNNA1 cause butterfly-shaped pigment dystrophy and perturbed retinal pigment epithelium integrity. *Nat Genet*. 2016 Feb;48(2):144-51. doi: 10.1038/ng.3474. Epub 2015 Dec 21. PMID: 26691986; PMCID: PMC4787620.
12. Jaouni T, Averbukh E, Burstyn-Cohen T, Grunin M, Banin E, Sharon D, Chowers I. Association of pattern dystrophy with an HTRA1 single-nucleotide polymorphism. *Arch Ophthalmol*. 2012 Aug;130(8):987-91. doi: 10.1001/archophthalmol.2012.1483. PMID: 22893068.
13. Marano F, Deutman AF, Leys A, Aandekerck AL. Hereditary retinal dystrophies and choroidal neovascularization. *Graefes Arch Clin Exp Ophthalmol*. 2000 Sep;238(9):760-4. doi: 10.1007/s004170000186. PMID: 11045344.
14. Empeglidis T, Vardarinos A, Deane J, Banerjee S. Intravitreal ranibizumab in the treatment of butterfly-shaped pattern dystrophy associated with choroidal neovascularization: a case report. *Case Rep Ophthalmol*. 2012 Jan;3(1):77-82. doi: 10.1159/000336987. Epub 2012 Feb 29. PMID: 22529806; PMCID: PMC3331880.
15. Zhang K, Nguyen TH, Crandall A, Donoso LA. Genetic and molecular studies of macular dystrophies: recent developments. *Surv Ophthalmol*. 1995 Jul-Aug;40(1):51-61. doi: 10.1016/s0039-6257(95)80047-6. PMID: 8545803.
16. Kempeneers HP, Dewachter A, Kempeneers GM. Pattern dystrophies of the retinal pigment epithelium. The study of three generations in a family. *Doc Ophthalmol*. 1990-1991;76(3):261-72. doi: 10.1007/BF00142685. PMID: 2103528.
17. Hannan SR, de Salvo G, Stinghe A, Shawkat F, Lotery AJ. Common spectral domain OCT and

electrophysiological findings in different pattern dystrophies. *Br J Ophthalmol.* 2013 May;97(5):605-10. doi: 10.1136/bjophthalmol-2011-301257. Epub 2013 Feb 20. PMID: 23426737.

18. 18. Kumar V, Kumawat D. Multimodal imaging in a case of butterfly pattern dystrophy of retinal pigment epithelium. *Int Ophthalmol.* 2018 Apr;38(2):775-779. doi: 10.1007/s10792-017-0497-3. Epub 2017 Mar 15. PMID: 28299497.

Captain Lho is a Staff Optometrist at the Doris Miller Department of Veterans Affairs Medical Center in Waco, Texas, and serves as a Captain in the U.S. Army Reserves 228th Medical Company. Dr. Lho is a 1998 graduate of the Pennsylvania College of Optometry.

Dr. Hoang is a Staff Optometrist at the Olin E. Teague Veterans Medical Center in Temple, Texas. A 2018 graduate of Midwestern University Arizona College of Optometry, Dr. Hoang completed an Ocular Disease Residency in 2019 at the Doris Miller Department of Veterans Affairs Medical Center in Waco, Texas, in partnership with the University of the Incarnate Word Rosenberg School of Optometry.

Dr. Perzan [erika.perzan@va.gov] is a Supervisory Optometrist at the Doris Miller Department of Veterans Affairs Medical Center in Waco, Texas. Dr. Perzan graduated in 2010 from the New England College of Optometry and completed an Ocular Disease Residency in 2011 at the Wilkes-Barre Veterans Affairs Medical Center in Pennsylvania in partnership with Salus University.

Dr. Smith is a 2020 graduate of the New England College of Optometry.

PEER REVIEWED

# Sleep Irregularity and Academic Performance

*Matt Valdes, OD, FAAO, Deidre Rios, MS, PhD, AHIP, Allison Rocha, BS, and Keila Rodriguez, BS | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

*This study highlights the limitations of self-reported data and sheds light on irregular sleep patterns and their effect on academic performance. Self-reported sleep habits were assessed using a pre-study questionnaire. Sleep patterns were monitored for up to 30 days with wrist-based accelerometers. Academic performance was assessed using students' self-reported grade point average (GPA). Twenty-one professional school students reported a mean sleep duration of 7h32m, with a mean time to bed of 23:14 and mean wake time of 07:32. Time-to-bed consistency, sleep-duration consistency and earlier time to bed during the weekdays were highly correlated with better GPA.*

**Key Words:** *activity tracker, sleep, accelerometer, patterns, students, learning, sleep logs*

## Introduction

Insufficient sleep has been labeled a public health crisis in the United States, with many adults receiving less than the 7-8 hours of sleep per night recommended by the Centers for Disease Control and Prevention.<sup>1</sup> Other national initiatives such as Healthy People 2020 and Healthy People 2030 from the U.S. Department of Health and Human Services include sleep health objectives that address this crisis. Busier schedules and lifestyle factors have led many to treat sleep as a commodity to be exchanged for greater productivity. Sacrificing sleep for study time is a prevalent practice in medical, optometric and other health science student populations.<sup>2</sup> Sleep has a relevant role in learning and academic achievement, and the literature investigating the relationship between student sleep and student learning covers many areas.<sup>3</sup>

Irregular patterns in sleep onset, wake time and sleep duration can result in poor quality of sleep,<sup>4</sup> which has been linked to cognitive impairment,<sup>5-7</sup> delayed reaction times and increased risk for health issues.<sup>8-10</sup> All of these can be detrimental for optometry students. The financial implications of insufficient sleep have also been well-documented in decreased productivity, treatment of sleeping disorders and premature or accidental death.<sup>11-14</sup> Optometry students may be aware of some of these risks, but with their focus on learning to navigate the rigors of the curriculum, few are cognizant of their sleep hygiene and how it may affect their learning and ultimately academic achievement. Studies focused on sleep duration and sleep/wake indices have closely linked student learning capacity and academic performance with sleep quality.<sup>15</sup>

Often referred to as the knowledge-behavior gap, the wealth of information on good sleep hygiene and physical/mental health is not reflected in personal sleep habits, with more than a third of all Americans reportedly not getting enough sleep.<sup>16</sup> Poor quality sleep among college students has been reported as high as 60% and has been associated with increased mental health issues and irregular sleep patterns<sup>16-19</sup> that lead to increased daytime fatigue, inattentiveness and poor academic performance.<sup>20</sup>

To date, much of the research regarding student sleep habits has been unable to address issues such as inherent optimistic bias, which can lead people to think more positively about their habits and result in poor decision-making.<sup>21</sup> Prior sleep studies have also required expensive equipment, relied heavily on

sleep journals/self-reported sleep habits, or were limited in days monitored.<sup>22,23</sup> The aims of this study are to integrate self-reported sleep habits with objectively recorded wrist-based accelerometer (WBA) data and relate subjects' sleep profiles with academic performance. Using technology, we look to minimize personal bias, broaden the view of subject sleep behavior, and improve data analysis of variations in bedtimes, wake times and sleep duration to develop individualized sleep profiles.

## **Methods**

### *Participants*

This longitudinal study was conducted during the Spring/Summer semesters at the University of the Incarnate Word Rosenberg School of Optometry. Twenty-three full-time (greater than 16 credit hours) graduate students were recruited to participate in a pre-study questionnaire and wear a WBA for 30 days (21-day minimum). Two subjects did not complete the study for personal reasons. Exclusion criteria included pregnancy, nursing or caring for a newborn.

### *Study approval*

All subjects provided written informed consent. This study was approved by the Institutional Review Board and was in compliance with the Declaration of Helsinki.

### *Data collection*

Two sets of data were collected: self-reported sleep behaviors and passively recorded sleep patterns. All subject data were de-identified, and unique identification numbers were used to track each participant. Data were stored on password-protected cloud systems.

### *Wrist-based accelerometers*

Participants were given the option to use a personal WBA or the study-provided tracker (Mi Band 2). The three WBAs used for sleep data analysis were: Fitbit Charge 2 (San Francisco, CA), AutoSleep application (Sydney, AU) with Apple Watch Series 3 (Cupertino, CA), and Xiaomi Mi Band 2 (Taipei, TW). Although their sleep algorithms are proprietary, all three trackers utilize movement and heart rate to define time to bed, sleep duration and wake time for all subjects.<sup>24-27</sup> Subjects were asked to wear the WBA throughout the day and night for the duration of the study.

### *Statistical analysis*

Data were collected and analyzed using Google Sheets (Mountain View, CA) and XLMiner Analysis ToolPak (Incline Village, NV). Pearson linear regression determined correlations between sleep patterns and grade point average (GPA). Paired t-test was performed to compare student perceptions of sleep habits and recorded sleep patterns.

### *Pre-study questionnaire*

**TABLE 1**  
Pre-Study Questionnaire

1. What time do you generally go to bed?	
2. What time do you generally wake up?	
3. How long does it take you to fall asleep?	0-15 min, 16-30 min, 31-45 min, 46-60 min, >60 min
4. To what extent has POOR sleep affected your concentration, productivity or ability to stay awake?	Scale of 1 to 5, with 5 being "very much"
5. To what extent has POOR sleep troubled you in general?	Scale of 1 to 5, with 5 being "very much"
6. How long have you had a problem with your sleep?	No problem (<1 mos.), 1-2 mos., 3-6 mos., 7-12 mos., >1 yr
7. On average my classmates get _____ hours of sleep per night	
8. How much caffeine do you consume on an average school day?	Less than 1 cup per day, 1-2 cups per day, 3-4 cups per day, 4-5 cups per day, more than 5 cups per day
9. My height is (e.g., 5'3")	
10. My weight is (lbs.)	

Table 1. [Click to enlarge](#)

All subjects were given a sleep study questionnaire designed to collect information regarding demographics, sleep habits, caffeine consumption, body mass index and perceived amount of sleep their classmates receive (**Table 1**).

## Results

Twenty-one professional school students [4 men and 17 women, mean age 25 years (standard deviation 1.5 years)] passively tracked their sleep patterns for a maximum of 30 days (minimum: 24 days; average: 28 days) using Fitbit (n=6), Xiaomi Mi Band (n=10) or AutoSleep app (n=5) WBAs.

### *Mean sleep duration*

Mean sleep duration based on students' self-reporting on the pre-study questionnaire was 7h32m (standard deviation 47m). Mean sleep duration based on WBA data was 7h39m (standard deviation 51m). A paired t-test was performed, and no statistical difference was found between the mean sleep durations ( $p=0.57$ ). A majority of students underestimated their amount of sleep (n=13) as compared with WBA data. The WBAs allowed for broader analysis, differentiating between weekday (WKD = Monday, Tuesday, Wednesday, Thursday) and weekend (WKE = Friday, Saturday, Sunday) sleep patterns. Mean sleep duration during the week [7h24m (standard deviation 58m)] was 38 minutes shorter than during the weekend [8h02m (standard deviation 1h11m)]. This may result from students sleeping-in during the weekend to make up for shorter sleep durations during the week. Pearson correlation coefficients for total mean sleep duration ( $r^2=0.06$ ,  $p=0.27$ ) and WKE mean sleep duration ( $r^2=0.00$ ,  $p=0.97$ ) showed minimal correlation with GPA. WKD mean sleep duration ( $r^2=0.15$ ,  $p=0.08$ ) correlated moderately with GPA and trended toward statistical significance (**Figure 1**).

### *Time to bed*

Based on the pre-study questionnaire, mean estimated time to bed was 23:14 (standard deviation 1h5m). According to the WBA data, mean time to bed was 00:06 (standard deviation 48m). A paired t-test found a statistically significant difference between self-reported time to bed and sleep tracker time to bed ( $p=0.003$ ). Sleep tracker measurements were 23:54 (standard deviation 46m) for WKD time to bed and 00:13 (standard deviation 54m) for WKE time to bed. The mean difference of 19m was not statistically significant ( $p=0.23$ ). Pearson correlation coefficients for total time to bed ( $r^2=0.06$ ,  $p=0.27$ ) and WKE time to bed ( $r=0.04$ ,  $p=0.41$ ) demonstrated weak correlation with GPA. Earlier WKD time to bed was moderately correlated with better GPA ( $r^2=0.17$ ,  $p=0.06$ ) (**Figure 2**).



**Figure 1.** Association between GPA and weekday (WKD), weekend (WKE) and overall average sleep durations. WKD sleep duration was most positively correlated with better academic performance, trending toward statistical significance ( $r^2=0.15$ ; 95% CI, 1.56 to 3.24;  $p=0.08$ ). [Click to enlarge](#)



**Figure 2.** Association between GPA and weekday (WKD), weekend (WKE) and overall average time to bed. WKD time to bed was most correlated with academic performance, trending toward statistical significance ( $r^2=0.17$ ; 95% CI, 0.99 to 1.33;  $p=0.06$ ). [Click to enlarge](#)



**Figure 3.** Weekday (WKD) time to bed consistency was the strongest predictor of GPA and statistically significant ( $r^2=0.26$ ; 95% CI, 0.98 to 1.33;  $p=0.02$ ).

[Click to enlarge](#)

### Wake time

Self-reported pre-study questionnaire data showed students' estimated mean wake time to be 06:46 (standard deviation 52m). WBA data measured mean wake time to be 07:45 (standard deviation 37m). A paired t-test was performed and found a statistically significant difference between self-reported wake time and sleep tracker wake time ( $p < 0.001$ ). Sleep tracker data was 07:17 (standard deviation 33m) for WKD wake time and 08:27 (standard deviation 58m) for WKE wake time. This mean difference of 1h09m was statistically significant ( $p < 0.001$ ). Pearson correlation coefficients for total mean wake time ( $r^2=0.01$ ,  $p=0.71$ ), WKD wake time ( $r^2=0.00$ ,  $p=0.88$ ) and WKE wake time ( $r^2=0.02$ ,  $p=0.57$ ) showed little to no correlation with GPA. Overall wake times were not predictive of GPA. We believe this is a byproduct of the academic schedule and early start times (as early as 07:30 for some students). This leaves little room for variations in wake patterns during the week as observed with a smaller standard deviation in WKD wake times (33m) as compared with WKE wake times (58m) (**Table 2**).



**Table 2.** Weekday (WKD) sleep duration and time to bed were correlated with better academic performance and trended toward statistical significance ( $p=0.08$  and  $p=0.06$ , respectively). WKD time to bed standard deviation (SD) is significant at the 0.05 level. Total and WKD sleep duration SDs trended toward statistical significance ( $p=0.06$  and 0.07, respectively).

[Click to enlarge](#)

### Consistency of sleep patterns

Variations in sleep patterns are thought to directly impact natural circadian rhythm and negatively affect a student's ability to learn.<sup>18</sup> Analyzing sleep patterns of students for 30 days, we developed a sleep profile of time to bed, wake time and total sleep duration trends using standard deviations. Wake time standard deviation did not correlate with GPA ( $r=0.00$ ,  $p=0.99$ ). The importance of sleep consistency was most apparent comparing WKD time to bed standard deviation with GPA ( $r^2=0.26$ ,  $p=0.02$ ). WKE time to bed standard deviation was not correlated with improved academic performance ( $r=0.00$ ,  $p=1.00$ ). Total wake time, WKD wake time, and WKE wake time standard deviations demonstrated weak correlations ( $p$ -value) with GPA [ $r=0.00$  (0.99), 0.038 (0.40), 0.00 (0.85), respectively]. Total and WKD sleep duration standard deviations were moderately correlated with GPA [ $r^2=0.18$  (0.06),  $r^2=0.17$  (0.07)]. WKD time to bed and duration variations were the greatest predictors of academic performance in our cohort (**Figure 3**).

## Discussion

### Duration vs. time to bed vs. wake time

Total sleep duration did not influence academic performance as we predicted and previous literature has stated; however, sleep onset correlated more closely to academic performance.<sup>15, 18-20</sup> It was only when

we looked at the variations in sleep duration patterns, specifically during the weekdays, that a moderate correlation between duration and GPA emerged. Similar to the findings from the BaHammam et al. 2012 study, an earlier bedtime and a longer duration during the weekdays showed a clear association with academic performance.<sup>28</sup> The importance of time to bed on sleep duration is a direct result of the restriction on WKD wake times. Of the two variables, “what time to go to bed” and “what time to wake up,” students increase their likelihood of receiving more sleep with earlier bedtimes. Wake times were less predictive of academic performance based on external factors (e.g., academic schedule), which were out of the students’ control.

### *Sleep consistency*

Our data support the impact sleep consistency has on a student’s ability to perform academically. The less variable/more regular the sleep duration and time to bed values were, the better the GPA. Regular sleep and circadian rhythms have been linked with learning and memory-forming.<sup>10</sup> This study was able to utilize data collected over 30 days to identify individual sleep profiles not usually seen in self-reported sleep studies. WBAs allowed for more accurate and consistent passive recording of data rather than reliance on subjective self-reported time to bed and wake times.

### *Weekdays vs. weekends*

A noticeable shift in sleep patterns was observed among our cohort when comparing WKD and WKE datasets. Students went to bed 19 minutes later, rose 1 hour and 9 minutes later and received, on average, 38 more minutes of total WKE sleep, which could be a response to chronic sleep insufficiency during the week. Prior studies of sleep-wake cycle shifts related to daylight savings time have found evidence of decreased productivity, increased traffic accidents and absenteeism.<sup>29</sup> Our data suggest regular sleep patterns during the weekdays are more related to academic performance compared with significantly different weekend sleep patterns.<sup>20</sup>

### *Self-reported bias*

To avoid bias regarding sleep duration and the often cited 8-hour recommendation, our pre-study questionnaire instead asked subjects to provide their typical time to bed and wake times. We calculated the difference to determine their estimated average sleep duration, which turned out to be accurate within 8 minutes of the overall measured sleep duration. What we found most interesting was how estimated time in bed and wake times were skewed earlier (23:14 vs. 00:06 and 06:46 vs. 07:45, respectively) when compared to WBA data. We feel the ability to collect data regarding sleep patterns with no explicit action from the user minimized subject bias and should be considered in future sleep studies.

