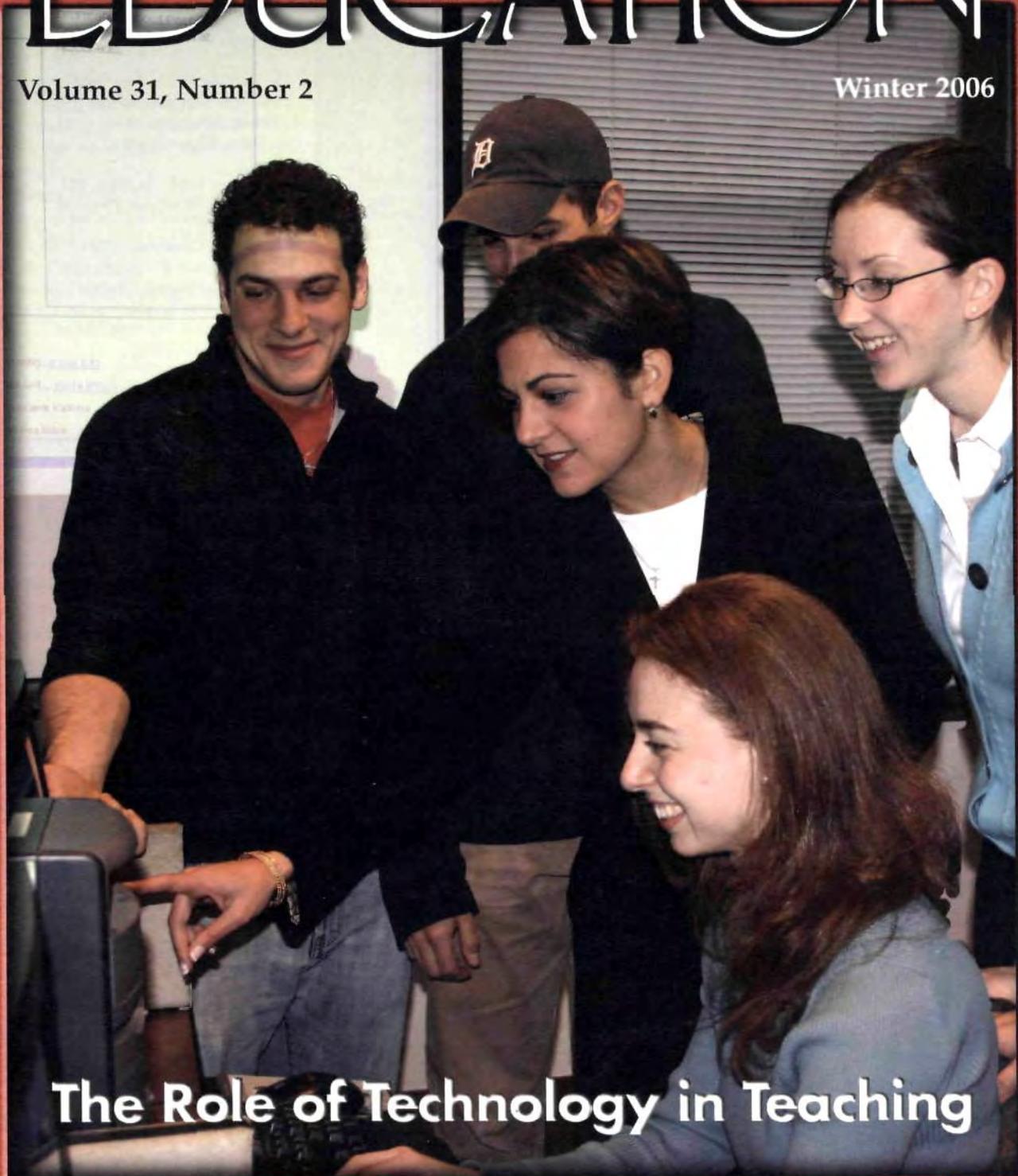


The Journal of the Association of Schools and Colleges of Optometry

OPTOMETRIC EDUCATION

Volume 31, Number 2

Winter 2006



The Role of Technology in Teaching

Association of Schools and Colleges of Optometry

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EDITORIAL

Educational Technology — A New Era in the Scholarship of Teaching

Elizabeth Hoppe, O.D., M.P.H., Dr. P.H., F.A.A.O.

An important theme emerges in this month's issue through the exploration of educational technology. Four different articles delve into the role of technology in teaching and learning. The first donation to the ASCO Informatics SIG repository of optometric educational software is described by Steinman. *Colorspace* is an innovative technology that can be used to enhance understanding of key concepts in color vision and perception. This technology is designed as a tool to be incorporated into optometric curricula.

Expanding from a single teaching technology to an entire course, Bailey describes a unique application of distance learning that involves translating a traditional lecture-style class into an online version. This newly formatted course was a hybrid of asynchronous and synchronous learning, and combined self-initiated learning with group discussion.

But what of the optometric student's preparedness and familiarity with both teaching technology and the skills needed to take advantage of multimedia scholarship? Farra and others describe the characteristics of one entering class. Gorman reminds us that instructional technology is not only important in the delivery of the optometric professional degree curriculum, but also in postgraduate continuing education.

These articles serve as a snapshot of today's educational technology in our schools and colleges of optometry, but they also raise important questions. How are our curricula fulfilling the promise of multimedia technology to enhance teaching and learning? What barriers may limit the application of educational technology? What does the future hold?

Stephanie Barish, former director of the Institute for Multimedia Literacy at the Annenberg Center at the University of Southern California, and Elizabeth Daley, executive director of the Annenberg Center and dean of the School of Cinema - Television at the University of Southern California, have identified that the most important step toward developing multimedia scholarship is to work with faculty to help them conceive of scholarly work that will be intellectually stronger because of the use of multimedia - that is, work that not only employs but actually requires multimedia.¹ *Colorspace* is an example that fits the bill, using the dynamic process of multimedia to best present the material.

Bailey identifies two key factors that may limit the application of online course work: the heavy time commitment required not only initially but on an ongoing basis, and the learning styles of students enrolled in the course. Barish and Daley have also recognized that most faculty do not have knowledge

of multimedia that in any way prepares them for approaching the integration of multimedia into their scholarly work and teaching.

Courses in the clinical sciences and patient care curricula may have an even greater possibility of integrating multimedia scholarship. Barish and Daley cite the example of a surgeon who prepared a multimedia software application that incorporated links to clinical images, radiological and laboratory studies, illustrative designs, and patient interviews. Hyperlinks to other papers, texts, bibliographies, and more in-depth studies were easily integrated by students with the simple click of a mouse. Incorporating this technology allowed for an entirely new dimension of understanding of the subject matter at the moment of interaction.

Is teaching technology here to stay or will it fall by the wayside in favor of more traditional methods? Only time will tell, but for now, I am betting that we will continue to see rapid growth in this area. As every other aspect of our lives integrates more and more technology and multimedia in the form of multi-function cell phones, the internet, e-mail, GPS systems, and entertainment avenues, it only seems natural that our teaching and learning processes will follow the same path.

¹<http://www.educause.edu/ir/library/pdf/ffp0509s.pdf>

The Sound of One Hand Clapping

Dominick M. Maino, O.D., M.Ed., F.A.A.O.
Geoffrey G. Goodfellow, O.D., F.A.A.O.

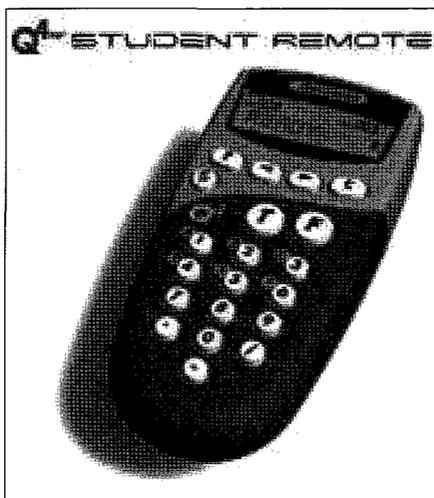
I'm (DM) energetically moving about the stage while making eye contact with my student audience. I'm using all the tricks of the lecture trade to engage my students in the teaching/learning symbiotic process and then.....I hear the sound of one hand clapping! The silence is deafeningly accompanied by a cacophony of quizzical stares. I have lost them.....or did I really ever have them? Has this happened to you? How do you know when students have disengaged? Must you become a Zen Master to hear the sounds of one hand clapping....when that other hand is not even remotely present?

It takes a minimum of two "hands" (the teacher and the learner) to meet the educational needs of our students. All too often the engaged learner becomes the missing limb. How do we as teachers make sure our students are fully invested in the learning process? One approach may be to utilize technology known as an Audience Response System (ARS). This technology is now being used throughout the United States and within at least two schools and colleges of Optometry.

ARS technology, at its minimum, provides a remote control device to students that allows them to electronically submit answers to questions posed by the lecturer. A PowerPoint slide might display a multiple choice question; the students are given an opportunity to answer with their remote controls, and the instructor can instantly display a bar graph illustrating how many students chose letter A, B, C, or D. Most systems allow the question to be formatted in a wide variety of formats including true/false, multiple choice, or numerical calculation. The student and teacher are given instant right/wrong feedback.

ARS technology connects you to the student in both an intimate and yet (if you wish) anonymous manner. Dr. Greg Fecho, an assistant professor at the NOVA Southeastern University College of Optometry, is helping his institution

evaluate the use of audience responses systems. He says that, "ARS helps to engage the student in a manner that is non-threatening and at the same time gives the faculty an idea as to what the class does or does not understand." He notes that, "ARS can also take class attendance, give quizzes, and even take class polls." The final assessment as to the "lecture worthiness" of ARS at NOVA is still several months away, but it is looking promising.



One of the biggest selling points of such a system is its ability to connect you and the subject you are teaching directly to the student. Allen and Tanner¹ write that ARS can deliver "on-the-spot feedback without grading pains." Burnstein and Lederman² also use the system for assessing if a student has read the required readings, attentional levels of the class, the students' ability to remember important facts and concepts and to determine if the pace of the class is appropriate (too fast/slow).

At the Illinois College of Optometry, we have reviewed several ARS systems. We first began by recruiting the names of potential vendors from technology and education trade journals and other educators. Next, we used the web sites of these companies to compile a brief comparison of the offered features and costs (To view a pdf of this table go to the

ASCO website — <http://www.oped.org> — publications appendix). After highlighting several systems that appeared to be a good fit for our institution, we invited the vendors to demonstrate their product in person.

At this point in time, we have seen demonstrations from Audience Response Systems, Inc. and from Qwizdom. Each of these systems has its own benefits and challenges. The Audience Response System, Inc. model integrated well with Microsoft PowerPoint, but the handheld remotes were clunky and had LCD screens that were difficult to read. Qwizdom's system had sleek remotes that appeared more functional, but the product uses a proprietary display program other than MS PowerPoint. The search for the best product is still underway.

Hopefully, as you lecture while using an audience response system, you will never have to hear the dreaded sound of "one hand clapping." All limbs (not to mention eyes, brains and other appropriate body parts) will be focused on the matter at hand and ready to fully participate in the learning process.

Websites:

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optometric faculty

CREATIVE THINKERS IDENTIFY THE MOST IMPORTANT DEVELOPMENTS OF THE LAST 20 YEARS AND PREDICT FUTURE ISSUES.....

AS I THINK ABOUT THE EDUCATIONAL ENTERPRISE, I BECOME CONCERNED ABOUT THE FUTURE OF THE FACULTY AND WHERE NEW FACULTY MEMBERS WILL RECEIVE THEIR POSTGRADUATE EDUCATION. WHEN OPTOMETRIC RESIDENCY PROGRAMS CAME ONTO THE SCENE IN THE MID-1970S, THEY WERE HAILED AS A NEW TRAINING GROUND FOR OPTOMETRISTS. THAT STILL HOLDS TRUE TODAY, BUT I THINK THAT RESIDENCY EDUCATION HAS MINIMIZED THE POOL OF OPTOMETRISTS WHO PURSUE POSTGRADUATE DEGREES. THIS PRESENTS A DILEMMA FOR OPTOMETRIC EDUCATION.

THE FIRST TWO YEARS OF MOST OPTOMETRY PROGRAMS CONSIST OF LARGE QUANTITIES OF BASIC SCIENCE COURSES, TAUGHT BY FACULTY MEMBERS WHO HAVE POSTGRADUATE DEGREES IN DISCIPLINES RELEVANT TO THE COURSES TAUGHT. THAT FACULTY IS, LIKE ALL OTHER FACULTIES, "GRAYING." **MY CONCERN IS, GIVEN THE SHIFT TO RESIDENCY EDUCATION, WHO WILL REPLACE THIS CADRE OF OPTOMETRIST-SCIENTISTS?** WHILE MANY OF THE UNIVERSITY-BASED SCHOOLS HAVE GRADUATE PROGRAMS IN VISUAL SCIENCE, MOST ARE FILLED WITH NON-OPTOMETRISTS AS STUDENTS. ONLY TWO PROGRAMS IN THE NATION HAVE COMBINED RESIDENCY-MASTERS PROGRAMS, AND ANOTHER PROGRAM HAS DEVELOPED A MASTER'S PROGRAM IN OPTOMETRIC EDUCATION. THE DEPARTMENT OF VETERANS AFFAIRS OFFERS A POST RESIDENCY FELLOWSHIP PROGRAM TO DEVELOP SCIENTISTS FOR THE VA. THE PROBLEM REMAINS — NONE OF THE ABOVE ARE ADEQUATE TO REPLACE OUR SCIENTIFIC FACULTY AS THEY RETIRE.

CHARLES L. HAINE, O.D., F.A.A.O., PROFESSOR
SOUTHERN COLLEGE OF OPTOMETRY

Twenty-nine years ago the first law allowing optometrists therapeutic drug privileges was passed in West Virginia. Two years earlier, the first law allowing optometrists the use of diagnostic drugs was passed in Rhode Island. Both of these historic and revolutionary laws changed the dynamics of optometry and optometric education forever.

