Khan Academy and "Flipping the Classroom"

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"The very first time that you're trying to get your brain around a new concept, the very last thing you need is another human being saying, 'Do you understand this?'"[1] This radical quotation is from Salman Khan, an MIT and Harvard graduate, former hedge fund analyst, and founder of Khan Academy.

Recently featured on 60 Minutes, Khan Academy is a nonprofit educational organization that is doing some very exciting things. It has a repository on You Tube of more than 3,100 video "micro lectures" covering subjects from math and science to healthcare and medicine. The videos are for students to watch at home and are meant to be paired with computer exercises found on the Academy's Website.[2] The strategy of sending schoolwork home in the form of short video lectures and doing homework at school is called "flipping the classroom." Should the schools and colleges of optometry adopt a similar strategy?

For many of us, the volume of material we must present to increasingly large numbers of students can be overwhelming. Prior to the Information Age, the most efficient way to present copious information was the lecture format. The lecture format was how we were taught, the same way as our teachers before us, stretching back to ancient times. We would listen and take notes. Some optometric education programs now use a transcription service so taking notes may be unnecessary, as it may also be for courses that are built around a good textbook.

Before laptops and tablets were the norm in classrooms, textbooks were the tool we used to flesh out the material we did not understand. Our teachers encouraged us to read them before class, but time constraints often prevented it. Besides, much benefit could be had from reading a good text even after the lecture was presented. For those of us who did not have an eidetic auditory memory, it was during the reading of the textbook that real learning took place. The lecture was the warm-up.

With our students today, surprisingly little has changed, except for the very important fact that textbooks are increasingly irrelevant to today's classroom learners. It is one of the ironies of the computer revolution that information is more available than ever, but as more students avoid traditional print media, they rely largely on what is presented in the classroom. To many educators, relying on lecture and class notes almost exclusively is an inefficient and limited way to secure information into long-term memory, which is a necessity for future patient care.

If there is one source that could replace textbooks for today's students, it is online video. Enter You Tube and programs like Khan Academy. Microsoft founder Bill Gates was so impressed when he discovered Khan that he used the free courses in topics like math and science to teach his own kids. Subsequently, both the Gates Foundation and Google have backed Khan Academy with millions of dollars in support.

These sorts of financial endorsements should command the attention of optometric educators. Can flipping the classroom help to improve graduate school the same way it might improve elementary school? While Khan does not (yet) offer many of its videos on topics of interest to optometric education, several of its principles are potentially of use to us as we teach the eye doctors of the future.

Principle #1: Asking Questions About Something They Should Already Know is Embarrassing to Students

Even our best students have holes in their understanding. Often, this includes some basic concepts. Without using textbooks for reference, concepts that are missed the first time (or forgotten since) may become more and more shaky. As students progress through a lecture-based curriculum, one that doesn't encourage interrupting to ask questions to begin with, these missed concepts can interfere with adding new knowledge. Avoiding embarrassment is human nature, so questions remain unasked all too often.

Now, consider the possibilities when a lecture – or better still, a micro lecture – is recorded for the student to play and pause at will. This condensed presentation needs only the basic concepts on a PowerPoint slide with voice-over audio. Khan Academy uses a digital whiteboard (SmoothDraw 3) but no video of the presenter.[3] Now, the student can take in the lecture when and where he or she is ready to learn, pausing and rewinding when a concept does not make sense.

These micro lectures are not hard to make with a podcast. Many university programs are already podcasting. At Pacific University College of Optometry, we use Camtasia Relay for classroom capture of video and audio, and iTunes University to collect the podcasts. However, podcasting can be done in a quiet home office (or closet as Sal Khan reportedly uses) and doesn't require a live audience present, just one to listen to it on their computers, tablets or MP3 players.

How these targeted podcasts can reach more students than a traditional lecture is the subject of the second principle.

Principle #2: One-On-One Tutoring is More Effective Than Teaching to the Middle

One challenge that optometric educators face is reaching students at different levels of achievement. Like all educators, out of necessity the instructor often has to adopt an almost utilitarian philosophy. With the aim of reaching the most students, many educators "teach to the middle," or somewhere between the most advanced and least advanced students on the topic. This may work for the middle of the class but has the distinct disadvantage of leaving the upper quartile unchallenged, and the lower quartile potentially unreached.[4]

While many other strategies exist, such as "teaching to the top," all have the limitations of the one-size-fits-all lecture style. Yet there is one educational strategy that is orders of magnitude more effective than standard classroom lecture: one-on-one tutoring. While extraordinarily effective, individual tutoring is inefficient, and therefore expensive. It has traditionally been limited to those who can afford to pay for it for themselves or their children. However, in the computer age, must efficiency be inversely proportional to effectiveness? Not necessarily. When delivered by a talented teacher, the recorded micro lecture is like having a personal tutor. When done well, the student feels as if the teacher is right there giving a personal lesson. This is partly because the micro lecture can be given at the time and place of the listener's choosing. Also, micro lectures can fit into small chunks of time.

By definition, the micro lecture is short. Khan Academy lessons last 10 minutes on average, which may be approaching the attention span of the typical student these days. Thus, it needs to distill information to its essence, while not skipping any critical subtleties. It can and should be heavy in illustrations as necessary to teach the salient points. It should also be unscripted and certainly not read from a slide. Sal Khan does no video edits. Instead, he re-records each take that doesn't come out well in one try. This preserves the one-on-one nature.

