

ABSTRACT

WELLS, MARY ELLEN. Mobile Learning in Medical Education: A Case Study Through the Lens of Sleep Education. (Under the direction of Kevin Oliver, PhD.)

Sleep disorders affect millions of Americans and are directly associated with many deadly diseases, including neurological disorders. Despite this impact, sleep medicine education is not included in many U.S.-based neurology residency education programs, resulting in under-diagnosed patients and missed therapeutic opportunities. This study aims to examine a possible solution to this gap by integrating a supplemental sleep education program that residents can complete via e-learning on mobile devices. The research goal is examining the educational experience of neurology residents as they participate in a supplemental sleep medicine e-learning module. This research included a case study of nine neurology residents involved in various years of residency training at the University of North Carolina at Chapel Hill's School of Medicine. Participants utilized an e-learning module with a streaming video lecture series, online discussion board, and authentic sleep medicine resources. Major findings include the following: pedagogical issues of the online module with regard to specific e-learning constructs include practical, authentic, and contextual information and teaching tools, facilitator scaffolding has a positive influence, module design should allow self-direction and mobile learning is preferred, and supplemental discussion forums may be useful; strengths of the module include flexibility, use of multimedia, practicality, and ease of use; areas for improvement of the module include timing of the module, content length and context, and addition of prompting and reminders; the usefulness, application, and takeaways from the module include that residents prefer mobile e-learning, will potentially use the module for foundational knowledge, for reinforcement, and

potentially for patient care during and beyond residency. Four themes emerged in the discussion, which include: Module timing and delivery presented the biggest issues, self-control of learning and non-linear design were large indicators of satisfaction, introverted nature of the participants governed their participation, and context is important and varies according to where residents are in their education. Overall, the findings of this research support the idea that supplemental education on sleep disorders completed through electronic learning (e-learning) and mobile learning (m-learning or mlearning) platforms provides a portable and acceptable solution for neurology residents to gain critical knowledge and skills in sleep medicine. The use of e-learning and m-learning in medical residency education are promising methods for understanding how residents experience online supplemental sleep medicine education; as well as promising for understanding the overall feasibility, educational impact, and applicability of the module itself.

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Mobile Learning in Medical Education: A Case Study Through the Lens of Sleep Education

by
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BIOGRAPHY

I began my career in medicine as a technologist in Greenville North Carolina in 1999, while working on my bachelor's degree at East Carolina University. After completing my degree in computer science, I continued as a technologist, assisting in the diagnosis and treatment of patient's with neurological, sleep, and behavioral disorders. I earned registries in Electroencephalography, Nerve Conduction Studies, and Polysomnography. I attended graduate school at East Carolina University and earned a Masters in Instructional Technology, and then began teaching college transfer computer courses at Pitt Community College.

In July 2006, I assumed a program director position in the Electroneurodiagnostic Technology program at Pamlico Community College, which offers an Associate Degree. After two years, I moved to Chapel Hill and assumed a position with the Department of Allied Health Sciences at The University of North Carolina at Chapel Hill to help create a baccalaureate degree in neurodiagnostics and sleep science. I am currently serving as program director and the program is about to graduate its second class of students and accept a fourth class of new students. As part of my professional goals, I started pursuing my Ph.D. in Instructional Technology in 2008, and finally stand at the finish line today.

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CHAPTER 1

Problem Statement

Medical education is facing many challenges, which have created a need for alternative means of education. Some of these challenges include time restrictions for teaching and learning (Ruiz, Mintzer, & Leipzig, 2006), gaps in learning (Oetting, 2009; Peters et al., 2008; Heard, Allen, & Clardy, 2002; Kochar, Simpson, & Brown, 2003), and issues in continuing medical education and on-the-job training (Pratt, 2002; Harden, 2005; Kamdar, Kessler, Tilt, Srivastava, Khanna, Chang, Balmer, & Auerbach, 2013). This study looks at these educational issues with e-learning as a possible solution, through the lens of a case study in sleep medicine education for neurology residents, as described in the following problem statement.

Sleep disorders affect approximately 70 million Americans and increase their risk of myocardial infarction, stroke, and death (Gottlieb et al., 2010; Redline et al., 2010; Nieto et al., 2009; Winkelman et al., 2008; Laugsand et al., 2011). Furthermore, sleep disorders and complaints are common in patients with neurological disease (Winkelman et al., 2008; Laugsand et al., 2011). Despite this impact, many U.S.-based neurology residency education programs have not incorporated sleep medicine as a significant part of their curricula. Approximately one third of the neurology residency programs in the U.S. do not meet the current Accreditation Council for Graduate Medical Education (ACGME) requirements for sleep medicine education. Inadequate and non-standard sleep medicine programs for

neurology residents can result in patients being under-diagnosed and missing therapeutic opportunities.

