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This is Not Your Grandfather's Medical School: Novel Tools to Enhance Medical Education

by Ryan Sheehy, PhD

Being able to integrate technology into medical education materials will close the professional gap between students and professors.

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Abstract

As new medical students start their journey to become the next generation of physicians, they are in awe of the wealth of knowledge at their fingertips as they begin medical school. Every student brings with them a unique story, and most bring with them a high tolerance for technology. The internet, smart phones, and the personal computer have shrunk the academic world and allowed students access to entire libraries that fit within their pockets. Medical school curricula continues to try to evolve to meet students in their increasingly technology filled world. How are medical schools evolving to integrate technology into their curricula? What follows is a review of the application of different technologies in medical education and a close look at the most efficient uses of technology within medical school curricula. This discussion is followed by perspectives from professors and a student on the use of a variety of different technologies for teaching and learning including podcasts, YouTube, Twitter, and varying online resources.

Teaching Technology

Teaching with technology is not new. The advent of the personal computer and the internet has changed medical education. For many years now, educators have used technology to enhance their teaching and students have used it to enhance their learning. The internet itself has opened up many opportunities to enhance learning. The ubiquity of the internet positions it nicely to provide creative learning opportunities that build collaboration, problem solving, critical thinking, and written communication skills.[1] The internet is the catalyst that accelerated, and continues to shape, the use of many of the technological methods used in today's medical school classrooms. Active learning is at the forefront of many of these technology-based methods as a metanalysis of undergraduate science, technology, engineering, and mathematics (STEM) courses found that active learning enhances student performance.[2] Active learning both in the classroom and beyond the lecture hall can be promoted by the creative use of technology within the medical school curriculum.

In-Class Technology Promotes Active Learning

The classic use of technology in the classroom is the use of slide sets in a lecture format. Slides can be used in a multitude of ways to influence the direction and course of in-class learning. Presentation format matters. A study done in the peer-reviewed journal *PLOS One* shows that slide software programs such as PowerPoint

and Prezi can lead to different amounts of audience engagement and enhanced presentation effectiveness when compared to an oral presentation.[3] The presentation software Prezi is unique in that it takes advantage of spatial relationships to give a lecture more of a story format.[4] Story telling is a great way to enhance learning and communication because stories are relatable. These are the reasons why stories make up nearly two-thirds of our daily conversations.[5] When directly compared to PowerPoint, results found Prezi to be the most engaging and effective medium.[3] Results further showed that Prezi use resulted in audience perception of a more organized, professional, and knowledgeable presenter.[3] However, it still takes significant effort to make a slide-based lecture result in active learning. One way is the use of an audience response system that allows all students in attendance to participate in lecture. iClicker is one of many audience response systems that allows students to respond to in-class poles, questions, and cases right from their laptop or phone. The beauty of iClicker is the ability for an instructor to look at student responses live in-class and for the instructor to adjust teaching to match any deficits or questions raised by the in-class poll.[6] Looking at student feedback regarding the use of clickers, 71% of respondents believed that clickers made lectures a more enjoyable experience, and 77% of respondents believed that clickers improved their ability to retain the lecture content.[7] In addition to iClicker, small group work within a large lecture format is another way to stimulate active learning. In undergraduate education, active learning has the greatest impact in classes of less than 50 students.[2] These results suggest that dividing large lecture classes into small groups to facilitate active learning will allow the educator to have the greatest positive impact on learning outcomes. Lastly, the application of expert tutor instruction into the large lecture hall increases active learning. A lecturer captures a one-on-one teaching experience in a large lecture class by implementing parts of the INSPIRE model. The INSPIRE (Intelligent, Nurturant, Socratic, Progressive, Indirect, Reflective, Encouraging) model was conceived by Lepper and Woolverton when they identified the seven characteristics of the most successful tutors.[8] In their article, Wood and Tanner apply the INSPIRE model to the lecture hall teaching format.[9] Focusing specifically on "indirect" from the INSPIRE model, one tactic an instructor can take would include telling the class that they all need to work together to come to a consensus on a case question rather than stating that 70% percent of the class answered wrong. Allowing students to reflect and turn in writing assignments about course material or specific questions can both allow the instructor to gain insight into how the students are thinking about the material and promote student metacognition.[9] Engaging students in a large lecture is not easy. It takes work and commitment on the part of the educator. As shown here, there are many ways to engage students and promote active learning within a traditional large class, lecture format.

Implementing podcasts into medical education allows for multitasking, helps learners overcome barriers of reading comprehension and language difficulties, allows the learner to grasp the information without a book, and enables the learner to further understand the in-class material.