### *Limitations and future considerations*

Potential limitations in our study included our sample population and size. Surveying students across three different grade levels can affect the weight of the GPA (e.g., an OPTIII GPA includes more than 60 credit hours, while an OPTI may only include 22). Due to the timing of this research, there was also a greater distribution of third-year year students (n=12) participating compared with the numbers of second-year and fourth-year students (n=3 and n=6, respectively). Also, as a pilot study, a small sample size was used, which may have resulted in lower statistical power. Follow-up studies will be limited to a single class to address these factors. Additionally, using three different activity trackers with potentially varying algorithms could have affected time to bed and wake time measurements. Future studies will utilize a uniform tracker for all subjects. The trackers were also unable to account for naps, which students often use to recharge after building sleep debt from the previous day. This software limitation may impact which tracker we elect to use moving forward.

## Conclusion

In summary, our results suggest regular sleep patterns may promote learning and academic performance. As wearable health technology continues to improve and becomes less expensive, large-scale datasets will allow researchers to analyze activity/sleep patterns with greater detail. By broadening our understanding of delayed sleep onset and shortened sleep durations, we look to explore techniques that help students develop improved sleep habits.

## Acknowledgments

This study was funded by an internal faculty development grant at the University of the Incarnate Word Rosenberg School of Optometry.

The authors would like to thank Dr. Jeff Rabin for his support of this study.

## References

1. Barnes CM, Drake CL. Prioritizing sleep health: Public health policy recommendations. *Perspect Psychol Sci.* 2015;10(6):733-737.
2. Cvejic E, Huang S, Vollmer-Conna U. Can you snooze your way to an "A"? Exploring the complex relationship between sleep, autonomic activity, wellbeing and performance in medical students. *Aust N Z J Psychiatry.* 2018;52(1):39-46.
3. Curcio G, Ferrara M, De Gennaro L. Sleep loss, learning capacity and academic performance. *Sleep Med Rev.* 2006;10:323-337.
4. El Hangouche AJ, Jniene A, Aboudrar S, et al. Relationship between poor quality sleep, excessive daytime sleepiness and low academic performance in medical students. *Adv Med Educ Pract.* 2018;9:631-638.
5. Medeiros AD, Mendes DF, Lima PF, Araujo JF. The relationships between sleep-wake cycle and academic performance in medical students. *Biol Rhythm Res.* 2001;32(2):263-270.
6. Krittanawong C, Tunhasiriwet A, Wang Z, et al. Association between short and long sleep durations and cardiovascular outcomes: a systematic review and meta-analysis. *Eur Heart J Acute Cardiovasc Care.* 2019;8(8):762-770.
7. Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. *Soc Sci Med.* 2010;71:1027-1036.
8. Banks S, Dinges DF. Behavioral and physiological consequences of sleep restriction. *J Clin Sleep Med.* 2007;3:519-528.
9. Benca RM, Obermeyer WH, Thisted RA, Gillin JC. Sleep and psychiatric disorders. A meta-analysis. *Arch Gen Psychiatry.* 1992;49:651-668.
10. Smarr BL, Jennings KJ, Driscoll JR, Kriegsfeld LJ. A time to remember: the role of circadian clocks in learning and memory. *Behav Neurosci.* 2014;128(3):283-303.
11. Smarr BL. Digital sleep logs reveal potential impacts of modern temporal structure on class performance in different chronotypes. *J Biol Rhythms.* 2015;30(1):61-67.
12. Hillman D, Mitchell S, Streatfeild J, Burns C, Bruck D, Pezzullo L. The economic cost of inadequate sleep. *Sleep.* 2018 Aug 1;41(8). doi: 10.1093/sleep/zsy083. PubMed PMID: 29868785.
13. Hafner M, Stepanek M, Taylor J, Troxel WM, Van Stolk C. Why sleep matters — the economic costs of insufficient sleep: a cross-country comparative analysis. Santa Monica, CA: RAND Corporation, 2016. Available from: [https://www.rand.org/pubs/research\\_reports/RR1791.html](https://www.rand.org/pubs/research_reports/RR1791.html)
14. Lunsford-Avery JR, Engelhard MM, Navar AM, Kollins SH. Validation of the Sleep Regularity Index in older adults and associations with cardiometabolic risk. *Sci Rep.* 2018 Sept 21;8(1):14158.
15. Scullin MK. The eight hour sleep challenge during final exams week. *Teach Psychol.* 2019;46(1):55-63.
16. Patel SR, Hayes AL, Blackwell T, et al. The association between sleep patterns and obesity in

- older adults. *Int J Obes (Lond)*. 2014;38(9):1159-1164.
17. Taylor DJ, Bramoweth AD. Patterns and consequences of inadequate sleep in college students: Substance use and motor vehicle accidents. *J Adolesc Health*. 2010;46:610-612.
  18. Lund HG, Reider BD, Whiting AB, Prichard JR. Sleep patterns and predictors of disturbed sleep in a large population of college students. *J Adolesc Health*. 2010;46(2):124-132.
  19. Tsai LL, Li SP. Sleep patterns in college students: gender and grade differences. *J Psychosom Res*. 2004;56(2):231-237.
  20. Eliasson AH, Lettieri CJ, Eliasson AH. Early to bed, early to rise! Sleep habits and academic performance in college students. *Sleep Breath*. 2010;14(1):71-75.
  21. Sharot T, Korn CW, Dolan RJ. How unrealistic optimism is maintained in the face of reality. *Nat Neurosci*. 2011;14(11):1475-1479.
  22. Czeisler CA. Duration, timing and quality of sleep are each vital for health, performance and safety. *Sleep Health*. 2015;1(1):5-8.
  23. Meltzer LJ, Hiruma LS, Avis K, Montgomery-Downs H, Valentin J. Comparison of a commercial accelerometer with polysomnography and actigraphy in children and adolescents. *Sleep*. 2015;38(8):1323-1330.
  24. Mi Band 2. Mi Global Home [Internet]. Xiaomi Corporation; c2010-2021 [cited Feb 19, 2021]. Available from: [www.mi.com/global/miband2/](http://www.mi.com/global/miband2/)
  25. Fitbit Technology. [Internet]. Fitbit Inc.; c2021 [cited Feb 19, 2021]. Available from: [www.fitbit.com/technology#sleep](http://www.fitbit.com/technology#sleep)
  26. AutoSleep [Internet]. Sydney, Australia: Tantsissa Holdings Pty Ltd; c2015-2020 [cited Feb 19 2021]. Available from: <https://autosleepapp.tantsissa.com/>
  27. American Sleep Apnea Association and IBM launch patient-led sleep study app [Internet]. Washington, DC: American Sleep Apnea Association; c2021 [cited Feb 19 2021]. Available from: <https://www.sleepapnea.org/american-sleep-apnea-association-ibm-launch-patient-led-sleep-study-app/>
  28. BaHammam AS, Alaseem AM, Alzakri AA, Almeneessier AS, Sharif MM. The relationship between sleep and wake habits and academic performance in medical students: A cross-sectional study. *BMC Med Educ*. 2012 Aug 1;12(61).
  29. Carey RN, Sarma KM. Impact of daylight saving time on road traffic collision risk: a systematic review. *BMJ Open*. 2017 Jul 2;7(6):e014319.

Dr. Valdes [[mvaldes@uiwtx.edu](mailto:mvaldes@uiwtx.edu)] is an Assistant Professor at the University of the Incarnate Word Rosenberg School of Optometry. He is a Diplomate in the Low Vision Section of the American Academy of Optometry.

Dr. Rios is Director of Optometric and Clinical Library Services at the University of the Incarnate Word Rosenberg School of Optometry.

Ms. Rocha is a fourth-year student at the University of the Incarnate Word Rosenberg School of Optometry.

Ms. Rodriguez is a fourth-year student at the University of the Incarnate Word Rosenberg School of Optometry.

PEER REVIEWED

# Assessment of the Utility of 3D-Printed Interactive Models in the Vision Science Classroom

*D. Joshua Cameron, PhD | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

*The use of 3D-printing technologies is becoming commonplace in health care and in the classroom. Most of the classroom activities using 3D-printed models occur in anatomy classrooms. This study sought to bridge the use of 3D-printed materials in the vision science classroom to ascertain whether they would enhance student learning. A 3D-printed and virtual model of the primary visual pathway was developed and tested in a vision science classroom. Student learning was assessed, as were student perceptions. Students preferred to use the 3D-printed models, but the greatest gains occurred after a multimodal learning experience.*

**Key Words:** 3D printing, vision science, student learning, primary visual pathway

## Background

Vision science is a topic that encompasses a complex interworking of optometry, ophthalmology, neuroscience, psychology, physics, information systems biology and other fields of science, engineering and math. As part of optometry students' study of vision science, they are expected to learn how and why vision works and then recognize when something goes wrong. Two areas in particular prove difficult for students to grasp, perhaps due to their unique visuospatial aspects. The first is the complex neural network linking the retina to the brain – principally the geniculostriate pathway. The second is the center-surround organizations prevalent in the retina and elsewhere in the vision system. These center-surround organizations are comprised of antagonistic receptive fields that provide on/off signals that help establish visual boundaries. Even with complex computer animations such as the synaptic organization demonstrated by Samuel Wu, students still struggle and underperform in these two subject areas.<sup>1</sup>

Commercial off-the-shelf models have proven useful in both anatomy and clinical training. An example is the SOMSOVRMS 10/1, Female Pelvis with Ligamentous Apparatus (Marcus Sommer Modelle GmbH, Coburg, Germany), which was shown to be more effective in student learning outcomes compared with either interactive or static images on a computer screen.<sup>2</sup> Estevez et al. takes this a step further by using both preserved brain specimens, including plastic embedded sets of coronally and horizontally sectioned brain slabs, and commercially available Human Brain Ventricles #566786 (Carolina Biological Supply Co., Burlington, NC). The students in their study rebuilt brain structures over the ventricles using clay. The students who participated in this type of activity had significant knowledge gains over students who did not participate.<sup>3</sup> One of the more thorough reviews on 3D modeling in the literature is presented by Azer and Azer. They reviewed more than 4,800 articles. While their conclusion appears at first glance to not support 3D modeling in the classroom, it is worth noting that two-thirds of the studies they focused on were web or computer-based models, not physical models. Most importantly, they recommended studies with more research quality and methods that consider other skills, aside from anatomy performance.<sup>4</sup> The goal of this project was to incorporate both of these observations – a research study in a non-anatomy classroom using a physical model, in this case a 3D-printed model.

3D printing, the process of taking a virtualized 3D model and turning it into a 3D physical object, is entering biomedicine at a breakneck pace. Six years ago, approximately 400 articles in PubMed

referenced 3D printing. As of the end of 2019 more than 5,000 did – an increase of more than 1,000% or >700 new articles a year! 3D printing is making significant strides in education from engineering to biology. Recent studies with anatomy and surgery students have shown that 3D-printed models provide significant education benefits over and above traditional textbooks and even 3D virtualization software in the classroom.<sup>5-9</sup> 3D printing is also making headway into clinical settings, including optometric clinics.<sup>10-15</sup> Recent predictions suggest that 3D-printed materials will become mainstream medicine, especially in eye health.<sup>16</sup> 3D-printed models can also be integrated with microcontrollers to facilitate custom interactive projects.<sup>17</sup> An unanswered question is: Can 3D-printed models be used to increase student learning in non-anatomy-based optometric classrooms?

To address this question, I developed an interactive 3D model of the geniculostriate, or primary visual pathway, with the assistance of our university's Educational 3D Visualization Specialists. I then used the models we developed to assess whether they improved student performance on knowledge recall and enhanced the overall learning experience.

## Methods

### *Model selection and design*

The 3D-printed model was designed using publicly available MRI brain scans and image files (Thingiverse.com) that were subsequently modified and sculpted or designed completely by myself or the Educational 3D Visualization Specialists using TinkerCAD (Autodesk, San Rafael, CA) and Solidworks (Solidworks Corp., Waltham, MA). The 3D models were printed on a Qidi X-Max (Qidi Technology, Ruian, Zhejiang, China), a Makerbot Replicator+ (MakerBot Industries, Brooklyn, NY) or a Formlabs Form 2 (Formlabs Inc., Sommerville, MA) printer. A Raspberry Pi Zero W (Raspberry Pi Foundation, Cambridge, United Kingdom), a tiny single-board computer, was programmed to control multiple strands of electroluminescent wire using a cell phone to remotely interact with the 3D model **(Figure 1)**.

The WesternU Educational 3D Visualization department designed a 3D virtual model and hosted it on Sketchfab.com (<https://sketchfab.com/3d-models/visual-pathway-prototype-05f7e3f3104944478485b50ba0bc279f>). A second model of the primary visual pathway, designed by the University of Bristol, was also chosen for this study (<https://sketchfab.com/3d-models/optic-tract-and-radiation-455cac9756ed42458d33a0dad97b3512>).

Three 2D models commonly used in the classroom were also included in the study **(Figure 2)**.



**Figure 1.** 3D-printed visual pathway model. A) Complete model in a well-lit room, showing the brain lobes, eyes, supporting base, control unit, electroluminescent wire and cell phone. B) Complete model shown in a darkly lit room with glowing wire, optic chiasm and visible control interface.

[Click to enlarge](#)



**Figure 2.** 2D visual pathway models.

The three pictures were provided to each group of students and are representative of images students had seen during classroom lectures. A) Figure 5.23 Cognitive Neuroscience, The Biology of the Mind 4th Ed by Michael S. Gazzaniga, Richard B. Ivry and George R. Mangun, W.W. Norton & Company, 2014. Reproduced with permission. B) By Ratznium (CC-BY-SA-3.0), from Wikimedia Commons. Reproduced with permission. C) Reproduction of the 3D model in 2D.

[Click to enlarge](#)

*Classroom study design*

All 79 optometry students in a second-year vision science course were randomly assigned to a group of four or five for a total of 16 groups. These students were enrolled in a four-year optometry degree program. The 16 groups were then each randomly assigned to begin at one of the four stations:

1. interacting with the 3D-printed visual pathway model (3DP)
2. interacting with both virtual 3D models (3DV)
3. interacting with all three printed 2D images of the primary visual pathway (2D)
4. drawing the primary visual pathway on their choice of a blank piece of paper or on a blank print of the brain and eyes (2DD)

Prior to any interactions, to establish a baseline score, the students were given a 10-question assessment, including two questions about their confidence levels related to the material – Assessment 1. Each group then rotated through each of four stations: 1) 3DP, 2) 3DV, 3) 2D, and 2DD. Four groups worked at each station independently for approximately 20 minutes. Each group within each station had identical models to work with.

At the end of each station, students completed a short four-question quiz before moving to the next station. Two questions in each quiz assessed learning, and two questions assessed confidence levels. Students were permitted and encouraged to use the materials available to them at their station to assist in answering the questions.

A final assessment, similar to the baseline assessment, was given at the end of the study – Assessment 2. Each assessment contained an equal number of questions that either indicated an anatomical problem and sought input on the expected visual field deficit or indicated a specific visual field deficit and sought input on the expected anatomical location that could have resulted in the deficit. Students also provided qualitative feedback via online surveys during the 3DV and 2DD rotations and at the conclusion of the study. The study was exempted from Institutional Review Board approval.

*Data analysis*




Survey results were collated in Google Forms (Alphabet Inc., Mountain View, CA). All assessments were taken electronically using TopHat (Tophatmonocle Corp. Toronto, Ontario), a student engagement platform. Statistical analysis was completed using SPSS (IBM, Armonk, NY). Univariate analysis of the variance and a pairwise comparison of the means were used to compare performance among the test groups. The Wilcoxon signed rank test and paired t-test were used to compare before and after test performance. A p-value less than 0.05 was deemed statistically significant.

## Results

A total of 79 students were each randomly assigned to one of 16 groups using Excel's random number picker. One student who had to leave the study prior to the last rotation and Assessment 2 was excluded from the analysis, changing the total to 78 students. All students completed a 10-question electronic assessment at the start of the study – Assessment 1. The average score was 62.8% (standard deviation 14.6%). Based on a univariate analysis of the variance and a pairwise comparison of the means, no significant differences in performance on Assessment 1 were noted among the 16 groups (**Figure 3**).

Student groups completed the assigned tasks at each station. Performance was assessed after each rotation using questions similar to those asked in Assessment 1, but fewer in number. The first round is most interesting and relevant because the groups had only interacted with one media type. No statistical difference was observed in the four media groups when comparing Assessment 1 scores; however, the two groups assigned to the 3DP and 3DV groups had markedly lower scores compared to their peers (**Figure 4A**). On the other hand, students who worked with either the 3D-printed models or the 3D virtual models performed significantly better on the Round 1 quiz than the students assigned to the other two groups (**Figure 4B**). On average, students performed much better on the Round 1 quiz than on Assessment 1.

As students completed each of the subsequent three rounds, post-round quizzes showed a varied range of performance both in comparison to groups in the same round and compared to Assessment 1. The final assessment, Assessment 2, demonstrated a significant knowledge gain by all students who participated in this study. The average score was 71.7% (standard deviation 10.6%). Using a univariate analysis of the variance and a pairwise comparison of the means, no significant differences in performance on the final assessment were noted between the 16 groups (**Figure 5**). However, student performance on Assessment 2 (71.7%) significantly increased relative to Assessment 1 (62.8%) as shown in a Wilcoxon signed rank test and paired t-test ( $p=4.05 \times 10^{-5}$  and  $p=1.89 \times 10^{-5}$  respectively). The improvement was almost nine percentage points.