In the past 20 years, educators have had to change the philosophy of teaching from "Optometry, the Drugless Profession," to "Optometry, the Full Service Profession." Major changes occurred in optometric educational curriculums, with a greater emphasis on treating diseases of the eye. This often resulted in extremely crowded scheduling, as well as some sacrifice of time allowed for other core subjects.

The next 20 years of optometric education is very critical. We can provide students with a well-rounded education that emphasizes their refractive skills as well as their right to treat diseases of the eye; or we can create a medical model, and allow other groups to provide refractive services.

Morton W. Silverman, O.D., F.A.A.O.
Professor, Nova Southeastern University
Health Professions Division
College of Optometry

As we prepare for the next 20 years, three areas of critical concern to optometric faculty are (1) **teaching and learning;** (2) **scholarship and professional development;** and (3) **academic culture/leadership.**

These areas will be the focus for the July 12-16, 2006 ASCO Institute for Faculty Development that seeks to provide faculty with the necessary knowledge and skills to enhance their success in an optometric academic environment.

Janice Scharre, O.D., M.A., F.A.A.O.
Professor, Dean/Vice President for Academic Development
Illinois College of Optometry and Co-Chair
ASCO Institute for Faculty Development

The most important issues impacting optometric faculty in the next 20 years are:

TEACHING:

Continued evolution of optometry's role in the health care arena

Development of innovative curricular design, delivery, and student assessment techniques

Continued generational differences in student expectations and faculty experiences

Increased need for student support resources: academic preparedness, financial, personal, learning accommodations

Increased diversity in students, faculty, and administrators

Greater integration of basic science education with clinical science education

Increased number of schools and colleges of optometry

Increased opportunities for intraprofessional and interdisciplinary collaborations, facilitated by evolving technology

RESEARCH/SCHOLARLY ACTIVITY:

Expanded need to develop more creative research funding opportunities

Expanded need to proactively recruit, retain, and develop well credentialed and dedicated faculty members in light of anticipated retirements

SERVICE:

Continued globalization of optometry

Linda Casser, O.D., F.A.A.O., National Board of Examiners in Optometry (Dr. Casser was Associate Dean for Academic Programs at Pacific University College of Optometry when this piece was written.)

The balance between teaching and research has always been a difficult one. As available resources shrink, emphasis on significant research funding will increase. Future faculty salaries are likely to depend at least partially on research funding obtained. Yet almost 75% of current faculty state their primary interest is in teaching — not in research, with less than 6% of current faculty rating themselves very successful as researchers. With a large number of retirements predicted and fewer students completing postdoctoral degrees, a looming faculty shortage will require emphasis on faculty retention and recruitment. We need to develop, promote, and visibly recognize outstanding teaching efforts in order to attract and retain faculty. We need to encourage and support the obtainment of postgraduate degrees during which both teaching and research skills can be developed. We also need to carefully evaluate the workload distribution between different faculty groups to ensure balance in this regard.

Sally Dillehay, O.D., Ed.D., F.A.A.O.
Director, Medical Marketing and Clinical Claims, CibaVision, Inc.

The single greatest impact on optometric faculty in the last 20+ years has been the **INCREASED DIVERSITY IN THEIR TRAINING.** Most of this has been through the federal health care delivery system. When I graduated nearly 30 years ago, almost all the faculty of my alma mater, and the institution where I first served as faculty were graduates of the same institution. In fact, with the exception of a few who had been in the military, most had never worked professionally anywhere other than their alma mater. Expanded opportunities for faculty to work or train in multidisciplinary environments helped open the doors for expanded scope of the profession and the movement toward being an integral part of the health care delivery system. Health care systems of the Department of Defense were the first opportunity for optometrists to practice with other health care practitioners. This was followed by the Public Health Service (primarily the Indian Health Service) and later the Department of Veterans Affairs (DVA). All these agencies now sponsor optometric residencies. The DVA, as the largest single source of optometric residencies, arguably has had the greatest impact on optometric education.

W. Howard McAlister, O.D., M.A., M.P.H., F.A.A.O.
Associate Professor, University of Missouri, College of Optometry

ONE OF THE CHANGES I HAVE SEEN IN OPTOMETRIC EDUCATION OVER THE PAST 20 YEARS IS A SHIFT IN HOW OPTOMETRIC EDUCATION IS DELIVERED. FACULTY HAD SIMPLY SHARED KNOWLEDGE FROM THE LECTERN WITH THE SUPPORT OF LABORATORIES AND CLINICAL EXPERIENCE. THE BODY OF KNOWLEDGE NEEDED TO PRACTICE HAS INCREASED LOGARITHMICALLY AS BOTH THE SCOPE OF THE PROFESSION AND MODES OF PRACTICE CHANGE. WE NOW NEED TO BE ABLE TO CONVEY THE ENORMOUS MAGNITUDE OF KNOWLEDGE IN WAYS THAT ALLOW THE LEARNER TO ABSORB AND ASSIMILATE MORE INFORMATION IN LESS TIME.

CURRENT OPTOMETRIC STUDENTS HAVE GROWN UP EXPECTING CONSTANT, DYNAMIC, AND NOVEL STIMULATION FROM THEIR INSTRUCTORS. FACULTY NEED TO BE ABLE TO EDUCATE AND ENTERTAIN SIMULTANEOUSLY IN AN EFFORT TO MAINTAIN THE ATTENTION OF THEIR AUDIENCE. THE FUTURE WILL DEMAND THAT FACULTY DEVELOP NOVEL METHODOLOGIES THAT ENCOURAGE INDEPENDENT THINKING AND A CONTINUED THIRST FOR KNOWLEDGE, BOTH DIDACTIC AND CLINICAL.

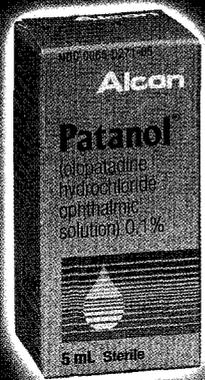
SANDY BLOCK, O.D., M.Ed., F.A.A.O., PROFESSOR
ILLINOIS COLLEGE OF OPTOMETRY

We must continue to increase the stature of all of our academic institutions, by responding aggressively to changes in pedagogical philosophy in the health sciences, becoming ever more flexible in our teaching of advanced skills as new knowledge and technologies evolve. Faculty must produce more world-class research in our traditional vision sciences, but also in the bio-medical sciences, as the profession takes on more responsibility in that area. We must address the possibility that clinical training will require more numerous quality training opportunities in multidisciplinary clinics and hospitals, and that these will need to extend well beyond those found within the federal services.

Felix M. Barker, II, O.D., M.S., F.A.A.O.
Professor, Pennsylvania College of Optometry

Future faculty will need information literacy skills to access, evaluate, validate and apply contemporary information as they contribute to GLOBAL learning and training in a new era for information technology.

Nancy Peterson-Klein, O.D., F.A.A.O., Associate Dean for Academic and Student Affairs
Michigan College of Optometry at Ferris State University



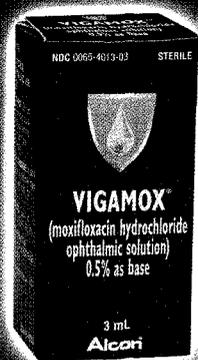
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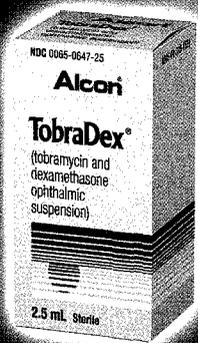


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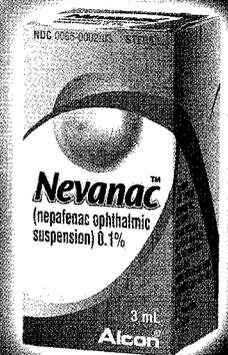


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Hoya Vision Care

Hoya has committed \$50,000 to the World Council of Optometry (WCO) Fellowship Program. This contribution will play a vital role in the ongoing efforts of WCO to provide quality, accessible eye care while responding to the World Health Organization's *VISION 2020: The Right to Sight* initiative. The WCO Fellowship Program is designed to foster an exchange of knowledge and expertise, and to encourage international partnerships for the development of primary eye care. Fellowships are granted to professional candidates with a commit-

ment to public service in both the public and private sectors, specifically in optometric education, patient care and community service and organizational development. SCO fellows are assigned according to their expertise and the needs of the host countries. Each fellowship requires a pre-approved program that specifies the action plan and program evaluation methods.

Headquartered in Japan, Hoya is a pioneer in optical technologies with leading products in diverse industries around the world. Founded in 1941, Hoya established its North American optical lab presence in April 1999, with the creation of Hoya Lens of America. Hoya Vision Care, North America Headquarters, was created in 2000.

CooperVision

CooperVision recently introduced PC Hydrogels, a unique category of contact lens material for daily wear that offers excellent health and optimum comfort. CooperVision is introducing its PC Hydrogel category of contact lenses in order to help eye care practitioners offer their patients more comfortable daily lens wear.

"CooperVision is committed to the PC Hydrogel category because we believe that eye care practitioners should be able to offer their daily-wear patients healthy contact lenses that provide better comfort," said Tom Shone, senior vice president of strategic marketing, CooperVision. "The definition of 'health' as it relates to daily wear requires a better balance of oxygen and comfort than is offered by the existing generation of silicone hydrogel lenses."

Volk Optical

Volk Optical, the leader in aspheric optics, has expanded its lens offerings for surgical use, adding the ACS Direct Image ACS Vitrectomy Lenses. The line includes eight new lenses that provide clear direct views

and can be safely steam sterilized. The new direct view lenses eliminate the need for the use of a reinverter. The low profile designs deliver high resolution optics for clear views during surgery. The lenses fit in a standard suture ring, working seamlessly with current surgical methods. As part of Volk's AutoClaveSterilizable (ACS) collection, the lenses can endure repeated steam-sterilization.

A free 30-day risk free trial is available from Volk direct. To order or obtain more information about Volk products, visit www.volk.com, phone Volk direct at 1-800-345-8655 or contact your local authorized Volk distributor. Volk Optical is an innovator in the design and manufacture of diagnostic, therapeutic and surgical ophthalmic lenses, equipment and accessories. The company is based in Mentor, Ohio, and has representatives and distributors around the world.

Transitions

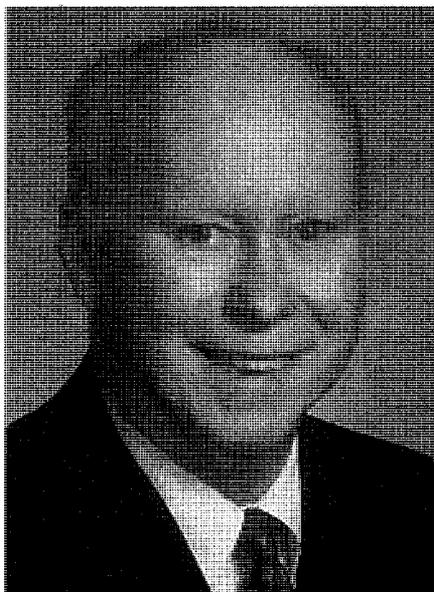
Transitions Optical recently celebrated its 15-year anniversary. Over the past 15 years, Transitions has remained committed to advancing photochromic lens technology in order to provide the most comfortable, convenient protection from ultraviolet radiation and glare. As a result, Transitions Lenses have become the #1-recommended photochromic lenses worldwide.

When the company was founded in 1990, Transitions had a production workforce consisting of fewer than 50 workers and only one lenscaster. Today the company employs over 1,200 workers worldwide and has partnerships with nearly a dozen lenscasters to offer more than 100 lens options in the fastest-growing categories of lens materials and the most popular lens designs. Headquartered in Pinellas Park, Florida, Transitions launched its Transitions V Lenses with ESP in 2005. Transitions Lenses were also

(Continued on page 48)

My Best Day in Optometric Education — Signing the Affiliation Agreement Between the Illinois College of Optometry and the University of Chicago

Charles F. Mullen, O.D., F.A.A.O.



In 1996, I accepted the position of president, Illinois College of Optometry (ICO), and brought with me nearly thirty years of experience in collaborative relationships between optometry and ophthalmology. My conviction of the importance of cooperation between the two professions began at the New England College of Optometry in Boston's community health centers, and was carried forward at the Pennsylvania College of Optometry with the affiliation with Hahnemann University's Department of Ophthalmology. It was tempered by my federal government experience as the director of optometry service at the VA and was fully realized with the signing of a comprehensive patient care, education and research affiliation between ICO and the

University of Chicago (UofC).

Thus, October 16, 1997 was my best day in optometric education and reinforced my conviction that cooperation between the two disciplines presents numerous opportunities for enhancing patient care and clinical training for students and residents, and for fostering a better understanding and respect between the two professions, while reinforcing their natural synergism. The affiliation continues to this day, as a vibrant patient care and clinical education collaboration.

Although I remain convinced that affiliation with academic medicine will significantly enhance both clinical education and patient care for both optometry and ophthalmology, there are other challenges that also need to be addressed before optometric clinical education can reach its full potential. Some schools and colleges of optometry have addressed several of these challenges, but much still needs to be done. With continued support from the American Optometric Association (AOA) and the Association of Schools and Colleges of Optometry (ASCO), many of these objectives can be achieved within the next five years.

- Include optometry in the federal programs of Graduate Medical Education (GME) and the National Health Service Corps (NHSC).
- Increase collaboration with community health care programs and increase commitment to public health responsibilities.

