Preparing Undergraduate Medical Students for Future Practice - Development of a Future of Medicine Elective
Preventing Undergraduate Medical Students for Future Practice - Development of a Future of Medicine Elective

Livingston Martin, BA¹; Jennifer Lilley, MS¹; Max Schimelpfenig, BA¹; Abigail Buckholz, BS¹; Simon C. Williams, PhD² and Mac Ansari, MD³

¹Texas Tech University Health Sciences Center School of Medicine, Lubbock, Texas 79430; ²Department of Medical Education, Texas Tech University Health Sciences Center School of Medicine, Lubbock, Texas 79430; ³Department of Internal Medicine: Interventional Cardiology, Texas Tech University Health Sciences

INTRODUCTION

Medical school shapes the mindset of the next generation of doctors. During these critical years, medical students are exposed to didactic and experiential learning activities to explore concepts central to medical care and learn about techniques and procedures used to treat medical conditions. The literature demonstrates that following the most up-to-date recommendations does reduce patient mortality and improve quality of care.¹ However, the cutting edge of medicine is not necessarily incorporated into a standard medical school curriculum. Outside pressures, including the use of standardized examinations for determining progression through medical education programs and ensuring that medical school curricula are designed to meet accreditation standards, tend to discourage the introduction of innovations into busy and crowded curricular structures.²,³ Despite these limitations, medical school is a unique time in the medical education journey, and experiencing a diverse curriculum can help future physicians grow as people, broaden the scope of their practice and ultimately provide better care for their patients.

Texas Tech University Health Sciences Center School of Medicine (TTUHSC SoM) has enabled this enrichment opportunity by offering first- and second-year medical students the opportunity to take electives that supplement, but do not interfere with, the standard curriculum. With these electives, students have the chance to explore content to which they would not otherwise be exposed.²,³ For example, electives are available in which students can explore topics such as the business of medicine, culinary medicine, and pre-hospital care. The Future of Medicine elective is one such opportunity, and it includes interactive sessions that enable students to fully interact with some of the latest technology in the medical field. For example, students gain experience with da Vinci robotic surgery, 3D printing of mediately-relevant structures, virtual reality with Google Glass and Microsoft HoloLens, electronic medical record systems as well as advanced imaging techniques in interventional cardiology. The content of this elective was designed and organized by a group of first- and second-year medical students, who coordinated with faculty to create sessions focusing on different aspects of technology in medicine. Enrollment in the Future of Medicine elective is a voluntary extra-curricular activity that awards elective credit on the transcript. This elective course is an example of a cost and time effective method for encouraging the inherent curiosity of medical students to explore new fields of medicine and to be prepared for their unique future practice environments. This report will describe the design of the elective and provide an analysis of student feedback about the elective.

Corresponding Author: Livingston Martin
Email: livingston.martin@ttuhsc.edu
The authors claim no conflicts of interest or disclosures.
AMSRJ 2019; 6(1)
http://dx.doi.org/10.15422/amsrj.2019.08.009
MATERIALS AND METHODS

The elective consists of eight lectures and five interactive focus sessions over an entire academic year for a total time commitment of 12-16 hours. Each focus session provides a hands-on approach towards an innovative technology that students otherwise would not learn. The elective also includes discussion components during which students interact with faculty educators and share their ideas for the future of medicine. The educational impact of this elective was studied by surveying nineteen students who received credit for the course completion. Specifically, we asked about the five focus sessions that gave students first-hand experience with a variety of emerging technologies (Figure 1).

Session 1: da Vinci Robotic Surgery Simulator; The da Vinci robotic surgery simulator involved a classroom component, led by a urology attending and several urology fellows, as well as a practical hands-on component in the operating room. In the classroom there was a discussion of the history of robotic surgery, and how advances in the field with the need for new surgical tools led to the modern da Vinci surgical robot. During the hands-on component, students were scheduled to report to the operating room in groups of three to use a simulated training program on the actual da Vinci robot to experience how surgeons are trained to use the machine. They manipulated the robot through a variety of training programs with guidance from the urology residents and developed an understanding of how the robot works in the operating room setting. The da Vinci robot training programs provided feedback to the students in the form of a report of the students’ efficiency of movement, accuracy, and speed (Figures 2 and 3).

Session 2: Hands-on Medical Applications of 3D Printing; Medical applications of 3D printing involved a discussion led by the 3D printing expert at TTUHSC SoM, followed by a hands-on 3D printing workshop. We discussed how 3D printing technology may influence the way medicine is practiced and provided 3D printed examples of pathologies such as an abdominal aortic aneurysm and aortic dissection (see Figure 4). The 3D printing workshop brought small groups of students into the 3D printing lab and enabled them to experience using the software to convert and process medical DICOM images into 3D printable forms. The students were then able to print pathology or objects of their choosing, including imaging from the National Institutes of Health 3D Print Exchange.

