

[MUSIC PLAYING]

JOHN BOIS: Hello, my name is Dr. John Bois. I'm a cardiovascular fellow at Mayo Clinic in Rochester, Minnesota. I'm excited to share with you today an endeavor which our fellowship has undertaken to create and novel curriculum for the education of our internal medicine residents in regards to cardiovascular disease. I have no relevant financial disclosures. I will be discussing some products made by Apple, which we've integrated into our curriculum.

Our objectives today are three-fold-- first, to describe several challenges facing us in medical education. Second is to summarize aspects of a novel curriculum which we've created to address some of these challenges. Third and finally, is to assess how this curriculum has performed in a prospective trial.

To achieve these objectives, we're going to begin by defining several challenges we face today in medical education. This includes living in a world of exponential expanding medical knowledge that's occurring simultaneously with the transformation of residency education, where we have less and less contact time with trainees.

In the second portion, we're going to propose a solution in the form of a novel curriculum, which we have created to address some of these challenges. We'll discuss how this curriculum adheres to the tenets of adult learning theory, or andragogy is tailored to teach different learning styles. And it's delivered on a mobile platform, a movement known as mHealth.

In the third and final portion of discussion, we're going to introduce to you the initial results from a prospective trial assessing how this curriculum has performed against traditional didactics. Let's begin now with the first portion of our discussion, and defining some of the issues we face.

We are very fortunate to be living in an era of exponential knowledge growth, and we can put this into a historical perspective by reviewing the figure provided here by the Natural Edge Project, a think tank group, out of Australia. They've noted that since the late 18th century, we've had six successive ways of knowledge acquisition. As you can see here on the x-axis time, each wave has a narrower and narrower width, meaning it's happening more and more rapidly.

Furthermore, the apex of each wave is demonstrating a greater and greater innovation impact on humanity. The reasons why this is occurring are multifactorial. One, there is a diverse spread of technology across the world which allows near simultaneous discoveries to be shared. Second, once thought to be distinct academic disciplines-- such as biology, structural engineering, and computing-- are now beginning to merge, when we look at endeavors such as nanomedicine and nanotechnology. Therefore, a discovery in one field has a synergistic effect on another field.

The era in which we live was foretold by the American theorist, Richard Buckminster Fuller, who is depicted here on the cover of *Time* magazine in 1964. He noted that in 1900, human knowledge was doubling every century. Currently, in 2016, human knowledge is doubling every 13 months. IBM Analytics anticipates that by the year 2020, human knowledge will be doubling every 12 hours.

In medicine, we are not exempt from this phenomenon. It's noted that since 2014, there has been 3/4 of 1,000,000-- 750,000-- new citations in the National Library of Medicine. So this exponential knowledge growth is occurring simultaneously with a transformation in medical education where we have less and less of that traditional face-to-face time with trainees. There's been several mandates handed down by our governing bodies-- the American College of Graduate Medical Education, or ACGME-- under the auspices of the Office of Safety and Health Administration, that stipulate certain duty hour regulations. These include an 80 hour workweek limit, a 10 hour rest period between duty periods, and no longer than 24 hours on continuous duty.

So what are some of the potential ramifications of having more to learn, but less time to teach it? Well, there's been a concern that one sequelae is decreasing knowledge acquisition. And we can see here that the pass rate among first time test takers of the American Board of Internal Medicine has dropped to 12% absolute reduction in a recent five year period.

So to summarize the first portion of our discussion, the challenges we face as medical educators, there's more to learn-- increasing demands. There's less opportunities for that traditional face-to-face teaching of the trainee. This could be potentially leading to decreased knowledge acquisition.

Let's now move to summarize aspects of a novel curriculum we've been developing here at Mayo Clinic to address several of these challenges. In this portion of the discussion, I'll be sharing with you excerpts from our curriculum. The curriculum in whole will be published in the spring issue of the *Journal of Graduate Medical Education*.

As fellows here at Mayo Clinic, we are truly blessed to have as our mentors, world-renowned cardiovascular educators. And in meeting with them, we set forth a mission statement-- to create a comprehensive, interactive, and dynamic cardiovascular disease curriculum for our internal medicine residents, and would have three underlying principles. First, it would adhere to the tenets of adult learning theory. Second, it would be delivered via mobile device technology. Third and finally, it would address the challenges of current medical practice, allowing our residents to have that core knowledge, but also to provide them with late breaking trials that occur during a residency.

