

INNOVATION AT U.S. MEDICAL SCHOOLS:
A MULTIPLE CASE STUDY OF LEADERS' PERCEPTIONS OF
EDUCATIONAL TECHNOLOGY

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ABSTRACT

The purpose of this qualitative case study was to better understand the implementation of educational technology in selected medical schools. This study utilized Rogers' Diffusion of Innovation theory to investigate the perspectives of educational technology leaders at four different medical schools in the United States.

In the coming years, healthcare in the United States will experience shortages of primary care physicians because of population growth, longer life expectancies, and changes in insurance coverage due to the Affordable Care Act (ACA). To address the need to produce a greater number of physicians, innovative approaches to both recruitment and education are needed. Educational technology has the potential to significantly increase access to healthcare professionals, especially physicians.

The methods of data collection included two sets of interviews, document analysis, and a short questionnaire. The interviews were transcribed and coded and through comparative analysis, themes were developed.

The four participants, all of whom held positions in the deans' office, were heavily involved in the implementation at their respective medical institutions. All the participants were considered to be innovators with respect to Rogers' Diffusion of Innovations. The major themes established in this study: outside influencing change in the organization, organizations and change, and individuals and change were developed through analysis of the data.

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CHAPTER 1. INTRODUCTION

In the coming years, healthcare in the United States will experience shortages of primary care physicians because of population growth, longer life expectancies, and changes in insurance coverage due to the Affordable Care Act (ACA). “Population growth would be the greatest driver of increased primary care use, requiring approximately 33,000 additional primary care physicians by 2025. Aging would also contribute to needs, but to a smaller extent, while insurance expansion (due to ACA) would require 8,000 additional care physicians” (Cooper, 2004; Kirch, Henderson, & Dill, 2012; Petterson et al., 2012). As health care needs rise there will be a corresponding need for more medical professionals, especially physicians. Many organizations have predicted shortages of physicians in the near future.

To address the need to produce a greater number of physicians, innovative approaches to both recruitment and education are needed. Educational technology has the potential to significantly increase access to healthcare professionals, especially physicians. Research has shown that educational technology is an effective method for instruction in medical education, especially when blended with traditional teaching methods (Chumley-Jones, 2002; Ruiz, Mintzer, & Leipzig, 2006).

Educational technology has already impacted clinical education in the form of simulations and interprofessional development. Approaches to skills training needed to be developed that did not put the patients at risk during initial encounters in clinical settings, as the need for a fundamental redesign of medical training was evident (Cox, Irby, Cooke, Sullivan, & Ludmerer, 2006). While educational technology has made inroads into other healthcare related

fields such as nursing (Erdley, 2006; Wu, Hwang, Su, & Huang, 2012), there are few opportunities for hybrid and distance education in medical schools (Kim, 2006).

Medical education has shifted away from traditional didactic methods towards a more self-directed learning environment. This emphasized clinical reasoning and problem-solving skills while teaching students to become lifelong learners (Gill, Kitney, Kozan, & Lewis, 2010). Educational technology helps supplement traditional medical education, especially as the demand for doctors and healthcare professionals increases dramatically. Educational technology gives medical schools the opportunity to provide core content that meets educational and curriculum needs while maintaining quality curricular materials that are scalable, reliable, reusable and not restricted by geographical boundaries.

Medical education has already embraced the use of technology in the didactic phase of programs with the use of presentation software, patient simulators, multimedia resources, and in some cases distance education. Technological advances allow the delivery and monitoring of clinical instruction by utilizing online discussions, computer simulations, assessment systems and databases of resources (Cook & McDonald, 2008; Souza, Kamin, O'Sullivan, Moses, & Heestand, 2008). Current medical students expect that medical schools will offer educational technology services. Educational technology is a growing field that provides learners and faculty innovative ways to improve teaching, learning, and assessment.

Statement of the Problem

The U.S. will need an additional 33,000 family doctors by 2025 due to a population that is growing and getting older. Furthermore, in an effort to provide health care to previously uninsured Americans, the Affordable Care Act will put an additional strain on health care

resources. Increasing the number of graduates of U.S. medical schools would, therefore, seem to be the preferred option (Blumenthal, 2004). One of the ways to accomplish that is through educational technology, as educational technology provides increased opportunities for learning and consequently can lead to more physicians being trained (Cooke, Irby, & O'Brien, 2010). “The development of teaching and learning modalities via new media can positively impact the physician supply problem by transforming medical education to a competency and evidence-based curriculum in an accelerated format” (Hess & Shrum, 2011, p. 345). However, little is known about educational technology in medicine, especially in medical schools producing physicians. The first step is to consult with identified educational technology leaders at medical schools to discover the current implementation of educational technology.

This research specifically focused on medical schools in the United States. Identified leaders had been operationally defined as individuals who were directors or in a leadership role at medical schools engaged in the use of educational technology in an organizational setting. Identified leaders were chosen due to their contributions to research in the field of educational technology in medical education. They were also required to have been in a position to contribute to the implementation of educational technology at their respective institution.

Purpose

The purpose of this qualitative case study was to better understand the implementation of educational technology in selected medical schools. It was essential to gain the unique perspective of the identified leaders of educational technology programs’ perceptions and rationale through the lens of the Diffusion of Innovations model with respect to the implementation of educational technologies in medical education.

Research Questions

To address that purpose, the following research questions were asked:

RQ1: How do identified educational technology leaders of specific medical schools describe the implementation of educational technology at their institutions?

RQ2: What do leaders describe as the strengths and challenges of incorporating educational technology into these select medical schools?

Significance of the Study

While educational technology research in general is plentiful, there are limited studies specifically regarding the application of educational technology in medical schools (Alexander, Bloom, Falchuk, & Parker, 2006; Bernardo et al., 2004; Fox, Chiem, Rooney, & Maldonado, 2012; Fraccaro & Giacomini, 2012; Kerfoot et al., 2006; Masiello, Ramberg, & Lonka, 2005). This study addressed that shortage of studies by looking at four medical schools that were using educational technology and used the data to better understand the characteristics, strengths, and challenges of integrating educational technology in U.S. medical schools.

Conceptual Framework

In order to investigate the research questions, this study intended to utilize a qualitative and descriptive case-study design. A multiple case study design was employed to explore the use of educational technology at medical schools with the intent of using multiple cases to draw a single set of cross-case conclusions. Descriptive case studies are used to describe events or a particular process in a natural setting (Yin, 2009) and the main objective of case study research is to answer “how” and “why” questions. The case study approach is very valuable to use when one needs to take a deeper look at an issue, event, or phenomenon in its natural context. Typically the

researcher has little control over events and the focus is on contemporary phenomenon within a real-life context.

A descriptive case study in education is one that presents a detailed account of the phenomenon under study along with the presentation of useful information about areas of education where little research has been done. These particular case studies frequently involved innovative programs and practices and often formed a database for future comparison and theory building (Merriam, 1998). Case studies are regularly used in education to inform or improve policies and practices. They also attempt to clarify a decision or set of decisions, such as including why a decision was made, how it was implemented, and what was the result.

The case study is one of the major research strategies in contemporary social science (Yin, 2009). Yin defines case study research as an empirical inquiry that investigates contemporary phenomenon with a real life context. It is a research design that explores or describes situations where there are more variables of interest than statistics can accommodate. A qualitative case study is utilized to gain an understanding of the phenomenon and to address a gap in the research.

Summary of Methodology

The case study is the most flexible of all research designs as it allows the researcher to retain the natural characteristics of real-life events while facilitating the investigation of empirical events (Yin, 2009). The empirical results have been considered to be more potent if two or more cases support the same theory but do not support an equally plausible rival theory. The multiple case study approach is utilized because the research is based on cases that are similar in nature. A number of cases are studied together, either simultaneously or sequentially, in order to investigate a phenomenon, population or general condition (Stake, 2006).

In this multiple case study, there were two stages of analysis: analysis that occurred within each case and cross-case. Each case was first treated as a comprehensive case on its own and data were gathered so the researcher could learn as much about the contextual variables as possible. Once the analysis of each case had been completed, cross-case analysis was initiated. A qualitative, inductive multiple case study sought to build abstractions across cases (Merriam, 1998).

Role of the Researcher

Case studies are typically very specific and qualitative case study researchers have often been responsible for the primary data collection. The intent of this study was to provide an analysis that others could learn from, based on the experiences of the participants.

In most examples of case study research, observations were often conducted and the researcher often assumed the role of the observer (Stake, 2010). This study collected data mainly using document analysis, a survey questionnaire, and interviews. The nature of the interaction during an interview typically depended on the personality and skill of the interviewer, the attitudes of the participant, and the definition of the situation (Merriam, 2009). The interaction between the interviewer and the participant was a complex phenomenon. Avoiding bias by acknowledging one's own subjectivity is a desired goal for a case study researcher (Yin, 2009), and in this study it was the intent of the researcher to be respectful and sensitive to the concerns of the participants from start to finish.

Limitations

Limitations to this study included a lack of generalizability. The data were obtained from a small pool of subjects, and the sample was not completely representative of the population of

141 medical schools. An additional limitation was that this research relied on the perceptions of the case study participants.

Definition of Key Terms

Apprenticeship. An apprenticeship is a method of learning a craft or trade by working with someone who is more knowledgeable and is considered an expert (Bonner, 1996).

Course Management System. Course Management Systems (CMS), also called Learning Management Systems (LMS), are software systems specifically designed for faculty and students to use in teaching and learning, typically utilized to design and deliver online courses (Bove, 2008).

Clinical Education. The intent of clinical education is to teach the medical student the fundamentals of clinical examination, diagnostic evaluation, and provision of care (Haynes & Haines, 1998).

Didactic Instruction. The didactic method or direct instruction is generally defined as a method where the instructor presents the same content material to the whole class at same time through lecture, giving explanations and directions, answering questions, and drilling students on facts (Esler & Sciortino, 1991). This model stemmed from Plato's and Aristotle's theories and was an approach where the authority of the teacher was forefront.

Distance Education. Distance education uses information technologies to deliver instruction to learners who are at remote locations from a central site (Ruiz et al., 2006). It is furthermore defined as institution-based and formal education where the learning group is separated. This format uses various means of technological communication systems to connect learners, resources and instructors (Simonson, 2012).

Educational Technology. Improving learning and performance by creating, using and managing appropriate technological processes and resources. It is also called web-based learning, online learning, distributed learning, e-learning, and Internet-based learning (Bove, 2008).

Innovation. An idea, practice or object that is perceived as new to an individual or another unit of adoption (Rogers, 2003).

Personal Digital Assistant (PDA). A handheld mobile computing device.

Preceptor. Refers to the experienced physician in the mentor role of an apprenticeship at the clinical site charged with supervising the clinical phase student (Davis, 1877).

Traditional Education. Typically involves instruction where the students and instructor are in the same physical proximity. Education normally occurs in a physical, structured classroom setting using the didactic method of instruction.

Virtual Patient: Computer simulations or representations of patients used to simulate various healthcare tasks and/or thought processes.

Summary

Doctors and healthcare workers continue to be in high demand, so it is necessary that we look for ways to support effective and sustainable learning in the field of healthcare. The data and results from this study are intended to help medical educators in their efforts to integrate technology and understand the influences and hindrances that affect medical school faculty incorporating educational technology. The outcomes of this study will also help ensure a better targeting of vital resources for faculty development of technological innovations. The information that was gathered with this research will assist medical education programs that do not maximize the use of educational technologies. The goal is to share a guide that provides

medical institutions with some direction and information on implementing educational technology in support of traditional courses. The case study approach was used in this study because of its ability to allow the researcher to take a deeper look at an issue, event, or phenomenon in its natural context.

CHAPTER 2. REVIEW OF LITERATURE

In the next decade the U.S. will need additional family doctors to accommodate a progressively growing population (Cooper, 2004; Kirch et al., 2012; Petterson et al., 2012). An aging population and changes to our health care laws will also put an additional burden on health care resources. To address these concerns educational technology provides increased opportunities for learning, which could lead to more physicians being educated and trained. Little has been known about educational technology in medicine, especially in medical schools producing physicians.

In order to understand the context for my study, the remainder of this chapter covers medical education, educational technology in medical education, and change models. Educational technology has helped supplement traditional medical education, especially as the need for doctors and healthcare professionals has risen. The purpose of this qualitative case study is to better understand the implementation of educational technology in selected medical schools.

Medical Education

This section discusses medical education as it evolved in the U.S.. In order to better understand how educational technology is being implemented in medical education, it is important to first briefly review the history and genesis of medical education in the U.S.

Formal medical education in the U.S. has been traced back to the mid-17th century when potential physicians had limited choices for training. Typically individuals looking for a medical education had to travel to a big city to work at a hospital or become an apprentice to a local physician (Shryock, 1972).

By the 18th century, apprenticeships were the most common form for training physicians (Bonner, 1996). Didactic instruction supplemented with hands-on learning using models in the form of drawings, skeletons, and cadavers was the foundation of most anatomy classes at the time (Duin & Sutcliffe, 1992).

During the 19th century the requirements for getting a MD degree consisted of three years of apprenticeship coupled with theoretical and clinical coursework. The arrival of medical textbooks revolutionized clinical education by providing students with current and relevant information about the medicine they were learning to practice (Shryock, 1972). Most medical schools provided large anatomical and pathological collections to complement coursework.

Another innovation at the time was having lecturers describe the symptoms and treatment of a particular illness in the presence of the patient (Hodges, 2005). By 1905, the American Medical Association (AMA) established standards for medical schools, which included stricter requirements for entrance. Various factors, including those previously discussed, led to a significant decrease in the number of medical schools over a period of less than 10 years.

Current medical education

Medical education has been shifting away from traditional didactic methods towards a more self-directed learning environment. This emphasizes clinical reasoning and problem-solving skills while teaching students to become lifelong learners (Gill et al., 2010). In recent years, medical education has moved towards a more constructivist approach, utilizing strategies such as problem-based learning (PBL) and case-based learning (Kneebone et al., 2006; Winston & Szarek, 2005). Medical schools adopted PBL in the expectation that learning from authentic cases early in the curriculum prepared students better for clinical training than the traditional didactic teaching (De Leng, Dolmans, Van De Wiel, Muijtjens, & Van Der Vleuten, 2007).

Problem-based learning is a term that refers to how the learning has been structured, and it is an active approach to teaching in which students deal with real-world problems and challenges. With this type of dynamic and engaged learning, learners are motivated to acquire a deeper knowledge of the subjects they are studying in a particular content area (Edutopia, 2014).

Case-based learning in medical education includes the review of actual clinical cases in small group settings under the guidance of teaching faculty. It is believed that this technique provides a more relevant context for students, and also improves knowledge, retention, application, and self-directed learning. Outside of the traditional lecture, PBL is the most frequently used learning strategy at medical schools (Patel, 1999).

In the last twenty years, evidence-based medicine had been making an impact in medical education. Evidence-based medicine took the focus off intuition, unsystematic clinical experience, and pathophysiologic rationale as the grounds for clinical decision making and stressed the examination of evidence from clinical research (Greenhalgh, 2014). Evidence-based medicine was the careful, sensible, and explicit use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine involved integrating individual clinical expertise with the best available clinical evidence from systematic research.

Typically it had taken approximately four years to receive an undergraduate medical education, starting with two years of pre-clerkship training and the concluding with two years in clerkship. During the first two years, the student would spend most of their time in a classroom or a lab where they learned the basic sciences that would be the foundation of their medical education. Science courses in undergraduate medical school covered all the basic principles that the new physician would need to know as they move on into their clinical education.

Students typically learned anatomy, biochemistry, clinical ethics, genetics, histology, human development, microbiology, neurology, pathology, pathophysiology, physiology, and pharmacology in those first two years (Brass, 2009). After the medical student completed the initial two years of basic sciences, they were required to take the first part of the United States Medical Licensing Exam (USMLE). The initial exam measured the student's ability to understand the basic science concepts and a passing score allowed the student to proceed on to their clinical training.

Clinical training usually had taken place at sites where medical care was administered. In the past, clinical training would take place exclusively in teaching hospitals. Recently there had been a subtle shift from teaching hospitals to smaller hospitals and clinics (Irvine & Martin, 2014). During clinical training students observed and participated in the care of patients under the close supervision of mentor physicians and residents. Clerkships, also known as clinical rotations, were required in family medicine, gynecology/obstetrics, internal medicine, neurology, pediatrics, psychiatry, and surgery. Third year rotations covered the fundamental areas that all students should know, while the fourth year students could choose rotations that were more specified and relevant to their chosen specialty area.

During these final two years the medical student would apply to a residency program that reflected the specialty area they were committing to. Additionally students would take the second part of the USMLE, which assessed medical knowledge along with newly acquired diagnostic and clinical skills (Van Zanten, Norcini, Boulet, & Simon, 2008). Once medical students had completed their pre-clerkship/clerkship training and passed the first two parts of the USMLE, they were eligible to take the final exam, after which they would be officially licensed as a physician.

In the last five years there had been a strong national push to restructure undergraduate medical education in order to align with the Accreditation Council for Graduate Medical Education's (ACGME) competency-based mandate (Triola, Feldman, Pearlman, & Kalet, 2004). The ACGME required all residents participating in a U.S. based residency program to demonstrate their competencies in six areas including: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice (Kim, 2006). Training would be linked to patient outcomes and would require a competency-based evaluation system that is easily accessible at any time.

Barriers in medical education

The curriculum in traditional medical school is fragmented. Basic science faculty often taught the discipline-based courses (anatomy, physiology, microbiology, etc.) with little coordination or reference to clinical work (Cooke et al., 2010). Basic science and clinical faculty did not always know what the other faculty were teaching, which left students to figure out for themselves the content relationships across domains and the relevance of various subjects to patient care.

Another curricular barrier is in the area of clinical teaching is that instructors are too often expected to address a wide range of educational goals that are unachievable, given not only the clinical setting and limited time allotted, but also the variability of learners' prior knowledge and experiences (Skeff et al., 1997).

Cultural barriers refer to the attitudes and traditions of medical schools and stakeholders, including faculty, students, leadership, and staff. Students' attitudes and expectations were one of the greatest barriers to the implementation of new teaching strategies as studies have indicated

that students prefer lectures over strategies that require active learning (Shell, 2001). Students' attitudes also discourage faculty from attempting to try new innovations.

Faculty members' attitudes toward teaching and toward faculty development were also barriers to effective teaching. Some faculty members pursue an academic career because they want to be working directly with students, whereas others see teaching more as a chore, an adverse challenge, or a diversion from patient care or research (Skeff et al., 1997). Faculty members often question the usefulness or importance of faculty development because they underestimate the need for it and/or the potential it has to improve their teaching.

Lack of institutional support can be seen as a barrier as medical schools do not always clearly communicate teaching expectations and responsibilities to new faculty (Green, Gross, Kernan, Wong, & Holmboe, 2003). Additionally faculty members do not receive any kind of instruction or guidance on how to balance and meet their coexisting patient care and teaching responsibilities.

Environmental barriers were associated with the physical settings in which medical education occurs. This included limitations such as time, space, and instructional, human, and technological resources. The dynamic and complex setting of a clinical teaching hospital is not an ideal environment where all the competencies future physicians need to master could be taught (Janicik & Fletcher, 2003). Time is one of the major barriers to effective teaching. Other environmental barriers to effective teaching and learning include inappropriately designed learning spaces and inconsistent access to pertinent patients. The Health Insurance Portability and Accountability Act (HIPAA) is an additional environmental barrier because of how it limits the use of patient data for education.

Financial barriers were also considered environmental barriers and they included the revenue and resource needs in medical education. Financial pressures on medical schools limited the funds that were available to compensate educators (Stites, Vansaghi, Pingleton, Cox, & Paolo, 2005). Funding sources rarely came from new external revenues but, in most cases, from the reapportionment of currently available internal resources. One of the biggest organizational barriers to change in medical education was the allocation of resources and curricular time among fiercely competitive departments (Lane, 2007).

Accreditation

Accreditation was a voluntary, peer-reviewed practice designed to evaluate the educational quality of new and established medical education programs. Systems of accreditation were frequently viewed by health care administrators and policymakers as effective mechanisms for ensuring the quality of basic medical education curriculum and specialty training programs amongst the nation's medical schools.

Accreditation was a procedure where external regulatory bodies which were officially appointed assessed educational institutions using established standards and criteria. It involved gathering data on the different aspects of the medical school and making decisions on an institution's compliance with the standards (van Zanten, Boulet, & Greaves, 2012). This was done to ensure the quality of medical education required to produce competent physicians.

In the U.S., the American Medical Association (AMA) and the Association of American Medical Colleges (AAMC) started to review medical institutions soon after the beginning of the 20th century. In 1942 the AMA and AAMC combined forces and the USA Department of Education and the Regional Councils on Post-Secondary Accreditation conferred national standing to this accrediting body, the Liaison Commission for Medical Education (LCME). The

LCME accredited complete and independent medical school programs, geographically located and operated by universities or medical schools chartered in the United States, that resulted in an M.D. degree (Dillon, Boulet, Hawkins, & Swanson, 2004).

In order to achieve and maintain accreditation, a medical education program leading to an M.D. degree in the U.S. should meet the standards set forth by the LCME. The accreditation process required medical education programs to provide assurances that its graduates exhibited general professional competencies that were appropriate for the next stage of their training and that served as the foundation for lifelong learning and proficient medical care (Boulet & Zanten, 2014). The LCME was recognized by the U.S. Department of Education as an accrediting agency for medical education programs leading to a medical degree. Burch et al. (2006) provided a list of advantages that accreditation can bring to medical institutions:

- Affirmation of the quality of education, based on reliable information
- Prestige and honor gained by the institution
- Attractiveness of the school to prospective students and their parents
- National or international recognition of the degrees awarded by the school
- Incentives such as administrative and financial autonomy
- Availability of funding and subsidies, based on objective data for performance
- Culture of periodic evaluation and improvement; identification of areas for planning and development
- Ranking as a competitive institution; peer recognition.

Accreditation by the LCME established eligibility for selected federal grants and programs, including Title VII funding administered by the Public Health Service (Boulet & Zanten, 2014). Most state boards of licensure required that U.S. medical schools be accredited by the LCME, as a condition for licensure of their graduates. Eligibility of U.S. students to take the United States Medical Licensing Examination required LCME accreditation of their school. Graduates of LCME-accredited schools were eligible for residency programs accredited by the Accreditation Council for Graduate Medical Education.

Institutional accreditation was granted by regional accrediting agencies and was a requirement in order to qualify for federal financial assistance programs authorized under Title IV of the Higher Education Act. Programmatic accreditation for medical education programs leading to the MD degree was granted by the LCME. Because the LCME was not recognized as an institutional accrediting agency, it lacked the authority to accredit stand-alone medical schools as institutions of higher education (Dillon et al., 2004). Medical education programs leading to the MD degree must first hold institutional accreditation to be eligible for initial full accreditation and for continuing accreditation by the LCME.

Revising criteria, standards and procedures was a more variable process. In the USA, anyone (medical school, organization, public) could propose a new standard for consideration by the LCME, followed by public review before the standard is adopted. The LCME regularly reviewed the content of the standards and elements, and sought feedback on their validity and clarity from its sponsor organizations and members of the medical education community. Changes to existing standards and elements that imposed new or additional compliance requirements were reviewed by the LCME's sponsoring organizations and were considered at a public hearing before being adopted. Regulators and certifying bodies needed to be aware of changes in doctor practices and emerging assessment tools, and how these could be incorporated into both initial and ongoing decisions regarding competence (Van Zanten et al., 2008). As patient care evolves, incorporating multidisciplinary teams with shared responsibility, the credentialing of individuals, as opposed to groups of individuals, might not be sufficient for addressing competency to practice.