Podcasts, Instructional Videos, and Video Streaming

Several technological mediums have also grown in popularity in medical education and these include podcasts, instructional videos (vodcasts), and video streaming applications. Podcasts are serial audio files recorded as an on demand radio show. Podcasts and instructional videos have been increasing in use in medical education.[10-14] However, their increased use has not led them to

completely replace in-class instruction. Schreiber, et al., found no significant difference in learning outcomes when instructional videos replaced traditional lecture indicating that there is not a significant rationale to completely replace in-class instruction with instructional videos.[15] The study went on to find that students enjoyed having the ability to pause, rewind, and speed up the video, however the students found watching only instructional videos to be a less engaging teaching method.[15] Even though completely replacing lectures does not seem to be the answer, podcasts and instructional videos have several benefits for learners. Specifically, implementing podcasts into medical education allows for multitasking, helps learners overcome barriers of reading comprehension and language difficulties, allows the learner to grasp the information without a book, and enables the learner to further understand the in-class material.[16] However, it is not enough to simply record a lecture and label it a podcast or an instructional video. An analysis of instructional video qualities most desired by students found that videos that are well organized and concise with high quality sound and images have the most favorable impact on the learner.[17] Concise and well organized videos help instructors avoid the "prof cast," as simply recording ones lecture and releasing it as a podcast or as an instructional video does not optimally take advantage of the medium. Video streaming is another technological medium that is growing in use in medical school. Many classes in a given curriculum can be recorded and made available to the student on demand after a lecture has taken place. Streaming recorded lecture material gives students the option to physically attend lecture, and a fraction of the students may choose not to attend due to the convenience of viewing lecture material from anywhere in the world at the student's desired pace. A recent study from the College of Medicine at the University of Central Florida found that a student's ability to self-regulate his or her effort was predictive of low attendance levels at a recorded lecture.[18] This indicates that self-sufficient students find more value in the advantages of streaming recorded lectures versus attending lecture in-person. The study went on to identify that attendance at a lecture was found to be higher in those students who orient more towards peer learning and help-seeking behaviors.[18] Most interestingly there was no correlation between performance on the final exam and the percentage of classes attended by the student.[18] This finding of no correlation between student performance and attendance is a result that has been collaborated by another study.[19] Additionally, research has been conducted on the use of interactive video conferencing systems to stream lectures live to locations outside the classroom. The literature on interactive video conferencing varies. Video conferencing has been found to have a positive effect when teaching clinical examination objectives to students located at remote sites.[20-21] However, another study found a neutral effect where video conferencing a class was just as effective as a traditional in-person lecture.[22] When done right in the correct context, podcasts, instructional videos, and streaming videos have great potential to increase the opportunity for active learning to occur within the classroom.

Simulation, Augmented Reality, and Virtual Reality

Exciting new developments in the areas of simulation and augmented/virtual reality have added new opportunities to engage students in active learning in medical school curricula. Simulations mirror real life scenarios and allow for imitations of real patients, anatomic regions, or clinical tasks.[23] Effective medical school simulations include timely student feedback, opportunities for repetition, ranges of difficulties, individualized and team based learning opportunities, defined outcomes, and simulator validity.[23] Research in the field of simulation is continuing to develop, however one study in particular reviewed literature from 1969 to 2003 and found that simulations are effective at enhancing and complementing medical education.[24] Simulation centers can be used to mimic operating rooms, patient rooms, intensive care units, or emergency departments.[23] Simulations have the unique ability to allow students to simulate the touch and feel of medicine through haptics and simulations can allow students to experience a clinical scenario at high fidelity with robotic mannequins and sophisticated computer algorithms. Haptics are defined as the ability to feel and sense motion during a simulation. One of the first blends of simulation and augmented reality came with the advent of the simulation PalpSim. Augmented reality involves the use of real world objects that are augmented visually by computer generated images. PalpSim provides training for femoral palpation and needle insertion, which is a common opening intervention in many radiology procedures.[25] What makes PalpSim unique is that students feel and sense the motion of the feedback devices with their hands and see a computer generated patient and needle with their eyes.[25] Augmented and virtual reality go hand in hand as new teaching methods in medical education. The biggest difference between the two is that virtual reality transports the user to a completely computer generated environment where the user sees, hears, and interacts with computer generated sights, sounds, and objects. One study reviewing virtual reality literature states that, "The possible impact of VR [virtual reality] on health care could be even higher than

the one offered by the new communication technologies like the Internet."[26] Virtual reality research has generated interest in the field of anatomy education. Nicholson, et al. found that a three-dimensional anatomical model of the ear enhanced student knowledge of three-dimensional relationships of structures within the ear.[27] However, the authors go on to acknowledge that future studies are needed to validate their results.[27] Both virtual and augmented reality seem to possess predictive validity in that skills acquired within the medium appear to be transferable to real situations.[28] More randomized control trials comparing virtual reality programs with augmented reality programs, high-fidelity simulations, or differing virtual reality programs are needed to assess the overall effectiveness of virtual reality programs.[28] The potential of virtual reality is only beginning to be tapped with the recent emergence of consumer accessible hardware. Simulation, augmented reality, and virtual reality will continue to shape medical school curricula for years to come.