- Downsize large single purpose and costly campus-based clinics and replace with smaller referral centers and community-based training sites.
- Achieve Joint Commission for the Accreditation of Health Care Organizations (JCAHO) accreditation for campus-based and college-operated clinical facilities.
- Reorganize the colleges' clinical programs into separate legal entities with their own administrations and governing boards.
- Implement incentive-based compensation (IBC) plans for faculty that integrate student and resident training.
- Develop and operate ophthalmic surgi-centers in partnership with medical school affiliates.
- Establish a national clearinghouse and placement service for optometric externships.
- Fund the Regional Centers of Eye Care Excellence (RCEE) within the Department of Veterans Affairs (VA) and expand the Vision Impairment Centers to Optimize Remaining Sight (VICTORS).

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Online Continuing Optometric Education: A Survey of the Schools And Colleges of Optometry

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Abstract

The computer and the Internet provide technologies for delivering continuing education courses. These technologies allow optometrists to access continuing education courses at times and places that are convenient to them and at reasonable cost. Also, these technologies provide optometrists with the flexibility to meet their continuing education needs as well as to meet their state board requirements for re-licensure without leaving their families and practices. This article discusses the current status and the future of online continuing optometric education. Also, it reports the results of a mail survey disseminated to the schools and colleges of optometry regarding their use of the Internet for delivering continuing education courses. Additionally, it suggests improvements that can be made to online continuing education courses so that they can be interactive and therefore more effective from a learning outcomes standpoint.

Key Words: Continuing education, Internet, online, computer, optometrist, educational research

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Introduction

With the introduction of the Windows-based personal computer in the early 1990s and the World Wide Web debuting in the middle 1990s, a new and exponentially expanding frontier for communication has emerged. During the past several years, both synchronous (time and place dependent) and asynchronous (time and place independent) systems for providing online distance learning over the Internet have been developed. These technologies provide optometrists with easy access to a rich environment for continuing education programs "without walls."

The computer and the Internet provide new technologies for delivering continuing education courses. These technologies allow optometrists to access continuing education courses at times and places that are convenient to them and at reasonable cost. Also, they provide optometrists with the flexibility to meet their continuing education needs as well as to comply with state board requirements for re-licensure without leaving their families and practices.

In the professions, formalized systems of continuing education began to emerge in the 1960s.¹ In the 1970s, states began to use continuing educa-

tion for re-licensure and re-certification.² In the 1980s, the health professions developed organized and comprehensive continuing education programs.³ State boards of optometry began to require optometrists to obtain continuing education credit for re-licensure in 1938.^a

During the past decade, the most common format for delivering continuing education courses was an individual lecturer presenting information at a lectern to a large assembly of doctors attending national, regional, state, or local meetings and conferences.⁴ Nowlen accurately describes the pervasive atmosphere at a typical continuing education conference by stating that an "instructor lectures and lectures and lectures to fairly large groups of ... professional people who sit for long hours in an audiovisual twilight, making never-to-be-read notes at rows of narrow tables covered with green baize and appointed with fat binders and sweating pitchers of ice water."⁵

One recent trend that has done the most to change the face of continuing education is the introduction of distance education.⁶ There are many continuing education providers that present traditional continuing education courses.⁷ However, few have the experience in developing and delivering distance continuing education courses, especially those courses that are delivered online. According to Cervero, a "major growth area...in distance learning programs" exists for the professions.⁶

In 1995, the Taskforce on Health Care Workforce Regulation issued a report to the Pew Health Professions Commission. In this report, a recommendation was made that "states should require each board to develop, implement and evaluate continuing competency requirements to assure the continuing competence of regulated health care professionals."⁸ Although one of the advantages of mandated continuing education is that it may update a professional's knowledge and skills and "offer the public some assurance that professionals have a foundation of knowledge to support their practice..., [it] will not prevent acts of negligence or the exercise of poor judgment."⁹

Ostensibly, the reason that regulatory bodies mandate continuing education for re-licensure of health professions practitioners is to protect the public from those who have not kept up with new information and tech-

nologies in their fields of practice. Another reason that continuing education is required to renew a professional practice license is to "improve practice" However, a number of professionals attend continuing education conferences simply because "they want to put in enough hours of classroom attendance so that they can meet a licensure requirement."¹⁰

Taking postgraduate continuing education courses is necessary for optometrists to learn new procedures, become aware of new knowledge in their field of practice, and apply this new knowledge to the care of their patients. The practitioners who seek better ways to think about what they do find an advantage of continuing education over pre-professional practice education.⁴ Lifelong learning is the cornerstone of the continuing development of optometrists and is requisite to maintaining their clinical skills and competencies as health care providers. The public looks toward the optometric profession to provide for its vision and ocular health needs utilizing current treatment modalities based on information obtained from evidence-based publications and continuing education presentations.

For optometrists as well as other health professionals, "continuing education is a distinct and definable activity that supports...professional development...and leads to improved patient outcomes."¹¹ Optometrists remain current in their profession through a variety of methods including review of the current literature, attendance at continuing education programs, and discussions with colleagues. The majority of continuing education programs approved by state boards of optometry take place at national, regional, state, and local meetings. To be effective, these programs need to combine reflection with concrete experience.¹² In describing Pennsylvania College of Optometry's new curriculum model, DiStefano and Dayhaw-Barker state "...the graduate [practitioner] must possess problem-solving and critical thinking skills, which integrate current knowledge, scientific advances, and the human/social dimensions of patient care to assure the highest quality of care for each patient." They also suggest "these problem-solving competencies are essential for effective clinical decision-making and life-long learning."¹³

According to the Council on Optometric Practitioner Education

(COPE) database (www.arbo.org/COPE) all 51 boards of optometry in the United States require optometrists to earn continuing education credits for re-licensure. To assist optometrists in meeting this regulatory requirement, continuing education programs are provided by a variety of continuing education administrators including local, state, and regional organizations, private for-profit companies, as well as schools and colleges of optometry.

Many professional associations have established agencies to monitor and certify the quality of continuing education providers in their field.¹⁴ In optometry, COPE is the clearinghouse for all continuing education provided in the United States. Prior to 2003, all boards of optometry accepted COPE qualified courses except Florida and the Virgin Islands.¹⁵ The boards in Florida and the Virgin Islands required that all continuing education courses be sent to them for review. In 2003, the Florida Board of Optometry (FBO) changed its policy and began accepting COPE approved courses for non-transcript quality (TQ) continuing education. The FBO continues to require that all TQ courses be submitted directly to them.

Nova Southeastern University College of Optometry established an Office of Continuing Optometric Education in June 2001, and it desired to add online continuing education courses to its continuing education program venues. The purpose of this study was to obtain information about online continuing education courses offered by other schools and colleges of optometry as well as their experiences in providing online continuing education. The information acquired through this study would be useful in developing the College's online continuing education courses.

Methods

Prior to beginning the study, a set of criteria was created for developing a questionnaire; a set of objectives for the questionnaire was created; and a set of survey items was created and formatted into a survey instrument. The criteria, objectives, survey items, and survey instrument were developed with the assistance of a formative committee and evaluated for face and form validity by a summative committee.

After receiving approval from the Nova Southeastern University Institutional Review Board to proceed with the survey research project, a survey

questionnaire (to view the survey, go to the ASCO website — www.oped.org — publications, appendices) was mailed on January 6, 2003 to the president or dean of each of the 17 schools and colleges of optometry in the United States that are members of the Association of Schools and Colleges of Optometry (ASCO) (Table 1). The survey contained questions regarding the institution's current and future use of the Internet for delivering continuing education courses, the types of course formats employed, as well as other information that was useful to the College in developing its online continuing education courses. In a cover letter, a request was made that the faculty or staff member in charge of continuing education for the institution complete the questionnaire. It was also requested that the questionnaire be completed and returned to the researcher within 14 days of receipt. Two e-mail reminders were sent to the presidents and deans to minimize non-response rates. Each institution's director or coordinator of continuing education completed and submitted the survey.

Results

Of the 17 schools and colleges of optometry surveyed, seven (41%) reported that they offer online continuing education courses (Table 1). Of the 10 schools and colleges of optometry that do not currently offer online continuing education courses, eight (80%) reported that they plan to do so within the next three years. One institution reported that it previously offered online continuing education courses, and it discontinued doing so because there was a lack of interest by optometrists in taking online courses, a lack of interest of faculty in developing online courses, a lack of adequate staff support, and online continuing education courses were too costly to manage. They do not plan to offer online courses during the next three years because of concerns about their financial viability. Also, it reported "the demand is low for the number of online providers." It stated that until there are changes in the state laws allowing credit for more online hours, it is a financial albatross." Another institution reported that it may offer online continuing education courses within the next three years. However, this institution is concerned about the financial viability of online continuing education courses. It stated "there are many organizations that are involved

Table 1: Schools and Colleges of Optometry in the United States and Their Use of the Internet for Delivering Continuing Education Courses

Institution	Location
Illinois College of Optometry (ICO) ^{2,3}	Chicago, Illinois
Indiana University School of Optometry (IU) ¹	Bloomington, Indiana
Inter American University of Puerto Rico (IAU) ^{2,3}	Hato Rey, Puerto Rico
Michigan College of Optometry at Ferris State University (MCO) ^{2,3}	Big Rapids, Michigan
New England College of Optometry (NECO) ^{2,3}	Boston, Massachusetts
Northeastern State University College of Optometry (NSU-OK) ¹	Tahlequah, Oklahoma
Nova Southeastern University College of Optometry (NSU-FL) ^{2,3}	Ft. Lauderdale, Florida
The Ohio State University College of Optometry (OSU) ²	Columbus, Ohio
Pacific University College of Optometry (PU) ¹	Forest Grove, Oregon
Pennsylvania College of Optometry (PCO) ¹	Philadelphia, Pennsylvania
Southern California College of Optometry (SCCO) ^{2,3}	Fullerton, California
Southern College of Optometry (SCO) ²	Memphis, Tennessee
State University of New York State College of Optometry (SUNY) ¹	New York, New York
University of Alabama at Birmingham School of Optometry (UAB) ^{2,3}	Birmingham, Alabama
University of California, Berkeley, School of Optometry (UC-B) ¹	Berkeley, California
University of Houston College of Optometry (UH) ^{2,3}	Houston, Texas
University of Missouri - St. Louis College of Optometry (UMSL) ¹	St. Louis, Missouri

Note.

¹ Offers online CE courses

² Does not offer online CE courses

³ Plans to offer online CE courses within three years

in the arena and to offer online continuing education because everyone else [is doing it] may not be financially feasible." Another institution reported that it does not plan to offer online continuing education courses during the next three years because there is a lack of needed technology at the University, concerns about financial viability of online continuing education courses, lack of demand by optometrists, and lack of adequate staff support.

Of the seven schools and colleges of optometry that reported that they offered

online continuing education courses, five reported that they used a Web site for delivering online continuing education courses and two reported that they use both a Web site and a course management system (CMS). One institution reported that it used eCollege and the other reported that it used Blackboard. Both institutions reported that the faculties who teach continuing education courses within a CMS as well as the optometrists who take these continuing education courses were satisfied with the format and usability of the CMSs.

The development of the Web site or CMS format or template and the placement of the content for the course on the Web site or CMS varied in the schools and colleges of optometry that deliver online continuing education courses. Two institutions reported that a staff member was involved; one reported that an instructor and staff member were involved; two reported that an instructor and an information technologist (IT) were involved; and two reported that only an IT was involved.

In regard to the format that is used to deliver online continuing education courses, the formats varied as well. One or more of the institutions used text only, text with tables and/or graphics, Hypertext with tables and/or graphics, full-text journal articles, case presentations, and hybrid Web-based courses with CD-ROM. None of the institutions reported the use of interactive case presentations, audio and text, audio slideshows, video lectures, Web casts, or multi-media.

The fee charged per credit hour for online continuing education courses ranged from \$15 to \$30. All institutions reported that their courses contained tests. Two of seven institutions reported that there was a separate fee charged for grading the tests, and five included the grading of the tests as part of the course fee. The separate charge for grading the tests was \$25 in both cases. Six of seven institutions reported that the test questions were in multiple-choice format. One institution reported that test questions were written in multiple choice, true-false, fill in the blank, and short answer. The method of delivering the tests varied. Both interactive online forms and printable tests were used. No institution used eMail attachments or mailed tests. The method for delivering answers to the tests varied as well. Online forms, eMail, and regular mail were used by examinees to submit answers. All seven institutions provided a certificate either by mail or as a downloadable and printable document when a course was successfully completed.

All institutions applied to either state boards or COPE for approval of their courses. Four of seven institutions reported that they applied for state board approval for all of their courses; two applied for some courses; and one institution did not apply at all. Three institutions reported that they apply for COPE approval for all of their courses; three apply for some of their

Table 2: Format and Number of Online CE Courses Offered at Schools and Colleges of Optometry in the United States

<u>Institution</u>	<u>Internet Location</u>	<u>Format</u>	<u>No. Courses</u>
IU	www.opt.indiana.edu/ce/online.html	Text with tables/graphics	1
NSU-OK	Arapaho.nsuok/~optometry/ie_index.html	Text	1
PU	www.opt.pacifiu.edu/ce	Text with tables/graphics	17
PCO	www.pco.edu/acad_progs/ce_progs.htm	No links to courses found	
SUNY	www.sunyopt.edu/ceprog/index.shtml	Text with tables/graphics	4
UC-B	spectacle.berkeley.edu/ubcso/courses_ce.html	No links to courses found	
UMSL	www.umsl.edu/divisions/optometry/ce/ WebaseCE.html	Text	2

Note: This data is from an evaluation of Websites conducted in 2003.

courses; and one institution did not apply at all.

The percentages of optometrists who register to take online continuing education courses and complete the post-course test were reported by three institutions to range between 90% and 100%, and three other institutions did not know. The percentages of optometrists who take tests for online continuing education courses and pass the tests on the first try were reported by four institutions to be between 90% and 95%; one institution reported 70%-80%; and one did not know. Five of the seven institutions reported that they provide a re-test if the optometrist fails to pass the test on the first attempt. Of these, one institution reported that they charge \$10 for a re-take, and one reported that they charge \$100 after two failed attempts.