So we're now going to focus on different milestones in educational theory over the past century, and provide you with examples of how we've incorporated these theories into the development of our curriculum. And we'll start with the turn of the century with Jean Piaget, a Swiss developmental psychologist pictured here. He is credited with the theory of constructivism, which states that we should be a facilitator of learning, and not a transmitter of knowledge.

One way to facilitate learning is to empower the resident by providing them a stake in the development and maintenance of the curriculum. Tertiary medical centers, such as Emory, have demonstrated that by doing this-- empowering the resident by giving them a stake in the curriculum-- fosters team learning and shapes a shared sense of responsibility. These are two critical attributes we want to see in the next generation of physicians, as we continue to collaborate more and more-- not only with each other, but with other members of the health care team.

To take advantage of this theory of constructivism, we created in our curriculum a residents corner. We encourage residents to share with other residents, in a standardized format, cases which they experienced on the wards or on the outpatient setting. Each case is mentored by a senior resident or a cardiovascular fellow. For instance, Dr. Megha Prasad-- one of our cardiovascular fellows-- mentored Dr. Durani, an internal medicine resident here at Mayo, on a case of spontaneous coronary artery dissection that they shared. Each case provides imaging when appropriate, discusses pathophysiology, has take-home points for the other trainees, and is fully referenced and vetted by our staff.

So we've discuss the theory of constructivism-- the need to empower the resident by providing them a stake in the development of the curriculum. Let's look at another concept we need to be cognizant of, and that's the Flexnerian model of education.

Mr. Abraham Flexner, pictured here, was an American educator who, in 1910, was commissioned by the Carnegie Institute to investigate the state of medical education in the United States and Canada. And as Mr. Flexner traveled across the two countries, he noted that medical schools-- for the most part-- were run like trade schools. They were for profit. They were run by one or two physicians. They were two years long. They were not associated with the university. And often, they did not provide basic curriculum, such as curriculum in anatomy. Therefore, Mr. Flexner concluded that there was a wide discrepancy in the competency of medical students upon graduation.

He published his findings in the extensive *Flexner Report*, cover pictured here. The key take-away is that there's a need for standardization in medical education. So the modern equivalent of the Flexnerian ideal of standardization for us when we sat down to create a curriculum for internal medicine students and learning cardiovascular medicine, was the ABIM-- or American Board of Internal Medicine-- blueprint. The ABIM provides 12 core topics that they expect internal medicine residents to have mastered upon completion of their training.

We therefore set about with our fellows, creating lectures for each of these topics. These lectures were provided in PDF format, and they were also professionally recorded so that the resident could use their mobile device and either read the lecture, or view the lecture.

So, for example, one of our former fellows-- Dr. Kalkidan Bishu-- created a lecture on the management of ST elevation myocardial infarction. When he graduated, an up and coming fellow, Dr. Carolyn Larson, updated that lecture as was pertinent. We were very grateful to now have over 15 fellows here at Mayo Clinic collaborate in the development and maintenance of this curriculum.

Let's now look at the third key concept we wanted to integrate as we created our curriculum, and that was the theory of adult learning. Alexander Knapp, a German theorist, was credited with this idea of adult learning. But it was Malcolm Knowles-- who is pictured here, an American educator-- who brought this theory to the United States. Andragogy, or adult learning, is defined as the science and art of helping the adult learn, and has five core concepts.

First, adult learners are independent and self-directed. Second, they have a wealth of experience of which to draw upon to bring to the current scenario. Third, they enjoy integrating learning into the daily ritual. Fourth, for the most part, they enjoy a problem-solving approach. And fifth and finally, they are internally motivated.

So our whole curriculum is predicated upon this concept of an adult learner. Recall in the first portion of our discussion today, we noted that we have less and less of that face-to-face time with our trainees. Therefore, there is going to be some shift in the burden of learning to outside of the work environment. We wanted our curriculum to be comprehensive, dynamic, and easy for the adult learner to interact and interface with.