Recently the LCME revised the structure of the standards and elements that were the basis for accreditation (AAMC, 2014). The efficiency of the accreditation process had been

streamlined as the LCME had reorganized the standards and consolidated the amount of total standards from 132 to 12. The only significant change to the actual content of the standards had been made in 2013 when the following element was added to the standards: *“The core curriculum of a medical education program must prepare medical students to function collaboratively on health care teams that include health professionals from other disciplines as they provide coordinated services to patients. These curricular experiences include practitioners and/or students from the other health professions.”*

Current standards from the Liaison Committee on Medical Education (LCME) were limited with respect to referencing educational technology, with little direction on how it should be organized or supported (Kamin, Souza, Heestand, Moses, & O'Sullivan, 2006). The standards called for curriculum that fostered self-directed independent study, so access to educational technology seemed to be implied. The standards suggested that there should be “appropriate educational infrastructure” to include computers, audiovisual aids, and laboratories.

Curriculum reform

A general lack of leadership in medical schools was often cited as the most fundamental barrier to curriculum change (Bland et al., 2000). Faculty and administrative leaders typically opposed curriculum change because they did not understand or agree with the vision and rationale for the change. They were unsure that the change would improve learning and in most cases were unwilling to take on the extra work required during the planning process or give up instructional time to try something new. Resistance to change could also arise from faculty failing to understand the significance of content outside their own domains of knowledge (Robins, White, & Fantone, 2000).

Tensions often existed between the individual values that guided faculty members in their approaches to teaching and the institutional values that underpinned the curriculum change process (Venance, LaDonna, & Watling, 2014). Curriculum renewal allowed oversight of the curriculum and provided clear expectations on what faculty was supposed to contribute. While accreditation was considered as a key agent of change, it might act to restrict faculty adoption of change if the standards it imposed failed to agree with individual faculty members' philosophies of education or with the perceived institutional culture.

Successful curriculum change processes have followed a standard model that includes needs assessment, specification of learning objectives, selection of content and teaching methods, and evaluation of change (Wartman et al., 2001). Needs assessment involves determining the appropriateness of current curriculum content, teaching methods, and timing of instruction. Once an initial needs assessment is complete, the focus shifts to reaching agreement on learning objectives, identifying content, selecting delivery methods, and creating appropriate forms of assessment (Allan et al., 2014). Accurate evaluation of curriculum innovation requires time to assess the important outcomes

Organizational models of educational technology units

There were four primary models for educational technology organizations that existed at medical schools in the U.S.; designations that were based on where the units were located within the governance of the school (Souza et al., 2008). Most medical schools utilized the School of Medicine Central Model, where the centralized educational technology unit resided within the school of medicine. Institutions with an SOM Central Model had dedicated resources in place to support educational technology directly in the school of medicine, and they had leadership in place to govern those services.

The University Central Model was based upon the premise that the centralized educational technology unit was based at the comprehensive university and shared by the various schools within that institution. The University Central Model was one in which medical schools had provided financial support to a larger university campus unit to support their educational technology needs.

The Health Science Center model was where the centralized educational technology unit was located at the health science center. Medical schools with an HSC Central Model provided support to the health science center (a freestanding parent health sciences university, which also comprised other schools such as nursing, pharmacy, dentistry, and allied health), which, in turn, provided educational technology services to the medical school.

The Dispersed Model applies to those institutions that lacked any centralized educational technology unit. The Dispersed Model referred to medical schools whereby no centralized governance provided support of educational technology infrastructure and services, yet the medical school had provided financial support to various groups to deliver these services.

The majority of schools relied on some type of centralized organization. The centralized models had more resources devoted to educational technology and a closer alignment with the academic mission than the Dispersed Model. In all the models, the identified leaders reported directly to the Deans' office.

Policy in medical education

Medical education followed the classical policy model, which presented a process that flowed from setting the agenda to problem construction, and finally decision making; it differentiated between crucial steps in the policy process and provided a language and terminology for a specific process in the organization (Hill & Hupe, 2008). The model provides a

structured and systematic way to clarify thinking about a decision-making process. The process does not need to be linear, but it recalled the roles played by various groups at every stage and how each step influences the rest of the process. Successful medical education leaders comprehended this model and understood how interests in power come into play.

Leadership in medical education

Medical school leadership has been defined in a multitude of ways. People think about the work of school leaders in ways such as participative, democratic, transformational, moral, strategic, and administrative. The academic leadership is responsible for providing guidance for teaching and learning, therefore they must play a key role with respect to innovative practices that improves the quality of the medical students' educational experience (Lucas, 2000).

For hundreds of years, the structure of the leadership at medical schools followed the top-down approach model, which focused on the hierarchy between levels and the subordinate levels (Van Meter & Van Horn, 1975). In the past 30 years, there had been a shift towards the governance model, which suggests that implementation is a horizontal relationship between various stakeholders united by a common objective (Hill & Hupe, 2008). In this model different groups work collectively in a social system and combine their powers and resources to achieve their goals.

Critiques of medical education

Medical schools are not effectively training physicians to perform in the complex organizational and social systems that have been a crucial aspect of modern medicine. The U.S. needs to start training physicians to be adept in the social sciences as well as the medical sciences (Sales & Schlaff, 2010). Many future physicians in the U.S. received a minimal amount

of formal training in the social sciences, particularly in the skills that were necessary when dealing with people (Schwab, 2010).

Another concern is the frequency of errors that occur during physician training, including mistakes made while performing surgery, waste, and overtreatment in medical care. To reduce error and improve overall quality physicians have to be trained to focus on system design. Medical students and residents are often taught clinical medicine by faculty who spent very little time actually seeing patients, while clinical skills are often taught by teachers who have less experience with modern biomedical science (Cox et al., 2006). Another critique of medical education is that medical schools have varying degrees sought to teach health care policy, but not in ways that came close to matching the rigor of training in the biological sciences (Alpern, Belitsky, & Long, 2011).

Educational Technology in Medical Education

The extensive availability of the Internet coupled with the development of educational technology provides an avenue to assist in facilitating and delivering online instruction. Educational technology has advanced dramatically in the past decade and information and telecommunications technology offers the opportunity to revolutionize the way we provide education. Educational technology is has been gaining in popularity as most participants have been satisfied with the experience and find it to be an effective learning format (Lau & Bates, 2004).

In the 1990s, computers became widely available and the Web was a practical place for dispensing educational materials (Wutoh, Boren, & Balas, 2004). Many of the barriers to using computer technology in the medical education environment had been overcome. Computers and mobile devices became readily available in most physicians' homes and workplaces, which in

turn influenced how physicians' used the technologies to search for information (Bennett, Casebeer, Kristofco, & Strasser, 2004).

One of the advantages educational technology has over more traditional teaching techniques is that it shares massive amounts of information to an unlimited number of students at a lower cost, effectively proving itself to be a valuable educational tool (Choules, 2007).

Research has shown that educational technology is an effective method for providing various forms of instruction in medical education, especially when it is blended with traditional teaching methods (Chumley-Jones, 2002; Ruiz et al., 2006).

Medical education has always depended on textual content as a way to convey information to the student, but new information technologies have been finding their way into medical school classrooms and providing instructors with additional options (Sandars & Langlois, 2006). Textbook-based education provides a problem to both students and teacher with its abundance of physical materials. Multiple textbooks, an abundance of photocopies, and handwritten notes all coupled with the lack of an effective retrieval system that allows the student to quickly find the information they require is overwhelming (Bove, 2008). Medical information is stored in three basic forms: text, images, and sound. All three forms of information are necessary to study medicine, and all three are converted to digital form for easy access.

Educational technology allows medical schools to provide the necessary science content to meet the educational needs of the institution, and these online resources allow the instruction to become learner-centered as students have been able to approach the educational materials at their own pace, choosing when and where they wanted to access the content (Ruiz et al., 2006). Most educational technology for medical education has been focused on the individual and less

time spent developing synchronous real-time lectures, labs, or tutorials that might be useful in situations in which faculty and students have not been geographically located at the same place at the same time (Barzansky & Etzel, 2005).

In medical training it has been especially important that the learners apply and use what they learn in practice. An effective way to accomplish this is providing challenging interactions that require the learners to take an active role in their own learning. Educational technology has been a great tool in achieving this kind of training. As more sophisticated technology has become available, there are more choices for students to access the essential information (Dror, Schmidt, & O'Connor, 2011).

Educational technology has been a challenge for medical educators. The difficulty came in how to use it to increase learning and to improve the effectiveness of educational programs (Souza et al., 2008). The arrival of the educational technology, like most innovations, has been considered a disruptive technology to those responsible for the facilitation of medical education. That is because it is a technology that has disrupted the status quo (Ellaway, 2011). It is a technology that has upturned the traditional learning model used at medical schools and presented a challenge for teaching faculty (Harden, 2005). Medical education has already incorporated the use of educational technology in the didactic aspect of medical programs through the use of presentation software, patient simulators, and multimedia resources.

Technological advances used in the delivery and monitoring of clinical instruction includes incorporating online discussions, computer simulations, assessment systems and the sharing of resources as part of the learning experience (Cook & McDonald, 2008; Souza et al., 2008). Medical students arrive at medical school with the expectation that their institution offers

educational technology services. Several examples include interactive case-based and problem-based learning, virtual simulations, and electronic portfolios (Sandars & Haythornthwaite, 2007).

Educational technology comes in a multitude of platforms with a variety of functions that are suited to the learner (Cook & McDonald, 2008). A single activity incorporates several different forms of e-learning. An example from a clinical radiology course had been to initiate the online instruction with a video tutorial about identifying a particular type of fracture, then working with a virtual case for practice, and finally using an online forum to discuss the prognosis for the case. In the remainder of this section, this paper examines the online course materials and resources that are being implemented at medical schools, including an in depth look at course management systems (CMS), and simulations/virtual patients. The following Table 1 results from a survey of medical schools in 2006 regarding the use of educational technology.

Table 1. Use of Educational Technology by Medical Programs

Educational Technology Resource	% of Medical Schools
Online Course Materials	97%
Course Management System (CMS)	95%
Virtual Patients/Gaming	80%
Online Examinations	69%
Streaming Audio/Video	61%
Personal Digital Assistant (PDA)	42%
Electronic Portfolios	26%

(Kamin et al., 2006)

Online course materials and resources

Applications of web-based instruction and computer-aided instruction have been increasing in medical education, particularly within the realm of undergraduate medical education. When the first web browser was introduced in the mid-1990s, Internet users were restricted to viewing content created exclusively for those working mostly in a business-related field. However, this quickly changed to include a much wider audience with the development of new Internet technologies such as blogs, wikis, and podcasts, which enable users to deliver online content easily without in-depth knowledge of web technology (Boulos, Maramba, & Wheeler, 2006). In its most basic form, the Internet existed as a digital storehouse for the same resources (PowerPoint presentations, lecture videos, and handouts) that students typically received during lectures and seminars. But there has been much more value that educational technology has brought to medical education.

Educational technology has allowed medical schools to provide core content that meets educational and curricular requirements and distribute materials that are both reliable and reusable and not restricted by geographical boundaries. Web-based resources that presented medical content are currently being used in a number of areas including anatomy, dermatology, pathology, cardiology, urology, pathophysiology, clinical ethics, outpatient medicine, and even clinical faculty development (Alexander et al., 2006; Bernardo et al., 2004; Bittorf, Bauer, Simon, & Diepgen, 1997; Fox et al., 2012; Fraccaro & Giacomini, 2012; Hallgren, Parkhurst, Monson, & Crewe, 2002; Kaelber, Bierer, & Carter, 2001; Kerfoot, 2008; Klatt, 1997; Lam, Veitch, & Hays, 2005; Masiello et al., 2005; Nguyen, Uthman, & Johnson, 2000; Parker & Seifert, 2001; Rediske & Simpson, 1999; Sakowski, Rich, & Turner, 2001).

Educational technology has been used in a multitude of ways and for a variety of content delivery, in some cases enhancing traditional lectures as well as being a standalone source for

learners to access resources (Bilham, 2009). One valuable resource that has been developed for medical students is a vast collection of online tutorials that covers a multitude of medical subjects. Online tutorials are similar to face-to-face lectures where they consist of information organized and presented in a linear manner, often improved by inclusion of multimedia and hyperlinked online resources. Several studies (Cook, Thompson, Thomas, Thomas, & Pankratz, 2006; Grunwald & Corsbie-Massay, 2006; Kerfoot et al., 2006) support the use of web tutorials in medical instruction, and those that are typically the most successful combine web-based tutorials with resource intensive, small group, face-to-face teaching sessions.

In most cases the tutorials utilize interactive elements that require the user to respond, such as self-assessment questions, patient cases, objects for manipulation, or games (Cook & McDonald, 2008) to enhance the learning experience. Online evaluation models effectually target specific content needs unique to each group of medical students. This allows facilitators to focus their instruction in a swift, formative, and highly effective manner, which helps improve the efficiency of traditional clerkship learning experiences (Alexander et al., 2006). Assessment in educational technology has a variety of roles to play in supporting course outcomes, and ensure that students are benefitting from the enhanced learning environment, where quick responsive feedback is necessary with regards to measuring progress and testing achievement (Macdonald, 2004).

Videos have been widely used in the medical domain and provide a variety of crucial learning opportunities that might not always come up during clinical cases and learning stages. The use of video has a long tradition with many universities and colleges that deliver courses through Instructional Television Fixed Service (ITFS) and cable television since the 1980's (Reisslein, Seeling, & Reisslein, 2005). With the emergence of the Internet and the increased

bandwidths from private homes to the Internet, the delivery of video via web-streaming has become more widespread. Video has long been recognized as providing an important resource for training and education in medicine.

Within a few years of the introduction of cheap and reliable video technology, a number of medical schools began to use video to help train undergraduate and postgraduate students in an assortment of interpersonal skills (Heath, Luff, & Svensson, 2007). Demonstrations in medical practice often go through an evolution that involve complex forms of interaction and are dependent upon the ways in which practitioners and students communicate within the activity at hand. Videos give a more holistic picture of a patient problem because it is the students who translate the images and sounds relating to the patient into a medically meaningful story.

The recording, streaming, and sharing of MP3 recordings of lectures came about as part of the iPod revolution and the phenomenon known as podcasting, which was formerly known as audiocasting. Podcasting is the method of publishing audio broadcasts on the Internet, with users able to subscribe to a particular feed of audio files (Souza et al., 2008). One of the more predominant uses of podcasting in medical education is a combination of an audio recording of a lecture with video images of an accompanying PowerPoint presentation. This combination is referred to as a video podcast (Sandars, 2009).

The two main advantages of podcasts in medical education are their ease of use and availability. There are many open source resources (or low-cost software) and hosting options to create and run them. Podcasting shows promise as a revision aid that could be incorporated into medical education, with lecture-based teaching being the most obvious choice to convert into a podcast (Shantikumar, 2009). The benefits of using podcasts to deliver such materials include the ability to review them when it was convenient for the learner, to start, stop, or restart at any time,

and to view the resource as many times necessary. The use of podcasts is been gaining in popularity and it has started to be used widely in medical education (Boulos et al., 2006).

Personal digital assistants (PDAs), which include mobile phones such as iPhones and tablet devices such as iPads, are increasingly gaining in popularity and use in both clinical practice and medical education as a method of providing instant access to resources while performing patient care (Tallett et al., 2008). Teaching programs incorporate PDAs with a number of features in medical school classrooms, learning laboratories, and in clinical settings (Ruiz et al., 2006). Since their introduction in the early 1990s, PDAs have become one of the most frequently used technologies in medical education, providing access to pertinent data, diagnostics, reference databases, and decision support systems in addition to accessing patient history and dictating notes (Ruiz et al., 2006).

It has been suggested that PDAs and iPads/tablets have the potential to change how health care is taught in future medical training opportunities. Research has shown that iPads play a significant role in in the clinical setting (George et al, 2013). Specifically iPads have been shown to enhance learning in the clinical environment by allowing the rapid and efficient acquisition of relevant information. Medical students often use PDAs and tablets because they provide instantaneous access to information to guide patient care and support self-directed learning (Kho, Henderson, Dressler, & Kripalani, 2006).

Electronic portfolios in medical education first appeared in medical literature in the late 1980s and early 1990s, although the origins clearly point back to the traditional use of portfolios in education (Garrett & Jackson, 2006). With the development of new curricula, medical schools were looking for new ways to evaluate students' performance and understanding during their clinical clerkships. Electronic portfolios have been used not only as a source of information for

assessing how a student performed in authentic situations, but also as tools which allowed learners to reflect on their own personal learning experiences (Driessen, Muijtjens, van Tartwijk, & van der Vleuten, 2007; Moores & Parks, 2010).

Course management systems

Considering that the volume of medical information has been doubling nearly every seven years, many medical institutions have adopted Course/Content Management Systems (CMS) to manage the plethora of digital content that existed (Bove, 2008). A CMS is web server-based software that allows instructors to manage course materials and communicate with learners in a quick and reliable manner (Ellaway, Dalziel, & Dalziel, 2008; Halbert, Kriebel, Cuzzolino, Coughlin, & Fresa-Dillon, 2011). The CMS displays educational content and collected educational outcome data. It complements traditional forms of instruction (lectures, case-based learning, etc.) and is one of the most important tools used in implementation of educational technology.

The CMS has developed into a unique way to present medical content based on likely clinical exposure. It demonstrated the ability to track resident learning while promoting lifelong learning skills, and it measured the student's medical knowledge competency as required by the medical examination board. The CMS provided the instructor with a variety of easy-to-use software tools so that they can focus on teaching and learning the content and not worry about the technology itself.

Medical information is dynamic as it has been constantly changing and evolving, and the CMS are designed to allow administrators some flexibility with how information is shared. Using the CMS to supplement traditional medical education provides many benefits and allows an opportunity for cooperative learning through interactive programming. The features available

in current CMS technology promote interactions with learning resources that can enhance student interest and provide motivation. The CMS allows students to be the center of learning and they chose where and when they want to learn (Aspden & Helm, 2004).

Some obstacles (Lovett, 2004) that medical faculty face with implementation of CMS include:

1. Faculty members are still faced with the same copyright restrictions they experienced in a traditional paper-based curriculum.
2. Time management in preparing on-line course materials.
3. Familiarity with CMS software and technology.
4. Faculty development resources and professional development opportunities to learn about electronic-learning.
5. Student access to adequate computer equipment (monitors, Internet connection speed).
6. The relevance of on-line instruction for promotion and tenure.
7. Researchers spending more time away from research as they invest more of their time learning how to use and implement the CMS.

Simulations/virtual patients

Educators in medical schools have used simulation for over 40 years; it was only in the last 15 years that we witnessed significant adoption for use in instruction and evaluation. Virtual patient cases have been defined as interactive computer simulations of real-life clinical scenarios for the purpose of medical training, instruction, or assessment (Ellaway & Davies, 2011). Virtual patient cases are valued for their application in the construction of clinical reasoning skills, which have been difficult to teach to large groups. This development is a noteworthy change

from the traditional approach to health care training, which previously had always hinged on having actual patients available for study (Issenberg & Scalese, 2008).

In most cases the role of medical simulations replicates actual interactions with live patients, and they are programmed to focus on particular anatomic regions or clinical tasks that a physician encounters in situations where medical expertise was needed (Berman et al., 2011). These simulations range from static anatomic models and single task trainers (such as mannequins that simulate a variety of basic medical procedures) to dynamic computer-based systems that respond to user actions (such as full-body anesthesia patient simulators). Examples included video game-based simulations for individual users and larger platforms that can host interactive role-playing scenarios that involve multiple users. Virtual patients provide interactive learning experiences that range from relatively simple patient encounters to high-tech virtual-reality simulators (Issenberg & Scalese, 2008).

Medical simulations and virtual patients have become very important tools in medical training. Patients in real practice have not always been representative of the ideal learning situations, and in most instances where the best examples were available, actual care for the patient took priority over potential learning opportunities (Dror et al., 2011). Training is a secondary role in the clinical environment and instruction only takes place when it does not risk patient safety and care. From a teaching standpoint, one of the main benefits of medical simulations is that they allow the instructor to choose the most effective clinical cases for learning-centered training (Cook & Triola, 2009).

Simulations also allow students to explore, test their diagnoses, and observe the consequences of the recommendations they provide. This is naturally very important for learning but is considered inappropriate and dangerous when applied to real patients. These learner-

centered simulations allow the users to ‘restart’ and ‘reset,’ so the learners can go back to the start of the procedure at any time, provide learning experiences that are not practical with live patients.

Virtual environments have proven effective for providing training for a variety of medical procedures. “Web-based 3D models for anatomy training had been proven to enhance learning, but such 3D models need to be used as part of an integrated training package that includes resources such as video clips, textbook descriptions, and self-assessment tools” (John, 2007, p. 29). One of the first uses of web 3D technologies in the medical domain had been to help students learn anatomical structure using surface rendered models, since animation of 3D models also provided a variety of perspectives for the learner.

The basic techniques utilized for visualizing medical concepts are used with Web based applications to provide supplemental value to medical education and training tools, especially when the tools offer a level of interactivity to the user (Kneebone et al., 2006). Visualization of detailed medical data has been extremely helpful for making a diagnosis, and there is an abundance of software programs that are available for this purpose. Virtual environments have proven effective for providing training situations for an assortment of medical procedures, and there are several products currently available on the market. Most solutions come as part of a comprehensive package that include special purpose hardware such as haptic interfaces, which provided tactile and force feedback sensations to the user (Tahmasebi, 2005).

Medical training is particularly well-suited for simulations. In particular, digital gaming captures many important elements that are critical for cognitively efficient learning that is applicable to medical practice. A game-informed learning activity is based on a narrative

scenario that contains a task and an objective, with the learner playing a dynamic role within that controlled environment (Begg, 2008b).

Variables such as time, external stress and distractions can be introduced into the simulation. With a digital game environment that has been designed in collaboration with medical educators, students learn to deal with the pressures of determining the diagnoses of virtual patients' through exploration of their various responses and consequences (Kanthan & Senger, 2011). Simulation achieves interaction with a variety of critical scenarios quickly and efficiently without inflicting potential harm to patients. Rare, but time-critical, conditions can be practiced and replayed as many times necessary by the user (Gaba, Howard, Fish, Smith, & Sowb, 2001).

In some cases medical procedures have been performed under less than ideal conditions, so having the ability to adjust certain variables provide facilitators an invaluable tool. If training is aimed to be applied in practice, it is important to adequately stage the training so the pertinent information is learned and becomes part of the student's repertoire (Gee, 2003). This involves adding elements of time/pressure, a range of authentic distractions, and context. Gaming also allows for training beyond the individual level as the medical context often involves distributed cognition across a number of team members who often need to collaborate and coordinate their treatment of patients (Dror & Harnad 2008).

Gaming provides opportunities for medical students to gain insight into the reality of working medical practices, the significance and consequences of making the proper decisions, and the unpredictable nature of many patient encounters. Virtual patient activities in the form of gaming have been emerging as flexible compelling tools for medical education (Begg, 2008a). When delivered online, game-informed learning has offered the potential for making significant

advancements in the realm of informal student evaluation. Learners make decisions and respond accordingly to the consequences of the decisions they have made. Instructors can also review individual user sessions and have access to a database record of each walkthrough that has been performed on the system.

Various costs are amongst the most significant challenges facing medical educators when they consider the employment of a simulation program, especially those that utilize sophisticated technologies. Even low-tech simulations can end up being very expensive when the issue of getting faculty involved and participating in training comes up (Issenberg & Scalese, 2008). Design and development of a variety of scenarios for use in simulator-based training can also be resource intensive. Another drawback of simulators in education is that many lack the convenience of portability due to their potentially fragile computer or hardware components. Thus training might only be limited to dedicated centers.

Latest Technology Trends

The latest trends in technology in medical education are Massive Open Online Courses (MOOC), Open Educational Resources (OER), and collaborative learning spaces. These latest technological developments will have a profound effect on policy, leadership, and practice at all levels impacting the future of medical education.

MOOCs have been gaining momentum over the last two years. MOOCs integrate the facilitation of an acknowledged expert in a field of study through the connectivity of social networking utilizing a collection of freely accessible online resources (Harder, 2013). The MOOC depends on the active engagement of several hundred to several thousand “students” who self-organize their participation according to learning goals, prior knowledge and skills, and common interests.