In regard to the relative cost of developing online continuing education courses as compared to onsite courses, three institutions reported that their cost was relatively higher; three reported that their cost was relatively lower, and one institution reported that the relative cost was unknown. In regard to the relative cost of delivering online continuing education courses as compared to onsite courses, only one institution reported that relative cost was higher for online continuing education courses.

The reported methods of compensating online continuing education course instructors varied as follows: 50/50 split of course fees; set fee; cash; hourly rate; payment varies; paid for preparation time and creativity; and

prep fee upfront and fee for updating course.

In regard to ownership of online continuing education courses, three institutions reported that the instructor or developer owned all or part of the intellectual property rights; three reported that the institution owned all or part of the intellectual property rights; one reported that the IT owned part of the intellectual property rights; and two institutions reported that the owner of the intellectual property rights varied.

Two of the seven institutions reported that they surveyed optometrists after completion of their online continuing education course. Of those two, it was reported that optometrists were satisfied with the online delivery of the courses.

For those institutions reporting that they deliver online continuing education courses on the Internet, their Websites were evaluated. The purpose of these evaluations was to ascertain the format of the courses offered (Table 2).

Discussion

Of 17 institutions submitting the survey, seven stated that they offered online continuing education courses. However, after visiting each of their Websites, it was determined that only one institution offered more than four courses. The institution that offered the greatest number of courses (17 currently and an additional 17 planned for release by the fall of 2003), presented courses that were formatted similarly to journal articles with text, tables, and

images but without the option of audio narration or interactivity. This institution's Website was visited again on April 5, 2005. There were 28 courses in their course catalog that were qualified by COPE, one of which was a DVD-based course. In addition, there were nine archived courses in which the COPE qualification had expired.^b

Reading text on a computer screen is sometimes difficult, and the availability of audio narration may be useful to some of the optometrists taking online courses. It is generally accepted that learning outcomes and the effectiveness of courses presented in an active learning environment are greater than for those courses presented in a passive learning environment. [Optometrists] who take...courses [presented in an active learning environment] are more likely to apply their newly gained knowledge to the care of their patients.¹⁶

The survey inquired if the institution used a course management system (CMS) or a Website for delivering online courses. Two institutions indicated that they did so, but that was not evident by visiting the Website of the two institutions. There are several advantages of using a CMS. First, access to courses can be limited by the use of user accounts that require a password. This feature can offer the continuing education administrator the option of excluding optometrists from taking courses until they register and pay for them. Second, CMS can provide more flexibility and options in the presentation of learning materials (ex. Hyperlinks to informational Websites,

video clips, audio clips, electronic discussion boards, and chat). The use of these options can allow for the delivery of interactive courses. Third, tests can be administered online and can be graded automatically, giving immediate feedback to the examinee. Fourth, the examinee who successfully completes a course can immediately download a certificate of completion. These automated functions benefit the institution by saving staff time in scoring tests and issuing certificates.

In regard to the effectiveness of distance and online education, research demonstrates that distance education can be as effective as traditional face-to-face instruction and will play an important part in continuing education for adults.^{5,17} However, the literature on the effectiveness of online courses requires careful analysis. According to Hopper "Internet teaching...is essentially a practice without a research foundation. Even the best research on distance learning is of doubtful relevance to Internet teaching." He also states "the bulk of research on distance learning was performed before establishment of the WWW in higher education, on methodologies that fundamentally differ from those employed in Internet courses." Additionally, he concludes, "the meager research published on true Internet courses tend to be deeply flawed (anecdotal, small sample sizes, confusion of variables, poor control of extraneous variables, lack of random sampling, questionable instruments, and so forth)."¹⁸ It is interesting to note that there are no published articles on the subject of online continuing education in the optometric literature.

In their review of the literature on the effectiveness of CME, Davis, Thomson, Oxman, and Haynes have concluded that "broadly defined CME interventions using practice-enabling or reinforcing strategies consistently improve physician performance and, in some instances, health care outcomes." They recommend that an "improved evidence-based CME delivery system" be developed.¹⁹

Seelig suggests that traditional [continuing education] courses are generally very passive, not requiring any interaction by the attendee or recall of information presented during the course. The information transmitted and knowledge gained from this type of activity has a short half-life, and it may not be able to be retrieved by the practitioner when needed in the patient care environment. This method

of presenting [continuing education] may not be the most effective from a learning standpoint.¹⁶ However, continuing education activities that are interactive are more valuable in providing a learner with knowledge, skills, and behaviors that are easily transferred to the practice setting. However, greater motivation is required to interact in this type of learning situation as compared to passive learning situations. Most importantly, motivation is "crucial to the concept of life-long learning."¹⁹

The importance of the schools and colleges of optometry is growing in continuing education as the result of a new and increasing focus on assessment of outcomes of continuing education programs. The current standard used to determine the outcome of a continuing education program is the reporting of the results of tests provided to attendees following the completion of continuing education programs. Schools and colleges of optometry are strategically positioned to deliver online continuing education programs due to the fact that they have easy access to the technological resources required to deliver and monitor the quality of continuing education programs as compared to most other continuing education administrators. They are also well positioned to evaluate learning outcomes for these programs as well as to develop new and more effective teaching strategies to improve learning.

The continuing development of online continuing education courses by the schools and colleges of optometry will fulfill the needs of optometrists to obtain information that is important to them in maintaining and improving their clinical competencies as well as earning continuing education credit toward re-licensure. Although many optometrists enjoy traveling to conferences and meetings, it is becoming quite expensive to do so, especially taking into account lost revenues from their offices, expensive transportation and hotel accommodations, and dining in restaurants. It is certainly more convenient and cost-effective to dial-up a connection to the Internet or use a high speed connection, log in to a Web site, pay a fee using a credit card or eCheck, complete a course, submit a test, and receive a confirmation of successful completion - all from the comfort of the office or home. In fact, a number of online courses are available free of charge through the generous

financial support of the ophthalmic and pharmaceutical industries.

The potential for the use of online education technologies in practice is only limited by one's imagination, and, of course, bandwidth. Whenever a practitioner requires just-in-time information, online courses can meet the need. These courses are easily developed and, if necessary, may be published to the Internet in a very short period of time. As an example, the SARS epidemic became a major public health concern in 2003. To educate health care practitioners about this devastating disease, the Centers for Disease Control and Prevention held a teleconference in April 2003 at centers around the country. However, this vital information was only available to practitioners who had access to teleconference centers in their areas. Information about the SARS epidemic could have been published to the Internet within a very brief time frame, and by doing so, access to this important information could have been significantly increased.

Conclusions

The computer and Internet technology have catapulted us at lightening fast speed from the industrial age into the information age, and the use of information technologies has made our world a much smaller place in which to live. Many of us have arrived at a point in time that, when information is needed, we are drawn first to the Internet. It is important for optometric practitioners to develop competencies for accessing information on the Internet. There is far too much health information available for practitioners to memorize, store in memory, and recall on demand. They must be able to access vital clinical health information when needed.

According to Toghil, "the profession[s] are now well placed to reap the benefits of the electronic revolution."²⁰ [Optometric] education must be on the cutting edge of continuing education and promote the use of information technology as a primary delivery system.²¹ [Optometric faculty] at the schools and colleges must become educationally competent to provide high quality [online] continuing education courses.²²

The schools and colleges of optometry should take the lead in the development of online continuing education courses. By delivering online

continuing education courses, the educational needs of optometrists across the country can be met at times and places that are convenient to them, and they will have a more cost effective way to access continuing education courses and obtain course credits for re-licensure.

However, the quality and effectiveness of online continuing education courses now available to optometrists should be improved. Online continuing education courses that are presented in a passive learning format should be replaced by courses presented in an interactive format. This can be best accomplished through the development of courses that employ active learning strategies that require the optometrist to interact within the online learning environment. Also, online courses should incorporate audio narration so that the optometrist will have the option of listening to segments of the course rather than having to read text on a computer screen. Finally, online courses should be presented within a course management system (CMS). This will afford the course author the necessary tools to create interactive courses that take full advantage of technology and the power of the Internet.

We need to understand how to develop just-in-time learning strategies that last a lifetime, so that learning opportunities can be structured and delivered exactly when the individual needs them - whether a young child in school or an adult in the workplace.

Ted Sanders, Co-Chair
National Educational Research
Policy and Priorities Board

Footnotes

- a. American Optometric Association, Continuing Education Requirements (chart), January 14, 2005.
- b. Pacific University College of Optometry (<http://www.opt.pacificu.edu/ce/catalog/>)

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Industry News

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the first to be granted the World Council of Optometry's Global Seal of Acceptance for Ultraviolet Absorbers/Blockers.

Alcon Laboratories

Alcon announced that the U.S. Food and Drug Administration (FDA) has cleared OPTI-FREE® RepleniSH® Multipurpose Disinfecting Solution (MPDS) for all soft contact lenses including silicone hydrogel lenses. This new formulation is designed to

be compatible with silicone hydrogel lenses, the fastest growing lens material in the U.S.

"OPTI-FREE® RepleniSH™ MPDS is a significant advancement in the field of contact lens solutions," said Dr. Ralph Stone, Alcon vice president of Consumer Products and Clinical operations. "Our clinical research clearly demonstrates it was successful in promoting comfort for contact lens wearers. Additionally, OPTI-FREE® RepleniSH™ MPDS increased clinical comfort outcomes in patients

who experienced discomfort when wearing the most commonly prescribed contact lens materials. We expect OPTI-FREE® RepleniSH™ MPDS to strengthen our leadership position in contact lens care."

Distance Education: A Professor's Unique Experience Developing Online Instruction

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Abstract

Technologies available for distance education in the early 18th century were quite limited in comparison to present day possibilities, though the circumstances surrounding the necessity for offering academic materials in this format were very similar to those of today. The emergence of computer hardware technology, along with software and the internet, have made the delivery of education from a distance and online a reasonable possibility. This paper will discuss factors surrounding distance education and online instruction and how technologies allowed a University of Houston College of Optometry professor to apply this teaching modality from half-way around the earth.

Key Words: *Distance education, online instruction, instructional technology, alternative instruction*

Introduction

Typically, when we think of distance education, we think in terms of distance learning; i.e., the professor presents course materials from on campus to students dispersed throughout the "instruction" area, which can be almost limitless. The course may or may not be interactive between students and professor, and it may be presented in 'real-time' (synchronous) or 'cyber-time' (asynchronous), with the latter allowing the student freedom to access the course material at a time that is convenient for the student. In contrast to this scenario, I will describe a situation in which the professor is at a distant location while the students are on campus or anywhere else.

During the spring semester of 2003, while I was on sabbatical leave from the University of Houston College of Optometry (UHCO) to teach and consult in a new optometry program at Ramkhamhaeng University (RU) in Bangkok, Thailand, I conducted the UHCO Community Health Optometry course online from RU to the UHCO students in Houston. Most of my course materials were developed prior to leaving for Thailand, while the remainder was developed and uploaded from RU to a server at UHCO following my arrival in

Thailand. I met face-to-face with the students on the first day of class, departing for Thailand the following day. My active management of the course continued throughout the spring semester from Thailand.

The Community Health Optometry course contains a potpourri of information related to the profession of optometry and its role in the health care system of the United States, with an emphasis on the public health perspective. This required course is taught to approximately 100 second semester, first year professional students. As course master, I manage the course and present approximately 75 percent of the course information with the remainder being provided by guest lecturers. In previous years, all lectures were given in 'real-time' in the classroom. During the spring semester of 2003, my materials were presented online in 'cyber-time' while the guest lectures were presented in 'real-time' in the classroom. I remained accessible to and active with the students, visiting faculty, and the administration almost daily by way of the online course content, online discussion groups, and by email. A faculty member conversant in instructional technology acted as my liaison as needed.

A brief discussion of the historical development and of a few basic principles of distance education and online instruction will enable the reader to appreciate the uniqueness of my experience in utilizing this teaching modality.

Background

We usually think of optometric instruction as taking place in the classroom, laboratory, or clinic with student and faculty face-to-face. Newer technologies are offering alternative modalities for instruction. Teaching methods for instructing students when students and faculty have been in different locations have existed for many years. It has been reported that the first such instruction was a private course in shorthand offered in 1728. The University of Chicago offered correspondence courses beginning in 1892.¹ In these instances, course materials were delivered between faculty and students by mail. As technologies developed, courses were offered to students off campus in real time by radio and television broadcast, some courses by traditional broadcast media and some by satel-

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lite transmission from campus. In more recent years, utilization of the internet and computer technologies has become a popular choice for this type of education.²

Over time these technological advancements have offered students the opportunity to attend class online at a place and time convenient to their personal schedules. Course materials and activities are often offered in an asynchronous rather than in a synchronous manner. Time often becomes equally, if not more, important than distance for students who cannot attend courses on campus at specified times.¹⁻³

Online instruction has also made it possible for students to move at their own pace rather than being forced at the pace set by the professor's lecture.³ Classroom lecture-centered instruction is teacher-centered with students usually assuming the role of passive learners, whereas online instruction is learner-centered, especially when the learner must actively search and investigate the course materials of a well-designed online course. Likewise, when there are fewer constraints on the location and timing of the learning activity, students must assume more responsibility for their learning.²

Learning communities may be classroom centered, centered online, or some combination of these two settings, i.e., courses may present material only in the classroom setting, fully online and web-based, or they may be web-enhanced courses with significant instruction occurring in the classroom with support information being provided online.⁴ Students respond variably when asked which learning environment is preferred. The preferred learning community tends to be related to learning style preference. If a student has a preference for teacher-directed learning, then the classroom is preferred; if a student is more self-directed, then the preference is for independent study with the convenience offered by online instruction. By most reports, however, outcomes, as measured by student examination on course content, have been shown not to be significantly different among these instruction methods.^{1,4-8} Therefore, factors other than student-learning outcomes will determine whether online-assisted or online-based courses are employed.