-  **Figure 3.** Results from Assessment 1 by group. Each point represents the average score percentage for the students assigned to the respective group. Error bars represent the 95% confidence interval for the mean. [Click to enlarge](#)
-  **Figure 4.** Comparison of the Round 1 groups to performance on Assessment 1 and Round 1 quiz. A) Round 1 groups are shown relative to their performance on the initial assessment, Assessment 1. B) Round 1 groups are shown relative to their performance on the Round 1 quiz. Each point represents the average score percentage for the students assigned to the respective group. Error bars represent the standard error of the mean. P-values were calculated using univariate analysis of the variance comparing a combined 3D-printed model (3DP) and virtual 3D models (3DV) to printed 2D images (2D) and drawing the primary visual pathway (2DD). [Click to enlarge](#)
-  **Figure 5.** Results from Assessment 2 by group. Each point represents the average score percentage for the students assigned to the respective group. Error bars represent the 95% confidence interval for the mean. [Click to enlarge](#)

The study also assessed student confidence levels and perceptions. Confidence increased marginally between Assessment 1 and Assessment 2. However, when asked, “I am more confident in my ability to correlate visual field deficits to visual pathway damage after interacting with the 3D-printed model of the visual pathway,” at the conclusion of the study, the confidence of those who responded “strongly agree” increased almost nine times compared to questions answered in Assessment 2, “I am confident in my

ability to identify common anatomical lesions from visual field information,” and “I am confident in my ability to identify visual field abnormalities from common anatomical lesion information.”

Students were asked, “On a scale of 1 to 5, rate how easy it was to correctly correlate visual field deficits to visual pathway damage” using each of the four modalities (1=easy and 5=difficult). The 3D-printed model received the highest ranking with 59.2% of respondents giving a score of 1 or 2 out of 5. Ranking next were the 2D at 50%, the 3D virtual model at 48.7% and the 2D drawing model at 43.6%. Students were also asked their level of agreement with the following statements using a 5-point Likert scale: “The 3D-printed model of the visual pathway would be a useful tool for optometry school education,” and “The 3D-printed model of the visual pathway would be a useful tool for patient education.” Most students (82.9%) “agreed” or “strongly agreed” that the 3D-printed model of the visual pathway “would be a useful tool for optometry school education,” and 69.8% felt it “would be a useful tool for patient education.” Students were finally asked to “Rank the visual pathway models in order of most helpful to least helpful (1=most and 4=least)” and “Rank the visual pathway models in order of most enjoyable to use to least enjoyable to use (1=most and 4=least).” When asked to rank the various models as either being helpful or enjoyable to use at the conclusion of the study, the 3D-printed model again came out on top (**Figures 6 and 7**).



**Figure 6.** Student rankings for which model was most and least helpful. [Click to enlarge](#)



**Figure 7.** Student rankings for which model was most and least enjoyable to use. [Click to enlarge](#)

## Discussion

Incorporating 3D interactive models into the vision science classroom enhanced student learning and provided a valuable and enjoyable experience for the students. The 3D-printed model, in particular, had a strong effect on the student learning experience. However, engaging students through a variety of media had an even greater impact. The immediate knowledge gains after the study were higher than expected – equivalent to a full letter grade improvement. It is possible that Assessment 1 was more difficult than Assessment 2. Future studies might aim to randomly administer both exams at the beginning and conclusion of the study to account for possible variance between the assessments.

Although the student participants were randomly assigned to groups, there was an apparent difference in student performance at the outset between the 2D/2DD and 3DP/3DV groups (Figure 4A). Although not significant, the noticeable difference may have skewed the results in unanticipated ways. For example, the initial 3DP/3DV groups may have been composed of more visual/kinesthetic learners. This may account for their dramatic rise in performance after just their first 3D interaction. It may also account for why the typical learning environment using 2D images may not have prepared them as well for Assessment 1. Repetition of this study or including additional details about student learning styles may shed more light on this observation.

The entire study was performed within a traditional lecture hall with tiered seating. Some students reported that an open classroom environment would have been beneficial, perhaps more reminiscent of an open lab space. The vast majority of students enjoyed the experience. Importantly, the study showed that even a 20-minute hands-on small group experience can provide immediate knowledge gains (Figure 4). However, this study did not explore whether or not the immediate knowledge gains were retained beyond the brief experience. A longitudinal analysis, which was beyond the scope of this particular study, could be used to ascertain long-term retention in the future.

As noted in the introduction, some previous studies have shown that physical models provide

advantages over computer-generated models, while others have demonstrated effective multimodal experiences can enhance learning.<sup>9,18</sup> This study showed some of both. From an assessment perspective, 3D-printed and virtual models enhanced learning, but completing the entire series (3DP, 3DV, 2D, and 2DD) had a much stronger impact on improving knowledge recall and comprehension. On the other hand, the 3D-printed model was perceived by many students to be the most helpful tool and was by far the most enjoyable to work with. Repeating this study using only 3D-printed models may provide additional clarity.

## Conclusion

Experience as an educator has taught me that students learn in different ways. The results of this study reinforce this concept. Although most students indicated that the 3D models were advantageous, a significant minority felt that either a 2D image or drawing their own model was more beneficial. I believe the student perceptions support a multimodal approach to teaching complicated or difficult topics. The significant increase in the assessment performance after completing this study supports this conclusion as well.

## Acknowledgements

This project was funded in part by an Educational Starter Grant from the Association of Schools and Colleges of Optometry and The Vision Care Institute, LLC, an affiliate of Johnson & Johnson Vision Care, Inc. I would like to especially thank Sunami Chun, Gary Wisser and Jeff Macalino from the WesternU Educational 3D Visualization Department for their help in developing the 3D-printed and virtual models.

## References

1. Wu SM. Synaptic organization of the vertebrate retina: general principles and species-specific variations: the Friedenwald lecture. *Invest Ophthalmol Vis Sci*. 2010;51(3):1263-74. doi: 10.1167/iovs.09-4396. PMID: 20185835; PMCID: PMC3258978.
2. Khot Z, Quinlan K, Norman GR, Wainman B. The relative effectiveness of computer-based and traditional resources for education in anatomy. *Anat Sci Educ*. 2013;6(4):211-5. doi: 10.1002/ase.1355. PMID: 23509000.
3. Estevez ME, Lindgren KA, Bergethon PR. A novel three-dimensional tool for teaching human neuroanatomy. *Anat Sci Educ*. 2010;3(6):309-17. doi: 10.1002/ase.186. PMID: 20939033; PMCID: PMC3189499.
4. Azer SA, Azer S. 3D anatomy models and impact on learning: a review of the quality of the literature. *Health Professions Education*. 2016;2(2):80-98. doi: <https://doi.org/10.1016/j.hpe.2016.05.002>
5. Marconi S, Pugliese L, Botti M, et al. Value of 3D printing for the comprehension of surgical anatomy. *Surg Endosc*. 2017 Oct;31(10):4102-4110. doi: 10.1007/s00464-017-5457-5. PMID: 28281114.
6. Pujol S, Baldwin M, Nassiri J, Kikinis R, Shaffer K. Using 3D modeling techniques to enhance teaching of difficult anatomical concepts. *Acad Radiol*. 2016;23(4):507-16. doi: 10.1016/j.acra.2015.12.012. PMID: WOS:000373034100015.
7. Vaccarezza M, Papa V. 3D printing: a valuable resource in human anatomy education. *Anat Sci Int*. 2015;90(1):64-5. doi: 10.1007/s12565-014-0257-7. PMID: 25287879.
8. AbouHashem Y, Dayal M, Savanah S, Strkalj G. The application of 3D printing in anatomy education. *Med Educ Online*. 2015;20(1):29847. doi: 10.3402/meo.v20.29847. PMID: 28229704.
9. Preece D, Williams SB, Lam R, Weller R. "Let's get physical": advantages of a physical model over 3D computer models and textbooks in learning imaging anatomy. *Anat Sci Educ*. 2013;6(4):216-24. doi: 10.1002/ase.1345. PMID: 23349117.

10. Tetsworth K, Block S, Glatt V. Putting 3D modelling and 3D printing into practice: virtual surgery and preoperative planning to reconstruct complex post-traumatic skeletal deformities and defects. *SICOT J.* 2017;3:16. doi: 10.1051/sicotj/2016043. PMID: 28220752; PMCID: PMC5319375.
11. Rothenberg S, Abdullah S, Hirsch J. 3D printing prototypes for healthcare professionals: creating a reciprocating syringe. *J Digit Imaging.* 2017 Oct;30(5):566-571. doi: 10.1007/s10278-017-9953-x. PMID: 28138795.
12. Heller M, Bauer H-K, Goetze E, et al. Applications of patient-specific 3D printing in medicine. *Int J Comput Dent.* 2016;19(4):323-39. PMID: 28008429.
13. Liew Y, Beveridge E, Demetriades AK, Hughes MA. 3D printing of patient-specific anatomy: a tool to improve patient consent and enhance imaging interpretation by trainees. *Br J Neurosurg.* 2015;29(5):712-4. doi: 10.3109/02688697.2015.1026799. PMID: 25822093.
14. Canabrava S, Diniz-Filho A, Schor P, Fagundes DF, Lopes A, Batista WD. Production of an intraocular device using 3D printing: an innovative technology for ophthalmology. *Arq Bras Oftalmol.* 2015;78(6):393-4. doi: 10.5935/0004-2749.20150105. PMID: 26677048.
15. Huang WB, Zhang XL. 3D printing: print the future of ophthalmology. *Invest Ophth Vis Sci.* 2014;55(8):5380-1. doi: 10.1167/iovs.14-15231. PMID: WOS:000343145500094.
16. Sommer AC, Blumenthal EZ. Implementations of 3D printing in ophthalmology. *Graefes Arch Clin Exp Ophthalmol.* 2019;257(9):1815-22. doi: 10.1007/s00417-019-04312-3. PMID: 30993457.
17. Lee N. The Lancet Technology: 3D printing for instruments, models, and organs? *Lancet.* 2016 Oct 1;388(10052):1368. doi: 10.1016/S0140-6736(16)31735-4. PMID: 27707486.
18. Moro C, Smith J, Stromberga Z. Multimodal learning in health sciences and medicine: merging technologies to enhance student learning and Communication. *Adv Exp Med Biol.* 2019;1205:71-8. doi: 10.1007/978-3-030-31904-5\_5. PMID: 31894570.

Dr. Cameron [[jcameron@westernu.edu](mailto:jcameron@westernu.edu)] is an Associate Professor at the Western University of Health Sciences College of Optometry. He teaches vision science and runs a basic science research lab focused on retina development and degenerative diseases.

PEER REVIEWED

# Student Perceptions of Cultural Competency

Crystal Lewandowski, OD, FAAO, Thomas Andrea, OD, FAAO, and Christopher Patrick Taylor, PhD |  
*Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

**Background:** Cultural competence is one approach to reducing healthcare disparities, yet few publications have evaluated cultural competency education in optometry. Our study assesses student perceptions of cross-cultural training in optometric education. **Methods:** Optometry students were surveyed on cultural self-awareness, skills and preparedness. **Results:** Most students reported confidence in self-awareness and general preparedness. Many identified being least prepared to examine patients with a history of domestic violence and least skillful at identifying religious and cultural beliefs that may impact care. **Conclusion:** Systematic evaluation of teaching methods is crucial to ensure optometry students are adequately trained to manage patients with various cultural backgrounds.

**Key Words:** cultural competency, optometric education, language barriers, healthcare disparities

## Background

Healthcare disparities among people of different racial and ethnic backgrounds have been well-documented in the United States for more than 30 years.<sup>1-5</sup> These disparities, which include differences in treatment, unnecessary testing, increased rates of disease and worse overall outcomes, are often the result of cultural or linguistic barriers and unexplored socioeconomic differences between patients and physicians.<sup>1,2</sup> Cultural competence in health care can be described as having the knowledge, skills and adaptability to provide care to patients with various social, cultural and linguistic needs.<sup>6,7</sup> As the U.S. population rapidly becomes more diverse, interest increases in cultural competency education in health care and assessing the impact of such training.<sup>1,8</sup> Providing culturally competent care has the potential to reduce healthcare disparities and improve overall health outcomes via services provided, access to care and increased treatment compliance.<sup>1-5</sup>

In an attempt to reduce inequalities within our nation's healthcare system, national standards were developed requiring medical schools to include cultural competency education within the curriculum.<sup>4,5,12</sup> Despite these standards, fewer than 50% of residents across various medical specialties at academic health centers reported being well-prepared to provide culturally competent care when surveyed in their final year of training in 2003.<sup>1,8,12</sup> In optometry, "Guidelines for Culturally Competent Eye and Vision Care" were created by the Association of Schools and Colleges of Optometry (ASCO) to be used by optometry schools as a framework for their education programs. According to a 2004 survey, 53% of optometry institutions provide cultural competency training for students.<sup>6,16</sup> However, to our knowledge, there have not been any investigations into students' perceptions of cultural competency training in optometry school.

The objectives of this study are to assess New England College of Optometry (NECO) students' perceptions of cultural self-awareness, cross-cultural preparedness to examine culturally diverse patients, and opinions of current NECO cultural competency teaching methods within the didactic and clinical education program.

## Methods

### *Optometry curriculum*

The four-year OD program at NECO is delivered through four academic departments (Vision Science, Biomedical Science and Disease, Primary Care, and Specialty and Advanced Care) and the Clinical Education Department (**Appendix A**). First-year (OD1) didactic coursework centers on anatomy, physiology, basic sciences, public health and policy, fundamentals of vision and optics, and clinical reasoning. Second-year (OD2) coursework focuses on advanced optics, general medicine, pharmacology, ocular disease, patient communication and practice management. Third-year (OD3) course concepts include advanced ocular disease and diagnostic techniques, pediatric eye care, low vision, community health, advanced care and management and patient care. Students' clinical experiences consist of pediatric vision screenings and clinical observation during their first year followed by placement at two to four different externship sites for both second- and third-year students. The fourth year (OD4) consists entirely of clinical rotations, with placement at three to four different practices among more than 150 options including private practices, group OD/MD practices, academic medical centers, Veteran's Administration hospitals, special populations rotations, and a mandatory community health center.

At NECO, there is no single course, workshop or universal clinical standards for teaching cultural competency topics to students. Education methods and messages vary based on preceptor, practice type and patient demographics. Various strategies used to teach about healthcare disparities include case discussion, observation, use of translated written materials, use of in-person, telephone and video interpreters, and review of the literature.

### *Sample selection*

The NECO didactic curriculum does not have one course dedicated to cultural competency. Rather, the concept is integrated within various lecture courses with laboratory sessions throughout the OD1, OD2 and OD3 years of the four-year program. Students participate in clinical experiences and formal rotations throughout each academic year of the program; therefore, all students at NECO were included in this study. Each student (N=518) was sent a web-based survey to assess their self-reported understanding, attitudes and skills pertaining to their cultural competency education and clinical experiences. The web-based survey was electronically distributed to the study participants by e-mail using Qualtrics survey software (Qualtrics, Provo, Utah) during the academic year 2016-2017, as part of their end-of-semester requirements in Spring term (May 2017). Response-enhancement techniques included setting a five-day deadline to complete the survey and sending students a reminder e-mail to complete it prior to the deadline. The protocol was approved by the Institutional Review Board at NECO.

### *Survey design and administration*

A draft of the survey instrument was developed based on a literature review that included questions from the ASCO Guidelines for Culturally Competent Eye and Vision Care "Student Assessment for Self-Awareness," as well as Betancourt et al.'s Cross-Cultural Care Survey.<sup>2,3,11,12</sup> The survey was initially sent to all optometry residents in the 2015-2016 NECO residency program (N=36). Feedback was obtained from those who completed the survey (N=5) and then survey questions were condensed and rephrased for clarity based on comments from the pilot study group. Respondents were asked to keep their participation confidential and not to discuss the survey with students who would make up the cohort of the study. The finalized survey (**Appendix B**) consisted of 30 questions, the first five of which were demographic questions.

### *Self-awareness, attitudes, preparedness and skills*

Four variables related to cultural competency were measured: (1) cultural and self-awareness, (2)

attitudes about the importance and impact of cross-cultural patient care, (3) self-reported preparedness to evaluate and manage specific types of patients, and (4) self-assessment of skills. Lower numerical responses indicated little to no confidence, preparedness, skillfulness and frequency. Higher numerical responses indicated complete confidence, very well-prepared, very skillful and often for frequency (Appendix B).

1. To assess cultural awareness, students were asked to complete the ASCO Self-Assessment from the Guidelines for Culturally Competent Eye and Vision Care.<sup>6</sup>
2. To assess overall attitudes about cross-cultural care, students were questioned about their perceptions of the impact of providing cross-cultural eye care. Students were asked how often in their clinical experience cross-cultural issues (including language barriers) had consequences for longer than average patient visits, unnecessary patient visits, delays in obtaining patient consent, errors in obtaining refractive endpoint, patient non-compliance, and a lower quality of care.
3. To assess preparedness to provide culturally competent eye care, students were asked to indicate how prepared they believed they were to care for different types of patients, including new immigrants, members of racial and ethnic minorities, victims of domestic violence, those who receive alternative or complimentary medical treatments, and those with cultures different from their own, health beliefs at odds with Western medicine, a distrust of the U.S. healthcare system, limited English proficiency, religious beliefs that might affect treatment, and substance use disorders. Questions about psychosocial issues of substance abuse and domestic violence were included based on previous research and their prevalence at practices within the clinical system.<sup>12</sup> The responses of “very unprepared” or “somewhat unprepared” were combined to indicate lack of preparedness, while the other responses combined to create a dichotomous variable indicating preparedness.
4. Students were also asked to assess their skill level in the following areas when delivering cross-cultural care: how to address patients from different cultures, taking a history, assessing English proficiency, working with interpreters, performing an eye exam, identifying the mistrust of healthcare system or optometrist, assessing patients’ understanding of their illness, negotiating treatment plans, identifying patients’ religious beliefs and cultural customs that may impact care, and recognizing decision-making roles within the family.

#### *Quantity of training, assessment of education climate and other variables*

To assess the quantity of cultural competency training received during their optometric education, students were asked how much additional training beyond what they received in their didactic coursework was devoted during clinical rotations to teaching them the cross-cultural aspects of each of the skills listed previously.