OER represents a broad variety of digital content, including full courses, course materials, modules, textbooks, videos, tests, software, and any other means of conveying knowledge. OER uses Creative Commons and alternative licensing schemes to more easily distribute knowledge, media, and educational resources, which guarantees that content is reproducible and accessible without costs (Harley, 2011). The American Association of Medical Colleges (AAMC) has facilitated a curriculum inventory portal, MedEdPortal, for medical schools to share curriculum and resources.

Medical schools are now looking at configuring their learning spaces to reflect a student-centered approach. The traditional classroom is being replaced by collaborative learning spaces in order to accommodate new pedagogies which take advantage of collaborative group strategies. Instead of rows of chairs facing the front of the classroom, medical institutions are creating more dynamic classroom layouts that promote collaborative work (Lippman, 2015).

Educational Technology in Nursing Education

One area of health care education that medical schools could learn from is nursing education. Educational technology is well accepted in nursing education and more widespread in its use when compared with general medical education. The implementation and use of technology within the nursing classroom is widely available and accessible (Jones & Wolf, 2010). As nursing programs continue to grow, the manner in which nurses are trained must prepare them for the challenges they will face in the workplace. Educational technology attracts a great deal of attention in nursing education internationally, and many health agencies adopt it for training their staff (Atack, 2003).

There is a shortage of registered nurses in the U.S., so there remains the same problem that was discussed in the Introduction chapter with respect to the shortage of general

practitioners in U.S. While there is a lack of registered nurses in the U.S., there is also a shortage of teaching faculty for nursing (Neuman, 2006). In nursing education this may explain the higher degree of adoption of distance education, which is slowly supplanting traditional classroom instruction. Recent research on nurse anesthesia educational programs shows that 58% of the programs approved by the accrediting body offer distance learning as part of their programs and 10% are delivered entirely through distance education (Pecka, Kotcherlakota, & Berger, 2014).

Interprofessional education has an extremely important role in nursing education and virtual simulations play a huge role as well. Nurses are finding themselves working with students in medicine, pharmacy, physical therapy, and other health care professions (Howard, 2013). In nursing education, there is a need to have parity between the nursing curriculum and interprofessional skills such as communication, teamwork, and leadership. For example, nursing students are paired with first-year medical students from Atlantic Medical School in order for them to learn how to work together from the start. A recent study indicates that medical students tend to be less positive about interprofessional education and collaboration than nursing students (Delunas & Rouse, 2014).

Nursing education deals with some of the same challenges that medical education does. Faculty acceptance is one of the biggest barriers to the implementation of technology in nursing education. This is due to the wide range of faculty ability and comfort level with new teaching technologies (Jones & Wolf, 2010). One of the most successful strategies for faculty development to counter this resistance is the use of faculty mentors. At most nursing schools, faculty are paired with a mentor and allowed ample time to learn the new technologies through workshops and individual training (Brannagan & Oriol, 2014; Montenery et al., 2013).

Change

Change in education is constant. New curriculum, learning strategies, and ideas are constantly being sought out in schools in order to improve student outcomes. While educators are constantly experiencing change, the way in which individuals experience it are different and might influence the successful implementation of new innovations. As a result, numerous models representing change have been developed to help understand individual and group reactions to changes.

While many of the models share common themes, each contains different views and processes for change related to implementing new innovation. The Diffusion of Innovations theory was used as the theoretical foundation for this study. A review of the literature on different aspects of change was also discussed in the following sections as it is helpful in fully understanding the complexities involved in the change process and adoption of new innovation.

Organizations and Change

An organization's members shaped and were shaped by the symbols and rituals of the institution as well as the unique history from which the organization derived. The organization reacted to stimuli from its environment, but it was also involved in creating and selecting the stimuli to which it responded (Tierney, 2006). In addition, the organization was sometimes able to affect change in that environment. The physical characteristics (such as size, resources, and policies) and the social dynamics (such as the attitudes and beliefs of the individuals) of the organization affect the change process.

Organizations typically received an enormous amount of external pressure to adapt to change. Organizations initiated change by engaging in cycles of reflection and planning.

“Organizational change is born of tension and succeeds best when it aims for alignment of

purpose and action and attunement of the internal and external environment.”(Gready, 2013, p. 1343) Organizations facilitated change after reflection and planning as they adopted new ideas and approaches. This often occurred for different reasons and was accomplished through different means.

There were various models for implementing change at the organizational level. In one of the more significant models in business literature, Kotter (1995) provided an eight-step model for leading organizational change: (1) establishing a sense of urgency, (2) forming a guiding coalition, (3) creating a vision, (4) communicating that vision, (5) empowering individuals to act and removing obstacles, (6) creating short-term wins, (7) consolidating improvements and creating more change, and (8) institutionalizing new approaches.

In addition to the characteristics of an innovation, the environment in which it was going to be introduced was another important factor when implementing a new innovation. First proposed in 1976 and later reconfigured in 1990, Donald Ely identified and validated eight environmental conditions that promote change. Ely’s research supported the hypothesis that for successful implementation, eight conditions in varying degrees need to occur. Ely (1990) could not explain the role of the setting in which the innovation was implemented.

However, these conditions served as indicators to help understand the complexities that lead to successful change. First, the stakeholders must be dissatisfied with the current situation in order to consider implementing an innovation. It is important that those involved with the innovation have the skills and knowledge to implement it effectively. All stakeholders should be involved in the entire process of the implementation, including a role in making decisions. Finally, commitment from leadership, key players (which include opinion leaders), and the remaining stakeholders is crucial for success of the implementation.

Any resources that helped facilitate the implementation of the innovation must be available to the stakeholders and they must have adequate time to prepare. One important factor that hinders change was the lack of funding for innovation (Hickey, Koithan, Unruh, & Lundmark, 2014). Calls for more public funding have met with resistance from Congress and state legislatures that predates the recent economic downturn.

Leadership and Change

Leadership changes often contribute to organizational change as new leaders come in with varying priorities (Erwin, 2009). Leadership was expected to lead from the front and maintain stability during the change while perpetuating history. People do not like to be told to change and leadership needs to positively create a climate such that change is desired (Sadri & Sadri, 2014). Leadership must have a clear vision and a clear mission, which are both articulated and known to all the stakeholders, involved in the organization.

Leadership also suggests a way of interacting not only with individuals within an organization, but also those outside of it (Tierney, 2006). Most major change initiatives are intended to boost quality, improve culture, or reverse negative trends. Reform efforts have driven change, and leadership actions were necessary in the development of innovation. In many cases, administrators did not realize that transformation was a process, not an event (Kotter, 1995).

Education leaders seeking to implement technology must understand how the changes will affect those who participate in them. Faculty tend to embrace changes that they have had a stake in creating and those rooted in research. Faculty resisted change when they felt it had been forced on them (Schriner et al., 2010). Resistance also resulted from poor communication and lack of transparency from leadership.

Transformational leadership tended to be more successful at promoting innovation within an organization than other leadership styles (Noruzy, Dalfard, Azhdari, Nazari-Shirkouhi, & Rezazadeh, 2013). Transformational leadership was a type of management where the leadership identified the needed change, created the vision, and facilitated the change.

The role of leadership is critical to the success of the implementation of any innovation, so it is important that administrators collaborate with all the stakeholders and work together to make the change successful. Effective leadership also requires the delicate balancing of inclusive processes and participation with narrower forms of leadership and decision making, as well as between decentralization and centralization.

People and Change

Frances Fuller was a counseling psychologist at the University of Texas at Austin in 1969 when she came up with the founding principles for what would later be called the Concerns-Based Adoption Theory. After teaching a required psychology education course for student teachers, Fuller discovered that the final course evaluation showed 97 out of 100 student teachers rated the course irrelevant and a waste of their time. After she conducted an investigation into the cause of these poor results, Fuller (1969) found that the three students who rated the course positively actually were all middle-aged men and women with considerable teaching experience.

Fuller hypothesized that the three students' concerns were different, since they already had previous background experience with education. As a result, Fuller started to conduct in-depth studies about the concerns of student teachers. She created a model showing how, with increasing knowledge and experience in a teacher education program, the student teachers concerns moved through four levels: unrelated, self, task, and impact.

Concerns Based Adoption Model (CBAM) is a participant-based change model that has been used a number of times in studying the adoption of educational innovations. Change is a process that is a highly personal experience that involves developmental growth in attitudes and feelings. The central assumption of CBAM is that the change process cannot advance without taking into consideration its impact on the people involved within the organization (Hall & Hord, 2010).

The importance of the CBAM framework was the premise that facilitating change meant comprehending the existing attitudes and perceptions of those involved in the change process with the focus being on the individual (Hord, Rutherford, Huling, & Hall, 2006). Individuals needed continuous support to implement a new idea, and the kind of assistance they required is different as their needs change (Loucks-Horsley, 2010). Change could be enabled by interventions directed at individuals. It was important to consider personal concerns as genuine, because resistance was a reaction due to the need for the individual to understand the potential impact of the innovation (Anderson, 1997).

The CBAM model (Hall & Hord, 2010) had the following assumptions about change: change is learning and it is a long process. While organizations choose to adopt change, it was the individuals that actually implemented change. Interventions had been an important aspect of the change process and when administered appropriately they reduced resistance to change.

People expressed their concerns about change differently. We demonstrate our concern by asking questions, analyzing the new changes, and considering the consequences of the changes that take place. It was our own personal perception that triggered our concerns, not necessarily the context of the situation (Hall, George, & Rutherford, 1979). The primary focus of

concerns typically go from the task at hand to the impact that it has on the workplace (Hord et al., 2006).

Faculty Barriers to Change

Teachers' own beliefs and attitudes regarding the significance of educational technology with respect to students' learning were viewed as having the biggest impact on their implementation. Most instructors indicated that internal factors (beliefs, confidence, and perceived value of technology) and support from others played key roles in shaping their practices (Ertmer, 1999). Teachers indicated that the strongest barriers preventing other teachers from using technology were their personal attitudes and beliefs toward technology, as well as their current levels of knowledge and skills.

Two types of barriers had impacted teachers' uses of technology in the classroom were developed. First-order barriers were defined as those that were external to the teacher and included hardware and software resources, training, and support. Second-order barriers were considered internal to the teacher and included teachers' confidence, beliefs about how students learned, as well as the perceived value of technology to the teaching/learning process.

Technology, Change, and the Diffusion of Innovations

Rogers (2003) defined an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption, and diffusion as the process by which an innovation is communicated through certain channels of a social system over time. Change takes place in the social system and it is described as the interrelated units engaged in collaborative problem-solving to accomplish a common goal. Rogers points out that the words innovation and technology have often been used synonymously.

Technology usually had two elements, a hardware aspect which was the material or tool, and a software aspect which contains all the information necessary to run the hardware (Rogers, 2003). While it was often easy to visualize and quantify the hardware aspect of an innovation, the way information was exchanged using the technology or the way the technology is used to solve certain problems is more difficult to observe.

When members of a social system share an innovation through various means, it is considered diffusion (Rogers, 2003). The characteristics of an innovation, as perceived by the members, determine its rate of adoption. The theory suggests that the adoption of a new innovation follows predictable patterns within a community and the characteristics of the innovation as perceived by the intended adopters determines its rate of adoption (Rogers, 2003).

Based on his research, Rogers identified five stages in the innovation-decision-making process that occur as part of the decision to adopt the innovation. The first stage, the knowledge stage, occurs when the stakeholder becomes aware of the innovation and seeks more information about it. Next, the individual forms an opinion about the innovation during the persuasion stage. This sets up the decision stage where a decision is made to accept or reject it. The ensuing stage, known as the implementation stage, is where the individual puts the innovation to use, and the confirmation stage occurs when the stakeholder validates their decision to implement the innovation.

In addition to the innovation-decision process, Rogers (2003) also notes five qualities that account for how quickly or whether one would adopt an innovation:

- **Relative Advantage** is the degree to which an innovation is perceived as being better than the idea it supersedes.

- **Compatibility** is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters.
- **Complexity** is the degree to which an innovation is perceived as relatively difficult to understand and use.
- **Trialability** is the extent to which an innovation can be tested prior to full adoption.
- **Observability** is the degree to which the results of an innovation are visible to others.

Thus an innovation that is perceived as having greater relative advantage, compatibility, and observability, along with less complexity, will be adopted more rapidly than other innovations. The diffusion theory is able to provide insight and greater understanding of the underlying mechanism of innovation adoption (Rogers, 2003).

At whatever point an innovation-decision is made, Rogers' theory held that there will be an increased rate of diffusion and adoption (defined as the relative speed in which an innovation was adopted) depending on how the potential adopter perceived the following attributes of the innovation: Was the innovation better than what had been currently in place? To what extent was the innovation matched with existing values and stakeholder needs? Has the usability and trialability been crucial to future implementation of the innovation by the stakeholder? Finally, could the stakeholder have seen the usefulness of the innovation with respect to their particular situation?

While the attributes of innovation influence the rate of adoption, so will the characteristics of the individuals involved in the process. An individual reacts differently to change based on his or her personal traits or predispositions. A classification scheme of the potential adopters was developed based on their receptivity to an innovation. Rogers (2003) provided a bell curve of adopter categories: Innovators are in the first category, defined as risk

takers who can tolerate uncertainty and are willing to try something new. Early adopters make up the next category, as they are typically the opinion leaders in the system. Next is the early majority, which is made up of careful individuals who are waiting for their peers before they commit themselves. The late majority is composed of those who are suspicious of change and thus are difficult to get on board. Finally, the laggards are those who are resistant to change.

In making the innovation-decision to adopt, Rogers (2003) described a mental process known as the innovation-decision process. This process begins when an individual or unit goes from having knowledge about an innovation to forming an attitude toward the innovation, to then making a decision to adopt, reject, or implement it, and finally to a confirmation of the innovation's use. Rogers (2003) suggests that several distinct stages exist in the innovation-decision process. These stages are knowledge, persuasion, decision, implementation, confirmation and discontinuance.

In addition to adding to the understanding of the types of innovation-decisions, the process that individuals and units went through in making an innovation-decision, and characteristics of both the innovation and the individuals that influenced the adoption rates, Rogers (2003) also helped shape the way we understand the influence of peers on an individual's willingness to try out and/or adopt an innovation. He defines this type of peer influence (or opinion leadership) as the degree to which an individual is able to influence other individual's attitudes or overt behavior informally in a desired way with relative frequency.

Opinion leaders hold a type of informal leadership and are unique in their influence on their social system's communication infrastructure. The opinion leaders' interpersonal networks allow them to have substantial influence over the use of innovation by the rest of the social system, and as members of the system their belief in the value of the innovation is paramount to

others in the system seeing the innovation's value (Rogers, 2003). Facilitators feel the need to have influence over a system, and as a result they are often mistrusted or resisted by a system.

Criticisms of Change Models

A primary criticism of innovation diffusion and adoption literature is its pro-innovation bias; e.g. the assumption that the innovation occurred in a given context was the right innovation and that the change facilitator was there to ensure the diffusion of the particular innovation across that context, whether or not it was the right innovation (Rogers, 2003). Anderson (1997) asserted that CBAM provides a framework and methodology for describing key dimensions of teacher implementation of change, but fails to predict or explain behavior — thus not qualifying it as a theory. This observation is based on the inability to find significant amounts of research yielding theoretical development while finding a series of applications of CBAM to study specific innovations and projects.

Summary

This chapter looked at specific issues found through earlier research: undergraduate medical education, educational technology in medical education, and change theory. Innovation and change were indicated as major factors for successful efforts in implementing educational technology in medical schools. In the next chapter, these variables are related to the research design and methodology for this study.

CHAPTER 3. METHODOLOGY

Doctors and healthcare workers will continue to be in high demand, so it is necessary to look for ways to support effective and sustainable learning in the field of healthcare. Educational technology might assist in this process, and the purpose of this qualitative case study is to better understand the implementation of educational technology in selected medical schools. The research presented in this project can be described as qualitative, positivist research involving a case study. The research design and methodology is discussed for this case study in the following chapter.

In order to develop a thorough understanding of each case, multiple sources of evidence have been used. The use of multiple sources of data (triangulation) has been found to increase the internal validity of a study. Additionally I related the role of the researcher, the background of the participants, and the context of the study. Finally I described the methods for data collection and data analysis. The unit of analysis was at the individual level and the perceptions of the facilitators were considered as well as the perceptions on the success of using educational technology.

Research Design

In order to investigate the research questions of this study, I utilized a qualitative, descriptive case-study design. A multiple case study design was employed to explore the use of educational technology at medical schools with the intent of using multiple cases to draw a single set of cross-case conclusions. Descriptive case studies were used to describe events or a

particular process in a natural setting (Yin, 2009) and the main objective of case study research was to answer “how” and “why” questions.

The case study approach is very valuable to use when one needs to take a deeper look at an issue, event, or phenomenon in its natural context. Typically the researcher has little control over events and the focus is on contemporary phenomenon within a real-life context. A descriptive case study in education is one that presents a detailed account of the phenomenon under study.

Case studies are useful in presenting basic information about areas of education where little research had been done. These cases studies involve innovative programs and practices and they often form a database for future comparison and theory building (Merriam, 1998). Case studies are used regularly in education to inform or improve policies and practices. They also attempt to clarify a decision or set of decisions including why a decision is made, how it is implemented, and what is the result.

The case study is one of the major research strategies in contemporary social science (Yin, 2009). Yin defines case study research as an empirical inquiry that investigates contemporary phenomenon with a real life context. It is a research design that explores or describes situations where there will be more variables of interest than statistics can provide. I chose to use a qualitative case study approach to gain an understanding of the phenomenon and to address a gap in the research.

The qualitative paradigm

Qualitative research seeks to gain an understanding of the characteristics regarding the phenomenon being studied and tends to use words rather than numbers to explain an event (Tashakkori & Teddlie, 2010). Qualitative research is not restrained by gathering pre-defined

variables, as it allows the researcher to explore the different themes that emerged during the study (Merriam, 2002). Through this approach researchers are able to gain knowledge from the situation being studied that has not been discovered yet. Choosing which qualitative design to use is best determined by the types of data that are being collected and the purpose of the research (Creswell, 2007).

There were several different approaches to qualitative research: case studies, ethnographies, grounded theory, narrative research, and phenomenology—all which were considered. Since this study was not coming up with a theory it was decided that grounded theory would not be appropriate for this study. Ethnography was not plausible since this research was not studying the culture of my participants and narrative study would not work because this research was not looking at constructing stories based on the participant's personal experiences.

Merriam (2002) suggested that researchers choose the case study approach to examine one or more groups, programs, or persons within a “bounded system.” The contribution of qualitative research in current studies of decision makers have shown many positive contributions, especially when using the case study method (Bryman, 2004). The purpose of this qualitative case study was to better understand the implementation of educational technology in selected medical schools. Study research questions included:

- How do identified educational technology leaders of specific medical schools describe the implementation of educational technology at their institutions?
- What do leaders describe as the strengths and challenges of incorporating educational technology into these select medical schools?

Multiple case study methodology

The case study is the most flexible of all research designs, allowing the researcher to retain the natural characteristics of real-life events while allowing the investigation of empirical events (Yin, 2009). The empirical results are considered more potent if two or more cases support the same theory but do not support an equally plausible rival theory. A number of cases might be studied together, either simultaneously or sequentially, in order to investigate a phenomenon, population or general condition (Stake, 2006). Thus, the multiple case study approach was utilized because the research was based on cases that were similar in nature. In a multiple case study, there are two stages of analysis: analysis that occurred within each case and across cases. Each case is first treated as a comprehensive case on its own and data is gathered so the researcher can learn as much about the contextual variables as possible. Once the analysis of each case is complete, cross-case analysis is initiated. A qualitative, inductive multiple case study seeks to build abstractions across cases (Merriam, 1998).

Weaknesses of case studies

The case study approach is not without its drawbacks. Case study research has been criticized for lacking scientific rigor and providing little basis for generalization (Merriam, 1998). Because the researcher is the primary tool used collect data in this study, one of the limitations is researcher bias because the researcher is not separable from what they are investigating (Creswell, 2007). Another problem with multiple case studies is having multiple investigators researching cases without having any continuity with regard to protocol (Yin, 2009).

Conceptual Framework

The conceptual framework for this study was based on the work of Rogers' Diffusion of Innovation. This theory was discussed in greater detail in Chapter 2. Rogers (2003) defines an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption, and diffusion as the process by which an innovation is communicated through certain channels of a social system over time. This study looked at the perceptions of the educational technology leaders of their respective medical schools through the lens of the Diffusion of Innovations framework. The educational technology leaders provided their experiences with implementing educational technology.

Participants and Context

Participants

The theoretical population included all accredited medical schools in the United States that grant a Doctor of Medicine (MD) degree, which at the time of this study was 141 institutions. The study population involved selected educational technology leaders at medical schools engaging in the use of educational technology in an organizational setting. The selection was intentional or purposive; participants were required to have been in a position to contribute to the implementation of educational technology at the institution.

One educational technology leader from each medical school was invited to participate in this study, and these individuals as a representation of their schools were defined as the unit of analysis or "case study" (Yin, 2009). The sampling frame consisted of respondents who met the initial requirements of the study. The usable sample size consisted of the entire population of 141 accredited medical schools (MD) and four medical schools were selected for this study.

Merriam (2002) suggests that participants should be selected based on those who would yield rich data pertaining to the topic of the study. The sample size for this study was small in comparison to the total number of medical schools in the United States; however, the scope of the study was limited to the institutions who are actively publishing research on the use of educational technology, in addition to using them extensively throughout their respective medical programs.

The number of cases for this study was purposefully selected to ensure that the sample size provided substance and was not so large that the data collection and analysis became too formidable. Since qualitative research does not involve making statistical generalizations, many qualitative researchers agreed that sample size is irrelevant and that sampling does not explain what occurs in qualitative inquiries (Creswell, 2007).

Each participant and their respective data were labeled with a pseudonym to preserve anonymity in this case study.

Study setting

Data collection in this multiple case study took place at four medical schools located in the United States. The interviews were approximately 45 minutes and were conducted online using Skype and were scheduled at a time and date that was convenient for the participants.

Instrumentation

This study sought to describe the attitudes and beliefs of participants who worked with educational technology at U.S. medical schools, based on the perspectives of four educational technology leaders facilitating educational technology at purposely selected medical institutions. Most case studies utilize at least two or three sources of data. Multiple sources of data, including

two rounds of interviews, document analysis, and surveys were involved in the collection of data (Stake, 2010; Yin, 2009). This case study used an online survey and document analysis in addition to two sets of interview questions that had been developed.

Survey questionnaire

Qualitative data was collected and analyzed through the utilization of the survey questionnaire that was distributed to the four participants. The qualitative survey was designed based on previous survey questions that were included in the pilot study (Parisky, Ortiz, McCann, Hoffman, & Boulay, 2009) while previously conducting research in this area. The survey was short-answer based and was utilized to collect demographic information. The survey was administered online for each participant via SurveyMonkey, and when the surveys were completed the data was analyzed prior to conducting interviews in the next phase of research.

Document analysis

The documents used as sources included departmental and simulation center web sites, distance education course information, educational technology resources developed by faculty or staff, official biographies, curriculum vitae, and relevant journal articles. All websites that were related to the programs were reviewed and analyzed with the intent of learning more about the organizational structure of the educational technology units at the respective institutions. Hatch (2002) states that the advantage of this type of data collection is that it has no influence on the social setting being studied.

The contents of the documents provided information that was not directly observable through the interviews. Performing a document analysis strengthened research validity by providing static, precise data which was not created as a result of the case study (Yin, 2009). The

document analysis provided an overview of the organizational structure of educational technology units and the types of technology they are utilizing.

The documents for this study provided information about program resources, activities, and processes. Documentary information was reviewed and analyzed to corroborate and augment evidence from other sources. Document analysis allowed the researcher to develop questions and to pursue emerging avenues of inquiry (Pope, Ziebland, & Mays, 2000). The document analysis contributed information about the background of the educational technology leaders and the organizational structure of the educational technology units at their respective institutions.

