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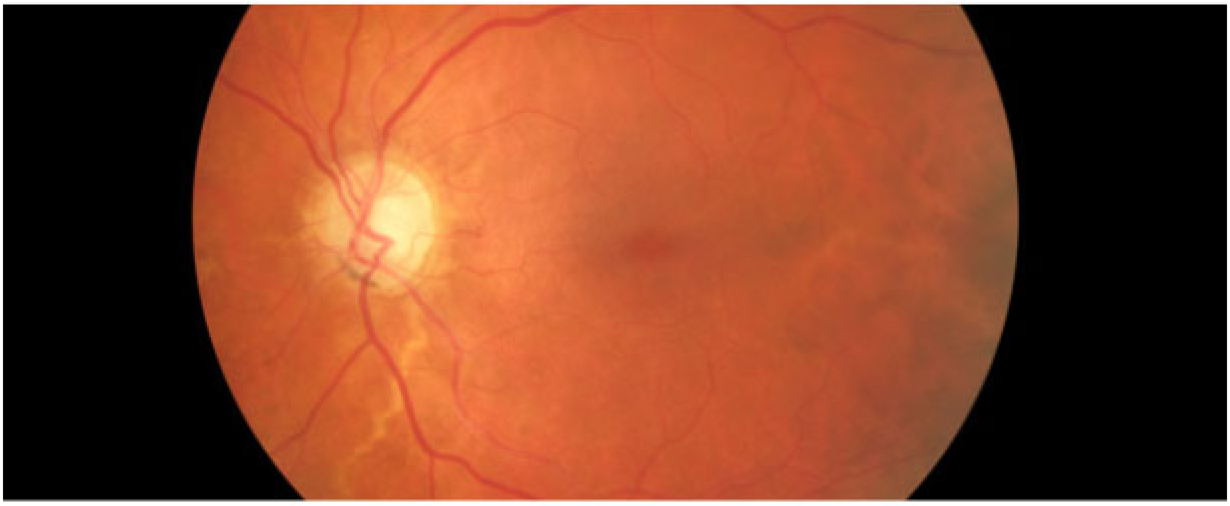

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Virtual Patient Instruction and Self-Assessment Accuracy in Optometry Students

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Abstract

We tested the hypotheses that virtual patient instruction aimed at developing clinical decision-making skills in second-year optometry students in the United Kingdom (UK), is (1) associated with improved self-assessment accuracy, and (2) that this occurs regardless of academic ability, gender or learning style. Self-assessment accuracy, the difference between perceived mastery (questionnaire) and actual mastery (multiple-choice examination), was determined for five learning objectives: question selection, critical symptom recognition, test selection, critical sign recognition and referral urgency. Virtual patient instruction was not associated with improved self-assessment accuracy, which was generally poor across all learning objectives. There was evidence of over-estimated self-assessment in students, especially males, with poorer academic performance. Opportunities for optometry students to develop self-assessment skills should start early in the academic program and be reinforced throughout the entire curriculum.

Key Words: *self-assessment accuracy, clinical decision-making, virtual patient, academic ability, gender, learning style*

Introduction

Decision-making in a clinical context is defined as "making choices between alternatives in order to decide what procedures to do, to make a diagnosis, or to decide what treatments to prescribe."[1] We developed a virtual patient software to teach these skills to second-year optometry students at Aston University. This software was inspired by Pane and Simcock's textbook "Practical Ophthalmology: a Survival Guide for Doctors and Optometrists," which promotes a symptom-based approach.[2] The intended learning objectives are shown in **Table 1**.

Table 1. Click to enlarge

Clinical instructors are required to assess students' clinical decision-making skills. This often takes place in training clinics where clinical instructors supervise groups of students. Group supervision makes it difficult, even when eye examinations are recorded on video, to provide timely feedback on every clinical procedure carried out by each student. Using virtual patient software, which automatically records every student decision via the keyboard and mouse, students can obtain immediate and consistent formative and summative feedback. Previous research has shown that assessments made by clinical supervisors can be inconsistent because assessment criteria can vary between supervisors, and the grades given by individual supervisors can vary on different occasions.[3] Virtual patient software overcomes this by operating via consistent grading criteria. Thus, virtual patient instruction has the advantage of allowing unlimited risk-free and self-paced opportunities to apply clinical decision-making skills. In addition, virtual patient software can be programmed to simulate any desired eye condition, ensuring that students are exposed to an ample variety of pathologies during their training.

Accurate self-assessment can be an indicator of student ability to understand their own strengths and weaknesses and to recognize areas in which further practice is required to achieve mastery. In this regard, we believe that teaching methods should be designed to promote accurate self-assessment regardless of learning style, academic ability or gender. In this study, we evaluated whether virtual patient instruction was associated with student variations in self-assessment accuracy regarding specific elements of clinical decision-making skills. In the context of the study, self-assessment accuracy refers to how well a student's perceived confidence in his or her mastery of the learning objectives listed in Table 1 reflects actual mastery. Self-assessment accuracy has been studied in students of various disciplines,[4-9] including optometry,[5] and some evidence that it is influenced by learning styles,[6] academic ability[6,7] and gender has been presented.[8,9] However, the effect of virtual patient instruction on the accuracy of self-assessment of clinical skills remains largely unknown.

In this study, for all learning objectives shown in Table 1, we tested the following hypotheses:

1. Better self-assessment accuracy occurs with virtual patient instruction because it facilitates unlimited practice and exposure to feedback that encourages students to re-evaluate their perceived skills
2. Self-paced virtual patient instruction gives all students an equal opportunity to improve self-assessment independently of student learning style, gender and academic ability

Methods

Ethics

This study adhered to the tenets of the Declaration of Helsinki and was approved by Aston University's Research Ethics Committee. Voluntary informed consent was obtained from all participants before any data were analysed.

Study design

Two cohorts of second-year optometry students participated in the study. The first cohort entered the course the year before the second cohort. Both cohorts received the same course content in which 22 types of presentation were covered: 10 presenting symptoms, such as vision loss and diplopia, and 12 presenting signs, such as eyelid spasm and anisocoria. These presentations covered more than 100 eye conditions.