To assess the education climate, three sets of questions were posed. Because clinical training is accompanied by formal evaluation, students were asked how often they were formally evaluated with respect to doctor-patient communication. For those who gave a response other than “never,” a follow-up question was asked about how much attention was paid to their ability to handle cross-cultural issues. Because optometric training includes both didactic training and applied clinical practice for each academic year, students were asked to identify problems they had in delivering cross-cultural care, including lack of practical experiences, lack of time, lack of training, limited access to interpreters, lack of materials written in other languages, lack of good role models, and dismissive attitudes among clinical preceptors and fellow interns. Because good role models may contribute to education outcomes, students were asked to report the number of preceptors skilled in providing cross-cultural care that they had worked with in their training.<sup>1</sup>

Other questions were asked about student characteristics including gender, ethnicity, ability to speak a language other than English, student year, birth country, current practice modality and number of

community health center clinical rotations.

## Results

### *Analysis*

Our analyses were primarily intended to be descriptive with the goal of contrasting answers given by respondents of different academic years in the four-year optometry program for particular questions. Only complete survey responses were used in our analysis, which reduced our sample size. Therefore, many of the results are provided as tabulations by academic year without multivariable adjustment. For analytic purposes, some answers were collapsed into dichotomous variables: “unprepared” (responses of 1 or 2) compared with other (responses of 3, 4 or 5) and “low skill level” (responses of 1 or 2) compared with other (responses of 3, 4 or 5). For the ASCO Self-Awareness questions, confidence levels were also collapsed into dichotomous variables: “not confident” (responses of 1 or 2) compared with “confident” (responses of 3, 4 or 5). All statistical analyses were performed using R (R Core Team, Vienna, Austria).

### *Respondent characteristics*

Of the 518 students in the original sample, 420 submitted responses to the survey (81% response rate), and 224 completed the survey in its entirety (43% completion rate). Characteristics of the study sample are displayed in **Table 1**. The majority of respondents were female (72.3%). Racial/ethnic characteristics reported were non-Hispanic white (58.5%), Asian (32.1%), Hispanic (2.7%), non-Hispanic black (0.5%) and other (6.3%). The distributions of sex and ethnicity were similar to those of all U.S. optometry students as reported by the ASCO Student Data Report.<sup>18</sup>

### *Student assessment for self-awareness*

The ASCO Student Assessment for Self-Awareness response summary is displayed in **Table 2**. The vast majority of responses among all academic years (>93%) indicated students were confident in understanding their own cultural beliefs, biases and differences within one’s own cultural group. A majority (>79%) also reported they were “very confident” in their awareness of prejudicial treatment, traditional and professional caring behaviors and the perceived role of optometrists among patients of different backgrounds. More than 97% of respondents reported accepting differences and similarities among different cultural groups, as well as having an appreciation of cultural sensitivity and awareness. Of note, recognition of the importance of home remedies and folk medicine among patients of different cultural backgrounds was least commonly reported among all academic years (75% of OD1s, 51% of OD2s, 55% of OD3s, and 67% of OD4s).



**Table 1.**

[Click to enlarge](#)



**Table 2.** Breakdown of students (%) by academic year reporting confidence levels of “moderate,” “very,” or “completely” for the “ASCO Student Assessment of Self-Awareness” questions. [Click to enlarge](#)



**Table 3.** Percentages of students by academic year who reported low levels of preparedness (“not at all” or “somewhat”) to care for specific types of patients. [Click to enlarge](#)



**Table 4.** Percentages of students by academic year who perceived they had low skill levels (“not at all” or “somewhat” skillful) for various aspects of cross-cultural encounters. [Click to enlarge](#)

*Attitudes, preparedness and skills*

Many optometry students believed that cross-cultural issues “often” resulted in negative consequences for clinical care, including longer office visits (82%), unnecessary visits (35%), patient non-compliance (54%), delays in obtaining consent (40%) and lower quality of care (31%).

Few optometry students reported being “very” or “somewhat” unprepared to treat patients from diverse cultures (9.4%). When asked about specific types of patients in cross-cultural encounters, such as those with a history of domestic violence or substance abuse disorder, a greater percentage of students reported being unprepared (>40% of OD1s and OD2s, >33% of OD3s, and >14% of OD4s). In assessing responses from all years, more than one in three students reported a lack of preparedness to manage patients who have religious beliefs that may affect treatment or practices that are at odds with Western medicine. OD4 students reported being least prepared to treat patients who use alternative or complementary medicine (24%), are victims of domestic violence (24%) or distrust the healthcare system (21%). A breakdown of responses by academic year are displayed in **Table 3**.

The percentage of students reporting low skill levels for various aspects of cross-cultural encounters ranged from 10% to 71% depending on the skill area and student year (**Table 4**). As a whole, approximately one in four students indicated they possessed low skills (responses of “not at all” or “somewhat” skillful) for taking a history (25%), working effectively through a medical interpreter (25%) and identifying whether a patient can read or write in English (27%). More than half of respondents reported low skill levels in identifying cultural customs that may affect care (54%), mistrust of healthcare providers (57%) and religious beliefs that may affect care (60%), with OD4s alone reporting similar low skill levels (38%, 40% and 48% respectively).

#### *Quantity of training*



**Table 5.** Percentage of students by academic year who reported little to no cross-cultural training on specific topics in clinic. [Click to enlarge](#)



**Table 6.** Percentage of students by academic year who reported not receiving instruction on interpreter topics. [Click to enlarge](#)

A large number of optometry students reported receiving little to no cross-cultural training in their clinical rotations in specific areas important for delivering cross-cultural care (**Table 5**). More than half reported receiving little or no training in identifying cultural customs (57%), patient mistrust (59%) and religious beliefs that might affect clinical care (62%). Less than half reported little or no training in identifying decision-making structure (44%), negotiating a treatment plan (42%) and determining how a patient wants to be addressed (39%). Approximately one in four students reported difficulty assessing patients’ understanding of illness (29%), taking a history (25%) and using a medical interpreter (23%).

Assessment of responses from the OD4 students alone showed approximately half reported the same areas as being taught least frequently in clinic: identifying relevant cultural customs (49%), identifying patient mistrust (46%) and identifying relevant religious beliefs that might affect clinical care (48%).

When asked specifically about instruction on various interpreter topics (**Table 6**), more than half of the OD1 students reported not receiving instruction on a patient’s legal right to an interpreter, how to use interpreters at specific clinic sites, the importance of eye contact with patients while using interpreters, potential dangers of using untrained interpreters, and how to respond to interpreter misinterpretation. The OD2 students’ responses showed a decrease by at least 40% in each of these questions, and OD3

and OD4 percentages decreased even further.

### *Education climate and evaluation*

Students of all academic years reported on-the-job training in a community health or hospital-based setting as most useful for their education. The second-most useful experience varied by academic year. OD3 and OD4 students reported diversity of colleagues being useful; OD2s reported case-based discussions; and OD1s reported case discussion and colleague diversity. When asked specifically about their clinical assignments, approximately 15% of students reported “never” being formally evaluated on patient-physician communication, and 19.6% reported they were “rarely” evaluated. OD1 students were far more likely to report “never” being evaluated (n=23) on communication, more than twice the number of respondents from all other academic years combined (n=10). The percentage of students who reported cross-cultural issues were “never” or “rarely” paid attention to was 34.64% (40% OD1, 23% OD2, 24% OD3 and 9% OD4). Although 51% of OD1 students reported never having a mentor skilled in providing cross-cultural care, that percentage increased significantly for all other academic years: 79% of OD2, 88% of OD3 and 84% of OD4. Some of the student comments highlighting the benefits of community health center experiences, clinical preceptors and faculty mentors are displayed in **Table 7**.



**Table 7.** Survey respondents' comments related to cultural competency training. [Click to enlarge](#)

Some of the most frequently reported obstacles to delivering cross-cultural care (presenting as moderate or major problems) were poor access to interpreters (40%), lack of appropriate written materials translated in other languages (health education pamphlets, consent forms, etc.) (38%), and lack of time (35%). Although previous studies have identified dismissive attitudes of attending physicians or colleagues as an encountered problem, only 22% of students reported this of clinical preceptors and 15% of student colleagues.<sup>1</sup> Language barriers between students and patients were “often” encountered by 46% of OD4s, 71.7% of OD3s, 34.9% of OD2s and 0% of OD1s.

## **Discussion**

### *Analysis of student responses*

Overall, few students (<10%) reported a lack of preparedness to care for patients of diverse backgrounds. However, when asked about specific scenarios, such as caring for those who distrust the U.S. healthcare system or use alternative medicine, far more reported being unprepared. Many reported they were unskilled in managing key aspects of effective cross-cultural care, such as the ability to assess how a patient prefers to be addressed during an examination or identifying relevant cultural beliefs and customs that may impact care. The gap between perceived preparedness in a general sense compared with specific cross-cultural situations has similarly been identified among resident physicians practicing in various specialties and has been suggested to be a result of “failure to incorporate these key concepts into their working definition of cross-cultural care.”<sup>1</sup> Though our study focuses on several aspects of culture such as race, language and ethnicity, we recognize the importance of educating students on how to care for various groups of people that may share common beliefs such as those with disabilities and gender diverse communities.

There was also a disconnect between students' responses about how frequently they were evaluated compared to frequency of required faculty evaluations, which possibly influenced student perceptions of attention paid to cross-cultural matters. Several students reported they were “never” or “rarely” evaluated on patient-doctor communication; however, this is a category on the grading rubric for all academic years that is submitted by clinical faculty a minimum of two to four times each year. Additionally, cross-cultural

issues are evaluated by faculty within the categories of technical skills, communication, treatment and management, and professionalism for each clinical evaluation submitted. This gap in student understanding of the clinical evaluation system in place can be lessened with greater emphasis from faculty and more frequent verbal feedback with specific observations, in addition to their final written evaluations.

### *Implications for cultural competence training in optometry*

Our data suggest that the education experiences of students vary, but the trends indicate that self-reported comfort levels generally increase as students progress through the four-year program. By assessing responses from each academic year, the results can be used as a platform to strategically integrate additional education opportunities at specific times throughout the curriculum. More than half of the OD1 respondents reported lack of cross-cultural scenarios, interpreter instruction and mentors with sufficient cross-cultural skills, likely reflecting the design of the clinical program in which OD1 students are not yet in a traditional clinic setting. Because most students of all other years responded more positively, this data can be used to support implementation of new mentorship programs and education opportunities for OD1 students. For example, creating a workshop involving mock patients with language barriers would provide students an opportunity to practice using interpreters and available resources and to discuss social determinants of health with teaching faculty prior to entering a formal clinic setting in their second year.

Many students reported lack of time as a barrier to addressing cross-cultural issues. This may reflect the current healthcare climate with demands on preceptors to examine a high volume of patients while using electronic health records, which increases charting time and decreases teaching time.<sup>19</sup> We suggest providing students with self-directed learning materials in the form of article review, online modules or video instruction prior to starting at a new clinic site and throughout the semester, with content that highlights patient demographics and prominent cultural beliefs that may impact care during clinical rotation.

Lack of access to translated materials and interpreters were identified as problems, which may reflect differences in financial resources, electronic medical records, and staffing among clinical sites or perhaps lack of student awareness of resources available to them. Despite these issues, no student from any academic year reported “often” feeling helpless about what to do when managing patients from diverse cultures, and the majority denied dismissive attitudes of clinical preceptors as a problem. These data indicate that students are given the knowledge and tools to prepare for diverse clinical encounters and that clinical preceptors and training sites model culturally competent care. Also, the data can provide insight to clinical faculty when teaching students about resources in clinic.

An area of concern identified by many OD4s was difficulty identifying cultural customs and religious beliefs that may impact care. This may be a result of the survey focusing on technical abilities rather than interpersonal skills, or perhaps due to language barriers or a perceived lack of access to translators. Other commonly identified patient characteristics that students reported low levels of preparedness to manage included those who use alternative medicine, have a distrust in the U.S. healthcare system or are victims of domestic violence. These data can be used by clinical preceptors as topics to focus on during their clinical discussions, specifically with fourth-year students before graduation.

### *Limitations*

Our study had limitations that may affect to what extent it can be generalized across optometry programs, including the lack of validated tools for measuring cultural competence training in eye care as well as a small sample size from one optometry school. Our low survey completion rate may have introduced a sampling bias if those who completed the survey were inherently prepared, skillful or

confident compared with those who did not complete the survey in its entirety. Another limitation was the reliance on self-reported data, which may not be suggestive of actual abilities nor predictive of future competency in clinical practice.

### *Education interventions and future considerations*

In 2007, ASCO identified cultural competency topics that were not prevalent in the curricula of ASCO institutions.<sup>2</sup> The quantitative and qualitative data from this study indicated which specific areas that NECO students reported receiving little training on, suggesting there is room for development and uniformity in their optometric education, both didactically and clinically. As a result of this study, various cultural competency handouts and resources were created and shared electronically with students and clinical preceptors. The materials included content related to areas in which students reported needing more instruction or preparation. A new two-hour lecture on cultural competency was developed and made digitally available to all students and faculty to view asynchronously online. These resources provide widespread teaching material available for use across the entire clinical network, regardless of the geographic location or preceptor at each clinical site.

The results of this study can be used to create additional lecture content, courses and workshops focused around cultural competency and healthcare disparities, while guiding optometric institutions as they evaluate their curriculum. As with any course or curriculum change, the long-term impact on student performance and perceptions should be measured to provide insight on its educational effectiveness. Future research including validation of a tool to assess cultural competency preparedness, expansion to optometry students nationwide, and evaluation of long-term impact of curriculum changes on student performance will benefit optometry schools when developing their curriculum and clinical education program.

### **Conclusion**

As educators in optometry, we are tasked with training the future generation of clinicians to deliver culturally competent care to reduce healthcare disparities. Our findings indicate that upon completion of each academic year and graduation, the vast majority of NECO students generally feel well-prepared to examine patients from diverse backgrounds. Further, students specified key concepts and skills for which they would like more tailored instruction, such as non-racial examples of cross-cultural scenarios and identifying patients' cultural customs, religious beliefs and decision-making structures that may impact care. Future research is needed to better understand the impact of our teachings on student perceptions and performance, including a thorough mapping of the didactic curriculum, investigating the specific types of training received by clinical faculty and exploring which clinical settings have the greatest impact on students' learning. With additional research measuring education outcomes, teaching strategies involving cultural competency education can be further developed and used by optometry schools nationally.

### **Acknowledgments**

This study was supported by a Starter Grant for Educational Research from the Association of Schools and Colleges of Optometry and The Vision Care Institute, LLC, an affiliate of Johnson & Johnson Vision Care, Inc.

We are grateful to Erik Weissberg, OD, Gary Chu, OD, MPH, Fuensanta Vera Diaz, OD, PhD, Jane Gwiazda, PhD, Paul White, OD, and the Research Committee from the New England College of Optometry for their support and helpful insight into our project, as well as Cameron MacMartin for delivery of the surveys. We are thankful to Anthony Guarino, PhD, Adjunct Professor, for his support with data and statistical analyses and to Joel S. Weissman, PhD, for sharing his Cross-Cultural Care Survey

instrument with us.

## References

1. Weissman JS, Betancourt J, Campbell EG, et al. Resident physicians' preparedness to provide cross-cultural care. *JAMA*. 2005 Sep 7;294(9):1058-67.
2. Brach C, Fraser I. Can cultural competency reduce racial and ethnic health disparities? A review and conceptual model. *Med Care Res Rev*. 2000;57(Suppl 1):181-217.
3. Fiscella K, Franks P, Doescher MP, Saver BG. Disparities in health care by race, ethnicity, and language among the insured: findings from a national sample. *Med Care*. 2002 Jan;40(1):52-9.
4. National standards for culturally and linguistically appropriate services in health care: executive summary. Washington, D.C.: Office of Minority Health, U.S. Department of Health and Human Services; 2001.
5. Betancourt JR, Green AR. Commentary: linking cultural competence training to improved health outcomes: perspectives from the field. *Acad Med*. 2010 Apr;85(4):583-5.
6. Marshall E, Pang Y, Mutha S. ASCO guidelines for culturally competent eye and vision care [Internet]. Association of Schools and Colleges of Optometry; 2008 [cited 2016 May 1]. Available from: [https://optometriceducation.org/files/Guidelines\\_CulturallyCompetentEyeAndVisionCare.pdf](https://optometriceducation.org/files/Guidelines_CulturallyCompetentEyeAndVisionCare.pdf)
7. Betancourt JR. Cross-cultural medical education: conceptual approaches and frameworks for evaluation. *Acad Med*. 2003;78(6):560-569.
8. Betancourt J, Weissman J, Kim M, Park E, Maina A. Resident physicians' preparedness to provide cross-cultural care: Implications for clinical care and medical education policy. New York: The Commonwealth Fund; 2007.
9. Beamon CJ, Devisetty V, Forcina Hill JM, Huang W, Shumate JA. A guide to incorporating cultural competency into health professionals' education and training [Internet]. Washington, D.C.: The National Health Law Program; 2006 [cited 2016 May 2]. Available from: [https://www.migrationpolicy.org/sites/default/files/language\\_portal/CulturalCompetency.052306.pdf](https://www.migrationpolicy.org/sites/default/files/language_portal/CulturalCompetency.052306.pdf)
10. Chun MB, Yamada AM, Huh J, Hew C, Tasaka S. Using the cross-cultural care survey to assess cultural competency in graduate medical education. *J Grad Med Educ*. 2010 Mar;2(1):96-101.
11. Park ER, Chun MB, Betancourt JR, Green AR, Weissman JS. Measuring residents' perceived preparedness and skillfulness to deliver cross-cultural care. *J Gen Intern Med*. 2009;24(9):1053-1056.
12. Ambrose AJ, Lin SY, Chun MB. Cultural competency training requirements in graduate medical education. *J Grad Med Educ*. 2013 Jun;5(2):227-31.
13. Seeleman C, Hermans J, Lamkaddem M, Suurmond J, Stronks K, Essink-Bot ML. A students' survey of cultural competence as a basis for identifying gaps in the medical curriculum. *BMC Med Educ*. 2014 Oct 11;14:216.
14. 2014 Health Center Data [Internet]. National Program Grantee Data. U.S. Department of Health and Human Services; [cited 2016 May 15]. Available from: <https://bphc.hrsa.gov/datareporting/research/hcpsurvey/dashboardmanual/datafilevariables.html>
15. Lambreghts K, Schultz B. Chief academic officer survey on teaching cultural competency in optometric education. *Optometric Education*. 2006;31(3):84-87.
16. Denial A, Hoppe E, Carlson N. Assessing cultural competency in optometric faculty. *Optometric Education*. 2006;31(3):92-95.
17. Fuchs H. Cultural competency assessment: a qualitative research study. Boston: New England Eye Institute; 2008.
18. ASCO annual student data report. Academic year 2016-2017 [Internet]. Association of Schools and Colleges of Optometry. [cited 2019 May 20] Available from: <https://optometriceducation.org/pdfs/ASCO-Student-Data-Report-2016-17-updated-May-1819.pdf>
19. Denial A, Bastian D, Chu G, Moy A. Faculty perceptions of the impact of electronic medical and health records in optometric education in the United States and Puerto Rico [Internet]. *Optometric Education*; 2018 [cited 2019 Aug 7]. Available from: [//journal.opted.org/article/faculty-perceptions-](http://journal.opted.org/article/faculty-perceptions-)

[of-the-impact-of-electronic-medical-and-health-records-in-optometric-education-in-the-united-states-and-puerto-rico/?pdf=5266](#)



**Appendix A.** [Click to enlarge](#)



**Appendix B.** [Click to enlarge](#)

Dr. Lewandowski [[lewandowskic@neco.edu](mailto:lewandowskic@neco.edu)] is an Assistant Professor of Clinical Optometry at the New England College of Optometry. She is also the Clinical Director of Vision Services at North End Waterfront Health and NEW Health Charlestown. She is a clinical preceptor to optometry students of all academic years. Her areas of interest include optometric education, diabetic eye care and public health.