Interviews

Strict protocols were followed for conducting the interviews. Interviews are important when researchers cannot observe attitudes, behavior, or reactions to real world situations. A broad set of interview questions was administered to each participant in two phases, consisting of a set of initial questions and a set of follow-up questions that were developed after reviewing the original responses. The questions were designed to elicit information from each participant with regard to the knowledge of their respective programs. These individuals were deemed key informants because they possess knowledge of the development of their program's history (McMillan, 2000).

Both sets of interviews were conducted online via Skype. The interviews were semi-structured, open-ended, and they were conducted with the same questions being asked of each participant. Merriam (2009) instructed researchers to use open-ended, semi-structured interviews to allow the views of the respondent to emerge and to reveal new ideas on the topic. Then, depending on the responses of the interviewees, the line of questioning is adapted to record the most important information.

The semi-structured interview questions were designed to reveal specific innovational leadership behaviors and perceptions. Data gathered through interviews were interpreted from the participants' perspective and any additional observations added a richer description to the study (Rubin & Rubin, 2005).

Data Collection

The primary data consisted of eight interviews, documents, and a survey questionnaire that was utilized to collect demographic information. All four participants engaged in the initial and follow-up interviews, as well as the survey questionnaire. The follow-up interview questions were developed after the initial interviews had taken place. The interviews were conducted using Skype and recorded using Super Tin-Tin Skype recording software for PC-based computers.

It was the responsibility of this researcher to ensure that the study maintained a high level of integrity by upholding professional and ethical standards for research. It was of utmost importance to this study to protect the rights and privacy of the participants. The researcher had completed the online course for Human Research protections that was provided by the National Institute of Health, and the University of Hawaii IRB application was approved in January 2014.

Purposive sampling was used to target medical schools that engaged in utilization of educational technology. The respondents were located by accessing the Medical School's online web directory. Contact was made with the individuals who were in charge of facilitating educational technology programs. A brief description of the research was provided along with a link to the online survey. For each case, an email was sent to a recipient who was asked to forward this email to the most appropriate person to answer questions about educational technology at their respective institution. Consent forms were provided to those individuals who agreed to participate in the research.

The online survey links were provided to participants after they had completed and returned the consent forms. The first set of interviews was scheduled after the surveys were completed. The participants were contacted via email to schedule their interviews. The eight interviews took place over a four-month period between January and April 2014.

The interviews were semi-structured in nature and additional questions came about in an effort to develop more details for the study. Additional questions that were developed during the initial interviews served as the questions for the follow-up interviews. This allowed all four participants the opportunity to respond to the questions.

The interviews were conducted according to their respective schedules. Each interview video was transcribed using MAXQDA. The data were stored on the researcher's computer and also on Google Drive (Cloud storage) and only accessible by the researcher. All data were stored under the respective participant's pseudonym to preserve anonymity.

Data Analysis

The data analysis plan for this multiple case study involved two different levels of examination (Merriam, 2009). Data were analyzed using the specific analytic technique of coding and categorization for each individual case. Data were then coded and categorized for all four cases. The initial data analysis was performed using the most recent version of MAXQDA for Windows and additional analysis was performed manually.

Data management

Data and information were collected solely for this study. All the data collected were secured online, saved on a personal laptop and stored in a personal file cabinet, and will be destroyed within one year of completing the dissertation. The surveys were stored online in a personal SurveyMonkey account. The interviews were recorded using a digital device and the

recordings were stored on the researcher's laptop. The interviews were transcribed and stored on the computer that was used for analysis. The subsequent analysis and results did not contain any names or references to specific medical schools.

Single case analysis

Data across all sources of evidence that were collected for these case studies were analyzed at the individual case level. Creswell (2007) shares a multi-step process for analyzing data that was followed:

- 1) Prepare and organize the data
- 2) Read through the data and form initial codes
- 3) Use categorical aggregation to establish themes or patterns
- 4) Develop generalizations
- 5) Represent the data in figures, tables, or a discussion

Cross-case analysis

The process for analyzing the data at this stage used the cross-case analysis procedure was developed by Stake (2006). This qualitative approach depends on immersing yourself in the data through repeated sorting, coding, and comparing the categories using themes. The themes were compared between the four case studies and the resultant patterns were described by the researcher.

Verification

Yin (2009) discusses four tests for judging the quality of qualitative research. The four tests include Reliability and three types of validity: (1) Construct validity, (2) Internal validity, and (3) External validity. These tests were applied continuously throughout the case study

process: during design, data collection, data analysis, and reporting. This increased the quality of the case study and helped overcome traditional criticisms of weak case study research.

Reliability included demonstrating that the operations of the study, such as the data collection procedures, could be replicated with the same results. Yin (2009) recommends that the researcher develops a well-defined study protocol and to create a case study database. The case study protocol was submitted as part of the IRB application and it included an overview of the study, the procedures that were followed in the “field,” the case study questions, and a guide for all the data collected. The case study database was generated using MAXQDA data analysis software and it included all of the data that were collected for this study.

The multiple cases were selected because of their significant role in medical education. Triangulation was used to increase the study’s reliability. Triangulation is a validity procedure where researchers seek convergence among multiple and different sources of information to form themes or categories in a study (Creswell, 2007; Patton, 1999). In addition the researcher sought review from doctoral advisors (Merriam, 2009) to assess if the findings of the study were plausible. Additionally a set of follow-up questions were developed after initial analysis and coding of the original interview questions within the individual case studies.

Construct validity refers to identifying the correct operational measures for the concepts being studied (Yin, 2009). In order to achieve Construct validity in this study, the researcher used multiple sources of data collection to establish a connection between the evidence and the research questions. This study used document analysis, a survey, and two sets of interviews in the data collection.

Internal validity seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions (Yin, 2009). This study does not need to achieve internal validity because it was only applicable to causal or explanatory studies.

External validity defines the extent to which the results of the study can be generalized (Yin, 2009). Case studies rely on analytic generalization. To improve external validity this research included multiple cases, as replication logic is comparable to repeatable experiments in the field of science.

Summary

The methodology for this study was provided in this section. An explanation of the method, rationale for the study, data collection methods, and analysis was based on the current literature. A description of the qualitative approach and the case study design that were proposed for this study as well as the rationale for the choices was provided. Descriptions of the participants and the study setting were shared to illustrate characteristics of the research site. My role as the researcher was described in addition to how the data would be managed.

Data were collected from multiple sources of evidence, including a questionnaire, analysis of documents, and two instances of semi-structured interviews, in order to answer the research questions. A discussion of how the data were collected and analyzed was done so at two levels. At first, data were analyzed according to each source of evidence, using the analytic technique of coding and categorization. At the second level, cross-case analysis was used to compare the themes between the four case studies and the resultant patterns were described by the researcher. Finally the biases were discussed and the possible threats to validity addressed.

CHAPTER 4. CASE FINDINGS

This chapter begins by describing the individual case studies of each of the participants. The comparative studies between the cases will be described in the next chapter.

Individual Case Analysis

The participants described in this study were four educational technology leaders who were employed at M.D. granting medical schools that were approved by the American Medical Association. One female and three males participated in the study. The participants were from different geographical areas in the United States. All participants come from top ranked medical schools in the United States that utilize educational technology as part of their programs. These individuals were identified as leaders of technology within their institutions and as innovators by their peers in the field of medical education.

Table 2. Characteristics of Participants

Participant ID	Location	Medical School Alias
A	Western U.S.	Ronald Reagan School of Medicine
B	Northern U.S.	Lewis and Clark School of Medicine
C	Eastern U.S.	Atlantic Medical School
D	Western U.S.	Medical School of the Pacific

Participant Information

Participant A

Background

Participant A had a background in education and his highest level of education is a Master's Degree. He completed a two-year fellowship in medical education at an upper tier medical school in the West.

Participant A was Director of the Office of Institutional Research and Effectiveness in the Dean's office at the time of this study. About 15 years ago, he was hired as an academic computing specialist at the Ronald Reagan School of Medicine (RRSOM). He additionally served as an instructor in the Department of Internal Medicine over the last 10 years. In the mid-2000s he was assigned the role of Co-Director of the informatics core and soon after he became the Director of Academic Computing at RRSOM. He has taught several courses on educational technology and the use of informatics in medicine.

He served on several committees at the school of medicine including the Educational Policy and Curriculum Committee, Educational Technology Group, Technology Coordinating and Planning Committee, and Academic Computing Advisory Committee. He was also the chair of the regional group of educational technologists that was part of the American Association of Medical Colleges. He has been the principal investigator or co-principal investigator on at least seven grants since he started working at the RRSOM.

Participant A had significant publishing experience that covered topics in educational technology in medical education, with an emphasis on the use of simulation technologies, digital libraries, and faculty development.

Structure of Educational Technology Unit

The Ronald Reagan School of Medicine has employed a unit for educational technology for over 10 years. The centralized educational technology unit is located within the health science center. This unit was part of the Dean's office and it was responsible for integrating educational technology into the medical school. The main objectives for the center included simulation technologies, video-based communications, electronic collaboration tools, telemedicine, and faculty development. Recently the unit has concentrated on developing simulated cases with an emphasis on interprofessional education for use in the medical school and related health professions instruction which included a developing nursing program.

The simulations were web-based and most were designed to be used by students as they were worked through their various clinical rotations. The resources were primarily case-based and provided students with the opportunity to work with other healthcare professionals on a simulated patient on the initial consultation, the diagnoses, the treatment, and preventative care. The simulation provided a variety of choices for the student that mirror the environment they faced in situations at the multitude of clinical sites that were distributed over a large urban area.

There has been a strong push due to geographical constraints to develop technology that supported clinical instruction. The center developed communications technologies for students to use in their clinical studies including videoconferencing solutions that focused on bringing together multiple sites. Additionally the center worked with other medical schools in the Western United States to develop educational technology solutions.

Topics

During the interview, four general topic areas were covered by all interviewees. These areas included: Adoption and resistance, On campus, Curriculum and educational technology,

and Learning from outside. *Adoption and resistance* involves technology adoption amongst faculty and students and suggestions for increasing the likelihood of adoption. *On campus* deals with the factors involved with innovation onsite at the medical school. *Curriculum and educational technology* looks at the relationship between the medical school curriculum and educational technology as a mechanism for content delivery. *Learning from outside* discusses different methods for learning about educational technology from outside the medical school. This findings chapter describes these topics and what was said during the interviews. Chapters 5 and 6 will more closely analyze the significance of these discussions.

Adoption and resistance. Participant A stated they felt that faculty often played a big part in determining what educational technologies were introduced into the curriculum. Faculty discovered a technology and they really wanted to introduce it into their curriculum. Faculty for the most part had embraced educational technologies but often they were not willing to put the effort in to develop the resources necessary to drive the innovation. He shared his thoughts on why some faculty members were resilient when it came to adopting new educational technologies:

They've always been doing simulated cases for their students. It used to be a piece of paper and it had a paragraph and that sort of thing, the new technology requires a little bit more than that. And the additional effort isn't something they necessarily want to put into it, they'd like somebody else to develop it and deliver it. They get to sit down for the fun part and debrief with the students, or they get to be the physician in the room for a simulation event.

Participant A felt they had been very fortunate at RRSOM because there was one highly motivated faculty member who has been leading the way in the area of simulation. They have

been actively building cases and working with other faculty to develop various types of simulation. But after a while that proactive faculty member had expressed some disappointment too since many faculty were willing to do the “fun part” of sharing the simulation, but they were not always willing to help develop the cases.

Participant A stated that it was important to have one or two “champions” if you wanted to be successful in getting faculty to embrace an innovation, otherwise you would not see much buy-in. He recommended that before you try to implement an innovation on campus, that you found a faculty member who was excited to use and develop the technology. He stated that faculty did not respond well to mandates from the administration so it was necessary to find a faculty member to lobby their peers. “Faculty had been more willing to accept an innovation if they feel it was their idea, so we strived to make it theirs.”

Participant A proclaimed that there had always been faculty that had to do things their way and they really did not want to change, and that was part of the environment in higher education. They did not necessarily resist innovation as much as they wanted to “own” that idea. That was why it was important to get those early adopters and gradually getting the faculty on board prior to implementation, “as opposed to having it at the end saying here's this new thing you had to take and implement in your rotations.”

He expressed that, getting faculty to accept innovations had been a challenge, but what started to win over their attention was when they started seeing the outcomes of the use of educational technologies. When they witnessed how the students became engaged through use of an innovation or when they started to see the data that came as a result of the implementation of an educational technology, you started to get a paradigm shift amongst faculty.

Participant A felt that getting students to accept educational technologies has been equally difficult. Sometimes it was too late to get them to try and learn how to work with it. There had been occasions when educational technologies had been implemented and it made it harder for students to learn the content. There have also been cases where students were spending more time learning how to use a technology in lieu of learning the clinical skills they were supposed to be mastering. Medical students were very fixated on medicine and everything else was part of the background until they actually needed it and realized the benefit. An example of what he had seen transpire:

Going back to the PDA project, students hated having to log the patients they were seeing. And they absolutely hated that, but the data that it allowed the student to go back and think, “You know I need to adjust the mix of patients that I am seeing.” And it allowed faculty to say, “Oh you know this clinical site might not be the best for that rotation because the patient mix that they have.” That definitely led to improvements in the experiences that the students were getting.

On campus. Participant A expressed that there were beneficial educational technologies in the classrooms to teach the content but not enough was being done to properly train and model how to best utilize those innovations. Since most innovations were grant funded, he worried about how that investment was put to best use. “It's really an investment in the future and you have to know it's going to have an ongoing cost of not just maintaining the equipment, but also in training and getting people to use it, holding hands, that sort of thing.”

Participant A asserted that the Ronald Reagan School of Medicine utilized the curriculum committee to make decisions on whether to employ an educational technology to address a

particular need in curriculum delivery. The curriculum committee decides how to implement the innovation within medical education. “Curriculum committees assure that the curriculum being delivered is appropriate and effective, and we would bring technology interventions to that committee to be vetted essentially as appropriate, for means of delivering curriculum or to enhance the educational experience.” He stated that an educational technology could not be utilized as a new way to teach the curriculum without bringing it in front of the curriculum committee first.

The curriculum committee was a place where you float ideas on how you implemented educational technology or how you were going to teach a particular skill or concept and eventually those were funded by the medical school:

A lot of our clinical simulation stuff has been because we were able to get funding for those activities and so we were able to build a lot of intervention specific programs in interprofessional education and things we knew there was a place for in the curriculum, but this allowed us to pursue them through the technology.

In most cases hardware and software was put in every learning space. But without the proper guidance on how to implement educational technology into the curriculum, it did not get used. “That’s an area we really need to work on more, is just modeling... showing faculty how to use it, finding good examples of faculty using technology that others can emulate.” It was important to consider how you were going to support an educational technology beyond its implementation.

Participant A seemed to be concerned about maintaining the educational technologies, rather than the actual implementation of them. “It’s relatively easy to start something new; it's very hard to continue supporting it. Once you started it demand increases and interest and

funding decrease, so suddenly it's hard to support programs and things once you've got them going.”

When he first implemented the use of PDAs as part of the clinical experience, everyone had been quick to embrace them but eventually stakeholder support started to diminish. When smart phones appeared on the scene, it became more difficult to deliver the content because the extensive variety of devices did not share a standardized platform. Maintaining those tools became complex, especially as the “environment for technology changed so rapidly, something that you were doing that's really neat and cool and exciting one day was old hat the next.”

Participant A expressed that those issues with maintaining innovations after their implementation could be addressed. He suggested creating a fund at the medical school that dealt with the disposable costs such as maintenance contracts. Since grant funding ended at some point in time and it helped you get an innovation started, there had to be a mechanism in place to deal with keeping it going. “One of the reason interest drops off very quickly because the money disappears and then suddenly nobody’s interested.” He felt that medical institutions were very good at bringing in money for new educational technologies but not as good at bringing in the funds for the personnel to support those innovations. “You bring in money for people, you have it for two years or three years and when the money goes, that person goes too.”

Curriculum and educational technology. Participant A acknowledged that the use of educational technology was being spurred on by the strategic need to deliver curriculum in an effective and expedient manner while adhering to the principles and guidelines that were set forth by the accreditation bodies for undergraduate medical education. “We have the same sorts of strategic goals for education that most of the schools do and the technology helps us address some of those. That was the strategy that's driving the educational technology.”

Participant A admitted that it has always been important to provide students with access to technology at clinical sites, especially when your medical school was located in a big city where students are scattered everywhere. He felt it was important to try to put technology “into the hand” of students so they had access to important information while they were in the presence of their patients. There was an advantage to having medical students working with PDAs (and later iPads) at the bedside because it not only provided educators with the opportunity to deliver content, but it had also allowed students to record and reflect on their clinical experiences at the point of care.

Participant A agreed technology in the form of PDAs allowed students to access vital resources such as drug databases, but if they could not look them up while seeing a patient, it really did not help. The need for technology came about because he had identified particular issues in interprofessional education and team communication that they were not able to accurately assess in the clinical setting. Educational technology was a platform that could be standardized and it enabled the faculty to teach and effectively engage the students.

He agreed that, in general people felt that doctors should be employing the “latest and greatest technology” in patient care, and the expectation was the same with respect to the education of doctors. But there was a right place and time for the use of technology in medical education, “I think you can do some things faster, and you can do some things better with the proper use of technology, but you can also do things worse.”

Participant A proclaimed that the use of simulations in the clinical setting should include opportunities for interprofessional education. He stated that most medical schools do not teach enough interprofessional skills as part of their curriculum. “Most of the education is very much

siloed in the respective professions, so you dump all these people into a hospital and say hey you've never met a nurse, now you are working with them day to day.”

He declared that you made sure that physicians and nurses were able to effectively work together and since there had been substantial investment in educational technologies like simulation, the best way to justify those expenditures was to use simulation technologies across multiple healthcare professions. Simulations provided the ideal platform for training physicians and health care professionals how to work collaboratively, because so many different personnel were involved in the care of a patient, not just the physician.

Participant A recognized that one of the major challenges to using simulations in the clinical setting was the topic of privacy of health information. The Health Insurance Portability and Accountability Act (HIPAA) was always a concern for medical students and preceptors because of the difficulty of conveying information into a simulation without revealing any identifying information about the patient. He stated that there were always concerns when developing simulations:

Sometimes you are simulating an actual patient that you just saw, so how do you translate that information into the simulation without giving away who that patient was, and what their conditions were? So that's a regulatory issue that impacts just all of the way medicine is taught. I think in some ways it tends to hamper to some degree the way faculty and students talk about the clinical environment, in terms of technology itself. Anytime you were creating content that was involved in simulations, the restrictions within HIPAA had a huge impact on what you actually do.

Learning from outside. Participant A emphasized looking at sources outside of the medical school for inspiration to discover innovations in healthcare education. “We can’t spend too much time playing and testing everything that’s out there.” He felt that one of the best ways to learn about new innovations was to see how other medical schools were using them. “You need to have the connections out there, otherwise there are no ideas. It works both ways because a lot of the time I will see what other people are doing and I’ll say that is so not for us.” The ability to collaborate with other schools to assess whether a certain innovation was appropriate for use at your own institution was an extremely valuable practice:

I like to see it being used. So I’ll go and visit schools that are using the technologies that I am interested in I can see how it works and I can see the effort that goes into it. So that when our faculty do hear about that sort of thing, we can say ok, that might work really great for them, but here’s some reasons why it might not work for us, or why there might be a better solution for us. It can spur the innovation but it can also quell some innovation that might lead us down a road that we didn’t want to go down.

Participant A felt there was really no need to waste time and resources to experiment with new educational technologies if one of your peers was already doing the same. “There are peer medical schools in California and Hawaii that we maintain pretty close relationships with all the people in educational technology at those locations and we try to keep our ears open to what’s going on.”

Participant A stressed the need to participate in professional associations and research organizations as another way to learn about new innovations in educational technology. He was a

member and past President of the professional association, Computer Resources in Medical Education (CRIME) which was part of the Western Group on Educational Affairs (WGEA).

Participant A had strong ties to CRIME because it represented all the schools in the west. CRIME had representatives from private and public schools both large and small, and that provided a healthy mix of perspectives that were focused on medicine. He felt that you got a good idea of what the shared goals were because you were all working to attain the same competencies in medical education.

Participant A encouraged participation as research organizations were good for giving examples of what was going on in the field of educational technology. “I am also am a member of Educause, so I'm keeping up on just the general education technology trends, not focused specifically on medicine.” The research was important because it focused on the effectiveness of a technology and often times that was one of the crucial aspects of deciding whether an innovation was worth pursuing.

Participant A stated that understanding the effectiveness of an innovation, “is the piece that lags the longest in the implementation of educational technology. Usually everybody is like, I want to do this before we even know if it's gonna be useful in helping students learn.” He asserted that knowing whether an educational technology was the right fit for the medical school was extremely important. A lot of the innovations that get implemented at medical schools were driven by research. “The first video conferencing that we did and multi-point conferencing was through Access Grid, things like that were originally pushed through research, we've adopted them in the education end of things as well.”

Participant B

Background

Participant B had a PhD in Education, which she received over 15 years ago in the field of educational technology. Her doctoral research concentrated on the use of computer-based tutorials to teach medical students how to identify issues they encountered in dispensing medical care.

At the time of this study, Participant B was the Director for Educational Innovations and Strategic Programs at LCSOM. In 2000, she was part of the education faculty in the Department of Family Medicine at the Lewis and Clark School of Medicine (LCSOM). She had spent six years in that position before she moved into the Department of Medical Education and Biomedical Informatics. In 2010, she had transferred to a top-tier California medical school and became the Director of Educational Technology there. She had spent two years at that medical school before returning back to the Lewis and Clark School of Medicine, where she took the position of Associate Director of the Center for Medical Education in the Dean's office.

Participant B resided as the Vice Chair of the Curriculum Committee at the LCSOM. Outside of the medical school, Participant B served as the Chair of the Re-Accreditation Committee of the Society of Simulation in Healthcare. Additionally she served as a committee member in the Society of Simulation in Healthcare Accreditation Council and the Association of American Medical Colleges.

Participant B had extensive publishing experience in the field of educational technology in medical education. She had written on a range of topics including interprofessional education for medical students, the use of animations in medical education, assessment in online medical courses, and communications skills of physicians and medical students in the workplace.

Participant B had authored/co-authored over 30 journal articles that had focused on the use of educational technologies in medical education.

Structure of Educational Technology Unit

At Lewis and Clark School of Medicine, there had been an institute in place for over 10 years, which was in charge of all educational technology initiatives at the medical school. The centralized educational technology unit is located within the medical school. The educational technology initiatives included simulations, interprofessional studies, and a variety of medical skills training. The institute had run simulation and training facilities for over 30 departments, which included a dry lab and skills center. The unit was well-known for its development of surgery-skills simulations that utilized a state-of-the-art virtual operating room. There were over 160 online courses and simulations developed by the institution to support student learning.

There was an emphasis on interprofessional education at the institution in order to establish a connection between the different healthcare professions. Online courses provided faculty instruction on how to design and utilize e-learning, how to use simulation in their curriculum, employing tele-health to improve communication between the medical school and clinical settings, and harnessing informatics to manage data that were used in everyday clinical teaching. LCSOM was in the process of putting together a center for leadership and innovation at the time of this study.

At LCSOM there was an emphasis on the use of simulations in basic medical education and in the clinical environment. Simulations were being developed to teach skills, help learn facts and procedures, and to measure performance. Virtual simulators were programmed with a

variety of scenarios and were capable of demonstrating a multitude of physiological responses to various stimuli.

Topics

Adoption and resistance. “I learned in my position that the human factor involving technology, innovation, and integration is very hard.” Participant B stated that one of the reasons faculty members were reluctant to embrace educational technologies was because the fluidity of their courses could be disturbed. There was a big concern that students would get frustrated with the new technologies, and that the frustration would be directed at the faculty.