The short, home-based lecture is one half of flipping the classroom. The other half is assessment. This takes the form of classroom-based homework, when students get to ask questions one-on-one rather than in front of all their classmates, as explained in the next principle.

Principle #3: Students Prefer Self-Paced Learning to Instructor-Paced Lessons

While listening to micro lectures on an MP3 player, a student is typically alone, be it at home, in the car or at the gym. This should happen before class, when a student of the flipped classroom will be expected to practice what was learned. Khan Academy students are often ones who have not yet graduated high school, but here's how the principle of self-paced learning might be applied to optometric education.

Imagine geometric optics lab taught with a flipped classroom. As currently taught, the students may work on an optical bench and may keep hard copy or virtual lab books in order to learn how light is affected by lenses, prisms and filters. Although the emphasis on some age-old topics (like mathematical ray-tracing) may be changing, other things are not. For instance, in many cases students must still complete their labs in the assigned lab period, whether or not they have mastered the principles being taught. Those who struggle may go through the motions but be carried along in part by their lab partner when they do not understand.

If the classroom is flipped, both lectures and assessments will occur at the student's own pace. The latter are done with computer-based drills given online. The instructor has access to graphs showing the speed and accuracy of each student's answer, and is free to answer questions even before they arise. The clock on the wall doesn't determine how far each student progresses during class time, but instead progress is dependent on each individual student.

Another key to the success of the Khan techniques is constant assessment. While every topic comes with exercises to be practiced in class the next day, there is some modularity to each lesson. In other words, in many non-linear topics, students may choose to tackle the middle or the end of the material first. For example, a lecture on five related congenital conditions affecting the eyes might be flexible as to which order a student masters them. However, they must all be mastered.

One might inquire why a student would need the teacher – or classmates – at all in this type of model. The answer is that the flipped classroom encourages collaboration. Classmates are encouraged to assist each other when one is stuck. Also, the teacher plays the important role of providing "surgical instruction" for any students who are stuck on a concept.[5] An instant study group can be assembled (to the extent allowed by the Family Educational Rights and Privacy Act). This is because in the flipped classroom, it is critical to master one concept before proceeding, the topic of the next principle.

Principle #4: Old Concepts Should be Mastered Before Moving on to New Ones

Think about the way American education traditionally works. First, information is delivered in traditional lecture format with spot checks in the form of quizzes, midterms and final exams. Except where practical exams are given,

such as in optometric procedures or methods courses, we do not usually expect that all students will reach mastery at each assessment. We may recheck as many areas as we can on the final and National Board exams, but because every student is not required to get an "A," this still leaves something to be desired.

In Khan Academy courses, "mastery-based learning" means students must get 10 questions in a row correct to move on to the next lesson.[4] When they do not, they continue to practice the muddy points until they clear up, in much the same way optometric procedures or methods courses are taught.

How do optometric educators know when their students need assistance? Too often, students don't know enough to ask. How many of us have sat through empty office hours the day before an exam without seeing a single student because they were studying for the exam and did not know which questions to ask?

For Khan Academy, the answer is the teacher's dashboard. Performance-measuring apps, long-used and old hat in the financial sector from which Sal Khan came, are novel to educators at all levels. Perhaps some have seen real-time test results roll in on learning management software like Blackboard or Moodle. Using a tablet or other portable interface, the instructor can circulate around the classroom and know exactly where each student may be excelling — or struggling.

All too often, optometric educators may find mathematics is the area of difficulty, which is the topic of the next principle.

Principle #5: Math is a Stumbling Block for Many Students Today

Schools and colleges of optometry face a challenge of homogeneity. Most incoming students, as high as 85%, were biology majors as undergraduates. The reasons for this are obvious when the prerequisites of optometry school are compared with those for various undergraduate majors.

For all the strengths of the average biology major in ocular anatomy, physiology and disease, as a rule, mathematics is not the strong suit. Fortunately, the Khan Academy techniques are most easily applied to very concrete subjects like mathematics, including optics.[3] In fact, most of the existing 3,100 Khan Academy videos on topics of interest to optometry students are currently in optics.

For most students who struggle, the problem in American education in mathematics certainly precedes optometry school. Many intelligent students may not have ever been required to attain mastery in basic arithmetic, algebra or trigonometry. While the prevalence of mathematical illiteracy in American society is on the rise, there is some disagreement as to the reason. Some blame the use of calculators from an early age. Others blame the use of manipulatives like geoboards instead of paper-and-pencil exercises.

Whatever the cause, it is not the sole duty of optometric educators to bring about a mathematical renaissance. However, if we wish our interns to be able to quickly calculate a net add or conversions from plus to minus cylinder, drills to practice these conversions should be done until the student attains mastery.

Principle #6: Be a Guide on the Side, Not a Sage on the Stage

This catchphrase of the flipped classroom movement has been around in educational circles since at least the 1990s.[6] Pragmatists can legitimately point out that it is a nice sentiment, but may be much easier to say than to implement. Proponents will admit it is easier for educators to imagine constructing new courses in the flipped classroom format than to imagine converting pre-existing standard lectures. While some topics in optometric education may lend themselves to this format better than others, with preparation of micro lectures and practice problems, the flipped classroom will come to life.

Personally, I plan to attempt some version of these techniques in my 40-student elective this summer. The long nights of the warmer months may lend themselves to both creating and listening to micro lectures, while the smaller class size (for us) may work better for me to be a guide on the side.

In the words of Bill Gates at the end of the Technology, Education and Design (TED) lecture by Salman Khan: "I think you've just got a glimpse of the future of education."[1]

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