For the first cohort (no virtual patient instruction; control group) classes were organized into nine two-week blocks in which students (a) received a didactic lecture, (b) applied what they had been taught over a period of one week by completing an online quiz, and (c) attended a class tutorial to discuss the same cases (constituting formative assessment). The online quiz aimed to evaluate students' ability to determine the most likely diagnosis and referral urgency of three cases (for which immediate summative assessment was given). As time did not allow for 22 teaching blocks, corresponding to the 22 types of presentations, some of the nine blocks covered just one symptom or sign whereas others grouped several symptoms or signs into one block. The structure of each didactic lecture led students systematically through the five learning objectives.

For the second cohort (virtual patient instruction; intervention group) classes were organized into 20 one-week blocks in which students (a) received a tutorial covering the virtual patient "at a glance" guides, and

(b) had unlimited practice on the virtual patient over a period of one week, in preparation for (c) online virtual patient assessments. This allowed enough time for all teaching blocks to cover just one symptom or sign except for two of the teaching blocks, which covered two presenting signs each.

The virtual patient was designed to provide a more interactive environment that matched, as closely as possible, the "natural flow" of an eye examination. Students were required to choose questions to ask based on the patient's chief complaint, and to choose clinical tests to look for signs that would lead them to the most likely diagnosis and appropriate referral urgency. The virtual patient responded to questions and revealed symptoms and signs in the form of text and images. All findings were available for review in a virtual eye examination record. At the end of the examination, the virtual tutor provided formative feedback on every decision entered by the student, via the keyboard or mouse. Summative feedback was also provided based on the chosen questions, tests, diagnosis and urgency. Points were discounted for incorrect procedures such as failure to carry out pre- and post-dilation checks or attempting to look for a sign before selecting the required test.

During the unlimited practice sessions, students in the second cohort could switch the virtual patient to teaching mode. Here, the virtual tutor showed the "at a glance" approach guides mentioned above before directing students through each step and demonstrating how this altered the list of differential diagnoses. The virtual tutor also presented "pop-up" messages explaining the significance of any critical symptoms and signs. The intention here was for students to acquire background knowledge and clinical reasoning more as an apprentice does when observing a master than a scholar would do when reading a book. Students were able to choose a specific case or have one randomly selected from the database.

Participants

Second-year UK optometry students, most of whom had entered the program directly from high school, participated in this study. The first year of the degree program covers basic sciences including ocular biology, geometric optics and basic clinical techniques. Pre-clinical skills are developed during the second year, mainly on fellow students, and include the eye examination, contact lenses and advanced clinical techniques. Clinical practice dominates the third year and involves direct patient care at various clinics such as primary care, contact lenses, spectacle dispensing, binocular vision, low vision and ophthalmology. After graduation, students enter a pre-registration training program that lasts approximately a year. This postgraduate training is spent under the supervision of a qualified optometrist either in private practice or a hospital setting. During this last part of their training, graduates are required to pass further assessments to become registered as qualified optometrists.

The first study cohort (no virtual patient instruction; control group) consisted of 102 students (62 females and 40 males). The second cohort (virtual patient instruction; intervention group) consisted of 93 students (64 females and 29 males). All students in the classes to which both cohorts belonged were invited to participate (118 students in the first cohort; 120 students in the second cohort) but some refused consent (16% of the first cohort; 22.5% of the second cohort).

Perceived mastery

Table 2. Click to enlarge

Perceived mastery was a self-assessed measure of the students' own perception of their confidence in the five learning objectives (Table 1). Previous literature has referred to this as "self-efficacy."[10] A questionnaire was released two weeks before the end of the academic year with a one-week deadline. The questionnaire **(Table 2)** contained items that corresponded directly to the five learning objectives. Students responded to each question using a five-level Likert score, which was converted to a percentage such that 0% corresponded to a Likert score of 1 (“strongly disagree”) and 100% to a score of 5 (“strongly agree”).

Actual mastery

Table 3. Click to enlarge

Following previous research,[1] actual mastery was determined using end of year multiple-choice examinations. Both student cohorts were assessed by means of identical multiple-choice examinations. Aston University’s rules require that a proportion of multiple-choice examinations are altered each year. This was adhered to but still allowed for 25 multiple-choice questions, five per learning objective, to remain unchanged between both examinations. Example questions are shown in **Table 3**, one for each learning objective. Actual mastery scores represented the percentage of the five questions correctly answered for each learning objective.

Self-assessment accuracy

Self-assessment accuracy was initially determined by subtracting the actual mastery percentage from the perceived mastery percentage.[12] Self-assessment accuracy was then classified into three groups: over-estimation, for percentage differences greater than zero; under-estimation, for percentage differences less than zero; and accurate, for percentage differences equal to zero.

Academic ability

Academic ability was based on the average grade achieved by each student across all second-year modules in sessional examinations performed at the end of the academic year.[13] Academic grading in the UK is typically defined as follows: first class (score of 70-100%); upper second class (60-69%); lower second class (50-59%); and third class (40-49% score). A score below 40% is considered a failing grade. Students must achieve a lower second class grade or higher to progress onto the pre-registration program. All students participating in this study were in the tier of first class, upper second class or lower second class.

Learning style

During the first half of the course, all students completed the established Index of Learning Styles questionnaire.[13] Students were initially classified along the four learning style dimensions: active-reflective, sensing-intuitive, visual-verbal and sequential-global. The four dimensions were then combined so that each student was re-classified as falling into one of 16 possible learning style profiles.[13]

Statistical analyses

Decision trees, a form of multivariate analysis, were generated using SPSS 21.0 (IBM SPSS Statistics) and findings were tested for statistical significance at the 95% level ($P<0.05$). Multivariate analyses eliminate confounding by accounting for all variables at once. Decision trees adopt a hierarchical output, where independent variables (i.e., virtual patient tuition, academic ability, gender and learning style) are shown in order of the strength of their association with the dependent variable (i.e., self-assessment accuracy). The most and least influential variables appear at the top and bottom of the trees, respectively. Branches only form for statistically significant associations.