The hardware supporting online instruction has made tremendous

advancements in recent years, but it is the development of advanced course management software that is playing a major role in the development of online courses. As faculty interest builds, the demand for user friendly course management software increases. Online instruction for health care professionals has grown within campus-based degree programs and for continuing education courses. In a few instances, some schools have offered online degree programs.¹

Having software that interfaces with the hardware and the internet in a user friendly way does not guarantee that online course content will be effectively delivered. Course design considerations become very important. Presenting course information online is quite different than speaking casually

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from lecture notes. In an online course, a small change in the lecture notes usually requires a complete revision of the affected online presentation. The revising and updating of course materials can make the maintenance of online courses quite time consuming.⁸ The time required to properly maintain an online course is generally greater than many first-time online faculty or administrators realize.

The following points, with some personal notes, are offered as important considerations during the development and delivery of an online course.^{9,10} Most would agree that these considerations are important, if not essential, to the development of any course, whether online or not. First, there must be a need for an online course in the subject area. Placing a course online just for the sake of placing a course online is little justification for using this course format. Some

courses may not be as suitable for online instruction as real-time presentations with face-to-face interaction between professor and students. Courses that require extensive instructor explanation of complex theory or process, or courses that require active interaction among students as part of the learning environment are examples of the latter. In many cases, however, the face-to-face classroom setting as a requirement may not be as essential as some may argue.

To put a course with student-professor interactivity online requires much planning and production detail to ensure the desired learning outcomes. The use of a high tech interface alone will not replace serious consideration of the targeted learning objectives and the teaching method. The choice of software for course presentation will depend on the familiarity of the professor with online instruction, the software, and availability of technical support. Having individuals proficient with instructional technology assist with the course design will improve the quality of an online course.

Planning for interactive components as part of the learning community helps to achieve desired outcomes. This interactivity may be only between the students and the online course materials; however, to develop meaningful learning communities, interactive relationships must also be developed between the students and the professor as well as among fellow students.^{2,11} Interactions among and between students and professor may be synchronous or asynchronous.⁶ The ability to communicate with the professor through email messages is also important; however, students should not expect the professor to be available all hours seven days a week. The professor should make every effort to reply to email messages from students in a timely manner, as well as to be available for 'office hours' online or in person where and when appropriate.

Another effective interactive tool is the online discussion. Asynchronous online discussions are more user-friendly for the student who wishes to post to the discussion at non-scheduled times. Discussion topics could be put forward by students or professor, but must be managed by the professor in such a way as to encourage students to think critically before posting responses. Rather than simply post-

ing observations, students should participate in thoughtful dialogue with fellow students and the professor. Asynchronous discussions offer benefit over classroom discussions in that students can enter the online discussion site, read the threaded conversation, think critically upon what has been said, and reflect upon how they will respond.¹² Comments can be written and edited prior to posting, which gives many students time for serious thought and comfort in a way they would not experience in a face-to-face classroom discussion. It has been found that those participating in thoughtful interactive online discussions earned higher grades than other students.¹² Effective participation by the professor in online discussions and instruction, whether synchronous or asynchronous, has been reported most productive when the class is about ten students in size.⁹ Within limits, the nature of the material being delivered and discussed is a factor in the class size that can be effectively managed in online discussions.

An essential element of online instruction is the evaluation of all course elements. The evaluations obtained from learner feedback are especially useful. Continuous monitoring for quality improvement is most important when introducing new online courses.^{11,13}

The Course

I became interested in the possibilities of emerging instructional technology for the first year Community Health Optometry course at UHCO several years ago after participating in a campus-wide three-day faculty workshop intended to inspire faculty to develop online instruction materials. Initially, I used the WEBCT courseware for online distribution of the syllabus and handouts, but did not post any direct instructional activities online. All lectures continued to be in real-time and face-to-face in the classroom.

When the opportunity came to participate in the developing optometry program at Ramkhamhaeng University in Bangkok, Thailand, as a World Council of Optometry Fellow, I needed to determine the best way to manage the Community Health Optometry course for which I had served as course master for some years. An option was to locate a substitute teacher for my activities, but I decided that a preferable option would be to

make the course a hybrid of online instruction from afar by myself and classroom instruction at UHCO by six guest faculty and presenters.

Upon consultation with Sam Hanlon, O.D., our UHCO consultant on instructional technology and the selected course liaison during my absence, it was suggested a web page be developed for the course using the course's syllabus as the format. An abridged copy of the syllabus appears in Appendix A of this paper for illustration purposes. In reviewing the accompanying syllabus, you will see for each class date the topic for that day's lecture and either the word "Classroom" or the word "Online." The word "Classroom" indicated to students that they were to go to the classroom for a real-time, face-to-face

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It has been found that those participating in thoughtful interactive online discussions earned higher grades than other students.

presentation. A click of the computer mouse on the word "Online" linked students to the PowerPoint slides with accompanying audio files for the presentation on the specified topic. When students scrolled to the Reading Assignment/References section of the syllabus for the date of any online presentation, they would see the highlighted word "Handouts," a click upon which would link to an outline of the lecture plus any other handouts that may be provided for that topic. Students could print these outlines and other handouts to follow while listening to the accompanying online lecture. In addition, the Reading Assignment/References section of the syllabus provided links to informational websites on the internet, as well as listing library reserve materials.

Very exciting online and classroom activities occurred simultaneously on March 24, 2003. The abbreviated syl-

labus (Appendix A) shows Drs. Ian Berger and me presenting on the topic of World Eye and Health Issues, with the class beginning 30 minutes earlier that day. My participation on that date was not absolute at the time of the distribution of the syllabus and, in fact, was not finally set until the week prior to that date, with success not being certain until the actual time of the class. On March 24 at 8:30 am Houston time and 9:30 pm Thailand time, I appeared in the classroom in Houston by way of a webcast (audio and video) from Chiang Mai University in the north of Thailand. Appearing with me was Jerry Vincent, O.D., a 1984 graduate of UHCO who had worked in Africa, Central America, and the Caribbean prior to going to Thailand in 1990. Over the years he has worked with several agencies, but for the past several years his primary employer has been the International Rescue Committee (IRC). Dr. Vincent has worked a number of years with refugees in Thailand, and more recently with those along the Thai-Myanmar border. He spoke to the students about refugee eye care in Southeast Asia in this interactive real-time format in which the students were given the opportunity to ask Dr. Vincent questions. The impact of this real-time online presentation on the students became quite evident from their comments made later in the asynchronous online discussion groups. The students were not only impressed with the technology and how small the world seems to have become, but also with this option of optometric service chosen by one of our alumni. Other than the high speed internet connection from the university in Chiang Mai, we were using a laptop computer with a small webcam. The Houston classroom had a large monitor and speakers designed to receive a webcast, and we were informed that the quality of both audio and video was quite remarkable and sufficient for the students in the large classroom.

An important new feature added to the course for this semester was an online asynchronous discussion for the students. The class was divided into six discussion groups with topics for discussion arising from the lecture topics. The students were encouraged to have meaningful dialogue between each other with my occasional input from Thailand. Approximately two-

thirds of the class of 100 participated in thoughtful dialogue in these discussions, with considerable evidence of critical thinking preceding most responses. This participation rate was greater than any I have experienced in face-to-face classrooms. In addition, I was available to the students by email for individual questions.

Discussion

I would like to compare my experiences with online teaching with some of the considerations from the literature presented above. First, there was a real need for placing my course material online at the time. The professor was going to be half-way around the world in Thailand, but needed to be active and available to his students in the Community Health Optometry class back on campus in Houston. The students had the flexibility of accessing the course online at any time and location throughout the week, twenty-four hours a day, so long as they had a computer with internet access. There was a definite advantage to having high-speed internet access, and this was available at the UHCO library.

Having technical assistance available was a necessity for me as we were using Macromedia's Dreamweaver to develop the webpage interface for the course. I could have used a 'packaged' courseware as WEBCTM, but we chose the flexibility of the chosen software. Course design and monitoring were very important to the success of the course. While this first attempt by the author was a greater success than anticipated, there were a number of areas identified as needing modification, and ongoing plans have been developed to continuously enhance the course. The time required for developing an interactive online course is more than most faculty and administrators initially imagine. Some may think that the only major time commitment is in the initial development; however, unless the material in a course remains constant, it will have to be updated on a regular basis. Changing a five-minute discussion point will typically require writing new script and re-recording the full lecture presentation; though the ability of software to seamlessly edit an online presentation will hopefully improve over time. The time required to deliver course components is a major consideration. Monitoring and

participation in online discussions and responding to email from students was time consuming. To have placed this course online without student access to the professor and each other to discuss and resolve issues or to expand concepts regarding the material would have made the course little more than a text book. The sheer size of the class, which far exceeded the recommended ten or so that is often recommended for interactive online discussions, made monitoring the online discussions extremely difficult. It was suggested to the students that the direction of the discussions should be between and among students with the professor monitoring and responding occasionally. I spent far more time monitoring and participating in the online discussions than I would have spent in the face-to-face classroom setting.

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and administrators
initially imagine.*

At the end of the course, the students were asked to give anonymous feedback regarding their experience in this online course. The responses covered the entire spectrum from grand approval to skepticism, with each response most likely associated with the student's preferred learning style. A few unedited student-evaluation comments may be seen in Appendix B, Student Evaluation Comments. I feel these student observations are representative of all the positive and negative comments received. The reader can see that some responses were thoughtful and will be of benefit when planning enhancements to this online course.

Summary

It is hoped that this professor's experience will encourage other optometry faculty to consider developing interactive web-enhanced or web-based courses. The benefit is not so much for students who prefer to 'attend' class away from campus as for flexibility in choosing a convenient

time to 'attend' class. Some may consider that this flexibility may allow students who lack self-discipline to fall behind; however, class assignments and examinations should encourage most students to keep up. An additional advantage is that professors can use a convenient time to end important lecture points rather than be bound to a 'lecture' hour. However, it is recommended that the students be made aware of the length of each online lecture presentation in order to plan their listening times. Of course, presentations can be in text format, but I chose PowerPoint with audio. As the reader has seen from this discussion, the sky is the limit when applying the latest instructional technologies.

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Appendix A Community Health Optometry Spring Semester 2003

Course Master and Lecturer - R. Norman Bailey, OD, MBA, MPH
Lecturer - Ian B. Berger, DrPH
Lecturer - Suzanne Ferimer, MSLS, MEd
Lecturer - Elizabeth Heitman, PhD
Lecturer - John W. Lewis, MD, JD
Lecturer - Jerald W. Strickland, OD, PhD

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Introduction

The Optometrist must work within the health care system in order to fulfill his/her responsibility to deliver quality, accessible and comprehensive eye and vision care services. This requires a knowledge base containing optometric diagnostic and therapeutic elements and a thorough understanding of the role of the optometrist in the current and evolving health care system. This course is designed to acquaint the student with the organization of the health care delivery system and to provide the underpinnings of the profession of optometry including its history, socio-economic, ethical and legal elements. In addition, the course will develop an understanding of components of the discipline of public health and the responsibility optometry holds in relation to the health of the greater community.

Course Objectives

By the completion of this course students will be able to:

1. Describe the nature of professions, professional behavior, and professionalism and to clearly distinguish between professionalism and commercialism.
2. Discuss the history and philosophy of the profession of optometry.
3. Characterize the roles of the optometrist and the profession of optometry in American health care.
4. Discuss the socioeconomic and legal aspects of the profession.
5. Describe the organization and administration of U.S. health care.
6. Define terms related to the U.S. health care system.
7. Recognize and describe community health concepts.
8. Design health education and self-care protocols and materials for optometric public health purposes, distinguishing between behavioral and educational objectives.
9. Define health care consumerism and pertinent issues thereof.
10. Define and describe the major terms and concepts of epidemiology.
11. Describe the major concepts of health screening in general and vision screening in particular.
12. Describe and exemplify principles of early intervention (preventive) ophthalmic public health practice.
13. Identify principles of ethics that apply to health care, describe the process of ethical decision-making, and recognize significant ethical issues in optometric clinical care and public health practice.
14. Describe the various roles an optometrist can serve in public health.

Grading Policy

Class participation in the real-time and online lecture classrooms and in your online electronic discussion group will be expected.....

This year, for the first time in the Community Health Optometry course, Dr. Bailey will be presenting his lecture material online through a website being maintained and monitored by UHCO. Any difficulties accessing these online materials should be addressed to the course liaison, Dr. Hanlon.

Participation in your online discussion group (not real-time) with Dr. Bailey is required

COURSE SCHEDULE

<u>Date</u>	<u>Topic</u>	<u>Instructor</u>
	<u>Course Orientation and the History of Optometry</u>	
6 Jan	Orientation to Community Health Optom - <u>Online & Classroom</u>	Dr. Bailey
	Historical Perspective of the Optometric Profession - <u>Online</u>	
	Introduction to Electronic Library Resources - <u>Classroom</u>	Ms. Ferimer

<u>Date</u>	<u>Topic</u>	<u>Instructor</u>
	Health Promotion and Disease Prevention	
13 Jan	Health Education & Behavior Modification I - <u>Classroom</u> Introduction	Dr. Berger
5 Feb	Assignments for the Health Promotion Project. Test Week	
11 Feb	Community Health Exam #1 Test Week	
	Epidemiology (The Basic Science of Public Health)	
13 Feb	Epidemiology I - <u>Online</u> Introduction and Definitions Epidemiologic Reasoning Brief History of Epidemiology & Public Health. A Brief Review of Some Basic Statistics	Dr. Bailey
*24 Mar	World Eye and Health Issues - <u>Classroom</u> *NOTE: Class begins at 8:30 am rather than the usual 9:00 am start time.	Drs. Berger and Bailey
26 Mar	Test Week Community Health Exam #2	
1 Apr	Test Week	
April 23 - May 2 Final Examination Week		

READING ASSIGNMENTS/REFERENCES

<u>Date</u>	<u>Topic</u>	<u>Chapters in Newcomb & Marshall</u>	<u>Classe</u>
6 Jan	Introduction Historical Perspective	2,3	1,5

Handouts

30 Jan	Economics, Gov't. Policy, Quality	10,11,14	2,17
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Handouts

On reserve in OPTO Library/Online:

*Classe JG. Release of spectacle prescription: an update. J Am Optom Assoc 1996; 67:631-7.