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
<th>Session 4</th>
<th>Session 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>da Vinci Robotic Surgery Simulator</td>
<td>Hands-on Medical Application of 3D Printing</td>
<td>Virtual Reality and Medical Education (Google Glass and Microsoft Hololens)</td>
<td>Electronic Medical Records Introduction</td>
<td>Multimodality Cardiovascular Imaging Workshop</td>
</tr>
</tbody>
</table>

Figure 1: Overview of elective focus sessions
Session 3: Virtual Reality and Medical Education (Google Glass and Microsoft HoloLens):
During this session, medical students and nursing students (from TTUHSC School of Nursing) collaborated in an interprofessional education setting to experience different forms of augmented reality. The first of these was Google Glass, an eyeglass frame with a camera and a small screen with content visible to the wearer. Students practiced wearing and using Google Glass and discussed how it might contribute as a physician-assist device during a patient encounter. Then the roles were reversed, and the Google Glass was worn by a “patient” to record the student physician during a simulated patient encounter. The footage from the Google Glass was analyzed to provide feedback about the medical student’s eye-contact and body language from the patient’s perspective. The Microsoft HoloLens is a wrap-around headset that detects objects in the room and then superimposes digital representations on top of physical surfaces. In this way, it augments things into the reality perceived by the headset wearer. In this case, holographic patients exhibiting a variety of pathologies were projected in the room as the student observed and interacted with the virtual patient presentation. Students learned hand gestures to interface with the headset and the virtual patient. Following the activity, the medical and nursing students discussed the utility of technology like this, and in what ways it could affect medical and nursing education.

Figure 4: 3D printed abdominal aortic aneurysm; created by the future of medicine elective using imaging data from the University Medical Center.
Session 4: Electronic Medical Records
Introduction:
The electronic medical records introduction was an interprofessional exercise pairing medical and nursing students as they learned to navigate, alter and control the Cerner PowerChart electronic medical record system (EMR). The students were challenged to find and retrieve mock patient data within the EMR system. Then they were tasked with entering different types of information into the EMR. Since the nursing and physician views within the EMR behave differently, the paired groups worked together to understand each other’s roles and access to information. At the conclusion of the exercises, there was an open discussion about the future of EMR and how it can be improved to meet the needs of medical personnel.

Session 5: Multimodality Cardiovascular Imaging Workshop:
The week-long multimodality cardiovascular imaging workshop involved small groups of students learning from interventional cardiologists in the catheterization lab at the University Medical Center. Students observed coronary interventions such as stent placement that was guided by multiple imaging modalities, including fluoroscopy. They also saw how to use electrophysiology mapping as a guide for advanced cardiac rhythm ablations. Another day, students engaged with the transesophageal echocardiography (TEE) imaging modality via a simulator that emphasized how existing technologies are applied and improved.

Survey Questions:
The online survey consisted of five one-sentence questions asking about recommendations, attitudes, and experiences regarding the elective focus sessions and the future role of technology in medicine. These are listed below:

1. “I would recommend this elective to future medical students.” The response choices were: strongly agree, agree, neutral, disagree, strongly disagree.
2. “Which focus session do you think should be implemented into the medical school curriculum?” The response choices were: da Vinci Robotic surgery, 3D Printing, Virtual Reality (Microsoft HoloLens and Google Glass), Electronic Medical Records, Cardiovascular Imaging, or None. Students could choose as many options as they wanted.
3. “I felt the focus sessions were effective and contributed to my education.” The response choices were: strongly agree, agree, neutral, disagree, strongly disagree.
4. “How would you describe your familiarity with emerging medical technologies prior to starting this elective?” The response choices were: high familiarity, moderate familiarity, little familiarity, no familiarity.
5. “My experiences in this elective have made me more likely to implement emerging medical technologies in my future practice.” The response choices were “yes” or “no.”

There was also a field available for optional comments.

RESULTS

The responses to question one, “I would recommend this elective to future medical students.” indicated that 13 (68.4%) students “Strongly Agreed” and 6 (31.5%) students
“Agreed” with the statement (Figure 5).

![Figure 5: Student response to the survey question “I would recommend this elective to future medical students.”](image)

The responses to question two, “Which focus sessions do you think should be introduced into the medical school curriculum?” indicated that 12 (63.2%) students selected “Electronic Medical Records”, 6 (31.6%) students selected “Cardiovascular Imaging”, 6 (31.6%) students selected “da Vinci robotic surgery”, 4 (21.1%) students selected “3D Printing”, 4 (21.1%) students selected “Virtual Reality (HoloLens and Google Glass)” and 1 (5.3%) student selected “None” (Figure 6). Out of 19 total student responses, students were able to select more than one answer to this question if they thought more than one focus session should be introduced into the medical school curriculum.

![Figure 6: Student response to the survey question “Which focus sessions do you think should be introduced into the medical school curriculum?”](image)

The responses to question three, “I felt the focus sessions were effective and contributed to my medical education.” indicated that 8 (42.1%) students “Strongly Agreed” and 11 (57.9%) students “Agreed” with the statement (Figure 7).

![Figure 7: Student response to the survey question “I felt the focus sessions were effective and contributed to my medical education.”](image)

The responses to question four, “How would you describe your familiarity with emerging medical technologies prior to starting the elective?” indicated that 1 (5.3%) student had “High familiarity”, 11 (57.9%) students had “Moderate familiarity”, 6 (31.6%) students had “Little familiarity” and 1 (5.3%) student had “No familiarity”.