Participant B stated that she felt some people were hesitant to adopt educational technologies and the challenge was to get faculty to work with innovations when they were happy with the status quo:

I think people who feel threatened by educational technology; their perception is that they have a lot to lose from the change, either in the form of control or status. They're just simply too stretched and busy to give their attention to something new. They may support innovation at heart but in reality it's so hard to free up their time for their due attention and effort .

There was a lot of resistance to active and blended learning opportunities. Some “local champions” were recruited to explore active learning with the intent on using those faculty as advocates for educational technology. “When your peer faculty says, ‘Hey I tried something, this worked, this didn't work,’ I think other faculty are more likely to listen.” This was a much better approach than having the Director of Academic Technology trying to coax faculty into using technology. Participant B felt it was crucial to reach out to early adopters that were willing to be

advocates in order to create practical solutions, so that other faculty might feel inclined to participate.

Participant B indicated that communication was the key when trying to implement innovations with faculty. Making a connection with your stakeholders was necessary in order to succeed with educational technology. There were many new faculty members who were more than willing to try something new and groundbreaking to improve the learning that went on in their classrooms. Resources such as programmers and graphic designers were provided to support these early adopters because of the perceived mutual benefits. This led to the development of educational technology resources that they were happy to implement into their courses. In turn, it gave faculty the opportunity to showcase their innovative practices with department leaders and their peers.

Participant B learned that when she was working with faculty, “they're not your enemies, you gotta partner with them so when you open up the communication early on, they become a lot more sympathetic. That’s how you bring people along.” It was important to instill the customer service model with staff, so that when faculty were dealing with issues that frustrated them, they were less likely to direct their anger toward those assisting them. “It's about communications, it's about needs, and it’s about persuasion. But also commitment to delivering high quality service.”

The resistance from students was a different experience for Participant B. She revealed that students often came from the customer angle, and they expected the technology to fit to their individual needs. Students were very diverse and had different learning styles and tastes. Many students took issue with the fact that the educational technology did not meet their preferences. That acute demands from students was met by different kinds of resources and technology.

One of the strategies that Participant B recommended was to connect with students ahead of time in order to try to “understand and anticipate their needs.” There was an effort to seek out the student representatives from each year’s class. Educational technology staff introduced themselves and let the students know they wanted to collaborate with them. “That anticipatory communication really paid off.”

On campus. Participant B declared that there had to be a coherent institutional strategy around promoting and fostering innovation. She noted it was very difficult to implement innovations when there wasn’t an institutional mandate. Lack of funding and the right personnel were also listed as critical to successfully making change happen. Innovations had to be piloted in strategic areas in the medical school and then adopted enterprise-wide. Participant B found that while there were significant individual innovations in educational technology, there were currently no strategies for scaling that up to the institutional level.

Participant B expressed that at LCSOM there had been a significant effort to develop innovative educational technologies on campus. The medical school recently established a center for leadership and innovation where one of the main objectives was to identify innovations in teaching, research, and leadership. As stated, “one of the core groups is instructional design and technology, so we have folks who think a lot about how to deploy technology.” One of the problems the center addressed was how to set up technologies to encourage communication amongst faculty and between faculty and students.

Participant B had recommended that medical schools that were considering integrating educational technology into their programs invest in some form of a unit or center that was dedicated to instructional design and technology. “It’s about instructional design really; technology is to support, to catalyze how people are to learn. And that takes some expertise in-

house, so my key recommendation is to create a board...a defined instructional design technology center.” The recommended center included social media as a mainstream technology because of its major role in many of our daily lives. And Participant B declared the center should support its people in the form of human capital development.

Participant B pointed out that on campus funding sources were necessary for driving innovate ideas on educational technologies. The hospitals that were partnered with the medical school were willing to provide funding for technological solutions “to improve hospital operations, patient outcomes, and institutional culture and climate.” The new center planned to offer small-scale grants to support innovators by identifying the individuals that were coming up with new educational technologies, and help them showcase their innovations. These folks became part of the new center’s culture and provided mentorship by helping “other people stimulate their thinking of how they can engage in innovative work.” Additionally there was a university-level group with business interests in educational technologies that was looking for patent opportunities that generated revenue for the university, “so there's a commercial aspect that promotes innovations on campus but I haven't had close contacts with them.”

Participant B revealed that she had sought out her colleagues at the medical school and formed teams to brainstorm ideas on educational technologies. There had been a campus-wide effort of people that tried to get together and write small grants in order to develop innovations. She shared a dialogue simulation at a recent WGEA meeting and planned to test it with a group of interprofessional graduate students that were based in the health sciences at Lewis and Clark. The strategy with educational technologies had been to seek out funding, develop the innovation, and pilot them on campus or amongst her peers.

She felt one of the reasons that the Atlantic Medical School had been so successful at implementing educational technology was that it was getting exceptional institutional support and that it was in tune with what was happening in the world of technology. “I point to Atlantic Medical School because at least from the outside it seems like their leadership, they have their eye on innovation and technology and integration into education.” It could not have been done without that type of institutional support for innovation. To be successful at implementing the right educational technologies, it took an organizational vision, which included leadership, funding, mandates, and the right people.

Curriculum and educational technology. Participant B expressed that there was a very close alignment between the curriculum and the advances in the technology world. Participant B emphasized how important it was to collaborate with other medical schools to learn about new educational technologies:

Well we are very fortunate to have top rated schools on the West Coast so I know Stanford recently hosted multi-medical school discussions on curriculum renewal. We will be receiving visitors from OHSU, Oregon Health Sciences University. Their Dean's office folks are coming over to share their curriculum renewal examples and part of that I'm sure, technology will be a topic.

Participant B mentioned that the medical school was recently involved in curriculum renewal, a top-down process involving hundreds of people who volunteered on committees. This curriculum deployment provided the ideal opportunity to bring in new educational technologies.

Participant B felt the accreditation process had provided a valuable learning opportunity for the institution to find out what the national accrediting body considered important for today's medical schools. It also gave the school a chance to collaborate with peer institutions to see how

they were dealing with certain curriculum guidelines and what innovations they were utilizing to meet those requirements. Participant B shared how her perspective on the accreditation process changed:

I used to think of accreditation as this kind of, dry wasteland that just sucks up your talent and energy but I've changed over the years. Seeing accreditation more as a channel and tools for thinking about your organizational practices in light of the national context and using it as an opportunity to learn from outside and bring about internal changes.

She commented that accreditation was a natural catalyst for bringing together peer institutions due to the common goal of meeting a regulatory mandate for medical education.

Learning from outside. Participant B saw a great deal of inspiration for innovation coming from outside of the medical school. Sometimes it was externally driven, “there are these national calls for grants that come through that are asking for cutting edge, innovative, educational practices. So then we all scramble and try put our school on the national map.” The rapid advancement of technology had necessitated that medical schools look to other sources for innovations in educational technology.

In many cases looking outside of the medical school for educational technology solutions satisfied the urgent needs of the school. At the LCSOM there was still a lot of work that needed to be done with respect to connectivity between the main campus and off-site locations. “I mean there are times that I just want to crawl into a hole because we are trying to connect with colleagues in another state and we're sitting in our reconfigured conference room and it doesn't work.” Seeing what peer institutions were able to accomplish with the same type of resources and personnel had a great deal of influence at LCSOM.

Participant B asserted that peer institutions were a major source for innovation. Especially New York University School of Medicine as “I think they are just the leading entity when it comes to educational technology in medical education.” Participant B mentioned how a colleague referenced the organizational chart for University of California San Francisco School of Medicine and noticed that they had a dedicated group to respond to innovative solutions, influencing LCSOM’s efforts as they were putting together a center for innovation of their own.

Participant B acknowledged that professional associations were very significant in helping facilitate change. She belongs to several national associations including CRIME and those groups are where you can find out about what the “hot button” topics are on a national scale, including “innovative research methodologies people are applying, cutting-edge practices that institutions are adopting, and most of all networking with people. Then through your networks you could build teams to try something innovative.”

Professional associations provided a critical pipeline of ideas that were facilitated through networking. Recent changes to LCSOM simulation center research infrastructure were based on ideas that were inspired by recent discussions that Participant B and a colleague engaged in at a conference of a national organization they belonged to. She stressed the importance of developing close relationships with colleagues at other medical schools and the need to collaborate with partners.

Current research studies were crucial to making decisions about what types of educational technology to deploy in medical education. Participant B stated that top medical education journals, such as *Medical Education* and *Teaching and Learning in Medicine*, had an in-development publication category that often highlighted some of the top innovative practices in educational technology and offered excellent research-based perspectives.

She described educational technology research, in general, entails how to go about collecting evidence to support “how we deploy what types of technology at what dosage” and what is needed to catch up with the simulation world in terms of rigorous high quality research. Participant B, who had been a consulting editor of an educational technology journal, seemed perplexed by the current state of research: “I’m still surprised by the kinds of research we do, which we were encouraged to move away from. We’re deploying technology in the intervention group, control group doesn’t get any. We compare their performances, and create a story about technology.”

Participant B expressed that a better research model should focus on instructional design by looking at two different types of instructional design features that are supported by technology. She declared this research model was a way to advance the field. In a sense it is not about technology, but how to improve the teaching and learning in medical education in a more efficient and cost effective manner. The innovation had to come from this knowledge as “we cannot create innovation out of thin air; it has to be grounded in evidence and what we know about how people learn. It’s not really the hype of new technology, but rather the enduring knowledge around human learning behavior.” The choices made about innovations should be guided by this concept and the resources involved in technology use.

Participant C

Background

Participant C had a background in medicine and received his M.D. at Atlantic Medical School (AMS) over 15 years ago. Participant C learned that his student advisor was working on pioneering educational technologies in medical education and he agreed to work in his lab over

the summer. After he completed his residency in internal medicine, Participant C embarked on a two-year fellowship in medical informatics research at AMS.

At the time of this study, Participant C was the founding Director for the Institute of Innovations in Medical Education and an Associate Professor of Medicine. Prior to that position he worked in the Office of Medical Informatics for approximately 10 years, which culminated in his advancement as the Associate Dean for Educational Informatics.

At the medical school he had served as the Associate Director of the Center for Health Information Preparedness and the Director of Research for Advanced Educational Systems. Outside of the medical school, he served as a member of the AAMC Group on Informatics, AMIA Professionals in Health care, MedBiquitous, and Education in Motion. He had been the principal investigator on several grants from the National Institutes of Health, the National Science Foundation's Advanced Learning Technologies Program, the Josiah Macy, Jr. Foundation, the USDOE, Center for Disease Control, and the American Medical Association's Accelerating Change program.

Participant C had substantial background publishing research in the areas of medical informatics and educational technology in medical education. His main focus had been on e-learning in medicine, which included numerous journal articles on virtual patients, interprofessional education, and developing web-based resources. Participant C had contributed over 50 articles that were educational technology related. He developed a plethora of educational software, and had written a textbook. He presented a TED talk on his research in the area of educational technology in medicine.

Structure of Educational Technology Unit

The Atlantic Medical School implemented the Institute for Innovations in Medical Education, where the Division of Educational Informatics (DEI) served the educational technology needs of the medical school. The centralized educational technology unit is located within the medical school. The DEI was involved in the strategic planning of future educational technology requirements and initiatives. Its main role was working with faculty and students to facilitate content creation using educational technologies and to provide maintenance of current resources. The medical school partners with the nursing school to provide interprofessional education opportunities focusing on collaboration and teamwork.

In addition to creating educational modules to teach skills and processes, there had been a great deal of work done on creating a digital database to house all the developed technology resources. This included two separate data warehouses of educational technology resources that had been developed by faculty and staff.

The DEI employed a large staff that included programmers, mobile app developers, 3D animators, instructional designers, and database engineers that took a project from the initial idea to an actual software product. Some of the latest projects included developing software for use with iPads in clinical settings, a completely 3D virtual reality human, and a virtual microscope project to replace conventional microscopes in the educational setting.

Topics

Adoption and resistance. Participant C declared that sometimes people were resistant to change. “People were not necessarily resisting technology but resistant to what that technology represents.” Sometimes that resistance was reflexive, but more often than not people tended to be

opposed because of the environmental pressures they faced in their work every day. For example some internal conflicts had taken place around modalities of instruction.

Participant C asserted technology competencies were instrumental in an information management-centric profession like that of a doctor. Faculty increasingly used technology in their personal lives, when they paid their bills or watched movies at home. He asserted that every physician should have a fundamental understanding of technology, especially considering that they were seeing more and more new technologies in the clinical setting and throughout their research. “Physicians spend somewhere between 45-55% of their time every single day in front of a computer doing information management for patients. It's the biggest activity they do and it's not something that medical schools even teach.”

Participant C stated that being proficient with educational technology and understanding how it helped or hurt what you were doing was part of being a modern day physician. Every new-hire participated in a formal orientation focusing on educational technology because “it is a part of every single person's life here in terms of evaluation, teaching, assessment and understanding outcomes.”

Participant C asserted that there was a gap between health professions education’s use of technology and its use among new medical students. Medical schools were responsible for training doctors and assuring a minimum level of skills and competencies and the effective implementation of educational technology supported that goal. It was important to be considerate about what you were trying to accomplish with your learners and how their input was informative.

He declared that it was beneficial to get regular input from students and other stakeholders such as residents, faculty, and leadership. Maintaining communications was

extremely important in order to understand the problems and come up with meaningful solutions while trying to rapidly implement educational technologies. “If we look at ‘where did the coolest ideas that result in amazing things come from?’ Our students and our faculty increasingly came up and challenged us with just wonderful, awesome, amazing, and often impossible ideas.” Advances in technology were coming faster than ever and that represented a challenge because faculty and staff had to keep up with it because students were always ahead of them.

Participant C shared that students partnered with the educational technology unit and were often used to connect with faculty. The key was engaging the students and providing them the necessary resources in the form of a student delegate program. They had great ideas and they often solved the problems with their realistic input on the situations they dealt with in their own education.

On campus. Participant C stated that the medical school and the medical center were responsible for approximately 70% of the funding for innovations and the other 30% was through national grants. He acknowledged that most medical schools had a great deal of difficulty coming up with funding for educational technology resources.

He also revealed that an executive committee on campus was where technology projects and scholarly output was shared. The committee was there to make sure the educational technology groups on campus were seeking grants, doing research, and publishing papers in addition to developing new technologies. Additionally there was an operating committee that worked with the stakeholders to see what was working or not working with educational technology.

Participant C asserted that there was formal governance that helped make decisions on what critical needs required immediate solutions. He stated that this was one of the areas that had

developed over the years within the medical school and it was a crucial aspect of their success with regard to implementing educational technologies. He felt that all the pieces were in place for the medical school, especially since it now had a software startup that had all the internal resources, from programmers, mobile app developers, instructional designers, and IT Staff, to develop those educational technology solutions.

Participant C expressed that leadership at the medical school recognized that educational technology was an important part of the future of medical education. “They didn't know what that meant, but they knew that it was going to be important, so they recognized this was not something we could ignore.” Atlantic Medical School had been fortunate to have leadership that recognized how important funding was to developing innovations, “so having your leadership be supportive of you and behind you to help move this stuff forward is key.”

This shift demonstrated a willingness to refine the quality of education being delivered. As a result this improved the reputation of the medical school, which was an important thing to invest in because it brought in better quality students and faculty as a result. The leadership approached educational technology with the intent of making the innovation process as rigorous and scholarly as possible, something that has been the cornerstone of the medical school ever since.

Participant C stated that faculty development was another challenge. Faculty were open to the idea of learning about new educational technologies, but were often too busy because of their clinical workload and research obligations. Every school that Participant C had worked with expressed the desire to do more faculty development and it was one area that he felt needed more content and resources available. Medical schools needed to focus on faculty development, getting faculty familiarized with the educational technology by not only showing them how that

made education more effective, but also providing examples of how it improved the faculty's lives.

Curriculum and educational technology. Participant C revealed that educational technology as an enabler was a key part of the medical school strategy. The medical school had undergone a recent curriculum reform and that led to powerful structural changes within the medical school curriculum. Those changes had their foundations in educational technology. Participant C acknowledged that one of the challenges was that the pace of educational technology innovations was not aligned with the traditional academic calendars of medical schools. It could be challenging to try new technologies and maintain the fluidity of the school's schedule.

The medical school recently implemented a virtual reality human simulator for anatomy instruction and there had been some concern about how it may replace the role of the human cadaver. While cadavers are very expensive and they lack scalability, they are considered integral to a particular educational setting. "Our school is really committed to the continued use of cadavers and we designed this technology to make that experience better, not to replace it."

The medical school recently decided to replace traditional microscopes with virtual microscopes after using them for 150 years. This was a point of conflict because faculty had used microscopes in the same way for most of their careers. But the main point of the change was that students used these tools to interpret what they saw in the physiological processes they were studying, and they determined whether they were normal or abnormal. The medical school felt that it was not necessary to have learned the physical use of the microscope in order to accomplish that. It was a significant change in how a particular content was being taught and it required an appropriate innovation to deliver the actual learning objectives for the microscope.

Participant C asserted that sharing data within the medical school could be accomplished with educational technology too. Medical schools had standardized data, such as electronic medical records and patient registries, to improve clinical education. Atlantic Medical School embarked on a mission to construct a data warehouse in order to combine all the data across their educational technology systems. Developing a data repository held value for every aspect of the medical school. For students, it enabled them to look at their own data and integrated information. The faculty benefitted from being able to see the curriculum as a whole, or to assess the performance in it. It also allowed leadership the opportunity to review faculty effort, how many hours teaching, or who was working on what in the medical school. “Having that data in a centralized combined repository is something that is a very straightforward way to demonstrate value to every single group of stakeholders. It's something that's already transformed our clinical mission at every medical center.”

Participant C declared that a majority of patient care was shifting out of the hospital and into the outpatient setting of clinics. Medical schools had been resistant to shifting the delivery of clinical education out of the hospital and into that clinic setting. “It's just not happening at most places, it's hard to get students out of the hospital and into these busy clinics where there isn't a lot of buffer for education. That's going to happen, and when that happens our students are going to be quite decentralized.” Educational technology helped make that transition work, as students did not have the luxury of sitting in a classroom or getting together in a conference room.

Students worked in many different places during different times of the day in very different settings. Educational technology in the form of electronic portfolios provided a constant connection to those students and enabled the medical school to assess them, understand their environment and educational situations they were in. It allowed faculty to distribute educational

content to their students and deliver the appropriate support tools in a decentralized environment. This was a big driver for medical schools to get on board. “Every medical school in the country is increasing the amount clinical time that's part of the curriculum and they will soon be trying to figure out how to get these students more time in clinics all over the place.”

Participant C proclaimed that iPads and other similar devices played a significant role in changing the way information and content was delivered in the clinical setting. He asserted that, “it is an amazing platform in this decentralized inventory space. We can push content, we can pull. We can create this mobile thing that means that we are with the student at every step of the way.”

He revealed that federal regulations created a challenge for educational technology in clinical education due to HIPAA and the types of clinical data that can be shared with students. HIPAA often posed an obstacle when you consider the role of the medical student in retrieving authentic clinical data. “HIPAA and technology appropriately protect our patients, but that means that we're sacrificing some opportunities for students to get into and see the clinical data that our health care system is generating every single day.” He stated that unfettered access to all that clinical data really improved the medical student’s educational experience.

Learning from outside. Participant C stated that educational technology was a catalyst for medical schools to share content, expertise, data, and ideas with each other. Historically, medical schools had been bad about sharing educational resources with each other. There had been isolated efforts to share amongst institutions but there really had not been a platform to do so.

Participant C commented that many schools share resources but were not necessarily aware of it. This occurred through students, who did not care what medical school the content

was coming from, but only cared about the usefulness of the information and how it helped them to prepare in their own studies. “They'll access publicly available content from any school in the country and internationally. They're really good at this stuff, and we should take a lesson from them and see that they're creating their own personal ecosystems of content.”

He acknowledged that while there was a robust network of collaborators from the various medical schools, more could be done with respect to sharing technology, best practices, and data. There were many like-minded medical schools that had the same goals with respect to medical education, but there were obstacles that prevented them from sharing. Participant C presented his thoughts on some inhibiting factors:

Well some of it socio-political barriers that, it's not entirely up to us what we share. We need to make sure we protect our learners, we need to make sure we protect the intellectual property of our institutions. Some of it is the heterogeneity of medical schools and the fact that our curriculum is structured a different way than another schools' curriculum. What works here may not work at another place, and a lot of it is this darned not invented here mentality that many medical schools have where they really do want to do things their own way. That's present at every single medical school, ours included, and it's something that we really need to overcome.

The professional societies represented a neutral third party that really facilitated that sharing of ideas and content. “They host conferences where we all go and talk at each other, and we share and network and that's critical.”

Participant C declared that professional associations could take it a step further by creating more opportunities to share and collaborate. The American Association of Medical

Colleges (AAMC) was developing a curriculum inventory portal with a non-profit group called MedBiquitous in an effort to create a technology standard for health care education. This made the content interoperable and compatible amongst medical schools. “What a great thing... and they use their position and their influence in a benevolent way to get that standard used throughout medical schools and throughout medical education.” The American Medical Association (AMA) was also funding a consortium of 11 medical schools to accelerate change in how medical schools work together.

Participant C revealed that participating in research organizations and reviewing research literature were some of his biggest sources for learning about innovations. He suggested looking at Educause, a big consortium of higher education, as they have particular groups that concentrate on educational technology. Educause provided a yearly synthesis on all the hot issues in educational technology. He asserted that New Media Consortium was another great source; especially the annual Horizon report which looked at new educational technologies and predicted the impact in one, three, and five-year projections.

Participant C admitted “that health care has the danger of being a bit myopic” because health care within higher education tended to isolate itself from general higher education and health care could learn a lot about educational technology from that realm. Organizations such as Educause had done a wonderful job bridging some of those gaps. While emerging technology literature was a great source to learn about new innovations, there seemed to be a lag in peer reviewed manuscript-based literature.

Participant C admitted that there tended to be a scarcity of evidence-based research literature. There were a lot of descriptive and innovative papers but there was a lack of research where you see authors who came out and said, “Ok I understand my environment, here's what

worked, here are the P values. I'm going to make an informed choice.” He expressed that more funding for research of innovative practices from an assessment and rigorous evaluation perspective was a good start. He felt that developing evidence-based best practices for efficacy had substantial benefits for those schools looking to implement educational technology in their medical education programs

Participant C expressed the desire to see more research on the value of using educational technology to bridge the gap between undergraduate medical education and graduate medical education. “I would just love to see an explosion of research, an explosion of new data analytic methodologies, an explosion of funding opportunities to really transform what the ecosystem of health professions education means in a technology enabled world.”

Educational technology to unite medical education. Participant C acknowledged that one of the big challenges that medical schools face is the lack of continuity between undergraduate and graduate medical education. In the United States there are two separate entities that are led by two different professional associations and groups, and technology has helped lessen that divide between them. “From the first day of med school to the last day of residency training and right into making this a certification for positions, technology could be all about supporting that continuum.”

He proclaimed that standardizing certain practices with educational technology provided some solutions to problems in medical education. One of those issues was how data were shared. Many medical schools had adopted the use of electronic portfolios to support their students as they progressed through their medical education. Students started out in medical school and then moved on to their residency programs, and finally ended up in their practices. However, the valuable portfolio data that reflected their growth did not follow them in their journey. “From a

pedagogical point of view, they should be empowered to build upon it and to develop a competency ladder that grows with them. But we don't have any standards for that, and therefore that often doesn't happen.”

Participant D

Background

Participant D had a background in biology and received his M.S. in Biology over 25 years ago. After he received his Master’s degree, he spent approximately 10 years working in the field of biological sciences and health care prior to gaining employment with Medical School of the Pacific (MSOP).

Participant D has been the Associate Dean for Medical Education since 2012. Before that he spent four years as the Assistant Dean for Medical Education and three years as the Director of the Office of Medical Education. Prior to those appointments, he was the founding Director of Educational Technology at MSOP from 2000 to 2010.