*Texas Contact Lens Prescription Act

www.capitol.state.tx.us/statutes/oc/oc0035300.html

*Texas Department of Health-Contact Lens Dispensing

<http://www.tdh.state.tx.us/hcqs/plc/contact.htm>

APPENDIX B Student Evaluation Comments

1. "The online class was a little different, but I think that it was definitely acceptable considering the material. He was always there to offer comments though. I would definitely say the online course could be considered a success."
2. "Don't particularly like listening to lectures online."
3. "I don't like the fact that we are taking a class where we don't have a professor. He is off in another country and we get stuck with doing lots of busy work like class discussions. It isn't that bad I guess."
4. "Although not in the country it felt like he was. It was a unique learning experience via the internet."
5. "The online lectures and discussion groups were great. The lectures could be livened up a bit...some put me to sleep. Other than that they were really helpful in understanding the material."
6. "The discussion boards were great because they stimulated the student's thought and allowed us to get to know one another better."
7. "Can you make it more exciting?"
8. "Online presentations were good, but wish it had a rewind button (not one that starts over from the beginning of the slide). Listening to the lectures online was tiresome due to the slowness and having to start over entirely when missed a point."
9. "Dr. Bailey made the material interesting and kept us thinking, even from the other side of the world. I feel I came away with a better understanding of optometry as a profession."

Technology Familiarity and Use Among Entering Optometry Students

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Elizabeth Hoppe, O.D., M.P.H., Dr. P.H., F.A.A.O.
Lucinda Hutchison, M.A.
Clifford Scott, O.D., M.P.H., F.A.A.O.

computer located in at least one administrative area and 98% also had Internet access,⁷ confirming the necessity of computer technology in a practice setting. The delivery of health care is also depending more and more on informatics. Informatics can be defined as the "development and application of information technology systems to problems in health care, research, and education."⁸ Informatics allows us to communicate, manage knowledge and information, mitigate error, and support decision making.⁹ For example, electronic medical records allow easy portability of a patient's complete health information between providers. They also allow clinicians to flag errors and participate as part of an interdisciplinary team, instead of an isolated practitioner. Furthermore, effective clinical practice mandates an evidence-based approach to ensure the best quality of care. Results of clinical trials, current practice guidelines and up-to-date medical information can be accessed electronically through the Internet.

Clinicians need to be prepared to deal with the changes in the methods of health care delivery. As a result, health profession schools have recognized the importance of developing informatics standards in their curriculum.^{10,11}

Studies show that computing skills have increased in medical schools¹² and optometry schools³ over the last six years. Other studies show that current medical students may be more comfortable using electronic information resources to answer clinical questions than the generations before them.¹³ To further understand this important topic, the New England College of Optometry (NEWENCO) developed a survey to learn more about the computing skills of its entering class. The survey also served to identify areas of weakness that need to be addressed in order to succeed in the didactic and clinical curriculum.

Methods

All entering optometry students at NEWENCO in the years 2002 and 2003 were asked to take a computer-based survey their first week at school. Surveys were administered during the library orientation using an Internet based survey site www.zoomerang.com. The survey was administered for two consecutive years, and the data was analyzed to determine the students' familiarity with, and use of, different forms of

Abstract

Purpose: To investigate technology familiarity and its use among entering optometry students.

Methods: All entering students at the New England College of Optometry in 2002 and 2003 were asked to take a survey regarding their computing skills and available off campus resources.

Results: Most students have access to a computer and Internet services while away from the college. Most students have used online technology to gather information and view course work. Entering optometry students are more familiar with computer technology today than they were in 1999.

Conclusions: We should take advantage of the entering students' computing skills to explore innovative ways of delivering optometric education, as well as to incorporate informatics into our curricula.

Keywords: Informatics, Information Technology, Optometric Education, Clinical Practice

Introduction

Computer technology can change the way we deliver education to health care professionals and students in training. Technology can be a good way of introducing new material to students in the health professions, as well as serving to reinforce concepts taught in the classroom.^{1,2} An additional advantage is that online course materials are available to students from anywhere, at anytime³ and support asynchronous learning as well as the development of life-long learning skills. Students should be trained how to gather information and solve problems using information technology, thus encouraging them to foster learning skills that will continue into practice.⁴ As curricula are placing greater emphasis on problem-based learning and case-based approaches to the delivery of information, information technology has the potential to play an even greater role.^{5,6}

After graduation, information technology and computing resources continue to play a predominant role in optometric practice. Administratively, computer technology has changed the way we run our clinics, from appointment scheduling to billing third party payers. A recent survey of physicians showed that 98% of physicians had a

Dr. Farra is associate professor at the New England College of Optometry (NECO). Dr. Hoppe is associate dean for academic affairs at NECO. Ms. Hutchison is director of library services at NECO and co-chair of ASCO's Optometric Informatics SIG. Dr. Scott is a professor at NECO.

technology. The results of this survey have been described using frequency distributions and proportions. The results were also compared to previously published reports of optometry students and use of technology using the z-test for two independent proportions.¹⁴ The survey consisted of nine questions shown in Appendix A.

Results

In the fall of 2002, 96 students enrolled in the Class of 2006 completed the survey for a response rate of 100%. In 2003, 103 students enrolled in the Class of 2007 completed the survey for a response rate of 93%.

The most frequently used information technology resources are library online catalogs and e-journals, with 87% and 78% (respectively) of students reporting use at least "every once in a while" in 2003 (Figure 1). The vast majority of students (78%) have had some type of exposure to online course software prior to their enrollment in optometry school, with the most commonly used type being Blackboard® and WebCT® (Figure 2). Most students reported that they would have access to a computer while not at the college (Figure 3), with the majority using PC-based systems (Figure 4). Most students do not plan to bring a laptop to school but approximately one-fourth of the class uses a personal digital assistant (PDA) or Palm Pilot™ (Figure 4). PDAs are used primarily for personal and scheduling purposes, with very few students using this resource for downloadable books or databases. Most students have high-speed Internet access either through DSL or cable modem (Figure 5). No significant differences were found between the entering class of 2002 and 2003 at NEWENCO.

Selected NEWENCO survey questions were compared with published results from a similar student survey conducted in 1999 at the Indiana University College of Optometry (IU).³ A statistically significant difference was found between the two groups when comparing the number of IU students who owned a computer (1999) with the number of NEWENCO students who reported that they would have access to a computer off campus (2003). A statistically significant difference was also found between the two groups when comparing the number of IU students who owned a modem (1999) with the number of NEWENCO students who

Figure 1
Proportion of Students Who Have Used Information Technology

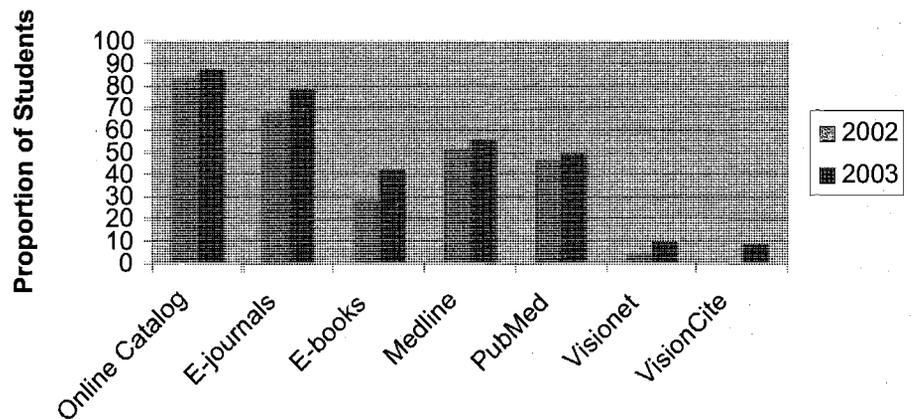


Figure 2
Use of Technology Software to View Syllabus/Lecture Notes

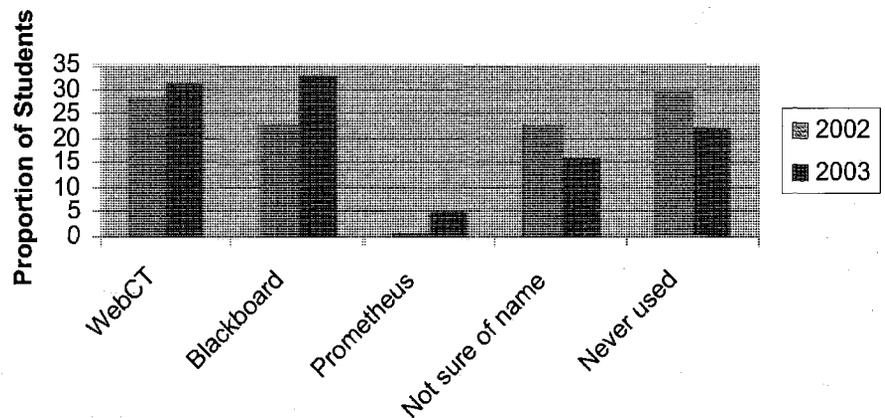
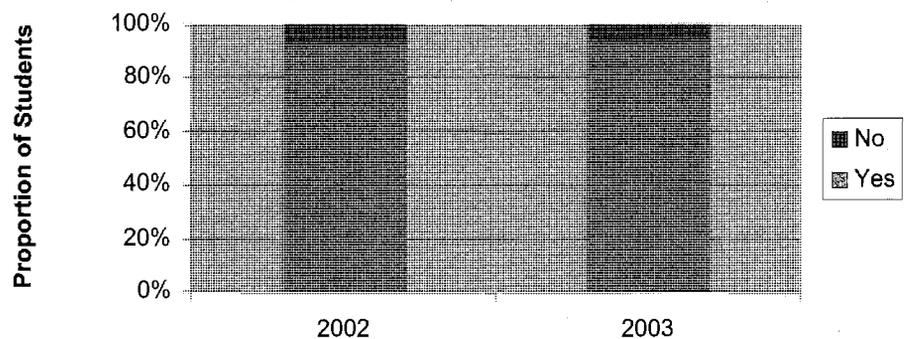


Figure 3
Proportion of Students Having Access to a Computer Outside the College



intend to have Internet access off campus (2003). While owning a modem does not necessarily determine Internet access (modem can be used solely for fax), this number overestimates, if any-

thing, those using the Internet at IU (1999), making a significant difference more difficult to achieve. No difference was found between the proportion of DOS/Windows based computers ver-

Figure 4
Computing Equipment Available to Students
Outside the College

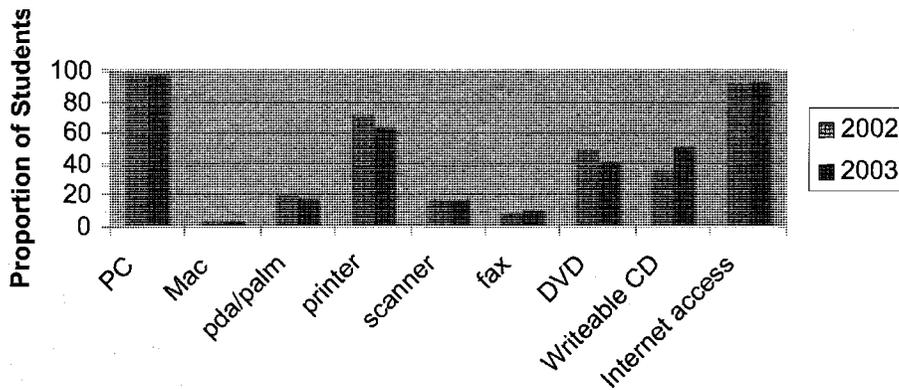
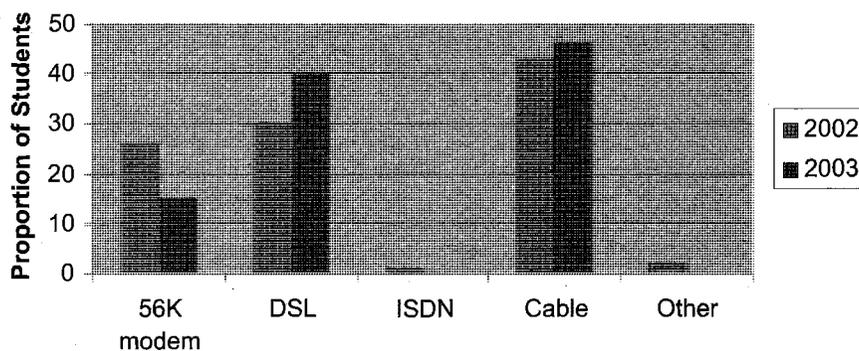


Figure 5
Types of Internet Access Available to Students Off Campus



sus Mac based computers between NEWENCO (2003) and IU (1999). The results of these comparisons are summarized in Table 1.

Another survey administered at the Southern College of Optometry (SCO) addressed the use of electronic information searches to complete an electronic media paper (EMP) assignment.¹⁵ A comparison was made between the proportion of students at SCO (1999) who have used Visionet at least once prior to the EMP assignment to the proportion of students at NEWENCO (2003) who have used Visionet services before starting at the college. No significant difference was found between these two groups.

Discussion

Because of greater access to computers, today's entering optometry students may be more familiar with computer technology than those in

1999. This increase in the utilization of computers and other information technology among optometry students mirrors that found in a survey of medical residents and faculty.¹² The authors of that study note that the increase in computing skills appears to be due solely to societal reasons and changes in device functionality but not due to any changes in their medical school curriculum or extra training activities. This also appears to be the case in optometric education.