The responses to question five, “My experiences in this elective have made me more likely to implement emerging medical technology in my future practice.” indicated that all 19 (100%) student responses were “yes.”

There was a single optional comment that recommended an addition to the elective of “A comparison of different EMRs or some of the theory behind what makes a good EMR” as well as a discussion of “how to solve the problem of every hospital having their own record system and failing to communicate with one another”.

**DISCUSSION**

The recommendations, attitudes, and experiences reflected in the survey suggest that the students enjoyed learning about innovative methods and novel medical technologies. Survey results from question one indicated that 100% of survey participants had a favorable recommendation [“agree” or “strongly agree”] of the elective to other students. One hundred percent of survey participants felt the focus sessions were educationally useful, meaning the
hands-on format of the focus sessions was subjectively valuable as a method of teaching. The interactive form of medical education is a powerful way to engage students in the learning process.

Several students suggested incorporating more than one of the focus sessions into the medical school curriculum. The highest number of students recommended making electronic medical record sessions as part of the first- and second-year experience. Although electronic medical records are ubiquitous in modern healthcare, being a proficient user is not a part of the standard medical curriculum. Learning how to use electronic medical records earlier in medical training will enable students to be more familiar with this essential aspect of medical practice and communication. The errors caused by a poor understanding of electronic medical records put patients at risk and showcase the disconnect between training and expectations in the workforce. In light of this, it is essential to discuss how EMRs can better meet the needs of healthcare professionals, and how to work on an interprofessional team within existing EMR systems. The interprofessional component of student nurses and physicians working together to solve some clinical documentation problems can forge a comradery and understanding of the challenges that the other faces and can facilitate communication as the team members understand how to work better together.

The second most requested content to add to the standard medical curriculum was cardiovascular imaging and the da Vinci robotic surgery. Advanced cardiac imaging methodologies and the da Vinci robotic surgery are examples of technologies currently being utilized by physicians at our institution and other hospitals around the country. Having some familiarity with this technology can encourage ready adoption of it in surgical practice and can inform physicians about the possibilities and pitfalls of the technology and what it means for patient health.

3D printing and virtual reality are innovative concepts that have the potential to play a significant role in how we educate and interact with our patients. For example, 3D printing pathology can be used to physically show a patient an anatomical defect they may have, or how a planned operation will proceed. Wearable technology, like Google Glass, can provide the physician with quick access to patient-specific information while enabling the physician to maintain eye contact and focus primarily on the patient instead of a screen. The augmented reality technology, Microsoft HoloLens, has the potential to improve clinical education by enabling virtual patient encounters in ways that standardized patients may not be able to emulate. However, both technological tools can also become a social barrier that makes the patient feel separated and alienated from the humanistic physician. Regardless of what technologies future physicians adopt, it is valuable to discuss what we want our clinical office to look like in a few decades, and what tools will help or hinder our ability to care for our patients.

When asked about their future medical practice, 100% of survey participants said they were “more likely” to implement “emerging technologies” into their practice following completion of the elective. Most survey participants had at least some familiarity with emerging medical technologies before beginning the elective. It is a promising indicator of how medical students will respond to the ever-changing dynamics of medical practice, with the ability to appraise and incorporate technology when its presence is beneficial for the patient. With the positive responses found in the survey, future student and faculty leaders can adapt the elective curriculum to suit the needs of their peers.

An important point to consider is the inherent limitations of the small sample size of this report. The pre-clinical medical students involved in this elective did so voluntarily to
fulfill their intellectual curiosity, and thus could have a bias affecting the survey results. Additionally, students who attend a technology elective could have a marginally greater awareness of technology in general. One question in the survey asks about students’ familiarity with emerging medical technologies before participating in the elective. Most students responded that they have either “moderate” or “little” familiarity with technology, which is helpful in qualifying the strength of the recommendations to incorporate these elements into the standard medical curriculum.

Going forward, we would like to determine if introducing new technologies to pre-clinical medical students aids in education in clinical rotations and residency. In the future, we would like to collect information from the medical school class as a whole and compare their technological familiarity with students who are in the Future of Medicine elective. We want to monitor student self-efficacy with a standardized questionnaire such as from Chen et al.7 which could provide a standardized survey to help elucidate student attitudes towards novel technologies.

In conclusion, a student-designed elective enabling first- and second-year medical students to use da Vinci robotic surgery, 3D printing, virtual reality with Google Glass and Microsoft HoloLens, electronic medical records and multimodality cardiovascular imaging was enriching to the pre-clinical medical school experience. It was subjectively rated highly enjoyable and useful by its participants, and they uniformly reported that the outlook they developed would be applicable in their future medical career. This elective not only aimed to equip students with a better understanding of novel technologies, but also emphasized the importance of critical thinking, creative problem-solving, and innovation in medicine.

REFERENCES

6. Functions and Structure of a Medical School - (contains the LCME Standards)._Liaison Committee on Medical Education. 2017.