At the medical school, Participant D served on the Anatomical Learning Center Design Committee. He had previously served on the Chancellor’s Advisory Committee on LGBT Issues. He also served on the IT Guidance Committee Instructional Technology Work Group and the Medical School Committee on Measuring the Educational Mission. Outside of the medical school, he served on the Association of American Medical College (AAMC) Group on Educational Affairs eFolio Interoperability Initiative and as the Chair of the AAMC Western Group on Educational Affairs.

Participant D has significant publishing experience in the domain of educational technology. He has authored numerous publications on such topics as educational technology infrastructure, organizational models of educational technology, best practices for educational

technology, and faculty development, in addition to co-authoring a handful of medical research journal articles.

Structure of Educational Technology Unit

The Medical School of the Pacific had employed an educational technology unit for over 15 years. The centralized educational technology unit is located within the health science center. The unit was part of the Office of Medical Education and its mission was to enhance physical and virtual learning spaces by applying technology to meet the educational goals of the medical school curriculum. The main focus of the educational technology unit was to research and develop new technology interventions to implement into health care education.

Current projects included the development of iPad applications to assist students in the areas of neurology and anatomy. The unit had also assembled a digital database of the entire medical school curriculum that had been generated in the last 15 years. In addition to the digital database, all learning resources had been made available for students, including over 180 discipline-specific multimedia-based learning modules. The medical school had been collaborating with other institutions on designing and developing improved learning spaces and flipped classrooms. The medical school was in the process of developing a Massive Open Online Course (MOOC) that covered interprofessional education in health care professions.

Topics

Adoption and resistance. Participant D admitted that he was lucky that he did not have to sell the faculty on the notion that technology was an important tool in teaching and learning. Faculty members that resisted were the “sage on the stage” type who felt threatened by the idea that their identity as professors was somehow tied to the success of the technology.

Participant D declared that some students were resistant when the medical school required the use of computers and an Internet connection. Those students came forward and stated they did not believe in the use of technology and that they refused to own any. John explained that they had discussions with the students about their professional responsibility and that they could not be a health provider in this day and age without utilizing technology.

He acknowledged that focus should remain on improving the livelihood of your students and faculty first, for a quick victory. Providing certain resources online can improve the lives of learners so much that it draws them into the realm of educational technology. Showing faculty and students that technology could make their lives easier often helped get their attention more effectively. Once they started buying into the technology, other ways to make innovative educational interventions could then be introduced.

Participant D recommended that schools that were having trouble getting faculty to use technology should consider engaging learners first in order to get resistant faculty on board with educational technology. He provided an example from his experiences:

I was working a job I had in the curriculum office and also trying to start up a new educational technology initiative. And I recruited four medical students that were really excited about this and kind of united them to help me and partner with me in this. And I think that was very transformative...Faculty engage with students differently than they engage with, I think the administrative leadership...The students know practically not only what they liked to have but what they are capable of using. Again this goes back to start simple, engage your learners, use your learners to engage your faculty. Work through your learners to engage your faculty.

On campus. Participant D acknowledged that this practice set them apart from most medical schools that had to deal with limited financial resources or lack of existing tools they could rely on. He expressed that schools that wished to start employing educational technologies should not be discouraged as he started with no budget when the medical school decided to embrace educational technology 15 years ago. He suggested that medical schools looking to implement educational technology start small and involve their learners in the process as much as possible.

He specified that there was no official policy that the medical school had in regard to the use of educational technology, but there were guidelines that drove the effort to include an online component in courses being developed. The medical school had an educational technology unit that drove a lot of the decision-making. In addition to that unit, there was a campus-wide committee for educational technology that reported through the IT governance structure at the institution. That committee made decisions about innovations and initiatives that influenced the entire campus. “That group also does strategic planning for the campus around educational technology and through that strategic planning encourages and promotes new innovations, new technologies that support health professions education.”

Participant D stated that one of the attributes of the medical school that made it so successful with educational technology was their unique way of internally funding innovation. When the institution first started their educational technology initiatives 15 years ago, they did a lot of strategic planning and decided after some time to offer awards of funding for innovative practices.

He specified that some awards were directly available through the educational technology unit that allowed faculty to approach the unit to get monies to develop specific content or

innovations. Those awards were based on the feasibility, desirability, and sustainability of the innovations. There was another funding opportunity that was called the Innovations Grant, which paid for faculty time to develop new curricular initiatives that may use technology. A third funding source encouraged the development of innovations in interprofessional education and it turned out that many of the innovations that resulted from that funding were simulation-based activities that were interprofessional in nature. Finally there was an award called the IT Innovation Award for coming up with an innovative idea that was developed and deployed within a two-month period, and that was basically a cash award that “would go straight in the winner’s pocket.”

The medical school had to develop and hire expertise locally in order to create and maintain innovation in educational technology. The other health professions schools located on campus had no initiatives in educational technology, so the medical school had taken the lead with respect to developing innovations. While the medical school was separate and independent from the rest of the school, leadership there felt there was a responsibility to “raise all boats not just ours, and so everything we do and create is available to them and our expertise is available to them.”

Participant D asserted the belief that the medical school had a very strong culture of innovation. It had really grown and matured in the last 15 years since that new curriculum was created. When that curriculum was being developed, a strong approach of iterative development was employed. He stated that, “we were talking about prototyping and the importance of getting things 70% right instead of 100% right, which can be very hard for academics because they want everything to be perfect before you put your work out there.”

Participant D stated that while the curriculum was being developed an infrastructure was set up so that when the prototypes were 70% ready, they moved to the piloting phase. There were mechanisms of feedback and quality control that were established, and from there this practice of innovation just became part of the culture of the university. People at the school were very excited about innovation and they had learned how to test innovations and partner with learners to develop new innovations. The institution embraced design thinking as a discipline and they even facilitated workshops on design thinking in innovation. “We want all of our faculty to think that way, and take risks and we teach our medical education staff the same. So in a nutshell, we actively cultivate a culture of risk and innovation.”

He recognized that it was an amazing decision early on by faculty to admit that there was a definite need for technology and they entrusted the leadership to show them the way. Leadership made it clear over 15 years ago that technology was going to be part of the culture at the medical school.

Participant D acknowledged that in the world of educational technology, faculty development remained one of the biggest challenges. He felt that the problem was how faculty were trained to utilize technologies effectively and use them in a way that improved their lives and the learning experiences of their students. Besides getting faculty to use educational technology more effectively, it was also imperative that they learned to innovate, “Learning how to put these technologies together and use those in a way that is innovative and helps move your program forward.”

Curriculum and educational technology. Participant D revealed that back in the late 1990s when the school was going through curriculum reform, the faculty and leadership

committed to implementing the use of educational technology to improve teaching and learning.

He described some of the first changes that were made:

The curriculum that we launched in 2000 was an integrated curriculum, there were no more departmentally owned courses. So suddenly, a course went from having three faculty to having as many as 175 faculty teaching in one course, and those faculty were across multiple hospitals; so scattered all around the city. And immediately we understood that we needed web-based environments for those faculty to collaborate with each other to even create the content, much less deliver it. And so today I'm guessing that maybe 80% of medical schools had migrated to that type of an integrated curriculum.

He declared that you had to embrace technology in order to enable the creation, management, and delivery of content.

Participant D revealed that state guidelines in California had an adverse influence on the use of educational technology. The legislature actually dictated how many weeks of instruction learners were required to have in a particular discipline. He expressed that while it did not directly impact technology, “It indirectly impacts it because it handcuffs us, it handcuffs our ability to innovate the clinical components of our education because the state is requiring our students go spend seven weeks in a particular type of learning experience.” He proclaimed that there was not a lot of policy that promoted innovation and that policy should be raising the bar of education instead of hindering it.

Participant D expressed that the necessity for technology at the medical school was most apparent in the clinical setting, where students spent more and more time. Since students travelled to various clinical settings it became difficult for them to get together in a centralized

classroom. Because students spent less time in a traditional learning space, there was a greater need for technology to help provide them with the instruction they were lacking. He revealed that a lot more of the content that was taught traditionally in a lecture setting was being digitized so that students that worked in clinical settings were able to come together in small groups and absorb the digital content. Lately the advances in mobile devices were spurring development of “new technologies that specifically addressed the kind of learning they would do at the bedside or in systems-improvement teams where we haven't had that before.”

He asserted that in the clinical setting most of the instruction involved using cases and often those cases were based on real life situations that were reconfigured to protect the identity of patients. Within those cases it was difficult to account for all factors that learners should consider when exploring the cases. He stated that the use of EMR was a more effective teaching tool as opposed to using paper-based cases alone. With EMR you retrieved all the medical files of a certain demographic that were exhibiting a particular illness and used that information to create composite cases that were authentic and representative of the population of patients in the teaching hospitals. It was a powerful tool but federal regulations such as HIPAA inhibited their overall utility in the clinical setting.

Participant D admitted that HIPAA was outside of the control of the medical school, and it had hindered the use of educational technology. One area that had impacted many health professionals was the use of Electronic Medical Records (EMR) for teaching and learning. There was a great deal of positive research on its efficacy as a tool for teaching in clinical education, but with that came a lot of controversy about the data and how that data should be retrieved from the EMR. The EMR contained a vast amount of data that provided very relevant educational information to learners and the faculty who taught them.

Learning from outside. Participant D proclaimed that the professional and networking communities had a great amount of value in the realm of educational technology. Because there was no definitive evidence that the use of technology improves teaching and learning, the communities of educational technologists and educators continued to look for new ways to do things and always brought new ideas to move things forward. This happened in a very collaborative atmosphere as opposed to being in competition with each other. He provided an example of that collaboration through his experiences with the professional organization CRIME:

They have a couple face-to-face meetings a year, they have a very active webinar series now where they share best practices, where they discuss emerging technologies and their impact on education. But where I think most importantly, they are a group of people who know each other and trust each other; that pick up the phone and say, ‘Gosh Jen, what do you know about this technology or I heard you were using it or playing around with it...I need the real scoop. I need to know, if it's a vendor for example, what is this vendor really like to work with.’ And people are really honest and share with each other and collaborate a lot. I find that to be an extremely powerful community that moves a lot of initiatives forward, particularly in the west.

Participant D explained that over the years he developed an amazing national network of peers that had a strong sense of trust within the community. They communicated often and worked together without feeling any sense of competition between their institutions, and most importantly they always looked forward to learning from each other.

He shared that another important group was the AAMC's Group on Information Resources (GIR). The majority of GIR's members were based in the area of education despite the fact that the group also covered research and administrative technologies. The education aspect of GIR was one of the strongest components. One of the unique things they did was come together in workshop-type discussions on innovation that eventually led to white papers.

Participant D acknowledged that he got a lot of educational technology ideas by developing partnerships and having discussions with companies in Silicon Valley. One example was the relationship with the Director of Education at Google. This relationship had grown since the director had been invited to give a talk at the medical school about how they used technology at Google to educate their staff of developers, programmers, engineers, and educators. Over time that relationship grew to a point where both entities worked together to develop educational technology innovations in medical education.

Participant D recalled how he learned about innovation when he was putting together a proposal for an educational technology program during the late 1990s, as the medical school was undergoing a major curriculum reform. One of the areas that he looked at for inspiration was the K-12 environment because they were so much further ahead of universities and health professions schools. Back then, only a few medical schools had started to dabble in educational technology. In most of those cases it involved faculty sharing web pages with their office hours and research information.

He admitted that he always looked to learn something new about educational technology and there was a hunger to always know what was going on in that world. He found himself constantly scanning all the educational technology blogs and reading the academic literature to keep abreast on the newest innovations. At the time, research literature did not provide any

evidence of improvements in teaching, but it demonstrated that educational technology improved the learner's experience. Participant D indicated that research organizations in educational technology were searching for good data that definitively said that one intervention or methodology was the right one to use, but that had yet to happen.

Summary

Participant interviews, survey responses, and document review provided data for the individual case studies. Participants described their perceptions regarding the implementation of educational technology at their respective medical schools. The next chapter will discuss the similarities and differences of the themes that were developed through cross-case analysis.

CHAPTER 5. COMPARATIVE FINDINGS

In the preceding chapter each case was discussed in detail. In this chapter a comparison is made across cases, specifically looking at the patterns of themes or factors that emerged.

Findings that emerged within each case were shared in the previous chapter; the similarities and differences that provided insight about the implementation of educational technology are shared in Chapter 5.

The following table reflects the main topics that were revealed during the course of analysis. The table is a summary of the discussion in Chapter 5. The main themes and their relative subthemes, where there was replication with at least three cases studies, were listed in Table 3. In the data analysis, the researcher discovered four themes and their 10 related subthemes where there was replication between cases.

Table 3. Main Topics

Data	Participant ID			
	A	B	C	D
Educational Background	M.A.	PhD	M.D.	M.S.
Topics/Subtopics				
Faculty and Student Adoption				
Faculty resistance (-)	X	X	X	X
Student resistance (-)	X	X		X
Supporting Innovation on Campus				
Funding is crucial	X	X	X	X
Educational technology unit (+)	X	X	X	X
Institutional Support and Leadership(+)	X	X	X	X
A Better Way to Deliver the Curriculum				
Curriculum needs technology (+)	X	X	X	X
Clinical education (+)	X		X	X
Learning from Outside the System				
Collaborating with peer institutions (+)	X	X	X	X
Professional associations (+)	X	X	X	X
Research (+/-)	X	X	X	X

Note: For sub-themes: + = strength; - = challenge

Each case in this study provided common and exceptional learning points that were previously shared. The cross-case analysis was performed to identify similarities and differences between the four case studies. In accordance with the case study design (Yin, 2009; Stake, 2006), the researcher utilized three primary methods of data collection: interviews, document analysis, and a survey.

Data from four educational technology leaders was collected and analyzed using the data analysis procedure outlined in Chapter 3 of this study. During the course of analysis, individual perspectives were recorded and themes were developed and shared. A cross-case synthesis procedure was used to compare and contrast participant perspectives and analyze themes found in the four case studies. The procedure entailed looking at the most significant evidence from each case and drawing cross-case conclusions based on the resultant patterns that were observed as similarities and differences became apparent. The data from the cases was also reviewed for connections with the Diffusion of Innovations model. In this chapter the individual cases were compared with an in-depth discussion on the similarities and differences that exist between the cases. In the data analysis, the researcher discovered four themes and their 10 related subthemes where there was replication.

Theme: Faculty and Student Adoption

This section looked at the theme of *Faculty and Students Adoption* and how they are related to the implementation of educational technology in medical education. The data analysis revealed that the subthemes of faculty and student resistance were seen as major challenges to the successful adoption of technologies.

Subtheme: Faculty Resistance

There was a consensus amongst all of the case studies that faculty resistance was one of the major challenges in the implementation of educational technology in medical schools. Faculty resistance took a variety of forms but overall it had a substantial effect on the use of technology in medical education. While all the educational technology leaders in this study acknowledged that faculty resistance was a factor in the implementation of technology, their experiences at their own institutions varied.

Participants B and C both agreed that there was concern from some faculty that revealed that any difficulties students had with the educational technology in their courses would somehow reflect back on the faculty. Participant A expressed a different perspective when he revealed that while most faculty members bought into the use of educational technology, many were unwilling to spend the time developing the necessary resources. Participants B and C expressed that some faculty members were resistant because the innovations represented a change in how medical education was always facilitated. Participants A, C, and D indicated that while there was faculty resistance to using educational technology, a common issue at most higher education institutions, they did not see it as an issue at their respective medical schools.

When asked for recommendations about dealing with faculty resistance, Participants A and B suggested seeking out early adopters in order to increase the likelihood of faculty buy-in. Each leader specifically recommended finding a “champion” to work with new educational technologies in order to develop resources for their implementation and eventually advocate use among other faculty members.

Participants A, C, and D proposed that using students to reach out to faculty was another good strategy in order to get faculty to adopt technology. Participant A stated that faculty members who saw students engaged with an educational technology were likely to consider

using the innovation themselves. Participant C shared that the educational technology unit at their institution partnered with students with the intent of connecting with faculty. Participant D suggested that faculty react more favorably to students than they do to administrative leadership.

Subtheme: Student Resistance

Three of the educational technology leaders felt that student resistance was another challenge they faced when employing educational technologies in the curriculum and each leader had varied experiences with student resistance. Participant D encountered students who simply refused to use computers 15 years ago when educational technology just started proliferating at his campus. Participant A witnessed situations where students were getting frustrated with educational technology because they were spending more time learning how to use it than they were actually learning the content it was intended to deliver. Participant B dealt with students who felt that the technology should meet their specific tastes and needs.

Participants B, C, and D emphasized the significance of involving students early on in the innovation process was conducive to the implementation process. Participant B shared how reaching out to students helped to anticipate their needs and was effective at countering student resistance. Participant C expressed how important it was for students to be involved in the innovation process because they often came up with great ideas to solve problems they encountered in their own education.

Theme: Supporting Innovation on Campus

This section looked at the theme of on campus innovation and how it is related to the implementation of educational technology in medical education. The data analysis revealed the subtheme of “funding is crucial” was seen as one of the biggest challenges that medical schools faced. Additional subthemes that were seen throughout all of the cases were the existence of

educational technology units and importance of leadership. All the medical schools in the study employed educational technology units/centers that identified and developed innovations. These units/centers allocated funds, collaborated with stakeholders, and provided faculty development on the use of educational technology. The various roles of leadership were discussed by the educational technology leaders in terms of supporting educational technology efforts.

Subtheme: Funding is Crucial

All four educational technology leaders acknowledged that proper funding was crucial to deploying the necessary resources to successfully implement educational technologies into medical schools but none of them were currently experiencing any lack of funding. The leaders related how institutional monies and grants were the main source of funding and they provided varied perspectives on where those resources came from.

Participant D advised that schools lacking proper funding should start small, involve students in the innovation process, and collaborate with peer institutions to learn about innovative technologies. Participant B revealed that the Lewis and Clark School of Medicine worked with partner hospitals to establish funding sources that supplemented traditional sources. Participants C and D recognized that their respective institution's leadership had provided substantial funding for educational technology initiatives and that they did not share the same concerns with regard to funding as most medical schools do. Atlantic Medical School and Medical School of the Pacific were considered by peers to be two of the most successful medical schools at incorporating educational technology into their programs.

Participants B and D conveyed that it was important to provide incentives through the educational technology unit in the form of grants and awards to individuals on campus that were coming up with innovative ways to incorporate educational technology into their curriculum.

Participant D stated that this strategy was one of the main reasons that stakeholders were keen to be part of the innovation process.

Subtheme: Educational Technology Unit

All of the institutions that participated in this study had established educational technology units/centers that were responsible for the development and implementation of educational technology. This included distributing funds, working with stakeholders on campus, and faculty development.

Participants B and D declared that it was important for medical schools to have an educational technology unit in place in order to coordinate innovation efforts on campus and to assist with decision making. Participant B felt that instructional design and technology use should be the major focus of the unit. Participant C asserted that the unit should house all the instructional designers, programmers, media developers, mobile app designers and IT staff in order to develop the necessary software to support educational technology initiatives at the medical school.

Participants A, C, and D all agreed that faculty development efforts needed to improve. Participant A stated that the medical school had all the right technology equipment in place, such as learning spaces. However, without the right guidance on how to implement educational technology into courses, the technology often did not get used. He felt that it was important to find good examples of how the technology could be used to enhance the learning experience for students. Participant C expressed that faculty members he had worked with were willing to learn about educational technologies, but they were often too busy because of their clinical workload and research projects. He stated that he believed that it was one area of educational technology that could use more dedicated resources and content. Participants C and D indicated that it was

important to not only showcase educational technology to faculty, but also to provide evidence of how it could improve their lives.

Subtheme: Institutional Support and Leadership

All of the medical schools involved in the study employed committees that made decisions and provided guidance regarding the use of educational technology. Each of the educational technology leaders participated on various committees that involved the advancement and use of educational technology and typically made decisions on what innovations would be supported.

There was some slight variability on how each school's committees interacted with educational technology ideas. Participant A discussed how the curriculum committee determined whether or not an educational technology was suitable to address a specific need in curriculum delivery. The educational technology unit would suggest a particular technology intervention and the committee would discuss its feasibility. Participant C revealed that new innovations and technology ideas were shared in front of an executive committee. At Atlantic Medical School there was an operating committee that worked with stakeholders to decide if an educational technology was working as intended. Participant D discussed how a campus-wide committee that represented all the health sciences made decisions about innovations and educational technology initiatives that influenced the entire campus.

Participants B, C, and D emphasized the importance of having leadership that was supportive of the use of educational technology. Participant B stated that in order to be successful at implementing educational technology, you needed leadership that was aware of its value and significance in medical education. Participants C and D both felt that their respective medical schools had leadership which went above and beyond supporting the use of educational

technology on campus and that was the reason their schools were having success with its implementation. Both participants acknowledged that leadership made educational technology part of the culture at their schools and that made the difference.

Differences

Participant A shared one area of concern with regards to funding that was not discussed by the other participants. He was worried more about maintaining educational technologies than the actual implementation of them. Once a technology was adopted on campus the demand for it started to increase but at some point the grant funding ended and the support, in terms of human capital, for that educational technology disappeared. Participant A suggested that a special fund be created at medical schools to deal with staffing and resources related to maintaining existing innovations.

Another difference between the case studies was related by Participant C. He revealed that educational technology should be used to bridge the gap between undergraduate, internship, residency, and graduate medical education. After completing undergraduate medical education and receiving their medical degrees, physicians must participate in a residency program that provides them with advanced training in their specialty area. In most cases medical schools require that new physicians perform their residency training somewhere different than where they received their undergraduate medical education. Participant C stated that this lack of continuity between the various stages of medical education made it difficult for students to reflect on their growth as they progressed from undergraduate medical education through residency or graduate medical school. He felt that educational technology in the form of electronic portfolios would be an easy way to solve that problem.

Theme: A Better Way to Deliver Content

This section looked at the theme of educational technology improving the delivery of the medical education curriculum. The subthemes of “curriculum needs educational technology” and “clinical education” were seen as positive, which favored the use of educational technology at medical schools.

Subtheme: Curriculum Needs Educational Technology

Educational technology leaders at all the medical schools asserted that there was a mutual relationship between curriculum and educational technology. All the participants discussed how the utilization of educational technology in medical schools was prompted by the need to deliver the curriculum more effectively and efficiently in an effort to improve teaching and learning. The specialized curriculum in medical schools required a delivery system that addressed the needs of today’s learners. Educational technology provided a platform for delivering that curriculum. Participant C provided an example of how the use of educational technology in the form of a virtual human simulation improved the educational experience of learning anatomy while it supplemented the traditional use of cadavers in anatomy courses.

Participants B, C, and D were at medical schools that had gone through significant curriculum reform/renewal in the last 15 years and educational technology was a key component of that process. The leaders felt the renewal process provided favorable conditions to introduce educational technology into medical education. Participant C felt that the curriculum reform at Atlantic Medical School changed the institution’s entire approach towards the implementation of educational technology.

Participants A & B stated that curricular reform was their organization’s reaction to changes in the LCME standards for medical schools. The accreditation process provided

motivation for schools to collaborate and learn from each other on how to deal with curriculum requirements and identify types of educational technology that were effective in helping meet them. Participant C mentioned that the pace at which educational technology innovations were being developed was not in sync with the traditional academic calendar and that remains a challenge for medical schools. Participant D revealed that state guidelines regarding medical education in California hampered efforts to use technology because it dictated how much time students should spend learning in a particular content area.

Subtheme: Clinical Education

Participants A, C, and D stated that one of the areas of medical education that demonstrated the greatest need for educational technology was clinical education. These leaders declared that educational technology provided a means to deliver the necessary content to students in the clinical setting where students spent most of their time. They revealed that PDAs, and more recently iPads and tablets, had significantly improved the nature of learning at the bedside as it provided students with access to information such as drug dosages and symptom charts that were not as readily available through conventional means.