The Chi-squared automatic interaction detection (CHAID) tree-growing method was adopted. Other researchers in the field of optometry have reported using the same method.[14] Our study variables were categorical; therefore, Chi-square was used as the splitting criteria for generating decision-tree branches, and Bonferroni adjustments were applied to p-values to account for multiple tests. Decision trees consist of parent nodes that branch into child nodes. In our study, the minimum sample size for parent and child nodes was set at 30 and 15, respectively. By default, SPSS sets the maximum tree branching levels to three. We increased this to five (one more than the number of independent variables) to ensure maximum tree growth was achieved.

We made power calculations using GPower (version 3.1.0.).[15] In our case, because any changes to teaching would require significant resources, we argue that it would only be justifiable to base changes on statistically significant findings for large effects. The highest degrees of freedom (df) required in our study was 30, i.e., 1 minus 3 levels of self-assessment accuracy (over-estimated, accurate and under-estimated) multiplied by 1 minus 16 learning style profiles (2 x 15 = 30 df). We calculated that a total sample of 99 students was required to enable Chi-square tests with 30 df to detect statistically significant large size effects at the 95% level of statistical significance with 80% power, a conventionally acceptable power.[16-17] Our total sample of 195 students far exceeded this.

Results

The decision trees in **Figures 1 through 4** show which of the independent variables (i.e., student cohort, academic ability, gender and learning style) were associated with self-assessment accuracy for each learning objective. “Question selection” decision tree is shown in Figure 1, “critical symptom recognition” in Figure 2, “critical sign recognition” in Figure 3, and “referral urgency selection” in Figure 4. No decision tree is shown for “test selection” as none of the independent variables was associated with self-assessment accuracy for this learning objective.

Figure 1. Decision tree showing statistically significant (P < 0.05 after correction for multiple comparisons) associations between academic ability, gender and self-assessment accuracy for the “question selection” learning objective (Table 1) for second-year optometry students (n = 195). This is a form of multivariate analysis that removes confounding between the independent variables entered (i.e., student cohort, academic ability, gender and learning style) before showing the remaining associations in hierarchical order (strongest to weakest). Each node of the decision tree shows the number (n) and percentage (%) of students for which self-assessment was over-estimated, under-estimated or accurate. Node 0 (the tree trunk) shows that accurate self-assessment was only found in 29.7% of the students for this learning objective. Academic ability showed the strongest association (first branching level leading to nodes 1 and 2, P = 0.002) in which self-assessment was over-estimated more often in students with lower grades (node 2: 49.5%) compared with those with higher grades (node 1: 23.9%). Decision tree analysis automatically governed assignment of students with first class, upper second class and lower second class grades as being of higher or lower academic ability. For students with lower grades, gender showed a slightly weaker association (second branching level leading to nodes 3 and 4, P = 0.024) in which self-assessment was over-estimated more often in males (node 4: 62.5%) compared with females (node 3: 41.3%). Click to enlarge

Root nodes (node 0) in each decision tree allow for comparison of the self-assessment accuracy measured for all 195 students across each learning objective. In the case of “test selection” (decision tree not shown), accurate self-assessment occurred in less than one-third of the students (28.2%, 55 students), being over-estimated (43.1%, 84 students) and under-estimated (28.7%, 56 students) in the remainder. This reflected a general trend across all learning objectives in which self-assessment was accurate for 26 to 31% of students and inaccurate for 69 to 74% of students (Figures 1 through 4).

The presence or absence of virtual patient instruction was only associated with variations in self-assessment accuracy for “critical symptom recognition” (Figure 2). Here, 61.3% of the cohort with virtual patient instruction showed over-estimated self-assessment compared with 35.3% of the cohort without this type of instruction. Academic ability was associated with self-assessment accuracy for all learning objectives except “test selection” (Figures 1 to 4). Here, over-estimation was more common in students with lower grades (37 to 76% of students depending on the learning objective) compared with those with higher grades (14 to 50% of students depending on the learning objective). Gender was only associated with self-assessment accuracy for “question selection” (Figure 1) in lower academic achievers, where over-estimation was more common in males (63%) than females (41%). Finally, learning style was not associated with self-assessment accuracy for any of the learning objectives considered.

Discussion

In this study, we investigated the potential effects of virtual patient instruction in student self-assessment accuracy. For that purpose, we selected a set of specific elements of clinical decision-making (“question selection,” “critical symptom recognition,” “test selection,” “critical sign recognition” and “referral urgency”) as variables within two student cohorts that were trained in classes that either lacked (i.e., control group) or included (i.e., intervention group) virtual patient instruction.

Our first working hypothesis was that, for the five learning objectives, better self-assessment accuracy would occur with virtual patient instruction. However, our results did not support this hypothesis. Virtual patient instruction was only associated with self-assessment accuracy for the learning objective “critical symptom recognition” and had the detrimental effect of increasing the proportion of students over-estimating their skills (Figure 2; 61.3% for teaching with virtual patient instruction [in node 1] compared with 35.3% for teaching without virtual patient instruction [in node 2]). Therefore, our notion that unlimited practice on the virtual patient would lead to improved self-assessment skills was not supported by the findings of the study.

Our second hypothesis was that self-paced virtual patient instruction would give all students an equal opportunity to improve self-assessment independently of student learning style, gender and academic ability. Our results did not support this hypothesis either. The associations detected between self-assessment accuracy and academic ability (Figures 1 to 4) and gender (Figure 1) were independent of the presence or absence of virtual patient instruction. In fact, our findings indicated that students exposed to virtual patient instruction were more likely to be left with an unrealistically high level of confidence in their ability to recognize symptoms of serious disease (Figure 2) and might, therefore, be unaware of their need for further study to improve this skill.

The lack of any positive association between self-assessment accuracy and virtual patient instruction was surprising in a generation of students that favor “concrete experience” and “active experimentation.”[18] Despite this finding, virtual patient instruction remains part of our second-year clinical decision-making course. Student satisfaction scores for this course have ranged from 89% to 96% since it was introduced, with virtual patient instruction often placed at the top of a “what has worked best for you” list of effective learning resources. Interestingly, a previous study at the Rosenberg School of Optometry concluded that use of interactive learning material for first-year gross anatomy classes did not improve test scores but did increase motivation.[19] Perhaps virtual patient instruction was beneficial for student learning on the basis that it motivates students rather than improves self-assessment accuracy.