Dr. Andrea is the Director of Vision Services at the Community Health Center of Cape Cod in Masphee, MA. He also serves as a Director of the New England College of Optometry (NECO) Alumni Association Board and as a clinical adjunct faculty member at NECO. His areas of interest include the provision of accessible eye care, utilization of technology in the domain of public health, and optometric education.

Dr. Taylor is an Assistant Research Professor of Vision Science at the New England College of Optometry. His areas of interest are myopia development, spatial and color vision testing, and optometric education.

PEER REVIEWED

# Student Satisfaction with an Objective Structured Clinical Examination in Optometry

Patricia Hrynchak, OD, MScCH (HPTE), FAAO, DipOE, Jenna Bright, BSc, MSc, OD, Sarah MacIver, BSc, OD, FAAO, and Stanley Woo, OD, MS, MBA, FAAO | *Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

An objective structured clinical examination (OSCE) is a performance-based examination in which students rotate through a series of stations where they are expected to perform specified tasks to demonstrate competency. This paper reports on student satisfaction with the OSCE administered at the end of a Doctor of Optometry professional program. Students were very positive about the interactions with standardized patients and the organization of the examination. They felt the examination used realistic scenarios. They had a mixed response to the use of simulators for skills assessment and the length of time available in each station to perform those tasks. Overall, the optometry students were very positive about the opportunity to participate in the OSCE prior to sitting for the entry-to-practice Optometry Examining Board of Canada examinations, which also use OSCEs.

**Key Words:** education, optometry, objective structured clinical examination, program evaluation, satisfaction, summative

## Introduction

Graduates of schools and colleges of optometry must have the knowledge, skill and judgement to practice effectively and safely. Optometric education requires a system of assessment to determine whether students have reached the desired competencies<sup>1</sup> for entry into practice. A system of assessment can include multiple assessment types including clinic-based assessment methods (mini-clinical evaluation exercise, global rating scales), written examinations (multiple-choice questions or key feature questions) and performance-based assessments.<sup>2</sup>



**Figure 1.** Miller's pyramid of clinical assessment with assessment method examples at each level.

[Click to enlarge](#)

Miller proposed a framework of four levels of clinical assessment in healthcare education.<sup>3</sup> Learners demonstrate increasing ability moving upward in a pyramid from knows (knowledge), knows how (application of knowledge), shows how (performance) to does (action). Each level of the pyramid requires the use of different assessment methods<sup>3</sup> that combine to form a system of assessment.<sup>4</sup> The objective structured clinical examination (OSCE) assesses at the “shows how” level (**Figure 1**).

The OSCE is a performance-based assessment in a simulated environment where students rotate from one station to the next and are expected to perform a particular clinical task or series of tasks in each station.<sup>5</sup> Typically, one or two examiners in each station rate the performance on checklists, global rating scales or both.<sup>6</sup> A standardized patient (SP) in the station may act to portray a relevant clinical scenario.<sup>7</sup> The SPs can also rate student performance.<sup>5</sup> The stations are timed, usually five to ten minutes in

length, and the student moves from one task to the next through a predetermined number of stations.<sup>7</sup> Rest stations are often interspersed through the examination.<sup>5</sup>

The OSCE is able to assess competencies such as communication, professionalism and patient-centeredness as well as the demonstration of higher-order reasoning skills in real time.<sup>6</sup> Reliability can be increased by conducting the examination in a controlled environment, which makes it more objective than practice-based assessments.<sup>1</sup> Reliability is a necessary component of a valid examination.<sup>8</sup> The OSCE extends the psychomotor skills examination (proficiencies) by using cases and requiring active problem-solving, diagnosis and planning.<sup>6</sup>

The OSCE as an assessment format was originally developed by Ron Harden in 1975.<sup>9</sup> It is considered the gold standard in high-stakes assessment in healthcare education.<sup>10</sup> It is used extensively in undergraduate and postgraduate healthcare education as well as in national board examinations.<sup>11</sup>

The Optometry Examining Board of Canada (OEBC) is the Canadian equivalent to the National Board of Examiners in Optometry (NBEO) in the United States. "OEBC establishes a psychometrically valid and defensible assessment to establish entry-to-practice competence in optometry in Canada."<sup>12</sup> The results of the examination are used in registration (licensure) decisions by the provinces. There are two parts to the OEBC examinations: 1) a case-based, written multiple-choice examination and 2) an OSCE. The OSCE was first used as an assessment format by the OEBC in 2017. Although the success rate of University of Waterloo students completing the OEBC did not change, the students' feedback to the school was that they generally felt unprepared when completing the OSCE. It was therefore important to introduce optometry students from the University of Waterloo School of Optometry and Vision Science to this assessment format.

Education program evaluation is the process of collecting, analyzing and interpreting data.<sup>13</sup> Some models evaluate outcomes and others evaluate the processes of the education program.<sup>13</sup> Kirkpatrick developed a four-level outcomes-based model. The levels are reaction (satisfaction), learning (knowledge or skill acquired), behavior (transfer of learning to the workspace) and results (impact on society).<sup>13</sup> Student satisfaction surveys assess the reaction level of the model with the results used to improve the program.

In this pilot project, we developed an OSCE to improve on the system of assessment used to determine end-of-program competency in the University of Waterloo Doctor of Optometry program. An additional reason for the development was to expose the students to this type of assessment within the program before they attempted the high-stakes OEBC examinations. Research has shown that practicing an OSCE can lead to improved confidence and lowered stress.<sup>14</sup>

Here we report on the satisfaction of the students immediately after taking an OSCE at the end of their formal optometric education and before taking their OEBC OSCE. The aim is to use information gathered from the surveys to inform future administrations of the OSCE as part of the evaluation process.

## **Methods**

We give a brief overview of the development of the OSCE followed by a description of the satisfaction survey administration. The OSCE was designed and developed by closely following the evidence-based principles outlined in AMEE Guide No. 81. Part II: organisation & administration.<sup>5</sup> A team of four faculty members worked on the design, development and administration of the OSCE during a period of more than one year. One team member had previous experience with the OSCE at another institution.

The examination content was mapped to the OEBC's national entry-level competency profile. Creating

this blueprint is a way of defining what is to be measured by mapping to entry-level abilities.<sup>8</sup> The domains of competence assessed were communication, professionalism, patient-centered care, assessment (skills), diagnosis and planning and patient management. The content areas were refractive care, binocular vision and ocular disease. The proportion of competencies in the cases was determined by the combination of frequency and importance of the competencies as described by OEBC in the development of its blueprint.<sup>15</sup>

We developed 11 stations: four stations on refractive care, three stations on binocular vision and four stations on ocular disease. Of the 11 stations, six interactive stations had SPs and five did not. To improve reliability, simulations (e.g., Eyesi Indirect Ophthalmoscope, VRmagic, Mannheim, Germany) were used for all skills where testing could have been done on a person. Three rest stations were interspersed among the active stations. Each station was 10 minutes long with two minutes available to read the case description and tasks required before entering the station and eight minutes in the station. This was the maximum number of stations that could be administered in a reasonable timeframe.

Two of the developers tested the stations with one acting as an assessor and the other as a student. The stations were then modified to fit within targeted time and difficulty level. Subsequently, we piloted the examination with seven volunteer students who had completed the International Optometric Bridging Program at the University of Waterloo School of Optometry and Vision Science. The results of the pilot helped to refine the stations for the next iteration.

The assessment tools developed for the stations were a combination of global rating scales and check sheets depending on the competencies assessed in the station. The assessors were volunteer faculty members and optometric residents at the School of Optometry and Vision Science. The 15 assessors were trained to grade performance consistently during a three-hour session. Specifically, they were trained to accurately and consistently distinguish between a “pass” (optometry candidate addressing all criteria determined necessary to be a minimally competent practicing optometrist) and a “fail” (optometry candidate not meeting the minimum requirement of competence). They assessed different levels of performance while viewing videos of mock performances (specifically a “pass,” “borderline” and “failing” candidate). These videos were of the development team acting out different levels of student performance. The assessment results were compared and discussed to ensure grading consistency.

The McMaster University Standardized Patient Program was hired to provide the SPs. We worked with the trainer from McMaster University to train the SPs to portray the character in the clinical scenario for each station that used them. If more than one SP was used for the same station they were trained together to ensure uniform performance. The SPs were very experienced and compensated for their expertise.

The examination was conducted in four sessions during two days. Ideally, there would be no opportunity for the candidates taking the exam to have any exposure to each other before taking the exam. However, this was not possible because the circuit took approximately two and a half hours to complete, and we lacked a sufficient number of assessors to run concurrent circuits with the number of students who were taking the examination. Students did sign a confidentiality agreement form requiring them not to disclose the content of the stations. We did not provide the content of the stations to the students; they did not have access to the assessment tools (check sheets and global rating scales), and they did not have advance knowledge of the psychomotor skills to be tested.

We invited 90 students in the graduating class to volunteer to take the OSCE via an electronic survey four months before the examination administration. Because this was a pilot, the OSCE was not a required element of assessment in the program. There was no incentive given for the students to participate. Students provided written consent to use their anonymized results from the examination during class time by a third party not involved with the project who did not instruct the students. The

study received ethics clearance from the University of Waterloo Office of Research Ethics with standards that follow the Declaration of Helsinki. The students then voluntarily completed a survey regarding their perceptions of the examination immediately following the OSCE.

The satisfaction survey used was developed by the School of Pharmacy at the University of Waterloo and modified for use in optometry. The School of Pharmacy uses OSCEs throughout its professional program. The survey employs nine statements to which students are asked to respond about their satisfaction with the components of the OSCE using a five-point rating scale of strongly disagree, disagree, neither agree nor disagree, agree and strongly agree. It also includes open-ended comments. The percentage of students choosing each category for each of the statements was calculated. Two of the investigators independently delineated themes from the open-ended comments by reading the comments and identifying recurring concepts. The results were compared and discussed until agreement was reached. The prompts for these comments were included in survey items labeled “Things done particularly well” and “Anything that may have hindered the performance.”

The response categories were assigned a number from one to five corresponding to strongly disagree to strongly agree. Cronbach’s  $\alpha$  was calculated to determine the internal consistency of the survey.

## Results

Ninety students were eligible to take the OSCE. Of those eligible, 54 students volunteered for the examination and all volunteers attended the examination. All 54 students completed the survey. The survey statements and results are presented in **Table 1**. Cronbach’s  $\alpha$  calculated for the internal consistency of the survey was good at 0.86. Deleting each of the questions did not improve the value, indicating that the separate questions contributed to the reliability of the survey.



### Table

1. [Click to enlarge](#)



### Table

2. [Click to enlarge](#)

Students agreed or strongly agreed that the examination was well-organized (100%) and that the staff members were helpful (94%). Students agreed or strongly agreed that the cases were representative of clinical optometric practice (98%). Students agreed or strongly agreed that the SPs were realistic (100%), provided the information they needed (92%) and resembled what they see in practice (98%). Students agreed or strongly agreed that information provided before the examination was sufficient (78%), equipment and resources provided were adequate (87%) and instructions provided in the non-interactive stations were clear (74%).

The themes delineated from the open-ended comments are reported in **Table 2**. Many of the comments echoed what was in the survey. Additionally, while there were some positive comments about the simulations (three responses), there were more comments about the difficulty of using simulators for skills normally performed on a person when they were not familiar with their use (16 responses).

The students were required to state what they were doing while performing a procedure and to state their diagnosis and plan while recording it (18 responses). They found these things difficult to do, as they were unfamiliar tasks. Students felt that the case information and station tasks posted on the outside of

the station was insufficient and more information would have been preferred (nine responses). Time was also an issue given that some students felt they had insufficient time to complete the task(s) (16 responses). Students felt the instructions were not clear (five responses) and they were unsure how to prepare for the examination (three responses).

The other comments were non-themed, including positive comments about enjoying the counseling stations and a good balance of material being covered in the assessment. The comments about what hindered the performance were mostly specific comments about specific stations (e.g., not knowing how to use the 20D lens in the indirect ophthalmoscope station, not knowing what to expect and knowing the examiners).

## Discussion

We report on student satisfaction with a pilot OSCE in optometric education as the first level in Kirkpatrick's program evaluation model.<sup>13</sup> The survey was internally consistent with a good Cronbach's  $\alpha$  of 0.86 and all questions contributing to the reliability. The results of the survey have helped to determine what practices to continue in future iterations and where improvements can be made. In addition, because the OEBC examinations include an OSCE we felt it was necessary to develop our own OSCE to give students experience with the examination format before they take the high-stakes assessment. Experience with the assessment method was intended to reduce anxiety and increase the feeling of preparedness.<sup>14</sup>

The students responded very positively to the SPs in the examination. It was the first time in the optometry program they were exposed to SPs. The positive response was likely because the SPs were hired from a professional SP program at McMaster University and were very experienced. We developed scripts for the SPs and trained them to respond to questions appropriately, including what affect to portray in each station.<sup>16</sup> The practice of using trained SPs will be continued in future administrations of the examination.

Students were positive about the organization of the assessment. Developing and administering an OSCE is a challenging task requiring a considerable amount of administrative time and coordination of students, assessors, administrators, support staff and information technology.<sup>8</sup>

The students felt that the stations represented authentic cases from optometric practice. The case writers have extensive experience in clinical practice in the school environment and private practice. Each case was reviewed by our team and refined. One of our team has experience with OSCE case writing for an external educational organization. This is in line with best practices in OSCE development.<sup>16</sup> Drawing on case writing experience will continue in the next iteration of our efforts to enhance the assessment.

We decided to use simulators for some of the skills testing that would typically be performed on a person. Simulators increase the reliability of an assessment by being standardized and reducing the variability found in clinical encounters.<sup>17</sup> Simulators can be programmed to portray a variety of complex presentations and perform the same way through multitudes of assessments.<sup>17</sup> The simulators used were either free or inexpensive with the exception of the VRmagic indirect ophthalmoscope simulator that was already available in the program. No device malfunctions occurred in this examination. However, students questioned the fidelity of some simulations that they felt did not represent their real-world experience. In addition, they did not all have an opportunity to practice on the indirect ophthalmoscope simulator, and none had an opportunity to practice with the cover test, oculomotor or retinoscopy simulators. This was a perceived barrier to performance even though the simulators were straightforward to use and the students were given standardized instructions at the beginning of the station. In the future, assessor training will improve to support the student in using the simulator. While

allowing the students to train on the simulators prior to the examination could be considered in future assessments,<sup>18</sup> this approach will need to be weighed against the security of the examination content.

Students did not feel they were adequately prepared for the OSCE in that they were not provided with adequate information. This is not surprising given that the students had not experienced the assessment format in the past. In addition, during the consent process where questions could have been asked, we were not allowed to be present as determined by the Office of Research Ethics. In an OSCE, the students need to integrate information and actively solve problems in contrast to a checklist for skills-based testing. This produces a challenge for traditional studying, as they do not know how to prepare for the assessment. Student-run mock OSCEs have been used to prepare students for high-stakes assessment with some success<sup>14,19</sup> More information will be provided to the students in advance of future assessments.

Students felt that time was too short in the stations that required them to perform skills whether using a simulator for the testing or using standard equipment. It was surprising how long it took the students to perform skills that were expected to be at the level of “unconscious competency”<sup>20</sup> at the end of their program. Perhaps some basic skills (e.g., manual lensometry) have been replaced in practice with automated devices making assessment of that skill questionable as an entry-level competency. In future administrations, the full case details will be posted outside of the examination room during the two minutes students are reading the stem, which should help alleviate the time pressure. In addition, the one-minute warning will be changed to two minutes to help students better manage their time.

There were limitations to this study. The student sample was biased to those who volunteered for the examination. One-third of the class was finishing an on-site clerkship, but the other two-thirds were off campus. This required the off-site students to return to campus to take the examination. Therefore, they were less likely to attend the examination. In addition, the sample size was small and limited to only one institution. The results are therefore not generalizable to all professional optometry programs.