For example, here's our title page. This is what our trainees see when they access our curriculum on their mobile device. It has 33 chapters. And, for example, a resident might be interested in learning about cardiac function. They simply type in cardiac function. They're taken to a myriad of different learning materials. They can look at PDFs, they can listen to audio, they can watch video.

Let's say that our resident is interested in looking at video about how the cardiac function interfaces with a chest x-ray. They tap here, and they're taken to a video presented by Dr. Arous, one of our staff cardiac imagers, discussing this for them.

So we can see how our curriculum helps the internally motivated, self-directed-- two key principles of andragogy-- adult learner interface, and answer the questions that they need to know. Let's look now at the fourth key concept we integrated in creating our curriculum, and that's looking at different learning styles.

David Cole, pictured here, noted in the 1970s that we all learn differently. There's four basic learning styles, and we can often be a mix of several of these. For instance, there's the diverger. This is the student who learns through direct experience. So you might imagine an internal medicine resident who watches a staff or fellow place a central line. They immediately learn by mimicking the movements of the staff or doing the next procedure. So they enjoy that video or audio, followed by tactile feedback.

The second learner is the assimilator. This is a student who learns by observing, and then recalling that experience. So you can imagine, a student who watches a staff consult and perform the pertinent components of an examination of a patient with severe aortic regurgitation. They then play back that experience through their mind and embed it. The third learner is the converger. This student likes to abstractly conceptualize different issues before bringing it to their experience.

So an example might be an internal medicine resident who knows that they're going to see a patient with Marfan Syndrome the next day in clinic. The day before, they read all about Marfan Syndrome, abstractly conceptualize what they anticipate their experience to be, and then bring that knowledge to the actual experience. The fourth and final learners they accommodate are who learn through experiment. So you can imagine this student learns best through case-based or question-based scenarios that helps them determine or see how their choices affect the eventual outcomes.

So let's look now at how two distinct learners-- the converger and the accommodator-- approach our curriculum in a different manner, but obtain the same knowledge. So we'll look at two learners-- learner A, learner B. We can imagine them to be internal medicine residents beginning at a cardiac rotation in several days. They're both interested in learning about stress testing. So they come here to our curriculum on their mobile device at our table of contents-- it's fully searchable-- and they type in stress test.

And we'll start with a converger. That's a student who wants to know that deep dive of material, and conceptualize it before coming to the experience. So they might look at stress tests in a PDF format. The PDF formats in our curriculum are similar to textbook chapters. This one on stress testing is provided by one of our staff consultants, Dr. Crystal Bonnicksen. So that learner can understand all the basics of stress testing, such as ECG interpretation, how to calculate and do treadmill score, the nuances of our stress medications, and how the stress test may affect prognostic implications for the patient.

Contrast that now to the accommodator. Recall, this is a student who learns through experience. They may not initially look at this deep dive textbook chapter, but instead, choose case-based teaching. If they were to choose this, they would be taken to a video on their curriculum by Dr. [INAUDIBLE]. It's a 15 minute video presenting to them different case scenarios with pauses and questions, so that learner can then interact in an experiment-like format, thereby tailoring it to the accommodating learner.

So we looked at four key learning theories and how we've incorporated it into our curriculum. But now we must ask how we're going to actually deliver this curriculum. What media are we going to use? So we chose to use iTunes University. It was introduced in May of 2007, and it's used by several universities across the world, including Harvard University in Cambridge. We chose it because it's easily accessible. All of our internal medicine residents, upon matriculation, receive an iPad for free. The app that we use to deliver our curriculum is iTunes University. And that's also for free, so completely accessible to the student.

Second, we note that mobile device technology is being rapidly adapted into a medical practice. This is a movement known as mHealth. So therefore, we thought it would be prudent that the learner learn using the same tool that they're using for practice. Third and finally, some initial preliminary small studies have shown that mobile device technologies, such as the iPad, has been effective for the instruction of residents.

Another key component of using mobile technology to teach is the Greek concept of Kairos. Kairos is the idea that you have to strike when the moment is right to push through the concept of learning. It's depicted here in the Italian Fresco. Kairos the winged creature, that moment that you have to capture-- that ah-ha moment-- before it is gone. So I'll give you an example of Kairos, and how that might best be obtained using mobile device curriculum.