Figure 2. Decision tree showing statistically significant ($P < 0.05$ after correction for multiple comparisons) associations between student cohort (i.e., the presence or absence of virtual patient instruction), academic ability and self-assessment accuracy for the “critical symptom recognition” learning objective (Table 1) for second-year optometry students ($n = 195$). This is a form of multivariate analysis that removes confounding between the independent variables entered (i.e., student cohort, academic ability, gender and learning style) before showing the remaining associations in hierarchical order (strongest to weakest). Each node of the decision tree shows the number (n) and percentage (%) of students for which self-assessment was over-estimated, under-estimated or accurate. Node 0 (the tree trunk) shows that accurate self-assessment was only found in 29.2% of the students for this learning objective. Student cohort showed the strongest association (first branching level leading to nodes 1 and 2, $P < 0.001$) in which self-assessment was over-estimated more often in students that received virtual patient tuition (node 1: 61.3%) compared with those that did not (node 2: 35.3%). Academic ability showed a slightly weaker association (second branching level leading to nodes 3 and 4, $P = 0.041$ and nodes 5 and 6, $P = 0.023$) in which, for both cohorts, self-assessment was over-estimated more often in students with lower grades (nodes 4 and 6 for the first and second cohorts: 75.6% and 65.0%, respectively) compared with those with higher grades (nodes 3 and 5 for the first and second cohorts: 50.0% and 28.0%, respectively). Decision tree analysis automatically governed grouping. Therefore, the assignment of students with first class, upper second class and lower second class grades as being of higher or lower academic ability differed for students with or without virtual patient instruction. Confounding variations in the academic ability, gender mix and learning styles in both cohorts (the first cohort studied the year before the second) were effectively accounted for in this analysis so that any associations remaining were most likely due to the presence or absence of virtual patient tuition. Click to enlarge

An interesting finding of our study was that self-assessment accuracy, for clinical decision-making skills at least, seemed generally poor across all learning objectives: 29.7% for “question selection,” 29.2% for “critical symptom recognition,” 28.2% for “test selection,” 26.2% for “critical sign recognition” and 30.8% for “referral urgency.” These findings corroborate earlier studies involving practitioners (practicing physicians, nurse practitioners and physician assistants) of a continuing medical education course on knee joint injection[9] and junior medical officers carrying out routine skills during their first postgraduate year.[20] However, accurate self-assessment has been reported in other studies involving third-year optometry students[5] and computer engineering students.[6] A systematic review[7] of studies that included practicing physicians, residents or similar health professionals from the United Kingdom, Canada, United States, Australia or New Zealand concluded that physicians had a limited ability to accurately self-assess and that more advanced students and practitioners showed better self-assessment skills.

Our data suggested that academically stronger students were less likely to over-estimate their performance on four of the five learning objectives: “question selection” (Figure 1; 23.9% over-estimation in node 1 for stronger students compared with 49.5% in node 2 for others), “critical symptom recognition” (Figure 2; 50.0% and 28.8% over-estimation in nodes 3 and 5 for stronger students compared with 75.6% and 65% in nodes 4 and 5 for others), “critical sign recognition” (Figure 3; 41.3% in node 1 for stronger students compared with 61.2% in node 2 for others), and “referral urgency” (Figure 4; 14.1% in node 1 for stronger students compared with 36.9% in node 2 for others). Thus, our data was in agreement with some of the previously published work and suggested more developed metacognition skills in the stronger students' group.

Nevertheless, a study on third-year students at the New England College of Optometry (NECO) showed that optometry students were competent at self-assessment of their clinical skills.[5] These students were asked to self-assess their knowledge base and clinical skills. The clinical instructor supervising each student also evaluated the students using the same criteria. Students' and instructors' grades correlated to at least the 95% significance level ($P < 0.05$).[5] We did not find statistically significant correlations between perceived mastery (self-assessment) and actual mastery (exam performance) for any of the five learning objectives we assessed (data not shown). So why did our study findings differ from those obtained at NECO? Several factors could have led to the differences observed. For instance, our students were in the second year of an undergraduate optometric program while the students from NECO were in the third-year of a doctoral program. In addition, perhaps different methods were utilized to measure self-assessment accuracy in each study.

We found that males who were academically weaker were prone to over-estimate their performance for the learning objective "question selection" (Figure 1; 62.5% in node 4 for males with second class grades compared with 41.3% in node 3 for females with second class grades). This also corroborates previous research on medical students taking part in a third-year surgery rotation,[8] practitioners undergoing continuing medical education,[9] and a meta-analysis of self-assessment in medical students.[12] The first of these studies[8] was designed to determine the ability of medical students to perform self-assessment. Data collected on medical students in their third-year surgery clerkship indicated that women under-estimated their performance and yet outperformed men. The second of these studies[9] investigated how confidence, background, education and skills influenced a practitioner's belief that he or she was qualified to perform a knee joint injection during a continuing medical education session. Participants completed questionnaires gauging confidence and self-assessment before and after instruction. Self-assessments were compared with actual performance on a simulator. Instruction improved confidence, competence and self-assessment, but men disproportionately over-estimated their skills and this worsened as confidence increased. The meta-analysis[12] was conducted to gain a greater understanding of self-assessment accuracy in medical students. Its findings raised the importance of conducting analyses on factors that influence self-assessment accuracy, including gender. The studies analyzed indicated that female students under-estimated their performance more than male students and that gender analyses were often unreported.