## Conclusions

The overall satisfaction of optometry students on the first administration of an OSCE was high. The SPs and the organization were both rated favorably. Students noted some possible improvements to the stations that used simulators for skill performance and felt that the time in those stations was insufficient. The results indicate promise for the OSCE being a feasible tool to add to a system of assessment for determining the competencies of graduating optometry students.

Future work will report on utility of the assessment, which includes validity, reliability, equivalence, feasibility, education effect, catalytic effect and acceptability of the OSCE in our context.<sup>14</sup> The examination results of this assessment will be analyzed and reported.

## Acknowledgement

This study was funded by the Center for Teaching Excellence, University of Waterloo, Learning Innovation and Teaching Enhancement Grant.

## References

1. van der Vleuten CP, Schuwirth LWT, Scheele F, Driessen EW, Hodges B. The assessment of professional competence: building blocks for theory development. *Best Pract Res Clin Obstet Gynaecol.* 2010 Dec;24(6):703-19.
2. Hrynchak P, Takahashi SG, Nayer M. Key-feature questions for assessment of clinical reasoning: a literature review. *Med Educ.* 2014;48(9):870-83.
3. Miller GE. The assessment of clinical skills/competence/performance. *Acad Med.* 1990 Sep;65(9)

- suppl):S63-7.
4. Norcini J, Brownell Anderson M, Bollela V, et al. 2018 consensus framework for good assessment. *Med Teach*. 2018 Nov;40(11):1102-09.
  5. Khan KZ, Gaunt K, Ramachandran S, Pushkar P. The objective structured clinical examination (OSCE): AMEE Guide No. 81. Part II: organisation & administration. *Med Teach*. 2013 Sep;35(9):e1447-63.
  6. Casey PM, Goepfert AR, Espey EL, et al., Association of Professors of Gynecology and Obstetrics Undergraduate Medical Education Committee. To the point: reviews in medical education—the objective structured clinical examination. *Am J Obstet Gynecol*. 2009;200(1):25-34.
  7. Newble D. Techniques for measuring clinical competence: objective structured clinical examinations. *Med Educ*. 2004;38(2),199-203.
  8. Khan KZ, Ramachandran S, Gaunt K, Pushkar P. The objective structured clinical examination (OSCE): AMEE Guide No. 81. Part I: an historical and theoretical perspective. *Med Teach*. 2013;35(9):e1437-46.
  9. Harden RM, Stevenson M, Downie WW, Wilson GM. Assessment of clinical competence using objective structured examination. *Br Med J*. 1975 Feb 22;1(5955):447-51.
  10. Harden RM. Misconceptions and the OSCE. *Med Teach*. 2015;37(7):608-610.
  11. Hastie MJ, Spellman JL, Pagano PP, Hastie J, Egan BJ. Designing and implementing the objective structured clinical examination in anesthesiology. *Anesthesiology*. 2014;120(1):96-203.
  12. Optometry Examining Board of Canada [Internet]. Accessed 2019 May 21. Available from: <https://www.oebc.ca>
  13. Mohanna K, Cottrell E, Wall D, Chambers R. *Teaching Made Easy: A manual for health professionals*. 3rd Ed. New York, NY: Radcliffe Publishing; 2011.
  14. Young I, Montgomery K, Kearns P, Hayward S, Mellanby E. The benefits of a peer-assisted mock OSCE. *Clin Teach*. 2014 Jun;11(3):214-18.
  15. Cane D, Penny M, Marini A, Hynes T. Updating the competency profile and examination blueprint for entry-level optometry in Canada. *Canadian Journal of Optometry*. 2018;80(2):25-34.
  16. Daniels VJ, Pugh D. Twelve tips for developing an OSCE that measures what you want. *Med Teach*. 2018;40(12):1208-1213.
  17. Scalese R. Simulation-based assessment. in: *A practical guide to the Evaluation of Clinical Competence*. 2nd Ed. Elsevier, 2018.
  18. Courteille O, Bergin R, Stockeld D, Ponzer S, Fors U. The use of a virtual patient case in an OSCE-based exam—a pilot study. *Med Teach*. 2008;30(3):e66-76.
  19. Bevan J, Russell B, Marshall B. A new approach to OSCE preparation – ProSCEs. *BMC Med Educ*. 2019 May;19(1):126.
  20. Manthey D, Fitch M. Stages of competency for medical procedures. *Clin Teach*. 2012 Oct;9(5):317-9.

Dr. Hrynchak [[patricia.hrynchak@uwaterloo.ca](mailto:patricia.hrynchak@uwaterloo.ca)] is a Clinical Professor at the University of Waterloo School of Optometry and Vision Science. She has a Master of Science in Community Health degree in Health Practitioner Teacher Education and is a Diplomate in Optometric Education with the American Academy of Optometry.

Dr. Bright is Director of the International Optometric Bridging Program at the University of Waterloo School of Optometry and Vision Science. Prior to obtaining her Doctor of Optometry degree, she earned a Master of Science degree with a focus on patient-centered communication in an optometric setting. Dr. Bright has a special interest in optometric education and cultural competency.

Dr. MacIver is a Clinical Associate Professor at the University of Waterloo School of Optometry and Vision Science and has a special interest in the treatment and management of chronic ocular disease, specifically glaucoma and dry eye. She has been invited to speak at various education events including

interprofessional conferences and public education events to disseminate knowledge about eye health and vision care. Her areas of research include glaucoma, dry eye disease, interprofessional collaboration with primary healthcare and optometric education.

Dr. Woo is Director of the University of Waterloo School of Optometry and Vision Science. He is a Diplomate in Low Vision with the American Academy of Optometry and a Diplomate with the American Board of Optometry. His research interests include vision rehabilitation, ophthalmic imaging, public health policy and systems for optimizing patient care outcomes

PEER REVIEWED

# Does Self-Regulated Test Duration Correlate with Vision Science Test Score in First-Year Optometry Students?

Patricia M. Cisarik, OD, PhD, FAAO, and Melissa Powers, MS | *Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

*We explored the relationship between self-regulated test duration and test performance in first-year optometry students using test administration software. The scores for two midterms (MT1 and MT2) and the final exam for a single course (Visual Sensation and Perception) and time from password submission to exam upload were obtained for 132 students in spring 2019. Statistical analysis suggests that the relationship between self-regulated test duration and test performance is inconsistent across the semester for this group. Exploration of self-regulated test duration and test performance for other courses and throughout the optometric program may provide additional insight.*

**Key Words:** test duration, multiple choice, test score, digital administration, performance

## Background

Students in the United States generally have experienced limited duration examinations several times before entering an optometric degree program (e.g., SATs, ACTs, OATs and in undergraduate course work). For optometric education didactic courses, typical practice is for students to be given tests of knowledge that are of limited duration (e.g., 60 minutes). Although students may apply for extended time for examinations if they have a qualifying condition, most students must complete their didactic course tests during the allotted time. Personal observation (in three different optometric courses) is that, for an allotted examination time of one hour, some students will complete the examination in approximately 15 minutes, many complete the exam within 45 minutes, and a handful of students remain for the entire test period. Whether the time they spend on the test (self-regulated test duration) is related to their test performance is unknown.

In a paper presented at the Association for Institutional Research Annual Forum, Chicago, IL, June 2010, Hosch examined time on test, student motivation and performance on the Collegiate Learning Assessment (CLA), which Hosch states is a “low stakes” examination.<sup>1</sup> The CLA is a timed essay test used to assess student learning at the undergraduate level. Hosch found a strong relationship between time students spent on taking the test and test performance ( $p < .001$ ). In a different study involving students in an undergraduate statistics course, Landrum et al. found that the students’ self-reported test completion time was sometimes, but not consistently, negatively correlated with test performance.<sup>2</sup> A literature review did not find any studies that examined time taking the test and test performance in graduate health professional programs or on tests with only multiple-choice items.

With digitally administered tests, information about how much time each student spends taking the test can be objectively obtained. Given the paucity of published research on the relationship between a student’s self-regulated test duration and test performance, reporting any identified relationship between these variables is of interest to both educators and students because the knowledge may help improve test performance.

We aimed to examine the relationship between self-regulated test duration on a test of known time limit and test performance on multiple-choice examinations in a required basic science class for first-year students in an optometric program.

## Methods

After affirmation by the Institutional Review Board of Southern College of Optometry (SCO) that the protocol met the requirements for review exemption, a retrospective review of already-existing data was performed. The multiple-choice test scores for two midterm examinations (MT1 and MT2) and a final examination for the first-year course “Visual Sensation and Perception” and the time spent taking each test were obtained for the first-year students at SCO in spring 2019. All tests were digitally administered via ExamSoft (ExamSoft Worldwide LLC, Dallas, TX). All tests had been administered in the same large lecture hall with consistent environmental conditions. Students had an allotted test duration of 60 minutes each for MT1 and MT2 (both administered from 11 a.m. to noon) and 120 minutes for the final examination (administered from 12:30 p.m. to 2:30 p.m.). The software automatically uploaded the responses of any student who had not self-uploaded their responses prior to the expiration of the test’s time limit. MT1 and MT2 each included 40 items; the not directly cumulative final examination included 60 items. Each test was worth 20% of the total course grade. A member of the Information Technology staff at SCO (second author) provided the instructor of record for the course (first author) with each student’s test scores for the three tests (percent correct) and the total test time (in minutes) between the password input by the student to begin the test and the completed upload of the student’s examination responses.

SPSS v.26.0 (IBM) was used for statistical analysis. The Shapiro-Wilk test was used to test the shape of the data distributions to determine the appropriate tests for evaluating the relationships between self-regulated test duration and test score. Related samples Wilcoxon signed rank test, related samples Friedman’s two-way analysis of variance (ANOVA) by ranks, Mann-Whitney U test, and independent samples t-test were used, as appropriate for data distribution, for data comparisons. All reported P values are two-tailed.

## Results

With respect to the class results as a whole, the Shapiro-Wilk tests for the distributions of self-regulated test times and test scores for each examination indicated that only the test scores for the final exam were approximately normally distributed. For the grouped data described for Analysis 1 and Analysis 2 below, all self-regulated test duration distributions were not normally distributed within each group, but test score distributions within each group were approximately normal.



Table 1. [Click to enlarge](#)

**Figure 1(a)** and **Table 1** (column 2) show the distributions of the self-regulated test durations for each of the tests. The related samples Wilcoxon signed rank test indicated that the median of the differences in the time spent on MT1 compared to the time spent on MT2 was significantly different from zero (standardized test statistic=-4.22,  $P<.001$ ). The mean times spent on MT1 and on MT2, respectively, were  $42.0\pm 11.0$  and  $39.1\pm 11.5$  minutes. The proportions of the allotted time spent on each test that the means represent were, for MT1, MT2 and the final examination respectively, 0.7, 0.65 and 0.43.

**Figure 1(b)** and Table 1 (column 3) show the distributions of the test scores for the two midterms and for the final examination. The mean test scores (percent correct) for MT1, MT2 and the final examination, respectively, were  $80.3\pm 10.4$ ,  $78.0\pm 12.1$  and  $64.5\pm 10.9$ . A related samples Friedman’s two-way ANOVA by ranks test indicated that the distributions of test scores for MT1, MT2 and the final examination were

significantly different (test statistic=102.07,  $P < .001$ ). Pairwise comparisons indicated that the distributions of test scores were different between MT1 and MT2, MT2 and the final, and MT1 and the final ( $P < .04$  for each, with a Bonferroni correction for multiple tests).



**Figure 1.** Boxplots showing the distribution of (a) self-regulated test times and (b) test scores across the three multiple-choice tests administered digitally in the course. Error bars represent 1 standard deviation from the mean. The median of the differences in self-regulated test time between midterm 1 (MT1) and midterm 2 (MT2) was significantly different from zero ( $P < .001$ ), and the distributions of test scores were significantly different across the three tests ( $P < .001$ ). [Click to enlarge](#)



**Figure 2.** Scatterplots, with regression line and  $R^2$  values, showing the relationship between self-regulated test time and test score for (a) midterm 1 (MT1), (b) midterm 2 (MT2), and (c) the final examination. Statistical analysis showed no significant linear relationship between the two variables for any of the three tests. [Click to enlarge](#)



**Figure 3.** Boxplots showing the distribution of (a) self-regulated test times and (b) test scores for the three tests across two groups defined by the proportion of the allotted test time that the subject spent taking the test. The distributions of self-regulated test durations (a) were significantly different for the two groups for all three tests; the means of the test scores (b) were significantly different only for midterm 1 (MT1) ( $P = .020$ ) and the final examination ( $P = .022$ ). [Click to enlarge](#)



**Figure 4.** Boxplots showing the distribution of (a) self-regulated test times and (b) test scores for the three tests across two groups defined by the median self-regulated test duration for each test. The distributions of self-regulated test durations (a) were significantly different for the two groups for all three tests; the means of the test scores (b) were not significantly different for any of the tests ( $P > .05$  for all). [Click to enlarge](#)

For eight students who used the entire exam period for MT1 and for nine students who used the entire exam period for MT2, the self-regulated test duration registered was  $>60$  minutes due to the upload times; however, none of these students had test durations registered that were more than four minutes past the allotted time; therefore, their data were included in the analysis. **Figures 2(a-c)** show that the relationship between test score and self-regulated test duration was not linear for any of the three tests (MT1:  $R^2 = .022$ ,  $P = .091$ ; MT2:  $R^2 = .001$ ,  $P = .70$ ; final:  $R^2 = .025$ ,  $P = .072$ ).

**TABLE 2**  
Proportions (%) of Students with Test Scores of "B-" and "B" Based on Test Time Group

Score	MT1 – Allotted Time Groups		MT1 – Median Time Groups		MT2 – Allotted Time Groups		MT2 – Median Time Groups		Final – Allotted Time Groups		Final – Median Time Groups	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
< 80	6	54	28	32	15	53	33	35	96	25	60	61
≥ 80	15	57	40	32	15	40	30	34	6	5	4	7
< 83	9	73	36	43	21	64	41	44	90	20	61	63
≥ 83	13	36	30	21	9	36	22	25	4	4	3	5

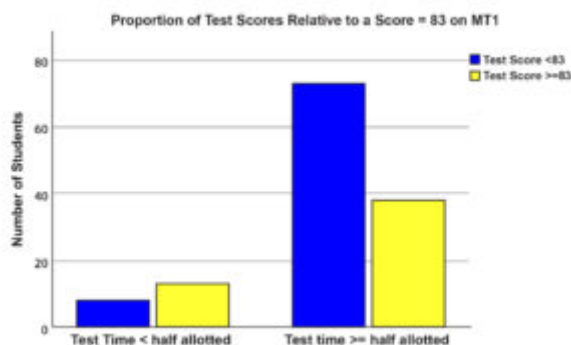
**Table 2.** Only the proportion of students scoring above 83 on midterm 1 (MT1) differed between the two groups defined by the time allotted for the test (Chi-square=5.70,  $P = .017$ ) [Click to enlarge](#)

To further explore the relationship between self-regulated test duration and test score, two different analyses were done in which, for each test, the students were divided into two groups. For Analysis 1, those whose self-regulated test durations were less than half the allotted time were assigned to Group 1, and those whose self-regulated test durations were greater than or equal to half the allotted test time were assigned to Group 2. For Analysis 2, those whose self-regulated test durations were less than half

the median time for each test were assigned to Group 1, and those whose self-regulated test durations were greater than or equal to the median time for each test were assigned to Group 2. The distributions of the self-regulated test durations were compared between the two groups formed for each analysis to assure that test time distributions were significantly different for the two groups compared. The test scores were then compared between the two groups for each analysis. Table 1 shows the means ( $\pm$  SD) of the self-regulated test durations (columns 4, 5, 8 and 9) and test scores (columns 6, 7, 10 and 11) for all three tests for each group for both analyses.

For Analysis 1, the number of subjects in each group varied depending on the test. For MT1, N=21 for Group 1 and N=111 for Group 2; for MT2, N=30 for Group 1 and N=102 for Group 2; for the final, N=30 for Group 1 and N=102 for Group 2. **Figure 3** and Table 1 (columns 4-7) show the results for Analysis 1 (groups defined by allotted time). Mann-Whitney U test indicated that the distributions of self-regulated test durations were significantly different for the two groups for all three tests (MT1: U=2331, Z=7.26, P<.001; MT2: U=3060, Z=8.31, P<.001; final: U=3060, Z=8.31, P<.001). Independent t-test indicated that the mean test scores were significantly different for MT1 (P=.020, 95% CI .93, 10.53), not significantly different for MT2 (P=.95, 95% CI -4.81, 5.14) and significantly different for the final (P=.022, 95% CI -9.56, -.76).

For Analysis 2, the number of subjects in each group varied slightly depending on the test. For MT1 (median test time=41 minutes), N=68 for Group 1 and N=64 for Group 2; for MT2 (median test time=38 minutes), N=63 for Group 1 and N=69 for Group 2; for the final (median test time=48 minutes), N=64 for Group 1 and N=68 for Group 2. **Figure 4** and Table 1 (columns 8-11) show the results for Analysis 2 (groups defined by median test time). Mann-Whitney U test indicated that the distributions of self-regulated test durations were significantly different for the two groups for all three tests (MT1: U=4352, Z=9.92, P<.001; MT2: U=4347, Z=9.91, P<.001; final: U=4352, Z=9.91, P<.001). Independent t-test indicated that the means of the test scores were not significantly different between groups for any of the tests (MT1: P=.09, 95% CI -.46, 6.64; MT2: P=.85, 95% CI -4.59, 3.76; final: P=.88, 95% CI -3.47, 4.06).



**Figure 5.** Bar graph showing the number of students who scored below 83 vs. 83 or above on midterm 1 (MT1) across the two groups defined by the proportion of the allotted test time that the subject spent taking the test. The proportion of students scoring above 83 was significantly different for the two groups only for MT1 (Chi-square=5.70, P=.017). Proportions of students scoring above 83 were not significantly different between the two groups for any of the other tests, nor for any test when compared between the two groups defined by median self-regulated test duration.