So take a moment. Imagine you're an internal medicine resident. It's your first day on service. Your consultant mentions in passing Scimitar Syndrome. Instead of waiting until the end of the shift or the end of the day to look this up, you have your mobile device with you. You search our fully vetted image library for Scimitar Syndrome. And immediately, you have a three dimensional reconstruction from CT imaging demonstrating what is Scimitar Syndrome. So you hear what it is, and then immediately, you see what it is. You strike when the moment is hot. That is Kairos.

Another example-- imagine you're a second year resident. You're admitting patients. It's 10:00 at night. You're done with admitting the patient. You're about to leave the room, and the patient says, oh, by the way, Doctor, I was told before I have double aortic arch. What is a double aortic arch? Instead of paging yourself out of the room to look this up, you can simply use your iPad at the bedside, search our library, and again, you have a reconstruction of a double aortic arch. You can share that knowledge both with yourself, and with the patient at the moment you need it. That's Kairos.

So to summarize the second portion of our discussion today, how we created a curriculum to address some of the needs of learning education in the 21st century. First, we talked about the theory of constructivism. You have to facilitate learning by giving the learner-- the internal medicine resident, in our case-- a stake in the curriculum.

Second, the curriculum must adhere to standardization. We looked at the 12 ABIM core principles, and created video and PDF lectures to address each of those core topics. And these were created by our fellows here in cardiovascular medicine.

Third, your curriculum has to adhere to the principles of adult learning-- that independent self-directed learner who's going to be now learning outside of the work environment more and more, specifically with those strict work hours that are being handed down.

Fourth, we need to tailor our curriculum to address different learning styles. Remember, we talked about how the accommodator might learn different than the converger. One likes to learn through questions and case face formats, interactive with a video. Other might prefer a textbook format.

And fifth and finally, we've delivered our curriculum through mobile device technology using iTunes University on the iPad. And this is that theory of Kairos. You have the curriculum right with you in your pocket at the moment that you need it.

So we discussed our first two objectives-- introducing the problem, and now discussing a possible solution. Now, while theories are important, we need to scientifically investigate whether our curriculum is actually having affect. And I'm going to share with you just some preliminary initial results from a prospect of trial we have initiated here at Mayo Clinic, assessing the efficacy of this curriculum we talked about.

We looked at endpoints for performance on pre and post tests, comparing our curriculum with a traditional didactic face-to-face lectures. And we also study the usage of the curriculum, how often students were interfacing with our mobile technology. Our study design was double blind, single center here at Mayo Clinic in Rochester. It was randomized, and it included all internal medicine residents rotating on the cardiovascular service.

We did this study for a six month period and had 118 participants. And we designed it so that the participants took a test prior to the intervention-- either the placebo or the original curriculum, the didactic face-to-face, or our intervention with the dynamic mobile curriculum.

That test had 24 questions, and it was vetted by staff. Our hypothesis was that our curriculum would actually be inferior to what we've been doing for a long time, the traditional didactic lectures. Because we wanted to ensure at first that we were doing no harm to the learner by introducing this curriculum.

So let's look now at the placebo group, that's the group that received the traditional lectures. You can see that they improved from their pretest to post-test in regards to percentage correct here on the y-axis. You would hope that this would be the case after undergoing a cardiovascular rotation. We saw similar pre to post-test improvement in the group that received our curriculum, that is, the electronic delivered curriculum.

Moreover, when we looked at the treatment group, those students who received the electronic curriculum, we looked at those who were users-- who were using it more often. And we saw that users actually did better on their post-test than those students who did not interact with their curriculum.

So to summarize our discussion today, we're facing several challenges as medical educators in the contemporary setting. There's an exponential growth in medical knowledge, and there's less and less of that traditional face-to-face contact time with the learner. In the second portion of our discussion, we summarize aspects of a novel curriculum we've been developing here at the Mayo Clinic. The curriculum is steeped in the tenets of educational theory, constructivism, andragogy, learning styles, et cetera. And it's delivered on a mobile platform, a movement known as mHealth.

Third and finally, we shared with you today some initial results from a prospective trial, demonstrating that this curriculum is non-inferior to traditional didactic teaching. It was my pleasure to introduce our curriculum to you today. And I hope you enjoyed it.