Figure 3. Decision tree showing the statistically significant ($P < 0.05$ after correction for multiple comparisons) association between academic ability and self-assessment accuracy for the "critical sign recognition" learning objective (Table 1) for second-year optometry students (n = 195). This is a form of multivariate analysis that removes confounding between the independent variables entered (i.e., student cohort, academic ability, gender and learning style) before showing the remaining associations in hierarchical order (strongest to weakest). Each node of the decision tree shows the number (n) and percentage (%) of students for which self-assessment was over-estimated, under-estimated or accurate. Node 0 (the tree trunk) shows that accurate self-assessment was only found in 26.2% of the students for this learning objective. Academic ability showed the only association (one branching level leading to nodes 1 and 2, $P = 0.013$) in which self-assessment was over-estimated more often in students with lower grades (node 2: 61.2%) compared with those with higher grades (node 1: 41.3%). Decision tree analysis automatically governed assignment of students with first class, upper second class and lower second class grades as being of higher or lower academic ability. Click

to enlarge

In contrast to the previously mentioned study on computer engineering students,[6] our results showed that learning style profile was not associated with self-assessment accuracy. It has been suggested that teaching methods that are adapted to include both poles of the four learning style dimensions would be close to providing the optimal learning environment for most students.[21] Therefore, the lack of any associations could be a positive finding as it suggests that our course on clinical decision-making, with or without virtual patient instruction, catered well to all learning styles. On a cautionary note, however, the study on computer engineering students made use of a more objective self-assessment scale and could, therefore, have been better set up to detect subtle variations associated with learning style.[6]

Study Limitations

The small size of each student cohort allowed us to achieve enough statistical power to detect associations with large size effects between virtual patient instruction, academic ability, gender, learning style and self-assessment accuracy. We believe, however, that only associations with large size effects justify changes to teaching practice, which would require substantial amounts of time and resources.

The first and second cohorts of students were recruited from classes that entered in different years. This could be a potential flaw in the study as the composition of classes can differ from year to year so that direct comparisons are confounded. The multivariate analyses carried out in this study do, however, provide protection against unsafe comparisons as they remove confounding. That is, yearly variations in the academic ability, gender mix and learning styles in both cohorts were effectively accounted for in our analyses. Therefore, any associations between virtual patient instruction and self-assessment accuracy represent only those that occur after removal of other confounding associations.

Like our virtual patient, the Ocular Disease Diagnostic Tutor (ODDT) software developed at NECO for fourth-year optometry students,[22] enabled self-paced study. The ODDT was comprised of five activities: (1) interactive topic files providing background knowledge, (2) recognition exercises introducing clinical terms, (3) diagnostic cases testing recall of background knowledge and clinical terms, (4) clinical reasoning cases requiring formulation of differential diagnoses and treatment plans, and (5) interactive quizzes. Similar to our virtual patient, the ODDT software was designed to encourage problem-solving rather than factual recall.[22] As mentioned in the Methods section, our virtual patient provided background knowledge via “at a glance” guides and allowed students to interact with a virtual clinical environment in order to demonstrate: 1) application of background knowledge, 2) recognition of critical symptoms and signs, 3) clinical reasoning, and 4) the use of appropriate terminology when recording clinical findings and selecting the most likely diagnoses and appropriate treatment plans. Despite similarities in the design concept of the virtual patient and ODDT software, ODDT was designed for fourth-year optometry students. This may explain, at least in part, why the results from the studies at NECO and our school differ.

Figure 4. Decision tree showing the statistically significant ($P < 0.05$ after correction for multiple comparisons) association between academic ability and self-assessment accuracy for the “referral urgency selection” learning objective (Table 1) for second-year optometry students ($n = 195$). This is a form of multivariate analysis that removes confounding between the independent variables entered (i.e., student cohort, academic ability, gender and learning style) before showing the remaining associations in hierarchical order (strongest to weakest). Each node of the decision tree shows the number (n) and percentage (%) of students for which self-assessment was over-estimated, under-estimated or accurate. Node 0 (the tree trunk) shows that accurate self-assessment was only found in 30.8% of the

students for this learning objective. Academic ability showed the only association (one branching level leading to nodes 1 and 2, P = 0.001) in which self-assessment was over-estimated more often in students with lower grades (node 2: 36.9%) compared with those with higher grades (node 1: 14.1%). Decision tree analysis automatically governed assignment of students with first class, upper second class and lower second class grades as being of higher or lower academic ability. Click to enlarge

Our questionnaire on perceived mastery was not validated on an independent student population; therefore, its reliability could not be determined. Interestingly, the systematic review on the accuracy of physician self-assessment[7] found that most studies had used self-assessment questionnaires that had not been validated. This was also true for some of the studies on medical students or practitioners cited above.[8,9] The study involving computer engineering students used an objective self-assessment scale based on Bloom's Revised Taxonomy.[6] Use of a similar scale in our study might have allowed detection of subtle variations associated with learning style and may also be a valuable tool for future studies on the improvement of self-assessment in students as they progress through undergraduate and postgraduate optometric training.

We had developed a notion that unlimited self-paced virtual patient instruction would give all students an equal opportunity to improve self-assessment independently of student learning style, gender and academic ability. On reflection, we missed an opportunity to test this notion more thoroughly. Had we monitored how many times students accessed the online virtual patient for self-paced practice purposes, we might have obtained the data to better explain our findings. For example, we might have found that students were not taking the opportunity to practice, or that gender and academically ability influenced the level of engagement in self-paced practice. This will be a potentially valuable avenue for further study.

Conclusion

The findings of this study suggested that our second-year optometry students had poor self-assessment accuracy in relation to the clinical decision-making learning objectives shown in Table 1, and that the use of virtual patient instruction was not associated with an improvement in self-assessment accuracy. Student feedback, nevertheless, indicated that virtual patient instruction helped them to learn. We also observed that lower academic ability, especially in males, was associated with over-estimated self-assessment. Previous research carried out on improving self-assessment skills[4, 23] has led to the suggestion that curricula should include opportunities for students to develop self-assessment skills early in their degree programs, and this should be reinforced throughout the entire curriculum.[4] Additional research is needed to evaluate the efficacy of different instructional methods in promoting self-assessment accuracy in students. Data generated through these studies will aid in the design of successful implementation protocols that could be adapted and incorporated into the optometric curriculum.