[Click to enlarge](#)

Finally, we investigated whether the proportion of students scoring 80 or above (grade letter B- or better) and 83 or above (grade letter B or better) on each test differed between the two groups defined for Analysis 1 and Analysis 2 (**Table 2**). The results indicated that only the proportion of students scoring

above 83 on MT1 differed between the two groups defined by the time allotted for the test (Chi-square=5.70, P=.017) (**Figure 5**).

## Discussion

The main finding of this study was that when the amount of time spent taking a multiple-choice test in a basic science course in the optometric program was less than half the allotted time for the test, this group of first-year optometry students demonstrated a mean test score that was significantly higher for MT1, significantly lower for the final examination, and not significantly different for MT2, compared to the scores of their classmates who spent more than half the allotted test time completing the test. Additionally, no linear relationship was found between self-regulated test durations and test score for any of the three tests. Finally, the proportion of students achieving a test score of 83 or above (equivalent to a letter grade better than B-) was significantly different between those spending more vs. less than half the allotted test time completing the exam only for MT1.

Several reasons may explain the lack of consistency across these results. First, students in an optometric program are not only well-versed in multiple-choice test-taking strategies prior to matriculation, but have demonstrated proficiency in examinations as ascertained through their optometry school applications. Although the material may be new to them, they likely rely on strategies that have brought them success (for example, a pre-determined number of times that the student will review the entire test). Second, the material covered by the first two tests differed in nature, though the amount of material covered by MT1 and MT2 was about the same; students may have found the material on the second examination more difficult to understand. Third, for the first test given by an instructor, students have the additional unknown of the instructor's question-writing style; hence, students may have put more effort into studying for MT1 compared to MT2 and the final examination.

The overall lower scores for MT2 and the final exam compared to MT1 suggested that cumulative knowledge may have contributed to lower scores on MT2 and the final exam, even though neither MT2 nor the final exam was directly cumulative. The overall lower scores for the non-cumulative final examination may have reflected the greater amount of material covered and the students' knowledge of their grades going into the examination, with study time and/or effort on the test resulting from their calculation of the score needed to achieve their desired grade.

Another factor that may explain the better performance on MT1 compared to the other two tests is that the students had no knowledge of how well they were doing in any of their classes at the time of the first midterm. If they had performed less than desired in other courses, they may have put in less effort on MT2 and the final for this course. Finally, the students had four midterm examinations scheduled for other courses in the two days following MT1 and MT2, but the final examination was the last of seven examinations in that week; therefore, fatigue may have contributed to the lower scores for the final examination despite the proportionately larger amount of time allotted for the examination.

Although the subjects were first-year students, they had exposure to the software for test administration for all of their first-semester courses; the data collection for this study took place during the second semester. Thus, although the students were relative novices with the software, unfamiliarity with the software likely did not contribute significantly to self-regulated test duration.

The way in which test time was calculated for this study also may have contributed to inconsistent results across the tests. We used the "total time" that each student had access to the examination questions. This value was unable to reflect how much time the students actually spent with their attention on the test. Other metrics may better reflect test scores, such as the number of times that the student viewed each question, the number of times the student viewed the more difficult questions, the number of times the student changed the answer for each question, whether or not certain features of the software were

used by the student (highlighting, etc.). Further investigation into whether these indices are related to test scores may provide useful information for improving student performance.

Non-test factors may also have differed across testing days and created inconsistencies in the results, such as alertness, caffeine consumption, non-academic stressors, food consumption, medications, health on test day, etc.<sup>3-5</sup> Additionally, for those who performed less than desired on MT1, test anxiety may have contributed to worse performance on the following tests. Finally, weaker language skills have been associated with longer completion times for multiple-choice exams;<sup>6</sup> we did not use any metric of language skills to evaluate the influence of this factor.

## Conclusion

Self-regulated test duration on a time-limited test as measured with digital test administration software did not show a consistent relationship with test performance on multiple-choice tests over the course of a semester in a basic science course in the first-year optometric program at SCO. Whether a more consistent relationship between self-regulated test duration and test performance would manifest when controlled for other academic and non-academic factors remains to be explored. Additionally, an analysis of self-regulated test duration and test performance in other first-year courses and in second- and third-optometric-year course work for this same class of students may provide insight into the development of test-taking strategies that may benefit new optometric program students. Further exploration of other test-taking strategy information obtained by test administration software is warranted.

## Acknowledgements

We wish to thank Southern College of Optometry for permitting access to the test duration information.

## References

1. Hosch BJ. Time on test, student motivation, and performance on the Collegiate Learning Assessment: implications for institutional accountability. *Journal of Assessment and Institutional Effectiveness*. 2012;2(1):55-76.
2. Landrum RE, Carlson H, Manwaring W. The relationship between time to complete a test and test performance. *Psychology Learning & Teaching*. 2009;8(2):53-56.
3. Mushtaq I, Khan SN. Factors affecting students' academic performance. *Glob J Management Bus Res*. 2012;12(9):17-22.
4. Rasul S, Bukhsh Q. A study of factors affecting students' performance in examination at university level. *Procedia – Social and Behavioral Sciences*. 2011;15:2042-47.
5. Gajghat RH, Handa CC, Himte RL. Factors influencing academic performance of the students at university level exam: a literature review. *Int J Res Eng Tech*. 2017;6(5):102-10.
6. Burnham TA, Makienko I. Factors affecting exam completion speed, exam performance, and nonexam performance. *J Mark Educ*. 2018;40(2):140-51.

Dr. Cisarik [[pcisarik@sco.edu](mailto:pcisarik@sco.edu)] has been on the faculty at Southern College of Optometry since 2008. In addition to clinical teaching, she is Instructor of Record for Visual Sensation and Perception, Introduction to Binocular Vision, and Neuro Eye Disease

Ms. Powers has a Master of Education in Learning Systems Technology. She has been the Systems Administrator for Learning Management at Southern College of Optometry for two years and has worked in higher education for more than 15 years.

PEER REVIEWED

# Faculty Development to Improve Teaching Skills of Optometric Educators: Experiences of a Healthcare Organization

Jessica T. Servey, MD, MHPE, FAAFP, Kevin M. Jackson, OD, MPH, and Thomas McFate, PhD |  
*Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

## Abstract

*Numerous studies demonstrate the impact of faculty development programs in health professions education, but few are in optometry. This paper describes the development of a three-hour faculty development clinical teaching skills workshop and its impact on federal service clinical optometric educators. Multiple teaching strategies were used in the workshop including lecture, role-plays and discussion (free and video-stimulated). To determine impact, participants responded to a short survey (18 of 34 responded, 52.9%). The positive impact we found mirrors that reported by medical and dental faculty despite the limitations of small sample size and only one organization involved.*

**Key Words:** *faculty development, health professions education, optometry, teaching, clinical skills*

## Background

Optometric educators are poised not only to care for patients but also to contribute to the profession by “guiding, developing and nurturing future generations of optometrists.”<sup>1</sup> Like other health professionals, optometrists often become teachers based on past clinical expertise and have no specific training in education principles.<sup>1</sup> There are multiple types of faculty development to improve skills for optometric educators from personal reflection to group workshops to longitudinal programs and additional degrees.<sup>2</sup> The best type of program has not been elucidated and likely needs to include a variety of options.

Numerous studies demonstrate the impact of faculty development programs in health professions education. A systematic review of faculty development initiatives concluded that short courses have a high level of participant satisfaction, as well as self-reports of increased knowledge, skills, confidence in teaching and behavior changes.<sup>3</sup> Efficacy of faculty development in optometry has not been established as optometrists have not been participants in the studies cited. Furthermore, optometric literature has generally been silent on the topic of faculty development. Because optometry is a learned profession with a unique training pathway, this is a gap in the literature.

In the past decade, non-optometric accrediting bodies have started requiring programs to monitor faculty development. The Accreditation Council on Graduate Medical Education started in 2012 with the Clinical Learning Environment Review<sup>4</sup> requiring faculty training in areas such as quality improvement and patient safety. The recent Common Program Requirements, starting July 2019, have a more specific outline of requirements for faculty development in areas of education, wellness and quality improvement.<sup>5</sup> The Liaison Committee for Medical Education has specific language in its standards as of 2015 requiring medical schools to provide opportunities for professional development specifically citing instructional design and program evaluation.<sup>6</sup> The Commission on Dental Accreditation’s 2019 standards state dental schools are required to have ongoing faculty development for dental educators outlining multiple domains such as curriculum design, working with students and use of technology.<sup>7</sup> In contrast to dental and medical accrediting agencies, the Accreditation Council on Optometric Education in its latest

standards (July 2017) has no specific faculty development requirements.<sup>8</sup> The standards state “the program must allocate adequate time and resources for faculty to enhance their skills and leadership abilities in education, service, research and scholarly activity, and patient care.” Even though the specific words “faculty development” are not written, enhancing skills in education and scholarship are often part of faculty development.

Faculty development was first discussed in optometric literature in 1980 when optometric educators recognized the need to enhance collaboration between educators, to keep current with changing teaching trends, and to implement faculty development locally.<sup>9</sup> With optometric clinical knowledge expanding and the number of colleges increasing, the need for modernizing teaching practices of the faculty is paramount. Educational degrees and national longitudinal faculty development programs are available. The Association of Schools and Colleges of Optometry offers two specific opportunities for faculty development: the Summer Institute for Faculty Development (SIFD) and the Future Faculty Program.<sup>10</sup> These programs include a variety of topics critical for optometric educators’ personal development including scholarly work, developing curricula, academic promotion and many teaching concepts. The SIFD has impacted numerous educators since 2006, citing the majority of attendees reach personal short- and long-term goals.<sup>11</sup> However, these national programs are often expensive, not flexible with clinical schedules, and only a few faculty from a single institution can attend. Local institutional workshops and personal guided reflection are more flexible and cost-effective ways to increase faculty teaching ability.<sup>2</sup> Furthermore, local programs can deliver targeted faculty development to a larger proportion of teaching faculty. There are no current studies describing faculty development programs based at local optometry colleges across the United States. Optometric educators could benefit from strengthened health professions faculty development programs collaborating with local medical, dental or nursing schools to share knowledge about core teaching skills and academic life.

Despite the number of articles published on the impact of faculty development and best practices, very few are specific to optometry. This paper describes the development of an institutional faculty development workshop including curriculum and data from its participants.

## Methods

A three-hour block of time was designated for a faculty development workshop at the March 2019 Armed Forces Optometric Society (AFOS) meeting at Southeastern Educational Congress of Optometry International and the October 2019 AFOS meeting at the American Academy of Optometry. Clinical teaching skills were identified as the target for improvement. Focused on optometric externship clinical educators, skills identified for the faculty development sessions were precepting, direct observation and role-modeling. The content development and facilitated learning was done by one of the authors experienced in delivering faculty development. All participants self-identified as clinical educators for optometry schools.

Kolb’s Experiential Learning Theory was the underpinning of the session.<sup>12</sup> Kolb’s theory describes using self-reflection on prior experiences, followed by the addition of abstract concepts, leading to direct application or planning of application in the future. For example, faculty learners reflected on prior clinical precepting experiences and defined the conceptual framework of the five microskills<sup>13</sup> (getting a commitment, probing for evidence, teaching a general principle, reinforcing things done well, and correcting mistakes). They then participated in a role-play for practice and ended with a debrief reflecting on that experience. This format based on Kolb’s theory has been previously described in faculty development for medical and dental educators.<sup>14</sup> To create realistic examples for the audience, both for discussion and the role-plays, the authors facilitating the workshop spent several hours observing two optometric educators actively educating externs in clinic. These faculty were iteratively queried about their experiences as educators, training as educators, and challenges in clinic. Externs were observed during patient presentations, responding to feedback from teachers and interacting with patients and

clinic staff.

Multiple teaching strategies were used in the three-hour faculty development workshop including lecture, role-plays and discussion (free and video-stimulated). Lecture was used to define and give examples of key concepts faculty would use in the future. Role-plays were designed to improve faculty self-assessment of teaching<sup>15</sup> and allowed for faculty to have direct practice of the five microskills. Best practices of role-play use were applied including scripting, detailed instructions and realistic encounters.<sup>16</sup> Discussion is a common active teaching strategy,<sup>17</sup> and was employed, both free and video-stimulated, to guide faculty reflection of prior experiences and to plan for future teaching. Free discussion, defined as time when learners explore emotive features of teaching concepts,<sup>18</sup> was utilized to examine faculty's personal barriers. Discussion allows for immediate application of knowledge gained, understanding different perspectives of a topic, and higher cognitive analysis. Using videos for faculty development to stimulate discussion has been used with good success.<sup>19</sup> Intentionally developed videos of teaching encounters fueled discussions of direct observation and role-modeling to enhance planning for future behaviors. These strategies were chosen to increase retention moving from passive lecture to active discussion, to analysis of videos, to actual practice for planning for future behaviors.<sup>20</sup> **Table 1** outlines each portion of the block of faculty development to include which active teaching strategies were utilized.



Table 1. [Click to enlarge](#)

A survey was used to assess efficacy of the workshop. The project was approved by the Institutional Review Board at Joint Base San Antonio-Lackland as part of the faculty development program evaluation. Two months after each AFOS faculty development session, the survey was sent electronically to all attendees. The survey was open for one month, with an electronic reminder sent one week prior to the end date. The survey was anonymous, and results were collated by one author who was not involved in developing or delivering the content.

## Results

Out of 34 attendees (12 the first meeting and 22 the second), 18 responded to the survey (52.9%) (**Table 2**). All respondents felt the session affected how they approached teaching with 83.3% acknowledging this weekly (ranging from "at least once a week" to "daily" since the session). All respondents stated that the session caused them to reflect on their teaching, with two-thirds at least weekly. Seventeen of 18 (94.4%) respondents perceived increased confidence using the five microskills as a tool in precepting to both teach and assess students, with 83.3% rating their confidence "somewhat or significantly" increased. 100% felt the role-play was effective for improving their reflection on precepting as well as the use of the five microskills. Seventeen out of eighteen (94.4%) respondents felt the session changed their direct observation skills. The changes ranged from observing more often, to being more purposeful with the same frequency, to trying new ways to observe. All respondents stated they would attend another faculty development workshop in the future, with 9.1% clarifying it "depends on the topic."



Table 2. [Click to enlarge](#)

Two open-ended questions were included in the post-course survey, "How have you utilized the information presented in the faculty development session since the meeting?" and "Do you have any other comments about the workshop?" Many comments were specific to precepting. Comments are listed in Table 2.

## Discussion

To our knowledge, this paper adds to the optometric education literature by describing the impact of an institutional faculty development workshop for clinical optometric educators and uniquely describes an institutional program. Participants shared a change in their precepting and direct observation skills in their teaching encounters. It could be assumed the workshop was worthwhile to the optometrists attending as their attendance is voluntary and they answered they would return to another workshop in the future.

Impact is more than knowledge of educational principles, but also networking, creating community and sharing pearls and struggles with colleagues to improve reflection and experimentation. The impact we found mirrors that reported in medical and dental faculty.<sup>3</sup> Our results demonstrate that institutionally based faculty development can be effective by increasing confidence in optometry educators' teaching skills. Comments from the participants discuss impacts that cannot be assessed with a post-test, observation of teaching or specific assessment of skills. Having discussion with colleagues surrounding teaching as well as recognizing and valuing the team approach in health professions education imply a larger impact beyond the individual attending faculty development.

Limitations of our educational research include a small sample size and involvement of only one organization. However, because our faculty represent multiple clinical teaching sites in all areas of the United States, it is plausible the responses represent more variety than some single institution studies. Another limit often cited is that participation was voluntary adding possible selection bias.

## Conclusion

Locally created and delivered faculty development can be effective, flexible and more cost-effective than programs overseen by national organizations. Additionally, it can increase the number of faculty exposed to core teaching concepts for immediate use. Leadership of academic institutions must value development of teaching skills of optometric educators to enhance effectiveness and promote participation.<sup>2</sup> If locally available, optometrists could attend faculty development for other health professions as the skills are shared. After all, when educators meet, the focus could be on principles of education and the skills of HOW to teach the clinical knowledge<sup>21</sup> – that is faculty development.

## Disclaimer

The opinions herein are those of the authors. They do not represent official policy of the Uniformed Services University of the Health Sciences, the Department of the Air Force or the Department of Defense.