Participants A, C, and D felt that educational technology in clinical education provided a platform to unite students in a common learning space, since most of the students were located at different sites and it was nearly impossible to get them together in one physical location. Educational technology allowed students in various clinical settings to access instruction and content when they needed it the most, providing a truly student-centered learning experience. All of the medical schools involved in this study had considerable resources dedicated to interprofessional education. Participant A was the only one who mentioned the need to develop

clinical simulations that provided learning experiences for the different health care professionals that work together in the care of a patient.

Participants A, C, and D declared that the Health Insurance Portability and Accountability Act (HIPAA) provided a challenge with respect to the use of clinical data in medical education. A portion of the law, termed the HIPAA Privacy Rule, placed restrictions on how patient information may be shared. Each participant stated that the use of patient information was extremely important to the education of medical students and those restrictions made it very difficult to provide authentic simulations that reflected the particular population of patients that students would encounter in their clinical rotations.

Theme: Learning from Outside the System

All the educational technology leaders agreed that they looked outside of their medical schools to learn about new innovations in the realm of educational technology. All the participants explained that their main sources for learning about innovations were peer institutions, professional associations, and research.

Subtheme: Collaborating with Peer Institutions

All the case study participants agree that one of the best ways to learn about a new technology or how to effectively implement an existing educational technology was to see how peers at other medical schools were using them. This basically represented a large-scale Community of Practice that bridged institutions and included collaboration within and across institutions. Participant C felt that historically medical schools were not good at sharing instructional resources, but educational technology provided a great platform for sharing innovations and new ideas. Participant A mentioned that peer collaboration was invaluable for determining whether a particular innovation was appropriate to use at your school. Participant B

stated that being able to see what peer institutions were able to achieve with the same sort resources and personnel type had a great deal of impact on her campus. Participant D revealed that there was a certain trust between peers in the community and they were able to communicate and collaborate with each other without any sense of rivalry. Participant C indicated that while there was a substantial amount of educational technology folks getting together and collaborating, more could be done with regard to sharing ideas and best practices involving educational technology.

Subtheme: Professional Associations

All of the participants in this study explained how professional associations provided unique networking opportunities that opened up dialogue between educational technology personnel at medical schools. Participant B acknowledged that professional associations were a catalyst in helping promote change as one could find out what the most current cutting edge technologies that were being implemented in the health sciences. Participant A indicated that it was vital to participate in professional associations in order to learn about the new innovations in educational technology.

Participant C stated that professional associations represented a neutral party that helped facilitate the sharing of ideas and content by hosting conferences where educators could learn from each other. Participant D explained that communities of educators within these professional associations were constantly looking for new ways to implement educational technologies and always shared ideas to move the field forward. Participants A, B, and D belonged to the group Computer Resources in Medical Education (CRIME) while the fourth, Participant C, was a member of a similar group on the East Coast.

Subtheme: Research

All the educational technology leaders encouraged participation in research to share and learn about innovations in educational technology. Participant A felt it was good to keep up with research because it provided good examples of what was currently working in the field of educational technology and it could help a medical school decide what was worth investing in. Participant D revealed that when educational technology was first being introduced in medical education, he learned a great deal from research in the K-12 environment because he felt they were so far ahead of higher education at the time. Participant B indicated that current studies were valuable with respect to what types of educational technology to deploy and what innovative practices were most effective for learning. Participant C revealed that reviewing research literature and actively participating in research organizations provided him with the most important information regarding educational technology.

Participants B and C emphasized the need for changes in how educational technology research is conducted in order to advance the field and how new research methodologies have to be developed to satisfy that deficiency. Both agreed that there needed to be more rigorous evidence-based research that concentrated on how people learn. Participant B had a PhD in Education and Participant C held an M.D., which may explain why they were more critical about current research in educational technology as those with higher levels of education might tend to place a higher value on research.

Differences

Participant C indicated that he developed many ideas about educational technology by partnering and having forums with corporate entities in Silicon Valley. One company that he collaborated with was Google and that evolved into a partnership that benefitted both parties as

they worked to develop educational technology innovations that could be implemented into medical education.

Overall Summary

There was unanimous agreement between the cases for eight of the ten subtopics. The remaining subtopics “student resistance” and “clinical education” were mutually discussed by three (of four) participants. Any other similarities where there was replication between at least two cases were discussed in the relevant subtopic but not reflected in the table. Additionally any noted differences between the cases were shared in the comparative findings but not listed in the following table.

In Chapters 4 and 5, findings were presented both as individual case studies as well as comparatively. Chapter 6 will relate all the findings into comprehensive conclusions, relating these back to the literature, providing recommendations and lessons learned, and looking more closely at the characteristics of the participants as leaders of innovation.

CHAPTER 6. CONCLUSIONS

Introduction

A practical goal of this study was to address the challenge of educating the next generation of doctors with the use of educational technology to help mitigate the anticipated shortage of primary care physicians. Recent studies have indicated that by 2025, the United States would need an additional 30,000 general practice physicians due to a growing population bolstered by longer life expectancies and expanded insurance coverage as a result of the Affordable Care Act (Cooper, 2004; Kirch et al., 2012; Petterson et al., 2012).

The purpose of this descriptive case study was to provide a better understanding of the current role of educational technology in selected medical schools. It was essential to gain the unique perspective of the identified educational technology leaders' experiences and rationale when adopting technology. This perspective was gained by observing these leaders through the lens of the diffusion of innovation model.

This study arose from identified gaps in the literature regarding the use of educational technology at medical schools. In response to these gaps, a qualitative study was designed using Yin (2009) and Stake's (2006) multiple case study approaches. The intent of this study was to develop a richer understanding of the experience of implementing educational technology into medical education from the unique perspective of leaders in educational technology at select U.S. medical schools.

Previous chapters established the context for the study and provided an overview of relevant literature, data collection, data analysis and findings. Four participants were recruited and data collection occurred during the specified timeframe of January 2014 through May 2014,

and included two sets of interviews, artifacts, and a short survey. The data were categorized, coded, analyzed, synthesized, and guided by the use of the conceptual framework, as defined in Chapters 1 and 3. The study addressed the following research questions:

RQ1: How did identified educational technology leaders of specific medical schools describe the implementation of educational technology at their institutions?

RQ2: What did leaders describe as the strengths and challenges of incorporating educational technology into these select medical schools?

The previous two chapters answered the research questions. This chapter will: (a) summarize these findings as related to Rogers' Diffusion of Innovations; and (b) discuss the significance of these findings and relate them to the literature. In general, the findings of this study were consistent with and built on those of previous organizational studies which described the implementation of educational technology in medical schools (Arnsdorf, 2008; Bove, 2008; Cook, 2006; Cook & McDonald, 2008; Ellaway, 2011; Han, Nelson, & Wetter, 2014; Kim, 2006; Masters & Ellaway, 2008; Ruiz et al., 2006; Souza et al., 2008; Triola et al., 2004). The study has compared the perspectives of four such programs through the lens of the Diffusion of Innovations Theory (Rogers, 2003) to describe viewpoints encountered during the implementation process.

Summary of Findings

Medical education in the United States has remained relatively constant over the past one hundred years since the Flexner report came out. This study looks at medical institutions that had implemented educational technology into their medical programs. In this investigation, the aim was to understand the perspectives of educational technology leaders with regard to factors that

allow or inhibit successful educational technology implementation in medical education. In the following section, these themes are summarized.

Outside influencing change in the organization

Changes that occur in organizations are typically a product of external stress that is placed on the organization, which in the context of this study is the medical school. The main outside influence that causes pressure on medical schools is the LCME, the accreditation body that sets the standards for how medical education should be facilitated in the United States.

Medical schools react to modifications within the LCME standards (relating to curriculum) by restructuring the curriculum. The curriculum reform is initiated through a process of reflection and planning by the organization, which looks to discover the best approach or strategy in addressing the alterations in the standards. While there is no explicit language in the standards that advocates for the use of technology, many medical educators agree that it is implied in the language of the LCME.

HIPAA and State regulatory requirements are influences that are seen as barriers to the implementation of technology in medical schools. HIPAA tends to cause issues in the area of clinical education because it restricts how patient information can be used in educational resources. State regulations on medical education vary, but they don't always align with the LCME standards.

As medical schools address their curriculum reform they tend to look outside their organization for ideas and strategies. Since all medical schools in the U.S. are dealing with the same LCME requirements, medical institutions look to collaborate with each other getting together to find solutions to address their common concerns. All the participants in this study felt it was important to belong to a larger collective that focuses on dealing with shared issues.

Organizations also learned about new strategies and approaches to dealing with the curriculum by participating in professional associations and engaging in research. Through interaction and communication with like-minded colleagues, organizations are provided with guidance and knowledge that helps them deal with the curriculum at their respective schools

Rogers (2003) confirmed these findings that innovators were always willing to seek out new ideas. He proclaimed that innovators are the gatekeepers that bring innovations from outside the system they are in since they are responsible for the flow of new ideas into the system. The innovator plays a crucial role in the diffusion process by establishing networks outside the system in order to bring new ideas inside the system.

The organization and change

An organization reacts to pressures outside its system and through a central unit directs the individuals within the organization to implement change. As discussed in the previous section, curriculum reform is the approach that organizations use to deal with changes in the accreditation standards. Through curriculum reform, the organization determines the best avenue for delivering the particular content. The curriculum reform process has recently favored the use of educational technology to deliver certain content in the basic sciences and clinical education. Studies have indicated that educational technology is one of the more effective strategies for the delivery of evidence-based and competency-based instruction.

Leadership plays an important role with respect to implementation of educational technology. Leadership represents the interests of the organization and provides guidance to the individuals within the organization who are implementing change. Leadership also makes important decisions with the help of committees regarding how and when curriculum reform will take place. Rogers (2003) stated that an innovation could not be adopted by individuals until the

organization had previously adopted it. At medical schools, the power and control to make important decisions about innovations is limited to a few individuals. Rogers also felt that innovativeness was related to independent variables such as leadership characteristics, internal organization structure, and external characteristics of the organization.

At the organizational level, the establishment of a centralized unit was necessary in order to carry out any curricular reform that required the use of educational technology. The centralized unit, which is seen as a change agent, is accountable for wide variety of responsibilities, including but not limited to, developing software and web-based solutions for delivery of the curriculum, providing funding for innovation, and faculty development on educational technology. The educational technology unit works with the individuals (faculty and students) that are directly involved with the implementation of technology.

Rogers (2003) model supports these findings, as he felt that change agents were necessary in order to initiate change. The educational technology leaders/innovators were seen as change agents when the innovation was first introduced on campus. Educational technology units eventually took over the role of change agents that seek to address the needs of the faculty and students. By limiting the decision-making to an educational technology unit or committee, the adoption of the innovation would be expedited.

The educational technology unit is responsible for allocating and distributing funds for new innovations and for providing incentives to the faculty for participating in the innovation process. The findings are supported by the DOI literature as Rogers suggested using direct or indirect financial incentive to increase the rate of adoptions and make relative advantage more effective. Incentives were a good strategy for motivating and supporting individuals of a social system as they adopted an innovation.

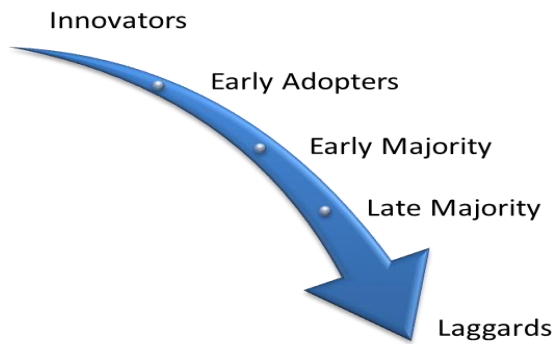
Faculty development initiatives developed by the educational technology unit are intended to provide faculty with the necessary support and guidance they need to implement technology into their learning spaces. Rogers (2003) argued that higher education institutions offered limited support for integrating educational technology into the curriculum and for faculty involvement in the innovation process. Effective faculty development would help alleviate adopter concerns about the complexity. The complexity of an innovation is a huge factor as faculty members consider whether to adopt an innovation or not.

Individuals and change

The individuals in an organization, represented by faculty and students in this study, have to deal with change at the level of application. The organization provided strategies in the form of faculty development and incentives to the individuals in order to increase the likelihood of adoption by the faculty and students. Faculty and students tend to resist change and this remains one of the biggest barriers in medical education. The findings are supported by Rogers' (2003) DOI as faculty and student resistance occurred during the persuasion stage of the DOI model's innovation-decision-making process, where individuals typically formed a favorable or unfavorable attitude towards the innovation.

Several strategies for mitigating resistance have been suggested, from finding “champions” and early adopters to recruiting students to entice faculty into using technology. The organization, through the centralized educational technology unit, sought out early adopters, which is reflected in Rogers' model of how information flows between the adopter categories in Figure 1 below.

Figure 1. DoI: Flow of Information between Adopter Categories



Rogers (2003) emphasized the need to find a champion, an individual who would support the innovation and help overcome any resistance within an organization. Champions often acted as brokers or middle-men, helping the innovation fit within the organization. Champions typically were seen as persuasive individuals who were skilled at negotiating and handling people.

Involving students in the innovation process to reach resistant faculty is a strategy that focused on improving the relative advantage attribute of the innovation. Rogers (2003) defined relative advantage as the degree to which an innovation is perceived as superior to the current practice. As faculty members witnessed how the innovation fit the needs of their students, they were more likely to adopt the innovation. Potential faculty adopters observed students working with the innovation, which reflected the attributes that Rogers classified as trialability and observability. Trialability and observability are the innovation attributes that represent the social system within organizations.

Implications

The previous section provided an overall summary of findings as related to Rogers Diffusion of Innovations model. Following is a discussion of the implications of these findings

as related to extant literature and in support of factors crucial to the success of implementing educational technology in medical school settings. Finally, specific recommendations for practice will be provided.

Outside influencing change in the Organization

When considering the implementation of educational technology, the data analysis suggests that medical educators could learn more about innovations in educational technology through networking with individuals from peer institutions, participating in professional associations, and reviewing research literature in the field of educational technology. The findings suggest that one of the weaknesses of educational technology in medical education is the lack of quality evidence-based research. It should be improved to provide better information on how to implement the technology.

Communities of Practice amongst partners who look to pool limited resources and develop new networking connections benefits the participating medical schools, and also advances medical education as a whole. Girot and Enders (2004) state that successful collaborative partnerships are founded on good communication, commitment, and understanding the needs of the participating partners. Peer collaboration allows medical schools to form partnerships where they can share innovations, best practices, and implementation plans for innovative instructional technologies (Huggett, Gusic, Greenberg, & Ketterer, 2011; Robin, McNeil, Cook, Agarwal, & Singhal, 2011; Schofield & Bourgeois, 2010).

Participation in professional associations is a crucial component in the career of any educator as it helps maintain their professional development and is a great way to learn about innovations in their respective fields. Irby and Wilkerson (2003) describe how medical education is becoming increasingly reliant on professional associations to learn about technology-enhanced

education tools. For those involved in educational technology in medical education, it is important to belong to professional associations that are concentrated in that area. Robin et al. (2011) discusses how effective curricular innovations in health profession education are shared internationally and in the U.S. through a framework that encourages collaboration and continuing discussion. The findings mention how important it is for educational technology leaders to participate in medical-based technology groups and how several of the participants belong to CRIME and various educational technology associations.

Current research studies are valuable because they provide guidance about what types of educational technology to implement, in particular learning situations. Robin et al. (2011) discuss the importance of connecting individuals with similar expertise and pursuits for the purpose of networking and collaborating in order to promote research in the field of educational technology in medical education. McGaghie et al. (2009) state that the expanding body of research evidence dictates the use of educational technologies for educating health care professionals. E-learning is becoming one of the dominant educational strategies in medical education and current research trends are reflecting that (Latchem, 2014). Research on the use of simulation technology is one of the leading areas in educational technology that is setting an example in medical education. Research on the effectiveness of simulations is developing quickly and it provides a great deal of guidance for clinical educators (McGaghie, Issenberg, Petrusa, & Scalese, 2010; Robin et al., 2011).

Analysis of the data indicated that one of the barriers to the use of educational technology is the need for more evidence-based literature and that adding to it would provide better guidance for schools looking to implement educational technology into their programs. Lack of research on the delivery process and its impact on evidence-based learning and application need to be

addressed (Johnston et al., 2004). Research should concentrate on tried and true educational technologies for more systematic outcome measurements (McGaghie et al., 2009). Researchers agree that there is a need for more research on learning technologies in medical education (Latchem, 2014; McGaghie et al., 2010; Norman & Eva, 2008).

Organizations and change

Leadership and the educational technology unit should work together to establish committees to help guide and promote the implementation of educational technology. Medical schools that are using educational technologies should either employ an educational technology committee to deal with new innovations or rely on the existing curriculum committee to make decisions and set guidelines on how curriculum planning should transpire. Typically these committees are made up of the stakeholders, which include teaching faculty, leadership, education professionals, and students. The research of Dubois and Franson (2009), McHagie and Fisichella (2014), and Mennin and Krackov (1998) corroborates the need to utilize committees in the process of medical curriculum design.

The data analysis demonstrates the importance of support from leadership as the cases that received the most support from leadership also felt that the implementation of educational technology on their campus was a complete success. Innovation literature reveals that support from leadership was crucial to a successful implementation of technology (Edquist, 1997, 2010; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004). Recent studies in nursing and medical education literature discuss leaderships' role in encouraging stakeholders to participate and collaborate in the innovation process by supporting and promoting higher morale and performance (Cooke & Walker, 2013; Goh & Clapham, 2014; Kirch & Boysen, 2010; Mennin et al., 2013; Mennin & Krackov, 1998; Robin et al., 2011).

The first research question sought to address leaders' perceptions of the implementation of educational technology at the medical schools in this study. The data analysis in Chapter 4 identified several practices that would increase the likelihood of success. Educational technology is a delivery system for the medical curriculum that provides alternative ways to learn the material. One of the first steps to making the marriage between curriculum reform and educational technology work is establishing a centralized unit at the medical school in order to oversee all the processes that are involved.

It was considered a good strategy to have the educational technology unit on campus reach out to student leadership early in the innovation process in order to get their input on the situations they encountered in their own educational experience. Medical schools should encourage and support students in actively contributing to curriculum development and their own learning (Grabowsky & Wright, 2013; Jefferies, 2014; Pearce & Evans, 2012; Potts, 2011).

Consistent with the findings of Goh and Clapham (2014), Nesbitt, Dharmar, and Katz-Bell, Hartvigsen, and Marcin (2013), data from the studies indicated that it was vital to establish a unit or center to centralize all the necessary resources needed to drive the implementation of technology. This includes collaborating with stakeholders and leadership by forming committees to set guidelines and make decisions during the process. Robin et al. (2011) stated that the educational technology unit should maintain an environment that promotes innovative technologies and brings together the expertise of the stakeholders; which includes teaching faculty, information technology personnel, instructional designers, e-learning specialists, and multimedia developers. The unit should take the lead in seeking out and distributing funding resources in order to stimulate development of innovations amongst the stakeholders.

Most medical schools face enormous financial challenges when seeking to adopt educational technologies to support instruction. Rogers (2003) states that adequate funding is a crucial component in the research and development of innovations. Ample funding resources are necessary in order to develop and implement innovations into medical education. Poon et al. (2006) indicate that lack of funding resources is a barrier to the wide-spread use of learning technologies. Strong financial support is necessary for developing innovations in addition to the costs of purchasing and maintaining hardware and software, and training faculty on its use (Berg, Wong, & Vincent, 2010; McGee & Kanter, 2011; Mechanic, 2008; Schifferdecker, Berman, Fall, & Fischer, 2012; Searle, Thibault, & Greenberg, 2011).

Faculty development is very challenging and it requires a great deal of effort to effectively train faculty on the use of educational technology. It is important to not only teach the technical aspects of educational technology, but also how to integrate the technology for teaching and learning. Faculty must learn to use educational technologies effectively and utilize them in a way that improves their own lives and the learning experiences of their students (Hatem, Lown, & Newman, 2006; McGaghie et al., 2009; Searle et al., 2011). Professional development on the use of educational technology should support faculty through workshops, seminars, and fellowships that concentrate on how technology could be used to support teaching and learning. Quality faculty development is essential to the success of technology implementation (McGee & Kanter, 2011; O'Sullivan & Irby, 2011; Ward, Gordon, Field, & Lehmann, 2001; Zayim, Yildirim, & Saka, 2006).

Curriculum reform is the driver and educational technology is the vehicle that allows the curriculum to move from one place to another without some of the restrictions encountered in traditional education. The use of educational technology supports experiences for learners that

are not really possible through traditional instruction and it provides the faculty with the flexibility to deliver content in the most effective manner while still maintaining the desired learning outcomes. The emergence of new learning technologies coupled with the explosion of new information is paving the way for the use of educational technologies to deliver medical education (Bahner et al., 2012; Bollinger et al., 2013; Dieter, 2009; Dubois & Franson, 2009; Gibson, 2008; Harris, Barden, Walker, & Reznick, 2009; Hosny, Mishriky, & Youssef, 2008; McGaghie & Fisichella, 2014; Pearce & Evans, 2012; Robin et al., 2011; Webster, 2011). Curriculum cannot stand alone without there being some educational strategy for distributing it and technology helps meet that need.

The data analysis reveals that technology use in clinical education has been considered one of the biggest strengths of implementing educational technology. Educational technology meets the curricular needs of clinical education and it provides access to the content at a time when medical students are learning in a multitude of different locations. One of the areas of clinical education that benefits the most is interprofessional education, which brings together the different health care professionals that are involved in patient care. Despite the encouraging advancements of technology in clinical education, HIPAA remains one of the biggest challenges and limits the authentic patient information that is crucial to developing authentic patient simulations.

In the past 20 years there have been significant changes in how medical and patient information is accessed at clinical sites starting with the use of PDAs and recently evolving to the utilization of iPads, tablets, and mobile phones. Recent studies demonstrate the increased use of these tools in clinical settings (George et al., 2013; Han et al., 2014). Simulation technology is steadily increasing in clinical education and it is one of the more prominent educational

technology tools in medical education (Ahmed, King Gardner, Atkinson, & Gable, 2014; Catling, Williams, & Baker, 2014; Lovell, 2014). The use of simulation technologies is common among U.S. medical schools since there is a need to develop a multitude of clinical skills among the various health care professions. These findings are consistent with recent research literature on the use of educational technology in clinical education (Lovell, 2014; Rowe, Frantz, & Bozalek, 2012; Sclafani, Tirrell, & Franko, 2013; Spooner, Hurst, & Khadra, 2012; Stephens et al., 2010; Triola et al., 2004).

In clinical education, students work in a variety of different places at various times of the day and educational technology makes it easier for teaching faculty to facilitate instruction to those students. The use of technology with a new generation of learners that are familiar to the practice of using computers to access information is vital to overcome obstacles such as the instructors and students in different locations (George et al., 2013). The flexibility of e-learning allows learners to access content asynchronously and join meetings virtually which has helped overcome a considerable barrier in clinical education. Medical students' learning takes place beyond conventional classrooms, such as clinics, operating rooms and simulation labs. Educational technology provides a platform for medical and nursing education to reach students who are not learning in the same geographical locations (Berg et al., 2010; Dubois & Franson, 2009; George et al., 2013; Gibson, 2008; Han et al., 2014; Luanrattana, Win, Fulcher, & Iverson, 2012; Reis, Visser, & Frankel, 2013; Robin et al., 2011; Vyas, Albright, Walker, Zachariah, & Lee, 2010).

Interprofessional education relates to the communication skills between the various team members that are responsible for the care of patients in clinical settings. Finding new ways to design and develop effective interprofessional education are crucial and educational technologies

provide a practical solution (Casimiro, MacDonald, Thompson, & Stodel, 2009). Advancements in simulations make it possible so that health care students do not have to be together in the same place in order to benefit from interprofessional education. Gillan, Wiljer, Harnett, Briggs, and Catton (2010) revealed that interprofessional education was important because it emphasized working together towards the common goal of the best possible care for the patient.