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Features

Editorial

Keeping Disruptive Technologies in Perspective

Aurora Denial, OD, FAAO | Optometric Education: Volume 43 Number 2 (Winter-Spring 2018)

Aurora Denial, OD, FAAO

In 1997, in his book "The Innovator's Dilemma," Prof. Clayton Christensen from Harvard Business School introduced the term "disruptive technology."[1] In the book, Christensen distinguishes sustaining technology from disruptive technology. He characterizes sustaining technologies as those that introduce small changes that improve the performance of an existing technology. He describes disruptive technologies as those that displace an established technology, and thus "shake up" an industry, or ground-breaking products that create a completely new industry.[2] Often, disruptive technology can underperform established technology, at least in the short term.[1] However, according to Christensen, products based on disruptive technologies are typically cheaper, simpler, smaller and frequently more convenient to use. Some examples of disruptive technologies (and the technologies/conventions they displaced): the personal computer (typewriter), health maintenance organizations (conventional insurers), transistors (vacuum tubes), cell phones (land lines), laptop computers (desktop computers), smartphones (cell phones).[1,2]

Disruptive Technologies in Eye Care

At a recent continuing education event at the New England College of Optometry, Dr. Howard Purcell, a Senior Vice President at Essilor of America, spoke about how disruptive technologies are impacting the profession of optometry. He urged practitioners "to look at the disruptive technologies and understand the value they can bring to your practice."[3] Dr. Purcell talked about smart phone apps, online and remote refractions, 3D printing, virtual reality devices and wearable technology. Also on the horizon is artificial intelligence software, which allows a computer to analyze conditions, symptoms, clinical findings, diagnosis and treatment.[4] In 2013, at the 90th annual SECO International meeting in Atlanta, Dr. David Talley, who practices in Memphis, Tenn., described trends and technology in the profession. Trends included refractive lasers, expansion of scope of practice including the use of injectable medications such as Botox and minor surgical procedures.[5] Technology included gene chip analysis, radio frequency technology, plasma surgery and tissue engineering and biomechanics, which includes organ regeneration and replacement, wound healing and adhesion.[5]

Adding Forward Thinking to the Skill Set

Optometric educators have a responsibility to provide students with the knowledge and practical skills that will enable them to practice in the world of today and tomorrow. Therefore, fostering an aptitude for forward thinking is a worthy goal. But how do we create a culture of forward thinkers both for faculty and students that embraces future technology and trends, yet acts in a responsible manner to ensure the safety of patients and a sound learning environment? We can nurture and support the characteristics that define a forward thinker. Although these characteristics are somewhat arbitrary, several that make sense to me are identified in the literature. Forward thinkers embrace both critical and creative thinking.[6] Critical thinking ensures complete, unbiased thinking whereas creative thinking ensures that people are thinking outside of the box and creating a new vision.[6] These qualities are particularly important for evaluating new technologies or trends. Forward thinkers do not dwell on the past.[6] They learn from the past but do not reside in the past. They have the ability to see the larger picture and set goals for the future.[6] Forward thinkers embrace risk-taking and persevere even if initial ideas are unsuccessful.[6] They tend to possess "intellectual empathy, which is an awareness of the need to actively entertain views that differ from your own, especially those with which you strongly disagree."[6,7] This allows insight into different points of view and the capability to be receptive to new ideas. In academia, nurturing these characteristics involves creating an environment of trust, support and respect.

Future optometrists, throughout their careers, will evaluate and make decisions on the incorporation of technology into practice, changes in scope of practice and utilization of current trends. Technology, either sustaining or disruptive, represents tools for the profession. Disruptive technology has the potential to alter the appearance of the optometric setting and patient interaction. However, as disruptive as it may be, technology will never replace the clinical judgment, knowledge and communication that defines the profession of optometry. In the educational arena, faculty are constantly forming a balance between letting go of the past and incorporating the future in a responsible manner. Supporting a culture of forward thinkers supports the future of the profession.

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Industry News

Special Announcement

It’s Time to Apply for a 2018 Educational Starter Grant

Desiree Ifft | Optometric Education: Volume 43 Number 2 (Winter-Spring 2018)

ASCO and The Vision Care Institute, LLC, an affiliate of Johnson & Johnson Vision Care, Inc., are pleased to announce the opening of the application period for the 2018 Educational Starter Grants.

The grants, which have been available for the past several years, are dedicated to supporting educational research. They are a great opportunity for faculty to get involved in conducting educational research, which impacts teaching, student learning and the profession.

Interested faculty can find information about the grants, past successful grant proposals and the current application at the ASCO website under Awards & Grants Opportunities. Completed applications should be submitted electronically to Sara Lau by midnight, July 24, 2018.

Industry News

Educator's Podium

When Early Intervention Fails to Improve Outcomes in Neovascular AMD

Ryan Bulson, OD, MS, FAAO, and Ambar Faridi, MD | Optometric Education: Volume 43 Number 2 (Winter-Spring 2018)

In the Summer 2017 (Volume 42, Number 3) issue of *Optometric Education*, we presented a teaching case report titled "Normotensive Glaucoma Follow-Up with Incidental Finding of Choroidal Neovascular Membrane." The case highlighted the need for student clinicians to be flexible and modify their exam plan when novel clinical findings emerge. The patient had presented for a Humphrey visual field test and glaucoma follow-up and was incidentally found to have a minimally symptomatic choroidal neovascular membrane resulting from conversion of non-neovascular to neovascular age-related macular degeneration (AMD) **(Figures 1 and 2)**.

Figure 1. Fundus photo OD on 06/28/16 showing a mottled appearance of the macula with several small and intermediate drusen and large central-superior subretinal hemorrhage.
Click to enlarge

Figure 2. Optical coherence tomography five-line raster scan of the macula OD on 06/28/16 showing drusen and pigment epithelial detachment with overlying subretinal fluid causing macular elevation.
Click to enlarge

Figure 3. Optical coherence tomography five-line raster scan of the macula OD on 7/26/16 showing reduction in the height of the pigment epithelial detachment and resolution of subretinal fluid.
Click to enlarge

The neovascular membrane was presumably discovered relatively early because the patient first began experiencing blurred vision only one week prior. She was seen same day in the retina service and found to have a fibrovascular pigment epithelial detachment (FVPED) with exudation, subretinal fluid (SRF) and large central subretinal hemorrhage (SRH). She subsequently received an intravitreal injection of bevacizumab (Avastin). Following a loading dose of three monthly bevacizumab injections, the scotoma, SRF and SRH resolved **(Figure 3)**. After the fourth monthly injection, because the patient had presented with a large SRH, a "treat and extend" rather than an "as needed" treatment strategy was selected.