## References

1. Ettinger ER. Optometric educators: contributing to the future of optometry. *Optom Vis Sci*. 1998 Dec;75(12):849-850.
2. Elam JH. Faculty Development programs for optometric educators. *Optometric Education*. 1996 Summer; 21(4):114-116.
3. Steinert Y, Mann K, Anderson B, et al. A systematic review of faculty development initiatives designed to enhance teaching effectiveness: a 10-year update: BEME Guide No. 40. *Med Teach*. 2016 Aug;38(8):769-86.
4. Clinical Learning Environment Review (CLER) [Internet]. Chicago: Accreditation Council for Graduate Medical Education; c2014 [cited 2019 May 21]. Available from: [https://www.acgme.org/Portals/0/PDFs/CLER/CLER\\_Brochure.pdf](https://www.acgme.org/Portals/0/PDFs/CLER/CLER_Brochure.pdf)
5. ACGME Common Program Requirements (Residency) [Internet]. Chicago: Accreditation Council

- for Graduate Medical Education; c2018 [cited 2019 May 21]. Available from: <https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/CPRResidency2019.pdf>
6. Standards [Internet]. Chicago: Association of American Medical Colleges and American Medical Association on behalf of the Liaison Committee on Medical Education; c2019 [cited 2019 May 21]. Available from: <https://lcme.org/publications/#Standards>
  7. Accreditation Standards for Dental Education Programs [Internet]. Chicago: Commission on Dental Accreditation; c2019 [cited 2019 May 21]. Available from: <https://www.ada.org/~media/CODA/Files/pde.pdf?>
  8. Optometric Degree Programs Resources [Internet]. St. Louis: American Optometric Association; c2019 [cited 2019 May 21]. Available from: <https://www.aoa.org/optometrists/for-educators/accreditation-council-on-optometric-education/accreditation-resources-and-guidance/optometric-degree-programs->
  9. A faculty workshop on clinical instruction for optometric education. *Optometric Education*. 1980 Winter; 5(3):16-23.
  10. Professional Development [Internet]. Rockville MD: Association of Schools and Colleges of Optometry; [cited 2019 June 29]. Available from: <https://optometriceducation.org/for-faculty-administrators/faculty-development/>
  11. Martin S, Horn F, Damari DA, Harris T. The SIFD and the three-legged stool. *Optometric Education*. 2017 Winter-Spring; 42(2):19-25.
  12. Segers M, Van Der Haar S. The experiential learning theory: D. Kolb and D. Boud. In: Dochy F, editor; Gijbels D, editor; Segers M, editor; Van den Bossche P, editor. *Theories of Learning for the Workplace: Building Blocks for Training and Professional Development Programs*. New York, NY: Routledge; 2011:52-65.
  13. Neher JO, Gordon KC, Meyer B, Stevens N. A five-step “microskills” model of clinical teaching. *J Am Board Fam Pract*. 1992;5(4):419-424.
  14. Servey J, Wyrick K. Teaching clinical precepting: a faculty development workshop using role-play. *MedEdPORTAL*. 2018 Jun 1;14:10718.
  15. Johannson J, Skeff KM, Stratos GA. A randomised controlled study of role play in a faculty development programme. *Med Teach*. 2012;34(2):e123-e128.
  16. Steinert Y. Twelve tips for using role-plays in clinical teaching. *Med Teach*. 1993;15(4):283-291.
  17. Step Four Educational Strategies. In: Thomas PA, editor; Kern DE, editor; Hughes MT, editor; Chen BY, editor. *Curriculum Development in Medical Education: A Six-Step Approach*. Third edition.
  18. Kitchen M. Facilitating small groups: how to encourage student learning. *Clin Teach*. 2012 Feb;9(1):3-8.
  19. Gallagher P, Tweed M, Hanna S, Winter H, Hoare K. Developing the one-minute preceptor. *Clin Teach*. 2012;9(6):358-362.
  20. Masters K. Edgar Dale’s Pyramid of Learning in medical education: a literature review. *Med Teach*. 2013 Nov;35(11):e1584-93.
  21. Naroo SA. Do educators need educating? *Cont Lens Anterior Eye*. 2014 Jun;37(3):123.

Dr. Servey [[jessica.servey@usuhs.edu](mailto:jessica.servey@usuhs.edu)] is Associate Dean for Faculty Development and Associate Professor of Family Medicine at the Uniformed Services University of the Health Sciences in Bethesda, MD. A retired United States Air Force Colonel, she currently oversees a faculty development program encompassing 22 outlying hospitals and the university. She is a prior residency program Director and medical school Clerkship Director. She has presented more than 400 faculty development workshops in her career and is still an active teacher and family physician who mentors women in her organization and advocates for faculty equity.

Dr. Jackson is Chief of Staff for the F. Edward Hebert School of Medicine at the Uniformed Services University of the Health Sciences (USU) in Bethesda, MD. As an optometrist with a degree in public

health he has published research in *Archives of Ophthalmology*, written a textbook chapter on public health informatics, authored a policy statement on emergency eye care for the American Public Health Association and consulted on a policy statement on pediatric vision screening for the American Academy of Optometry. A retired United States Navy Commander, he spent much of his Navy career as Extern Coordinator for the Navy's 23 optometry training sites. Dr. Jackson came to USU following his tour as Director for Education, Training and Research at Fort Belvoir Community Hospital.

Dr. McFate is a Senior Education Program Specialist at the Henry M. Jackson Foundation for the School of Medicine Faculty Development Program at the Uniformed Services University of the Health Sciences in Bethesda, MD. He has a background in basic science and clinical research, research management and program management.

## Features

### Invitation to Participate

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

*Desiree Ifft | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

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 **Sept. 1, 2021**

For more information, e-mail journal Associate [Editor Keshia S. Elder, OD, MS, FAAO](#), or journal Editor [Aurora Denial, OD, FAAO, DipOE](#).

## Editorial

# Unforeseen Outcomes of Remote Learning

*Aurora Denial, OD, FAAO, DipOE | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*



Aurora Denial, OD, FAAO, DipOE

During the past year our country faced many challenges. The SARS COVID-19 pandemic is at the forefront and changed the lives of many people. The effects of the pandemic impacted multiple areas: politics, public health, medicine, research, education, etc. On a personal level, people's lives changed with social distancing, wearing of masks, limited gatherings, travel restrictions, lockdown and the tragic loss of lives. Businesses and communities were forever affected by the lockdowns and phased reopening. The impact on education was felt at all levels K-12 as well as in higher education. How can we continue the educational process when our students can no longer gather in person? Remote learning became the norm as schools shut down to try to contain the spread of the virus. Both students and teachers had to adapt to a different style of education in a short period of time. Higher education students and institutions may have had an easier transition because most already had some experience with virtual or remote learning.

At the K-12 levels, parents, students and teachers dealt with not only a new delivery of the curriculum but also other issues such as child care, navigating technical issues, helping children with learning and the inherent isolation associated with remote learning. The sudden change was out of necessity, not a path that most would have chosen. As the pandemic continued into the summer months, school departments made the decisions to offer synchronous or asynchronous remote education, in-person instruction or a hybrid model. Most communities resorted to either a model of synchronous or asynchronous remote learning or a hybrid version. Hybrid models usually contain some component of remote learning. Parents chose different models based on their preferences or a student's skills, personality and learning style.

### **A 7-Year-Old Rises to the Occasion**

In optometric education, most institutions implemented a hybrid model consisting of labs and clinical assignments in-person and lecture and seminar material delivered remotely. Remote learning had inherent challenges such as the need for reliable access to technology, a skill set to manipulate technology, the potential disconnect between teachers and classmates and difficulty staying motivated or focused. There has been much negative press and personal opinion expressed about the challenges of remote learning in grades K-12 with a rush to reopen all schools for in-person learning. It would be an understatement to imply that children do not miss the "normal" interactions with peers and teachers that were taken for granted before the pandemic. We are all striving for a time when a new normal allows the majority of the population to interact in a safe manner.

However, society should ask the question: Did a year of full-time or partial remote learning develop positive attributes in children and teens that will serve them well as they move through the education system? My own anecdotal experience comes from watching my 7-year-old grandson during full-time remote second grade. I have had the pleasure on several occasions of sharing the dining room table with his second-grade class as I worked remotely. The students all seemed highly engaged, eager to participate and focused on the education process. Over time, my grandson learned a new skill set and can now easily manipulate the technology. Yes, he has even helped me on several occasions. I have watched him problem-solve as technical or learning problems occurred, initially seeking help from an

adult but then becoming increasingly self-sufficient. At times he has become frustrated but has learned alternative ways of dealing with frustration and problem-solving. I highly commend his teachers for the attention they dedicate to each student. The school feels like a community, collaborative and supportive. My grandson does miss playing and talking in-person with his friends and most likely will attend in-person school when it is safe to do so. However, his remote learning experience has provided him the opportunity to learn a valuable skill set and become a much more independent, self-confident learner.

### **Valuable Skills for Future Optometrists**

As educators in a healthcare profession, we strive to enroll and teach students who have problem-solving skills and exhibit self-directed, independent learning. These skills build self-confidence and allow the learner to accept responsibility for learning. In all medical professions, knowledge is constantly changing, which necessitates the need for lifelong, self-directed learning. These important skills occasionally seem to be lost in our current student population.

Given the extraordinary circumstances that the COVID-19 pandemic delivered, did it provide a unique learning opportunity for students? Will we be seeing a more independent, self-directed student who has the self-confidence and skill set to learn and solve problems? The bigger question is will these traits be maintained, fostered and supported when in-person learning returns?

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

## Industry News

Desiree Ifft | *Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*

### Industry News

#### New Daily Disposable Contact Lens for Astigmatism Launches in U.S.



Alcon launched a new daily disposable silicone hydrogel contact lens, PRECISION1 for Astigmatism. Pointing out that studies show only a fraction of astigmatic patients wear toric contact lenses, and a significant percentage of contact lens dropouts have astigmatism, the company says PRECISION1 for Astigmatism offers a significant opportunity to attract new contact lens wearers and reduce the number of patients who abandon contact lens wear.

The new lens, based on Water Gradient Technology, features SMARTSURFACE Technology to support comfort and high performance and PRECISION BALANCE 8|4 design for stability. Alcon data show the toric lens settles in less than 60 seconds and within three degrees of ideal orientation for a 99% first-fit success rate. A single 6-o'clock scribe mark also simplifies fitting.

Eyecare professionals, with or without fit sets, can order trial and revenue lenses directly from Alcon or an Alcon-authorized distributor. Visit [www.Precision1.com](http://www.Precision1.com) for more information.

#### Five-Year, \$50-Million Program to Address Racial Inequities



## ACADEMIC PARTNERSHIP

**A SHARED VISION FOR EXCELLENCE**

Biopharmaceutical company AbbVie is investing \$50 million in a five-year program to support underserved Black communities across the United States. AbbVie will collaborate with six nonprofit partners ? Direct Relief; University of Chicago Medicine's Urban Health Initiative; National Urban

League; Year Up; United Negro College Fund (UNCF); and Providence St. Mel School ? to support the groups' efforts in health and education opportunity.

UNCF, for example, will receive \$10 million as seed funding for its Healthcare Diversity Workforce Program, which aims to reduce barriers to advancement in health professions and increase the number of Black professionals in a wide variety of healthcare careers. Scholarship, academic and career development support will be provided to students who are interested in a career in health care, but who might otherwise not have an opportunity to go beyond high school.

[Click here for more information](#) about this initiative and AbbVie's ongoing commitment to racial justice.

### **Myopia Management Highlighted at Contact Lens Educators' Meeting**



At the sixth consecutive Educators' Meeting sponsored by [CooperVision](#) and CooperVision Specialty EyeCare ? held virtually at the 2021 Global Specialty Lens Symposium in January ? contact lens faculty members from schools and colleges of optometry across North America received updates about advancements in specialty technology emerging in the past year, including:

- MiSight 1 day, the first FDA-approved soft contact lens designed for myopia control
- the Brilliant Futures Myopia Management Program certification for optometry students
- the [new 5-mm customization](#) for Paragon CRT and Paragon CRT Dual Axis contact lenses
- the relaunch of OneFit MED+ scleral contact lenses
- the announcement of the latest Paragon CRT topography-guided fitting software, which is slated to launch in February 2021

In breakout sessions, attendees discussed best practices for teaching and practicing myopia management in their academic clinics. They voted on which groups provided the most helpful best practices. Those who earned the most votes selected a charity to receive a donation from CooperVision, resulting in a total of \$2,500 donated to the American Academy of Optometry Foundation, Optometry Cares and Vision to Learn.

### **Virtual Event Shares Latest Optical Industry Insights Globally**



[Transitions Optical](#) presented a first-of-its-kind global virtual event, *Transitions the Pulse*, bringing

together more than 10,000 industry professionals from 98 countries. The event was filmed following safety protocols that allowed Transitions Optical to safely connect with partners around the world, while attendees could also engage and network with each other through live chat and a social wall. It was broadcast three times over two days and translated into 13 different languages for eyecare professionals around the world.

After a surprise DJ performance from Transitions influencers Coco and Breezy, attendees connected live on screen for the general sessions with Transitions Optical leadership and industry experts. Doug Stephens, founder of [Retail Prophet](#), shared his unique perspective on retailing, business and consumer behavior. Attendees heard from experts and educators during breakout sessions on the heartbeat of the industry and learned from their peers and partners through the sharing of best practices.

Within the general session, Transitions Optical shared new details on several launches and programs for the upcoming year, including Transitions XTRActive Polarized and tools to help eyecare professionals simplify the increasingly digital consumer journey. Highlights from the event and bonus content including a follow-up Q&A with Stephens are available on a [new virtual learning platform](#).

### New Platform Elevates Myopia Management Capabilities



Haag-Streit introduced [Lenstar Myopia](#), a solution for the increasing demand for myopia management and patient education. Lenstar Myopia consists of the Lenstar 900 optical biometer and the corresponding EyeSuite software EyeSuite Myopia.

EyeSuite Myopia uses the latest axial length growth curves from the myopia experts at the Erasmus University Medical Center in Rotterdam, the Netherlands, and has been developed in close cooperation with leading myopia experts Dr. Thomas Aller and Pascal Blaser of [myopia.care](#). In addition to precise axial length measurements, Lenstar 900 provides a wide range of data, including keratometry measurements, for predicting myopia onset and progression.

To learn more, visit [haag-streit-usa.com](#). For a product demonstration, [e-mail Tonya Lay](#), Director of Specialty Sales, or call her at (513) 680-7506.

### Doctor's Article Highlights Role of Technology in the New Normal



Just before shutting down their practice in response to the COVID-19 pandemic, Kerry Salsberg, OD, and his colleagues were in the midst of relocating. In a digital insert published with the

November/December 2020 issue of *Modern Optometry*, Dr. Salsberg writes about their unique opportunity to build a new space from the ground up with the needs of the pandemic in mind.

As part of "[Finding Opportunity in Response to Challenging Times.](#)" Dr. Salsberg explains how two technology solutions in particular ? Topcon's CV-5000S digital phoropter and DRI OCT Triton multimodal swept-source optical coherence tomographer ? helped the practice safely return to a new normal while elevating the care provided to patients.

#### **New Indirect Ophthalmoscope Incorporates Several Innovations**



Now available from Heine is its newest indirect ophthalmoscope, the Omega 600. The instrument features several innovations, including low weight courtesy of an ultralight battery, visionBoost technology, which significantly improves retinal exams for cataract patients, and a sophisticated surface design for easy cleaning and disinfection. A 10-year warranty is also available.

[Click here for more information](#), a 3D view, and to order the Omega 600 today.

#### **Optical Retailer Ranks as No. 1 Eyecare Franchise on *Entrepreneur* Magazine List**



[Pearle Vision](#), a retail division of [Luxottica Retail N.A.](#), has been ranked the nation's top eyecare franchise on *Entrepreneur* magazine's 2021 Franchise 500 list. Pearle Vision ranked No. 32 overall among franchise companies on the current list (a move up from No. 58 a year ago). This is the 13th consecutive year Pearle Vision has been ranked among the Franchise 500. The annual rankings are based on outstanding performance in areas such as unit growth, financial strength and stability and brand power.

The company's top ranking comes on the heels of a year in which the brand grew even as it coped with the challenges of the COVID-19 pandemic. Pearle Vision opened 16 new eyecare centers and signed several area development agreements, increasing its total number of locations to 552 in 2020.

#### **Save Time and Money Utilizing Anterior Segment Tomography for Specialty Lens Fitting**



Order fewer lenses and decrease patient chair time while increasing first-fit success rate with the Oculus Pentacam. This instrument simplifies the specialty contact lens fitting process by providing true elevation data independent of the tear film. Direct links to advanced fitting and design software add to the benefits of the Pentacam.

Visit the [Simplify Your Lens Fitting pages](#) to learn more and download the latest case study.

**Company Names Vice President of Business and Channel Management for the Americas**



[Keeler](#) promoted Eugene R. VanArsdale to the position of Vice President of Business and Channel Management for the Americas. In this role, VanArsdale is responsible for the strategic growth of established partnerships with group purchasing organizations, corporate accounts, optometry and ophthalmology schools and national dealers across the Americas. Together with his team, he will identify key opportunities to help grow Keeler's product portfolio pipeline, as well as cultivate novel relationships that align with the company's business objectives.

According to Eva Kosanovic, President of Keeler USA, "Gino has been an invaluable member of the Keeler team for the last 38 years. During this time, he has developed a comprehensive understanding of our business, as well as thorough command of the diagnostic equipment and clinical space within the eyecare industry. Well done Gino, thanks for your continued support and love for Keeler and our industry."

In addition to the aforementioned responsibilities, VanArsdale will continue to be involved in product development and new product launches in conjunction with Keeler's partners. He will also expand Keeler University globally, with the primary goal of further developing the company's KOL network and medical advisory board.

## Sponsors

### VSP Global Innovation Center

*OptometricEducation | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)*



# FOCUSED ON THE FUTURE

The VSP® Global Innovation Center continually seeks out transformative trends and emerging opportunities within the eye care and eyewear industries.

Keep your finger on the pulse of developing trends by downloading our Futurist Reports, created in collaboration with CB Insights.

Visit [vspglobal.com/innovation](https://vspglobal.com/innovation) to learn more.



Classification: Public

©2021 Vision Service Plan. All rights reserved.  
VSP is a registered trademark of Vision Service Plan. 91134

# Essilor

OptometricEducation | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)



GENUINE SINCE 1937

# RAY-BAN® AUTHENTIC ESSILOR® SPECIAL EDITION

Introducing the **perfect match** of Ray-Ban's legendary style and Essilor's expertise in sight.  
[Learn more at EssilorPRO.com/Ray-Ban](https://www.essilorpro.com/ray-ban)



SEE MORE.  
DO MORE.

©Essilor International - ©Luxottica Group - March 2021. Ray-Ban® is a trademark of Luxottica Group.

# Alcon

Journal Author | Optometric Education: Volume 46 Number 2 (Winter-Spring 2021)

## PRECISION1® FOR ASTIGMATISM READY TO PRESCRIBE



**Born from the Water  
Gradient Technology  
of DAILIES TOTAL1®**


- Featuring the proven **PRECISION BALANCE 8|4®** lens design
- **99%** first-lens fit success rate<sup>1\*</sup>
- **Easy** to handle

**All at a mainstream price.**

Fit your patients in  
PRECISION1® for Astigmatism.

\*Based on lens movement, centration and rotation at initial fitting.

Reference: 1. In a study where n=78 eyes; Alcon data on file, 2020.

See product instructions for complete wear, care and safety information. 

© 2020 Alcon Inc. 11/20 US-PRA-2000031

**Alcon**