As an educational institution, we should take advantage of the increase in computing skills by supplementing coursework with Internet-based learning opportunities. This survey shows that most students will have access to personal computers and Internet services off campus, which further promotes the idea of virtual teaching in conjunction with classic teaching methods. The optometric curriculum has been expanding with-

out extending the length of the program; therefore we need to use classroom time more efficiently and find other ways of delivering information to students outside the classroom.³

It is interesting to note that there was no significant difference in the reported use of Visionet between newly enrolled optometry students (NEWENCO 2003) and those who were immersed in an optometric curriculum but before a required electronic media paper assignment (SCO 1999). This suggests that, in addition to having the proper resources, students must be exposed to and taught how to use these electronic information sources before they can effectively use this pool of information. It is further interesting to note that 24% of NEWENCO students have reported use of Visionet prior to their enrollment in optometry school. Perhaps pre-optometry course work or an interest in vision research has allowed them to work in a vision laboratory where they needed to use the Visionet software. Knowledge and familiarity with this type of vision-specific database indicates a further depth and sophistication beyond casual Internet searching.

Handheld computers, or personal digital assistants, are being widely embraced by health care providers and in medical and nursing education.¹⁶⁻²² PDAs can be used to access patient data, as a clinical reference tool, to track patient encounters and procedures done during medical school rotations and residency training,¹⁸ and as a teaching resource for real time clinical teaching and data collection.²¹ PDAs are expected to become an increasingly important part of clinical practice in the near future.²³ It is anticipated that 50% of all physicians will use PDAs as a point-of-care medical informatics tool by 2005.²¹ Our survey found that 18% of the entering optometry students use PDAs; however, their use is confined to personal scheduling and personal information. If our students are not encouraged to use PDA's as part of their optometric curricula, we as health professionals, might find ourselves behind others in getting easy access to useful clinical data.

Clinical practice is also becoming more technologically demanding. Students will need to adapt to keep up with current modes of practice including electronic medical records and advanced eye care diagnostic technologies such as HRT, OCT, GDx, and digital photography. Furthermore,

Table 1: Comparisons Between Different Surveys

IU Survey Question Data from 1999	% distribution	% distribution	NEWENCO Survey Question Data from 2003	% distribution	% distribution	z-score
Do you own a computer?	Yes 60%	No 40%	Will you have access to a computer when you are not at the College?	Yes 94%	No 6%	-5.49; statistically significant difference*
If you own a computer, what kind is it?	DOS/ Windows 93%	Mac 7%	Select all the computing equipment that will be available to you on a daily	DOS/ Windows 97%	Mac 3%	-1.63
If you own a computer, do you have a modem?	Yes 58%	No 42%	Do you intend to have internet access off campus while you are at the College?	Yes 92%	No 8%	-5.31; statistically significant difference*
SCO Survey Question Data from 1999	% distribution	% distribution	NEWENCO Survey Question Data from 2003	% distribution	% distribution	
I used the Visionet at least once to find information for a required assignment at SCO before the EMP assignment	Yes 40%	No 60%	How often have you used these services in other libraries (visionet)?	All other choices 24%	Never or don't know about it 76%	0.65

electronic ways of communication and gathering information are becoming the standard of care. Current medical students have been exposed to personal computing throughout their education and will welcome electronic methodologies given the resources.¹³ One of our duties as an educational institution is to teach our students these skills before they start to deliver clinical care.

Currently there is a deficiency in our educational system in informatics. Students might be taught specific skills in information technology, but they are not taught how to use these skills in the clinical setting. Research has shown that medical residents' familiarity with desktop computing and software applications for productivity does not correlate with knowledge in medical informatics, suggesting that even students who may be knowledgeable about general computing topics lack the skill set to apply information technology to clinical care.²⁴ Informatics standards are being developed in schools of medicine and optometry for a variety of reasons such as increasing success in today's health care environment, making appropriate clinical decisions, and optimizing opportunities for continuing education beyond professional school.²⁵ However, the field of informatics is changing so quickly that it can be difficult to design a curriculum to meet the needs of student clinicians

once they graduate. Skills taught should be flexible and plastic in order to allow clinicians to build up proficiency and manage future informatics effectively. In one program, significant barriers to the introduction of medical informatics education have been identified that include an unclear understanding of the discipline, faculty and administrative detractors, and the demanding and dense undergraduate medical curriculum.²⁶

Along with the development of curricula, means for assessing its effectiveness must be considered. Guidelines for evaluating students' informatics competency and suggestions for computing infrastructure²⁵ would be beneficial for all of the schools and colleges of optometry. Adequate computer resources for both students and faculty are critical. One study found that a lack of sufficient computing resources is the most significant barrier to effective computer use.¹²

Furthermore, faculty mentors are also being asked to serve as role models to help students develop skills in the use of informatics and to use information in evidence-based practice. Support of faculty is crucial and studies have shown that faculty education in informatics can change the culture within medical residency programs to increase the use of computers and the Internet as a source of up-to-date information.^{27,28}

Conclusions

As optometric educators, we should incorporate health care information technology and informatics into our curricula, as well as explore new and innovative ways of delivering information to our students.

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(Continued on page 63)

ColorSpace: Educational Software for the Interactive Demonstration of CIE Color Space Manipulations in the Classroom

Scott B. Steinman, O.D., Ph.D., F.A.A.O.

Abstract

An understanding of CIE color space is critical to one's grasp of the clinical diagnosis of color vision deficiencies. ColorSpace is an educational computer program that interactively demonstrates color specification, additive color mixture and color complements in CIE color space. It allows the classroom instructor to explore the following principles about color:

- Combination of red, green and blue primaries to create colors
- Specification of colors as hue, saturation and brightness
- Dominant wavelength and excitation purity of colors and mixtures
- Mixture of colors in CIE color space
- Position of the white point in the CIE diagram
- Movement of a color towards the white point or the spectral locus with changes in saturation
- Independence of CIE coordinates on brightness
- Location of a complement relative to the white point
- Mixture of complementary colors to create an achromatic tone

ColorSpace is the first donation to the planned ASCO Informatics SIG repository of open-source optometric educational software.

Keywords: Software, vision science, color vision

Introduction

One of the difficult topics for optometry students to conceptualize during their vision science education is that of the CIE color space diagram.¹ However, an understanding of CIE color space is critical to one's grasp of the clinical diagnosis of color vision deficiencies, especially the design and interpretation of pseudoisochromatic plate tests, panel tests such as the Farnsworth D-15 and Farnsworth-Munsell 100-hue tests, and the Nagel anomaloscope.^{2,3} In addition, the National Board Examination often contains questions that require knowledge of CIE color space.

The CIE diagram, color specification, additive color mixture, and color complements are typically explained in the classroom through the use of static PowerPoint slides displaying one or two examples of the mixture of colors with the graphical determination of dominant wavelength and excitation purity, and a slide showing the graphical representation of complementary colors. It is therefore not surprising that students often have difficulties in conceptualizing the application of the CIE diagram or do

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not retain this knowledge.

The ColorSpace CIE color space educational program addresses this problem by dynamically and interactively demonstrating the location of colors, color mixtures and color complements directly in CIE color space.

Program Features

ColorSpace allows the instructor to specify colors in either RGB (red/green/blue) format or HSB (hue/saturation/brightness) format to demonstrate how different proportions of color primaries (RGB) or changes in saturation and brightness affect both the resultant color and its CIE color coordinates. Two colors may be mixed in various proportions, with the mixture displayed in the main window, and plotted on the CIE color diagram by means of matrix mathematics calculations.⁴ A color's complement may be displayed and plotted on the CIE color diagram.

A full help system provides information about color definition, CIE color space, and how to control the ColorSpace program.

Classroom Instruction Using ColorSpace

Color Specification

Colors are specified using the sliders in the group boxes labeled **Color 1** and **Color 2** on the left hand side of the main color specification window. There are two ways to specify colors, which are determined by the popup menu above the color boxes: (1) as combinations of red, green and blue primary colors (RGB), or (2) as hue, saturation and brightness (HSB).

In RGB mode, the instructor can demonstrate that colors can be specified as combinations of three primaries - red, green and blue - roughly analogous to the CIE diagram's x , y and z components (Figure 1). In this mode, the amount of red in the color is set with the slider marked **R**, green with the **G** slider, and blue with the **B** slider. Above each slider, a colored circle shows the amount of that particular primary. The resulting color is updated dynamically in the large round field on the right side of the group box as its red, green and blue components are altered. When this is done in the **Single Color** display mode, the **Color 2** and **Results** group boxes are deactivated.

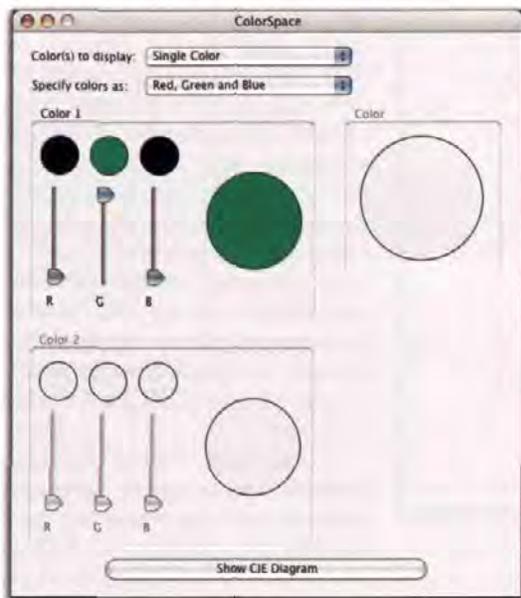
In HSB mode, the instructor can demonstrate that colors can be speci-

fied by three color dimensions - hue, saturation and brightness (Figure 2). The sliders are now labeled to reflect their new roles. In this mode, hue is set by the **H** slider. This is analogous to setting the mean wavelength of light. The hue can be seen in the circular field

above this slider. Saturation is determined by the **S** slider. This changes the "purity" of the color. When the slider is at its maximum, the color is pure (in the real world, this would mean it is restricted in the range of wavelengths comprising it). As the slider is moved

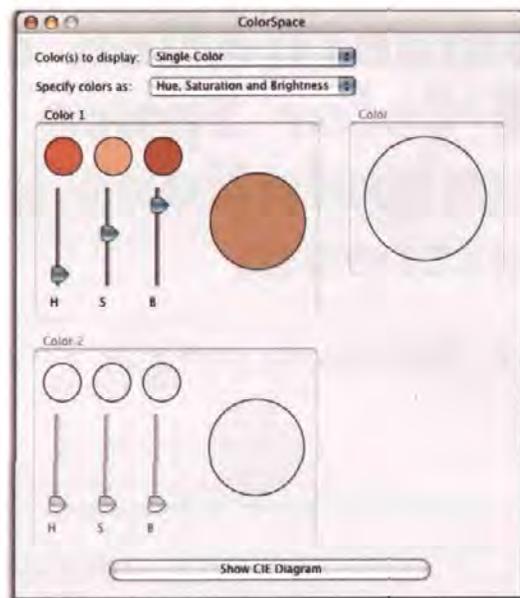
downward, the color is desaturated, or made less colored, by adding an achromatic component (white, gray, or black). When the slider is at its minimum, there is no hue at all, and a pure white, gray, or black results, depending upon the brightness setting. The satu-

Figure 1: The Main Color Specification Window



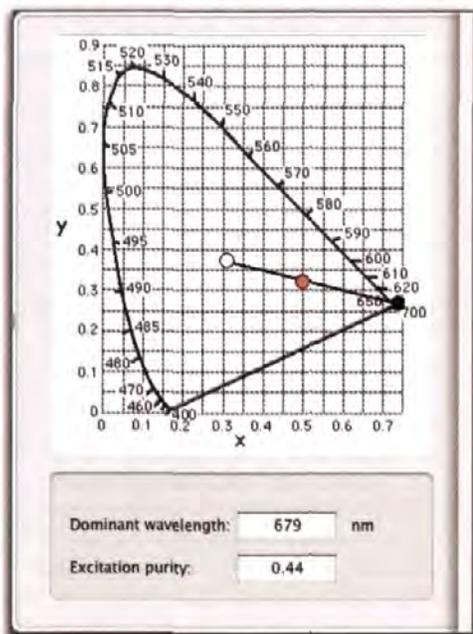
This window allows the selection of two colors, plus their mixture and the complement of the mixture. In this figure, a single color is displayed, with RGB color definition mode selected; colors are defined by a combination of red, green and blue primaries. The amount of each primary is reflected in the ovals above the sliders that control each primary. The resulting color is displayed in the large oval within the Color 1 box.

Figure 2:



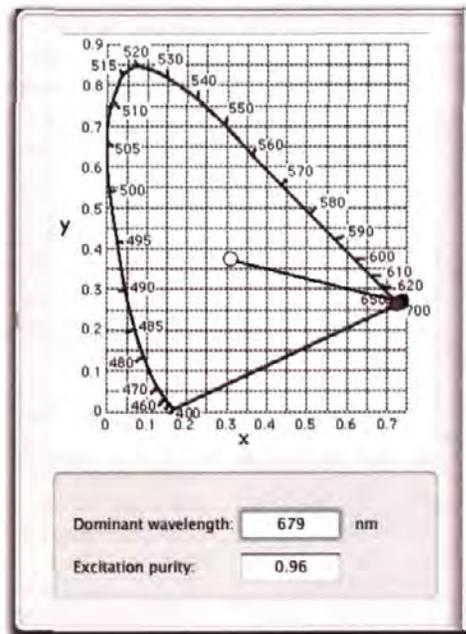
Here the color definition mode is set to HSB, in which colors are defined by hue, saturation and brightness. The labels for the sliders are changed to reflect their new functions, and the ovals above the sliders display the color's hue, saturation, and brightness, respectively.