Case Update

Figure 4. Fundus photo on 11/16/16 showing new large central subretinal hemorrhage and bullous sub-retinal pigment epithelium hemorrhage.
Click to enlarge

Figure 5. Optical coherence tomography five-line raster scan of the macula OD on 11/16/16 showing massive worsening of the pigment epithelial detachment with fluid, retinal pigment epithelial tear and subretinal hyper-reflective material.
Click to enlarge

Unfortunately, despite the early intervention with significant anatomic improvement, the patient's visual outcome was poor. Findings remained stable at the five-week extension visit, i.e., the SRF or SRH had not recurred. Therefore, another bevacizumab injection was given, and a six-week extend period was pursued. Despite the stabilization of the condition, three weeks after the fifth injection, the patient urgently presented with a dramatic reduction in vision and new large scotoma. Her uncorrected visual acuity had dropped from 20/40 at the previous visit to 20/400 (eccentrically). Ophthalmoscopic exam showed a new large central SRH involving the entire macula and a retinal pigment epithelium (RPE) tear with bullous sub-RPE hemorrhage **(Figure 4)**. Macular optical coherence tomography (OCT) supported the exam findings, showing dramatic worsening of the PED and new RPE tear with subretinal hyper-reflective material **(Figure 5)**.

The patient was treated with an intravitreal injection of aflibercept (Eylea) 2 mg and scheduled for a two-week follow-up visit. At follow-up, she reported only minimal improvement in vision. Visual acuity was finger counting at three feet (eccentrically). Ophthalmoscopic exam showed persistent subretinal and sub-RPE hemorrhage, and OCT showed no appreciable change. Treatment with Eylea was continued at two- to four-week intervals in an effort to resolve the hemorrhage and reduce the risk of re-bleeding **(Figures 6-7)**. Despite several months of aflibercept treatment (total of 8) and resolution of the large hemorrhage, vision improved only minimally to 20/200 due to the RPE tear and development of central dense subretinal fibrosis **(Figure 8)**. The utility of ongoing intravitreal treatment was questioned given the abnormal retinal anatomy. The patient, however, chose to continue because she felt her scotoma had improved significantly. She currently receives aflibercept injections at six- to eight-week intervals to maintain her current level of vision and reduce the risk of another catastrophic macular bleed.

Discussion

AMD is a multifactorial disease with a poorly understood pathogenesis. Age is a major risk factor, and smoking remains the only known modifiable risk factor.[1] Genetics also plays a role as 52 genetic variants across 34 loci have been associated with development of AMD.[2] Conversion to neovascular AMD is characterized by the uncontrolled expression of pro-angiogenic vascular endothelial growth factor (VEGF), which leads to the development of new abnormal blood vessels from the choroid.[3] While the emergence of intravitreal anti-VEGF therapies for neovascular AMD has been a significant advance in eye care in recent years, 10-15% of patients do not respond to anti-VEGF therapy and lose >15 ETDRS letters of visual acuity.[4] It is unclear why patients respond to anti-VEGF treatment differently, and current practice involves treating poorly responsive patients more aggressively, i.e., more frequently, or with increased dosing and/or a different anti-VEGF drug, often with variable responses.[3]

Figure 6. Optical coherence tomography five-line raster scan of the macula OD on 12/06/16 showing reduced height of the pigment epithelial detachment and retinal pigment epithelium tear.
Click to enlarge

Figure 7. Fundus photo OD on 1/31/17 showing old subretinal hemorrhage inferior and resolving sub-retinal pigment epithelium hemorrhage parafoveally and retinal pigment epithelium tear.
Click to enlarge

Figure 8. Optical coherence tomography five-line raster scan of the macula OD on 07/11/17 showing persistent retinal pigment epithelium tear with subretinal fluid and subretinal hyper-reflective material.
Click to enlarge

Tears of the RPE are characterized by a separation of the RPE basement membrane from the adjacent layers of Bruch's membrane.[5] Visual acuity is often significantly affected, with an average visual acuity of 20/150.[6] On ophthalmoscopic exam, an RPE tear is visualized as a well-demarcated area of bare choroid immediately adjacent to a hyperpigmented, rolled-appearing area.[7] With a reported incidence of

0.06%-0.8%, RPE tears are an infrequent sequela of intravitreal anti-VEGF therapy.[5] Eyes with AMD, with or without choroidal neovascularization, particularly those with PEDs large in height, and eyes that have undergone previous treatment, including laser photocoagulation, photodynamic therapy or intravitreal corticosteroid or anti-VEGF injection, are most susceptible to developing RPE tears.[8] Increased pre-injection lesion size and increased SRF also increase a patient's risk for developing a tear of the RPE.[9] While an RPE tear following treatment of choroidal neovascularization may be visually devastating, the benefits of vision-preserving treatment outweigh the relatively low risk of the potential complication.

A common assumption, particularly among student clinicians, is that a patient "will be OK" once he or she has been referred to the appropriate specialist, ophthalmic or otherwise. This case highlights that, even with early detection and intervention demonstrating significant anatomical improvement, patients with neovascular AMD may still have poor visual outcomes. AMD is a multifactorial disease, and VEGF is only one part of its pathobiology. Fortunately, numerous new therapeutic interventions are in the pipeline. They include oral tyrosine kinase inhibitors,[10] bone marrow-derived stem cells,[11] nanoparticle-loaded biodegradable injectable implants,[12] and RPE transplantation.[13] An improved understanding of the role of genetics in the management of retinal disease accompanies the potential new treatment options.[14] It is encouraging that these promising interventions may someday improve the care of patients with AMD.