Interprofessional education has expanded its role in medical and nursing schools, and other forms of health professionals' education. Previous research states that quality care outcomes are incredibly important in health care and that collaborative practice between the various professions improves these outcomes (Bridges, Davidson, Odegard, Maki, & Tomkowiak, 2011).

Additional improvements in patient care instruction are occurring because of the expanded role of interprofessional education at the clinical sites. Future doctors are learning to collaborate with nurses and other health care professionals as they deal with patients on a daily basis. There has been a shift from performing procedural skills on patients to simulations-based practice (Casimiro et al., 2009; Davidson et al., 2007; Ellaway, Poulton, Fors, McGee, & Albright, 2008; Irvine & Martin, 2014; McGaghie et al., 2009; Nestel et al., 2008; Reis et al., 2013; Robin et al., 2011; Tilley & Kaihoi, 2011; Weiner, Barnet, Cheng, & Daaleman, 2005).

Advancements in the area of simulation technology, which are meant to improve patient care, are hampered by restrictions put place due to HIPAA. Legal, ethical, and privacy concerns are shaping the way health information is used in clinical simulation which in turn influences the effectiveness of patient care. HIPPA regulations are viewed as an extremely complex policy for relating privacy rules in the current age of digital information (Annas, 2003; Kilbridge, 2003; Ness & Committee, 2007; Nosowsky & Giordano, 2006; Sataloff, 2008; Weiner et al., 2005; Williams & Schafer, 2014; Wolf & Bennett, 2006).

Individuals and change

Analysis of the data revealed that faculty and student resistance was seen as major challenge to the implementation of educational technology. Strategies such as seeking out early adopters amongst the faculty, involving students in the innovation process, and using students to engage faculty were seen as effective ways to combat the resistance to technology.

Faculty resistance to educational technology occurs at all levels of education. Many medical faculty members often resist moving away from traditional teaching methods that have been in place for hundreds of years (Bollinger et al., 2013; Jacobsen, 1998). In the case of medical schools, faculty that resist innovations often cite the lack of time and resources needed to adapt courses to use educational technology and the lack of incentives for doing so. Faculty members' ability to spend time working with educational innovations is restricted due to heavy clinical loads and the constant need to seek grant funding for research (Mennin & Krackov, 1998).

Some are the "sage on the stage" type of faculty who feel that their reputation as professors would be tied to the success of technology implementation. Faculty often feel intimidated by technologies with which they are unfamiliar (Robin et al., 2011). Medical school faculty fear that educational technology will cause them to lose control over their teaching time, content, methods and possibly place their students at a disadvantage. Faculty members who are seen as resisters will often question the effectiveness of educational technology before they will commit their time and effort to implement it in their courses (Willcockson & Phelps, 2010; Zayim et al., 2006).

One of the ways that medical schools can get faculty on board is to reach out to early adopters of technology. When faculty see their colleagues using educational technology

successfully they are more likely to try it themselves. It is crucial to get the early adopters involved prior to implementing educational technology with the mainstream medical school faculty (Schifferdecker et al., 2012; Zayim et al., 2006). Early adopters have the potential to act as role models and they have the ability to promote the introduction and implementation of an innovation, which has a substantial impact on the diffusion process (Rogers, 2003). Analysis of the data indicated the importance of seeking out one or two adopters to initially work with the educational innovations. Early adopters tend to be attracted to new technologies and get personal satisfaction from finding new ways to implement them in their teaching practices (Jacobsen, 1998).

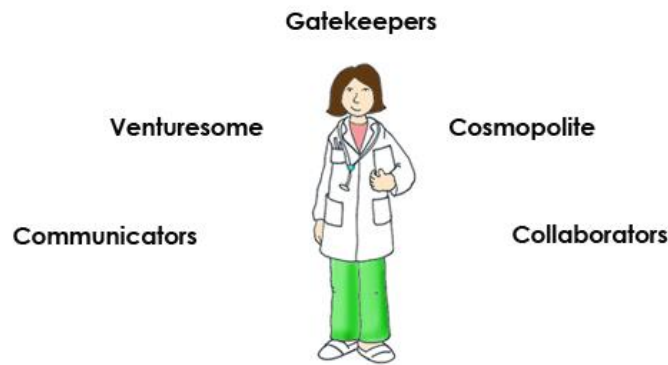
Another strategy for convincing faculty to buy into the innovation process is using students to demonstrate the effectiveness of using technology. When faculty witness students engaging with an educational technology or they see the data associated with technology use, this often motivates them to become more involved in the implementation process. These findings were consistent with the latest research from Dieter (2009), McGee and Kanter (2011), and Potts (2011).

Students are sometimes resistant to the implementation of technology too. They often do not want to spend time learning new technologies when it takes time away from learning the actual content. As newer technologies emerge, students feel unsure about how to use these technologies efficiently (Kennedy, Gray, & Tse, 2008; Robin et al., 2011; Willcockson & Phelps, 2010). An effective strategy for mitigating student resistance is to involve them in the innovation process. One of the advantages of involving students in the innovation process is that you are able to understand and anticipate their learning needs (Bajgoric, Appiah, Wass, & Shelton, 2014; Dieter, 2009; McGee & Kanter, 2011).

Interviewees Shared Characteristics with Rogers' DOI

The educational technology leaders in this study were classified as innovators according to Rogers' Diffusion of Innovations adopter categories. This section will review the personality and communication characteristics that the educational technology leaders share with Rogers' DOI. Socioeconomic characteristics will not be addressed since there is not a significant degree of variance in socioeconomic status amongst medical school personnel.

Figure 2. Characteristics of innovators



Rogers (2003) confirmed that innovators were willing to experience new ideas. Innovators venturesomeness necessitated that they go outside their local network of peers seeking more cosmopolite collaborators. Their venturesomeness also requires that they have complex technical knowledge. Rogers (2003) stated, “communication patterns and friendships among a clique of innovators is common, even those these individuals may be quite geographically distanced.”(p. 294)

Innovators are considered gatekeepers, introducing the innovation to members of the social system and dealing with the uncertainty that comes with innovation. They obtain the innovation from outside their own system and introduce it within their own system. Innovators must also be able to deal with setbacks when innovations do not work out as intended.

Rogers (2003) provided many generalizations regarding characteristics of earlier adopters. Many of these generalizations were evident in the actions and statements of the participants interviewed. Specifically, Table 4 provides Rogers generalizations and how these mapped to the participants of the study.

Table 4. Rogers' Generalizations as Related to Study Participants

Generalizations	Indicators
Generalization 7-13: Earlier adopters have a more favorable attitude toward change than do later adopters.	Each participant exhibited this behavior as demonstrated by their willingness to go outside the system to learn about innovations in educational technology.
Generalization 7-14: Earlier adopters are better able to cope with uncertainty and risk than are later adopters.	Each participant shared difficulties they faced and their ability to find solutions while building their programs.
Generalization 7-17: Earlier adopters have higher aspirations (for formal education, higher status, occupations, and so on) than do later adopters.	Each participant achieved a Master's degree at a minimum. Each participant had advanced at the institution and was working in an administrative role.
Generalization 7-18: Earlier adopters show more social participation.	Each participant sought out Communities of Practice in order to learn about innovations.
Generalization 7-19: Earlier adopters are more highly interconnected through interpersonal networks in their social system than are later adopters.	Each participant emphasized the importance of developing networks and looking to their peers for ideas and solutions.
Generalization 7-20: Earlier adopters are more cosmopolite than are later adopters. Innovators' interpersonal networks are more likely to be outside, rather than within, their system. They travel widely and are involved in matters beyond the boundaries of their local system.	Each participant discussed the professional relationships they had with their peers outside of the system. Participants A, B, and D belonged to the Computer Resources in Medical Education group and Participant C participated in a similar group.
Generalization 7-23: Earlier adopters have greater exposure to interpersonal communication than later adopters.	Each participant sought out peers outside their medical schools in an effort to establish networks.
Generalization 7-24: Earlier adopters seek information about innovations more actively than do later adopters.	Each participant stressed the importance of going outside of their medical schools in order to learn about innovation.
Generalization 7-25: Earlier adopters have greater knowledge of innovations than do later adopters.	Each participant emphasized the importance of learning about innovation through research and peer collaboration.

Innovators are significant players in the change process as they initiate the flow of information through the system (see Figure 1.). They are motivated from within and that inspires them to keep going even when they encounter setbacks.

Limitations

Although multiple data sources were analyzed and the experiences of multiple educational technology leaders were described in this report, there were existing limitations to this research study. While the case study approach for this research was not as systemized as other methodologies (Yin, 2009), the multiple case study has been valuable in answering the research questions. Comparative case studies and semi-structured interviews provided valuable insight into the processes that frame the implementation of educational technology in medical education. Limitations of this study could be addressed with further research that is detailed in a later section.

One limitation of this study was that the data collection relied on the historical memory of the research subjects. This research relied on information gathered from participants that represented their subjective view of the situation (Creswell, 2012). This limited my empirical study of the implementation of educational technology to a present-day perspective in lieu of following the process over a given time period, which would have provided a more definitive picture of issues encountered in the diffusion of the innovation.

Another significant limitation was the number of case studies used in this research. There are currently 141 M.D. granting medical schools in the United States. The inclusion of international institutions outside of the U.S.-based system of medical education could have provided additional insight on how educational technology could be implemented. Also not all of

the schools that met the selection criteria were included in the study due to a potential participant being concerned about how their involvement in the study would be perceived by leadership.

Other limitations to this study included the data sources, which were collected from the educational technology leaders only. Another approach would be to include the perspective of others involved with the innovation and additional sources of evidence such as observations. It would have been desirable to include a wider range of research subjects such as the facilitators and end-users of the educational technology. Additionally the perspectives of the medical school leadership would have added to the robustness of this study.

The final limitation to this study included the researcher's own bias which could have an effect on the interpretation of the data. This potential bias was mitigated through the use of member checking with each of the interviewees.

Recommendations for Practice

The following recommendations for practice are based on the identified suggestions and approaches of the four educational technology leaders that had demonstrated success in implementing educational technologies at their respective medical schools. Those interviewed were deemed to achieve some level of success in integrating educational technology in their respective medical schools. One of the most significant aspects learned from this study were specific recommendations for action that emerged as these leaders were relating their experiences. Table 5 summarizes these recommendations.

Table 5. Recommendations for Practice

Recommendation	Innovator Example
Create an educational technology unit/center to facilitate the design and development of educational technologies.	“I would recommend investing in an infrastructure in the form of a unit. Technology is to support, to catalyze... um how people are to learn.. and that takes some expertise in house” - Participant B
Seek out representatives for all of the stakeholders at the medical school throughout the entire innovation process.	“We have a governance process by which we have regular input and communication with our students, with our residents, with our faculty, with our leadership. And we just have to have a lot of discipline around keeping at that, understanding the problems, coming up with solutions and rapidly implementing.” - Participant C
Look outside your local network of peers and seek more cosmopolite collaborators.	“You need to have the connections out there, otherwise there's no ideas.. and it works both ways because a lot of the time I will see what other people are doing and I'll say "that is so not for us" ... and I can see how it works and I can see the effort that goes into it”- Participant A
Obtain innovations from outside your own system in order to introduce it within your own system.	“But where I think most importantly, they are a group of people who know each other and trust each other; that pick up the phone and say "gosh Jen what do you know about this technology" or I heard you were using it or playing around with it.. I need the real scoop. I need to know. If it's a vendor for example, what is this vendor really like to work with? And people are really honest and share with each other and collaborate a lot. I find that to be an extremely powerful community that moves a lot of initiatives forward.” - Participant D
Contribute to current educational technology research in medical education and participate in national research organizations.	“They are a critical pipeline of ideas um of networking, and in fact because of one of the organizations that we had gone to. My colleague just wrote up a document as to how we are going to revamp our simulation center research infrastructure, and that was a direct result from having been stimulated at the national organization.” - Participant B
Establish a culture and infrastructure that supports innovation and allows it to propagate.	“Fortunately here people are excited about innovation... We, for example, embraced design thinking as a discipline very strongly here, we teach workshops in design thinking in innovation. We want all of our faculty to think that way, and take risks and we teach our medical education staff the same. So in a nutshell, we actively cultivate a culture of risk and innovation.”- Participant D

<p>Establish and institutionalize an educational technology advisory committee that has representatives from the various stakeholder groups on campus including, but not limited to: leadership, faculty, students, educational technology, information technology, curriculum developers, and partnering clinics and medical centers.</p>	<p>“We have governance, we have formal governance that helps us make decisions around what we should do nextwe also don't want to get mired down in prolonged decision making.. otherwise this stuff moves much faster than that.. we have a governance process by which we have regular input and communication with our students, with our residents, with our faculty, with our leadership.. and we just have to have a lot of discipline around keeping at that.. understanding the problems, coming up with solutions and rapidly implementing.” – Participant C</p>
<p>Seek out champions.</p>	<p>“They found a few local champions to come and try active learning and use the faculty as kind of the advocate, cause I think when your peers, when your peer faculty say hey I tried something, this worked, this didn't work..I think other faculty are more likely to listen.” - Participant B</p>
<p>Seek out early adopters amongst the faculty who will willingly develop and promote the use of educational technologies with their peers.</p>	<p>“Find your faculty member, the first one who buys in. Don't even try a project unless you have a faculty member who is really excited about it, they don't take well to mandates from administration. It has to be their idea, and so, make it their idea.” – Participant A</p>
<p>Establish and institutionalize collaborative partnerships with peer institutions and professional associations to learn about and share innovations in educational technology.</p>	<p>“That's where you find out what sort of the hotbutton issues are nationally, innovative research methodologies people are applying, cutting edge practices that institutions are adopting. And most of all networking with people, and then through your networks you can build teams to try something innovative.” - Participant B</p>
<p>Provide funding incentives and awards to encourage faculty participation in the innovation process.</p>	<p>“They have money to specifically develop new content or new innovations in partnership with faculty. And it's at their discretion, a faculty member when they come to them with an idea and our team understands how much impact or how feasible the project is, how desirable the project is, and how sustainable it is over time.” – Participant D</p>
<p>Develop an educational technology plan driven by the medical schools' curriculum needs, overall vision, and long-term strategy.</p>	<p>“Well do you need to create some sort of fund at the institution that supports the disposable costs, and the maintenance contracts, things like that because grant funding is generally one-off money.. it will help you get something running but then you've got to maintain it on your own” - Participant A</p>
<p>Design and develop faculty development that demonstrates how to use educational technologies</p>	<p>“My next piece of advice would be to focus on faculty development.. get faculty to be familiar with these tools.. to be facile with them, to be thinking about</p>

effectively and utilize them in a way that improves their lives and the learning experiences of their students.	interesting ways that they could not only be used to make education better but be used to make the faculty's lives better“ – Participant C
Involve students early on in the innovation process and utilize them to engage resistant faculty.	“Faculty engage with students differently than they engage with, I think the administrative leadership. Again this goes back to start simple, engage your learners, use your learners to engage your faculty, work through your learners to engage your faculty.” - Participant D
Research and review educational technology resources such as Educause, which publishes a yearly report on hot topics in educational technology and the New Media Consortium Horizon Report which looks at emerging technologies that will have an impact on teaching and learning.	“I would say there are several sources, some of them more mainstream sources include Educause, which is a big consortium of higher education, and they have specific groups focused on educational technology and they do some wonderful yearly synthesis of top ten issues in educational technology, or things like that. Another is the New Media Consortium and they issue this yearly horizon report, which is just an awesome resource.” - Participant C

Recommendations for Future Research

The following are some recommendations for further research based on the findings and limitations of this study:

1. Replicate this study with a different set of schools to see if comparable findings emerge.
2. Perform a similar study that incorporates a larger sample of medical schools, including those located outside of the United States.
3. Examine the insights of other stakeholder groups such as faculty, students, and leadership to get a broader perspective of the process of implementing educational technology at medical schools.
4. Conduct additional research studies on early adopters of educational technology in medical education.

5. Conduct additional research studies on student resistance to the implantation of educational technologies in health professional education.
6. Explore the role of innovators at higher education institutions and compare to innovators in medical education.
7. Replicate this study by looking at innovators in other areas of professional education, such as law and nursing schools.

Conclusions

This study provided an opportunity to investigate how educational technology was implemented in medical education at four different institutions in the United States. The research was conducted through the lens of Diffusion of Innovations as the theoretical framework, which guided the data collection and analysis. The comparative multiple case study approach was used to encapsulate the perspectives of educational technology leaders whose views are not represented in current literature with regard to the implementation of educational technology in medical education.

The goals of this dissertation were to: (a) describe how educational technology leaders viewed the implementation of educational technology at their respective medical schools, (b) identify the strengths and challenges of incorporating educational technology into medical education. While all the educational technology leaders interviewed felt their respective implementations were successful to varying degrees, each expressed that there were still areas that could use improvement. With this in mind, the analysis of data led to several conclusions:

1. Medical schools need to create and embrace a culture that fosters innovative practices amongst all its stakeholders. Establishing a technology unit/center should be one of

the first steps they take to accomplish this. This is one of the most significant attributes of successful educational technology programs.

2. Obtain innovations from outside your own system in order to introduce it within your own system. Collaborate with others from peer institutions to share or learn about best practices with respect to innovations in educational technology.
3. The accreditation process should be the basis for a discussion on the curriculum and how educational technology could be used to deliver it.

APPENDIX

University of Hawai'i

Consent to Participate in Research Project:

*Innovation at U.S. Medical Schools: A Multiple Case Study of Leaders Perceptions of
Educational Technology*

My name is Alex Parisky, doctoral student at the University of Hawai'i at Manoa (UH), in the Department of Educational Technology in the College of Education. The purpose of my current research project is to evaluate the implementation and use of educational technology at select U.S. medical schools. As a result of your involvement in developing educational technology at your institution, I invite you to participate in this project. Your expertise and knowledge will help us better understand educational technology implementation in medical schools.

Project Description - Activities and Time Commitment: If you decide to participate, I will email you a link to complete a brief online survey and I will follow up with a Skype at a time to be mutually agreed upon later date. The interview will be approximately 45 minutes. I will record the interview using a digital audio-recorder. I am recording the interview so I can later type a transcript – a written record of what we talked about during the interview - and analyze the information from the interview. If you participate, you will be one of a total of four medical schools who I will interview individually.

Benefits and Risks: I believe there are no direct benefits to you in participating in my research project. However, the results of this project might help me and other researchers learn more about how and why educational technology is being implemented at medical schools. I believe there is little or no risk to you in participating in this project. If, however, you are uncomfortable

or stressed by answering any of the interview questions, we will skip the question, or take a break, or stop the interview, or you may withdraw from the project altogether.

Confidentiality and Privacy: During this research project, I will keep all data from the interviews in a secure location. Only I will have access to the data, although legally authorized agencies, including the University of Hawai'i Human Studies Program, have the right to review research records.

After I transcribe the interviews, I will erase the audio-recordings. When I report the results of my research project, and in my typed transcripts, I will not use your name or any other personally identifying information. Instead, I will use a pseudonym (fake name) for your name. If you would like a summary of the findings from my final report, please contact me at the number listed near the end of this consent form.

Voluntary Participation: Participation in this research project is voluntary. You can choose freely to participate or not to participate. In addition, at any point during this project, you can withdraw your permission without any penalty or loss of benefits.

Questions: If you have any questions about this project, please contact me via phone (805) 444-5222 or e-mail (parisky@hawaii.edu). If you have any questions about your rights as a research participant, in this project, you can contact the University of Hawai'i, Human Studies Program, by phone at (808) 956-5007 or by e-mail at uhirb@hawaii.edu.

Please keep the prior portion of this consent form for your records.

If you agree to participate in this project, please sign the following signature portion of this consent form and return it to parisky@hawaii.edu or via fax # (888)693-1194.

Signature(s) for Consent:

I agree to participate in the research project entitled, “*Innovation at U.S. Medical Schools: A Multiple Case Study of Leaders Perceptions of Educational Technology*” I understand that I can change my mind about participating in this project at any time, by notifying the researcher.

Name (Print): _____

Signature: _____

Date: _____

Survey Questions

As briefly outlined in the consent to participate form, this survey is being distributed to you so that we can learn more about you. Your responses to this survey are appreciated and they will remain anonymous. Educational technology includes any technologies (ex. Internet, videos, simulations) which are a crucial component in student/instructor learning transactions.

Please feel free to email me at parisky@hawaii.edu should you need clarification on any of the items.

A. Demographics

Subject area of expertise: (Mark the one that best fits your background.)

____ Humanities / Education (e.g., art, communication, Education, Educational Technology, English, history, interdisciplinary studies, psychology, sociology)

____ Medical Education/ Health Sciences. (e.g. medicine, health systems)

___ Mathematics / Physical Science. (e.g. agriculture, biology, geosciences, molecular biology)

___ Business / Computer Science / Leadership. (e.g. management, accounting, information networking and telecommunications.)

Level of Education: (Mark the highest degree that you hold.)

___ Doctorate ___ M.D . ___ Masters ___ Bachelors

Total number of Educational Technology courses you have taught at medical institutions:

___ Educational technology/Distance Learning courses

Self-estimate of technological expertise: (Check one of the following that best describes your expertise in using Educational Technology.)

___ Recognized leader in using technology in educational technology.

___ Very high level of expertise in using technology in educational technology.

___ High level of expertise in using technology in educational technology.

___ Above average level of expertise in using technology in educational technology.

___ Average level of expertise in using technology in educational technology.

___ Below average level of expertise in using technology in educational technology.

Please answer the following questions with a brief response:

B. Courses and Context

1. Should medical students be able to complete at least part of a medical degree through distance education?

2. Should students be able to complete an entire medical degree through distance education?

Interview Questions

1st Round Questions-

1. When it comes to innovation, what/ who are your sources?
2. How do you learn about innovations?
3. What role do professional associations and research organizations play in helping facilitate change?
4. Why did the medical school decide to implement educational technology?
5. With respect to strategy and innovation, what are your schools' most important values?
6. Is there any educational policy at the Medical School with regards to Educational Technology?
7. What are the major challenges to adopting innovations?
8. How are decisions made regarding innovations? How does organizational structure enter into innovation decision-making?
9. Is there an executive committee or steering committee?
10. Have there been any internal conflicts regarding the use of technology?
11. How are technology innovations typically funded?
12. How does your organization use collaboration with other medical schools to gain understanding of innovation, develop new value networks, and help adopt innovations in medical education and technology?
13. Do you believe that the implementation of educational technology has been successful at your institution?

14. Do you have any recommendations for medical schools that are having difficulty integrating educational technology into their programs?

2nd Round Questions-

1. Does your institution place a high priority on innovation?
2. Does your institution have a formal structure that fosters innovation? Or informal?
3. What groups tend to resist innovation at your medical school?
4. Are innovative ideas most often stimulated from inside or outside the medical school?
5. Have changes in the perception of medical education stimulated innovation?
6. Have technological advances enhanced innovative initiatives?
7. Is your institutions ability to innovate hampered by and federal or state regulations? Or limited by accreditation bodies?
8. Is there anything else you would like to mention about educational technology and medical education?

Initial Codes

Code	Frequency
accreditation	3
best practices	13
challenges	54
change	5
clinical	8
collaboration	31
committee	14
community	12
content development	4
culture	2
curriculum	14
curriculum reform	11
data	4
decision making	8

Code	Frequency
design thinking	2
desire to learn	2
developing resources	20
developing technology	10
education associations	16
ed tech journals	6
educational technology	56
expectations	1
faculty	39
faculty development	12
funding	30
implementing technology	7
improve teaching	8

Code	Frequency
improvement	2
information	2
innovation	34
inspiration	7
institutional support	3
instructional design	4
interprofessional	9
interventions	2
iterative development	1
leadership	16
learner experience	26
limited resources	6
LMS	2
medical education	24
medical schools	18
networking	8
online course	1
organizational change	3

Code	Frequency
participant background	4
own education	1
peer institutions	6
personnel	1
planning	1
policy	3
prototyping	2
research	5
research organization	2
resistance	1
risk taking	3
sharing resources	7
standards	2
strategy	14
students	16
sustaining technology	9
technology	12

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