Figure 3: The CIE Color Diagram Drawer



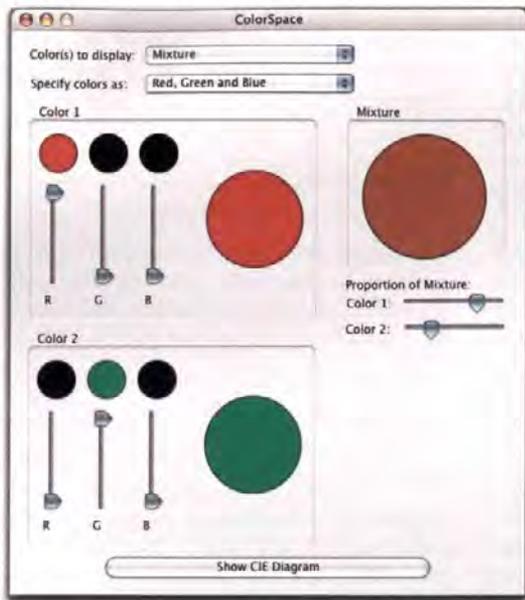
Desaturating a color moves its coordinates towards the center (white point) of the CIE plot. The dominant wavelength (apparent hue) and excitation purity (saturation) of the color are displayed graphically on the CIE diagram and numerically at the bottom of the drawer.

Figure 4:



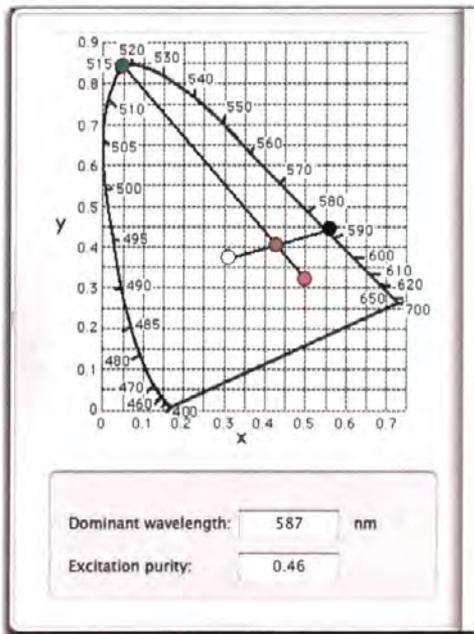
Reducing the brightness of a color does not alter its coordinates on the CIE diagram.

Figure 5: Mixture Mode in the Main Color Specification Window.



The mixture is displayed in the box on the right of the window. Sliders under this box control the proportion of color 1 and color 2 in the mixture.

Figure 6



On the CIE diagram, mixtures of two colors fall on a line connecting the two component colors in the mixture.

Figure 7

A color and its complement are displayed.

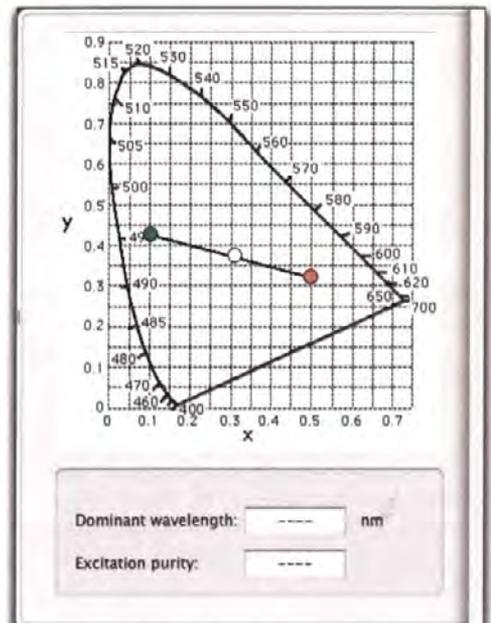


Figure 8

When two complementary colors are mixed in equal amounts, the result is achromatic. In this case, a gray is produced.

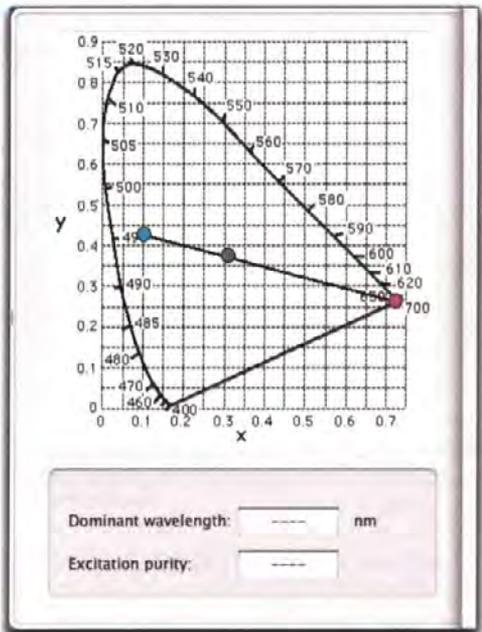
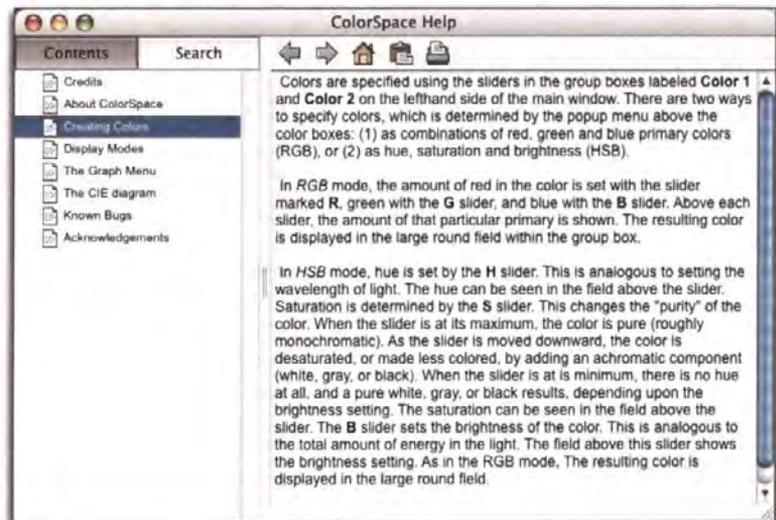


Figure 9: The ColorSpace Help System



ration can be seen in the circular field above the slider. The B slider sets the brightness of the color. This is analogous to the total amount of energy in the light. The circular field above this slider shows the brightness setting. As in the RGB mode, the resulting color is updated dynamically in the large round field.

Color Coordinates on the CIE Diagram

By clicking on the **Show CIE Diagram** button, a drawer opens that displays a graph of the CIE color space (Figure 3). The colors created in the main window will be displayed in this color space according to their chromaticity coordinates. The application uses the matrix mathematics techniques of Spiegler⁴ to determine the CIE coordinates of a color, color mixtures and color complements.

Effects of Hue, Saturation and Brightness on CIE Coordinates

Figure 3 shows that desaturating a color moves its coordinates towards the center (white point) of the CIE plot. However, the CIE diagram does not represent brightness at all. As expected, reducing the brightness of color 1, defined as a pure red, does not alter its coordinates on the CIE diagram (Figure 4). If a relatively desaturated color is selected by the instructor in HSB mode, changing its hue alone will cause the plotted point on the CIE diagram to encircle the white point of the plot in an oval path.

Color Mixtures on the CIE Diagram

In *Mixture* display mode (Figure 5), the **Color 2** group box and its contents are activated, as is the **Results** group box. **Color 1** and **Color 2** are mixed together and the result displayed in the **Results** group box's circular field. **Color 1** and **Color 2** are mixed together with sliders that appear underneath the **Results** group box. These sliders work as a team so that the amount of color 1 and color 2 covary and are always proportional; that is, increasing the amount of color 1 decreases the amount of color 2 to keep the total at 1.0. As the sliders are changed, the mixture is updated dynamically.

On the CIE diagram (Figure 6), the two original colors are displayed, plus a line connecting them. All mixtures of two colors in CIE space must lie on a line connecting the component colors. As the proportion of one component color in the mixture is increased, the

mixture point moves towards that component's coordinates. The displayed color and coordinates of the components and mixtures are modified dynamically on the CIE plot as the component colors and the mixture are changed by the instructor.

Also displayed is a line from the white point in the center of the graph through the mixture point to the horse-shoe-shaped *spectral locus*, where fully saturated monochromatic spectral hues are located. The intersection of this line with the spectral locus is the *dominant wavelength*, which represents the hue that the mixture appears to be. The distance of the mixture point along this line to the spectral locus represents its *excitation purity*, or saturation; the closer the mixture point to the center of the graph, the less saturated the color, and the closer to the spectral locus, the more saturated. At the bottom of the CIE diagram drawer are text boxes showing the numerical values of the dominant wavelength and excitation purity.

The mixture point, its dominant wavelength, and its excitation purity are all dynamically updated if the components' colors or their proportions in the mixture are altered by the instructor.

Complementary Colors on the CIE Diagram

In *Complement* mode, the **Results** box now displays the color that is complementary to **Color 1**. A mixture of equal amounts of the mixture and its complement would yield an achromatic result - white, gray, or black. On the CIE diagram (Figure 7), **Color 1** and its complement are both plotted. Here, too, the displayed color and coordinates of the mixture and its complement are modified dynamically on the CIE plot as the component primaries of Color 1 are manipulated by the instructor.

By definition, complementary colors add up to white (or shades of gray). When in mixture mode, if the instructor sets color 1 and color 2 to be complementary colors, a mixture of equal amounts of the two colors will be achromatic (Figure 8).

Color Gamuts and the CIE Diagram

The *ColorSpace* program assumes that the displayed colors span the full range of the CIE diagram. This is not technically correct, since LCD monitors cannot display fully saturated red, green and blue primaries. Therefore, the resulting plot is idealized, that is, it makes concepts easy to explain, but

does not accurately reflect the true colors of the LCD monitor.⁵

Help for the Instructor

ColorSync provides a complete help system to guide the instructor using the program as an instructional tool (Figure 9).

Future Directions

At present, the *ColorSpace* application plots the mixture of two colors defined by the user and displays its appearance. A future version will allow the mixture of more than two colors.

Availability

The *ColorSpace* program is available free of charge from the author to all optometric educators as a service to the profession. It represents the first donation to the ASCO Informatic SIG's proposed repository of open-source optometric educational software. It is hoped that this repository will be used as a resource shared by and contributed to by all colleges of optometry for the improvement of optometric education through computer technology. The compiled *ColorSpace* program may be downloaded from <http://homepage.mac.com/drsteinman/>. The program source code is available from the author at Steinman@sco.edu.

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Appendix A

NEWENCO Survey of Computing Equipment and Skills Administered to the Entering Classes in 2002 and 2003

1. The Library provides access to many types of services. How often have you used these services in other libraries?

1. Library's Online Catalog	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it
2. E-journals	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it
3. E-books	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it
4. Medline	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it
5. PubMed	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it
6. Visionet	Never	Rarely	Every once in a while	Regularly	Every Day	Don't know about it

2. Did you ever use online course software that enabled you to review syllabus and lecture notes, take exams, and do other course related activities electronically? If yes, select the software below that you used. If no, just click never used.

- | | | |
|------------------------------|---------------|---------------|
| 1. WebCT | 2. Blackboard | 3. Prometheus |
| 4. Used but not sure of name | 5. Never used | |

As we evaluate new Library services and products, it is helpful for us to know what types of computing equipment are available to you. The following 6 questions are to help provide us with an overview of your current computing situation.

3. Will you have access to a computer when you are not at the College? Yes No

4. If you answered Yes in question #3, select all the computing equipment that will be available to you on a daily basis. If you will not have access to a computer off-campus, proceed to question #6.

- | | | |
|------------------|-----------------------------------|----------------|
| 1. PC Desktop | 2. PC Laptop | 3. MAC Desktop |
| 4. MAC Laptop | 5. Palm Pilot or other PDA device | 6. Printer |
| 7. Scanner | 8. FAX | 9. DVD |
| 10. Writeable CD | 11. Other | |

5. If you have a laptop, do you expect to carry it to school?

- | | |
|--------------------------|----------------|
| 1. Always | 2. Quite often |
| 3. Every once in a while | 4. Rarely |

6. If you have a palm pilot or PDA, please describe how you use it.

7. Do you have or intend to have Internet access off campus while you are at the College? Yes No

8. Select the type of access you have or are likely to purchase.

- | | | | | |
|----------------------|--------|---------|----------------|----------|
| 1. 56k dial-up modem | 2. DSL | 3. ISDN | 4. Cable Modem | 5. Other |
|----------------------|--------|---------|----------------|----------|

9. What library services would you find helpful in supporting your work here at the New England College of Optometry?

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*O₂OPTIX Dk/t = 138 @ -3.00D. NIGHT & DAY Dk/t = 175 @ -3.00D. Other factors may impact eye health.

Important information for O₂OPTIX: For daily wear or extended wear for up to 6 nights for near/farightedness. Risk of serious problems (e.g., corneal ulcer) is greater for extended wear. In rare cases, loss of vision may result. Side effects like discomfort, mild burning or stinging may occur.

Brief statement of intended use: NIGHT & DAY lenses (tetraflouren A) are indicated for daily wear or extended wear for up to 30 continuous nights. Warning: The risk of serious ocular complications is greater for extended wear as compared to daily wear of contact lenses and smoking increases the risks. The long-term risk of microbial keratitis has not been determined for this lens. Post-marketing studies are in progress. Precautions: Not all patients can achieve the maximum wear time of up to 30 nights of continuous wear. Patients should be monitored closely during the first month of 30-night continuous wear. The maximum suggested wearing time should be determined by the eye care professional based upon the patient's physiological eye condition because individual responses to contact lenses vary. Side effects: Irritative keratitis was reported at a rate of approximately 5% during the one-year US study of 1300 eyes. Other side effects included conjunctivitis, GPC, and lens discomfort, including dryness, mild burning, or stinging. Contraindications: The lens should not be used when an inflammation or infection of the eye is present, or when there is any disease or injury in or around the eye or eyelids. The lenses should not be used by individuals who have medical conditions that might interfere with contact lens wear. Consult the package insert for complete information about NIGHT & DAY lenses, available without charge from CIBA Vision Corporation at 1-800-241-5999 or cibavision.com.

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