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Industry News

Industry News

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Industry News

Intern Program Taking Applications

Walmart is accepting applications for its Optometry Intern Program, which is designed to prepare the company's next generation of optometrists for practice within Walmart and Sam's Club stores.

According to Walmart, the flexible 10-week hands-on training program takes place during the summer between first and second year. It includes an OD mentor, is in-depth, and provides experience across a range of areas. Interns gain experience in basic visual services as well as diagnosis, management and treatment of visual problems and ocular disease, contact lens fitting, patient education and clinical business strategies. The internship may extend beyond the summer and is open to first- through fourth-year students who wish to participate on weekends and during academic breaks. Start and end dates are flexible to accommodate the interns' school curriculum timelines.

Interested students should e-mail Maritza Fernandez or call her at (479) 204-4603.

Charitable Giving Aids Access to Eye Care

Alcon, a division of Novartis, donated nearly $65 million in cash and products to fund medical missions, community organizations, eye exams, glasses, ophthalmic care and patient awareness programs in 2017.

To further educate consumers about the importance of regular eye care, Alcon also announced its continuing commitment to Think About Your Eyes, the national consumer education campaign presented by The Vision Council and the American Optometric Association. Alcon has supported the campaign four years in a row, contributing $2 million for 2018. Eyecare professionals interested in having their practice listed with the Think About Your Eyes doctor locator and accessing digital banners for use on their practice websites can visit ThinkAboutYourEyes.com.

For more information about Alcon's partnerships and corporate giving efforts, visit the Corporate Responsibility section of the company's website.

Also: Alcon recently launched new U.S.-specific packaging for Air Optix plus HydraGlyde contact lenses to promote proper purchase and wear. The new packaging follows the 2017 launch of U.S.-specific packaging for Dailies AquaComfort Plus contact lenses.

Connecting and Supporting Optometry Practice Buyers and Sellers

The Practice Management Center (PMC), Vision One Credit Union and VSP Global are teaming up through optometrymatch.com to assist doctors who are looking to buy or sell all or part of an optometry practice. The service utilizes PMC's Smart Match model to connect buyers and sellers and then works closely with the doctors to provide support and consultation throughout the practice transition process.

According to PMC CEO Mark Wright, OD, "Purchasing a practice can be a challenging experience for doctors. Similarly, selling a practice can also be an overwhelming experience for retiring doctors. Our goal is to make the process smooth for both sides, which will in turn help ensure the future success and growth of independent optometry."

New Website Launches with Doctors and Patients in Mind

HOYA has launched a new global website designed to make lens technology easy for patients and eyecare professionals. At the new site, eyecare providers can find not only product technology information but also practice development and other content that is geared toward helping them build their business and differentiate their brand. For spectacle wearers, jargon-free content is written by experts in the field. Also at the site, which has been translated into more than 40 languages, eyecare professionals can connect with their local company representative, and patients can find eyecare providers in their ZIP code.

"This is an exciting time for HOYA," says Barney Dougher, president of HOYA Vision Care, North America. "We're growing as an international company and brand, yet the new website offers functionality at the local level that helps us stay connected and relevant to our customers."

Stay Tuned for a Revamped Brand Identity

Beginning in May 2018, patients and eye doctors will see a rejuvenated brand identity, including a “Light Under Control” consumer advertising campaign, from Transitions Optical. The new look and campaign build upon the company’s efforts to recruit new wearers of photochromic lenses. Primary aims are to showcase the relevance of the lenses to today’s fast-paced lives and to attract a younger generation of single-vision wearers to the photochromic lens category.

Point-of-sale and digital assets that support the new visual identity will become available to eyecare professionals in the second quarter. For more information about the company and Transitions lenses and helpful resources, visit Transitions.com or TransitionsPRO.com.

Also: Research conducted on behalf of Transitions Optical indicates that while enrollment in vision benefits remains high among all employees, younger generations, who make up an increasing portion of the workforce, are less likely to enroll and less likely to understand the importance of regularly scheduled, comprehensive eye exams.

Dr. Mayers Steps into New Role

Johnson & Johnson Vision appointed Michael Mayers, OD, FAAO, to the position of Director, US Advocacy, Vision Care. In his new role, Dr. Mayers will shape strategy and lead eye health advocacy efforts to promote patient health and safety in collaboration with legislators, regulators, associations and doctors. Dr. Mayers joined the company in 2011 and has since held roles in R&D clinical development, global medical affairs and global marketing.

Also: Johnson & Johnson Vision has expanded the available parameters for 1-Day Acuvue Moist Brand Contact Lenses for Astigmatism, a daily disposable contact lens that offers patients Blink-Stabilized Design for clear, stable vision and Lacreon Technology designed to provide a cushion of moisture for long-lasting comfort.

New Tools for the Practice Software Platform

Rev360, the eyecare software and business services company for RevolutionEHR, launched Pulse, a practice performance dashboard that helps users manage their eyecare business, all from within RevolutionEHR. Pulse provides instant, robust views into practice data for tracking key performance indicators, analyzing and exploring trends, and comparing performance metrics across the practice.

Because RevolutionEHR is cloud-based, Pulse was instantly enabled for all practices using RevolutionEHR, with no setup or installation required. Pulse data is automatically kept up to date and is provided to RevolutionEHR users at no charge. Learn more about Pulse at the RevolutionEHR website.

Inspired Students Earn Grants

Optical retailer National Vision Holdings Inc. selected a grand prize winner and two runners-up in its 2017-2018 Grant Program. Inspired by Simon Sinek's TED Talk "Start with Why," National Vision asked third- and fourth-year optometry students what inspired them to become ODs and what they believe to be their personal mission as future optometrists. Students entered by submitting an essay or short video, and a panel of judges from National Vision selected the winners.

The 2017-2018 grant recipients:

- First place ($5,000 grand prize) ? Leanne Leung, MCPHS School of Optometry, class of 2019
- Runner-up ($1,000 prize) ? Kandace Alfred, University of Missouri – St. Louis College of Optometry, class of 2018
- Runner-up ($1,000 prize) ? Bee Bui, University of California – Berkeley School of Optometry, class of 2019