Using Technology to its Highest Potential in Medical Education

Technology in medical education truly arose due to the increasing prevalence of technology in the lives of today's students and the changing societal expectations surrounding patient safety. Today's focus of many medical schools is to create the best physician possible and to promote patient safety in the training of student doctors. Ethical issues were raised by society including learning interactions and procedures on live patients.[23] Thus, the advent of technological means to learn medical processes and apply this knowledge prior to using it on a live patient became paramount. This further prompted medical schools to seek out and create curricula that teach lifelong learning to accommodate the explosion of medical knowledge accumulated over the lifetime of the profession. In the 21st century, the focus of medical education has shifted from knowledge-based medical education to competency-based medical education. Scientific facts and data learned in medical school may be outdated by graduation and memorizing facts does not prepare students to learn and practice in a clinical environment that is prone to change.[29] Sherwin writes that, "Competency-based medical education focuses on what a physician should actually be able to do."[29] In order to remain competent and up to date, today's physicians must have skills that ensure they continue to be lifelong learners. In order to become an effective physician, medical students need to be given more responsibility for their own learning and they need to learn to assess a situation and draw effective conclusions.[29] More responsibility and autonomy will help hone a student's intrinsic motivation and help them focus more on becoming the best physician they can be and less on extrinsic motivators such as specific course grades. The expense, work hours, and change necessary to implement technology into medical school curricula is worth the effort to create better physicians. By doing this medical schools can improve patient safety and prevent undue patient harm.

Today's medical students have high expectations for technology to be integrated into their medical education. Students expect efficiency and proper integration as today's medical student is accustomed to technology and they expect their instructors and learning materials to seamlessly integrate into their learning experiences.[23] "Today's students are no longer the people our educational system was designed to teach," writes Prensky in his article about digital natives and digital immigrants.[30] Medical students of today have spent countless hours using and surrounded by technology including cell phones, video games, and personal computers. An average college graduate has spent over 10,000 hours playing videogames and 20,000 hours watching TV over their lifetimes.[30] As a result of student's interaction with technology from an early age, it makes sense that, "today's students think and process information fundamentally differently from their predecessors."[30] Prensky describes these students as "digital natives" as they natively speak and represent the culture of the digital age because they've been immersed in it their entire lives.[30] This information is essential for an effective medical educator to understand, because a failure to integrate technology into the education of medical students would be doing the student a disservice in their long-term future growth as a lifelong learner.

Despite all of the good things technology brings to medical education, educators need to proceed with caution when planning to shape curricula around technology. Technology is a tool that helps an educator achieve the end goal of having his or her learners meet certain learning objectives. It is easy for an educator to become caught up in the excitement and attractiveness of technology and, therefore, it is essential for educators to remember that teaching should drive technology use. The use of technology should not drive teaching. When educators first begin to explore the insertion of technology into their teaching methods, they need to ask themselves, "How will technology enhance teaching and learning?"[31] Greenhalgh writes, "New technologies may have important educational advantages, but without support and training for staff and students they could prove to be an expensive disaster."[32] This statement effectively illustrates the commitment needed by both

educators and administrators to effectively train for precise and specific use of new technologies in the classroom in order to utilize the new tools to their greatest potential. As stated previously, integrating new technological teaching methods is a time consuming and work intensive process. Both educators and administrators must work together to find technology that fits the teaching philosophies and teaching styles of individual educators. This process will not be a "one size fits all" solution as educators need to feel motivated and safe if they are to integrate new teaching methods into their educational repertoire.[33] Svinicki writes, "Successful incorporation of technology tools will depend upon the extent to which they are connected to course goals, combined with effective pedagogies, and designed to improve student learning, rather than being used for their own sake."[31] This is the golden rule when it comes to incorporating technology in teaching, and for that matter into medical education. If a technological medium cannot be linked back to teaching objectives and cannot be combined with effective pedagogy, then the technology will not be an effective tool in medical education.

The future of technology in medical education is bright. Years from now this article will feel antiquated and out of date as new technologies become common place in medical schools across the nation. Building connections between technological savvy students and their educators is vital. Any small connections that educators can make with their students helps to build cohesiveness and community within the classroom. Being able to integrate technology into medical education materials will close the professional gap between students and professors. Closing the gap has the potential to result in cohesive, integrated educational experiences and the achievement of improving learning outcomes by creating in-class opportunities for active learning and skills building to create lifelong learners.

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