A possible solution to this gap in neurology resident training is to integrate a supplemental sleep education program that residents can complete online, and thus, does not interfere with their required face-to-face clinical training. Supplemental education on sleep disorders completed through electronic learning (e-learning) and mobile learning (m-learning or mlearning) platforms provides a portable and accessible solution for neurology residents to gain critical knowledge and skills in sleep medicine in order to improve clinical practice and decrease patient morbidities and mortality associated with sleep disorders.

Purpose of Research and Research Question

The research goal is examining the educational experience of neurology residents as they participate in a supplemental sleep medicine e-learning module. There is an identified learning gap in the subspecialty practice area of sleep medicine among many medical residency education programs, as described in detail later in this chapter. Common learning barriers include the ACGME duty hour restrictions (ACGME, 2011), sleep deprivation, stress, and burnout (Collier, McCue, Markus, & Smith, 2002; Levey, 2001; Barger et al., 2006), and lack of resources and content experts (Avidan, Silber, Vaughn, 2011; Dietrick, Nirupama, & Young, 2010; Marks et al., 2011; Kopp et al., 2011; Skye et al., 2011).

The overall research question is:

How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning?

Ultimately, the intended outcome and future application of the research is to provide preliminary evidence of the ways sleep medicine education through e-learning and mobile learning may or may not be a feasible and an effective supplement within neurology residency education. The future implications deriving from the research goal include an understanding of the outcomes of the following research sub-questions:

- What are the pedagogical issues of the online module with regard to specific e-learning constructs and mobile learning?
- What are the strengths and areas for improvement in the overall resident educational experience?
- What is the usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents?

Research Approach

With the approval of North Carolina State Universities Institutional Review Board, I studied the experiences and perceptions of nine neurology residents in the University of North Carolina School of Medicine. This investigation involved a qualitative approach and case study methodology. Neurology residents participated in a three-week online supplemental sleep medicine education module, in which they had mobile access. Data collection involved in-depth interviews, online discussion boards, and learning management system statistics.

Rationale and Significance

Adequacy of Sleep Medicine Education in Medical Education

“Most physicians have little to no understanding of sleep” ~ Dr. Bradley Vaughn

Sleep medicine education is most certainly lacking in the medical curriculum at the undergraduate and graduate levels. According to Dr. Bradley Vaughn (the Vice Chair of Neurology and director of the Sleep Disorders Center at The University of North Carolina Chapel Hill; and a pioneer and leader in sleep medicine and sleep medicine education), there is very little research evidence of the importance of sleep in general, which has extended into the underlying bias in medical training for sleep. The recent history and adequacy of sleep medicine training in medical school and residency is discussed next.

The four-year medical school.

In 1978, 46% of medical schools did not provide any sleep medicine education, and only 10% of medical schools provided sleep medicine education considered adequate (Owens, 2005). A follow-up study, commissioned by the National Commission on Sleep Disorders, showed little improvement, with 37% of medical schools still not providing any sleep medicine education (Rosen, 1993). The follow-up study reported that the sleep medicine education in the 4-year medical curriculum added up to only a little over 2 hours, and that 89% of the medical students had never clinically evaluated an individual with a sleep disorder (Rosen, 1993; Rosen, 1998).

The Liaison Committee on Medical Education is the nationally recognized accrediting authority for medical education programs leading to the MD degree in medical

schools in the United States and Canada (LCME, 2012). In the 1993 survey of accredited medical schools in the U.S., over two-thirds indicated that education in sleep medicine was inadequate, and that less than two hours of total teaching time was allocated to sleep medicine (Rosen et al., 1993). A survey of medical schools in the United States and Canada revealed that only about three hours is dedicated to sleep medicine education, which is only a slight increase over almost 20 years (Mindell et al., 2011).

Physician performance on sleep-related knowledge or skills assessments is historically poor (Haponik et al., 1996; Rosen et al., 2001; Owens, 2001). The poor performance has been attributed to limited curriculum time and access to sleep medicine education in undergraduate medical training, and lack of qualified teaching faculty (Rosen et al., 1998; Owens, 2005). Physician recognition and knowledge of sleep disorders continues to be a recognized problem. For this reason, the Institute of Medicine (IOM) suggests “sleep medicine exposure should begin prior to entering into residency and early on as part of the medical school curricula” (Ulmer, Wolman, & Johns, 2009).

The National Center on Sleep Disorders Research, at the National Heart, Lung, and Blood Institute, established the Sleep Academic Award Program in 1996 to enhance medical education with regard to sleep medicine, based on the survey data that medical schools usually have less than 2-4 hours of sleep medicine undergraduate training (NCSDR, 2012). 20 awards were given over the 7 years the program ran, which involved 23 primary investigators (Strohl, 2011). The 20 sites involved developed model educational interventions and curricula in sleep medicine for dissemination to medical schools across the country.

The Sleep Academic Award recipients banded together with a primary objective of developing model sleep medicine curricula and to promote faculty development and interdisciplinary learning environments (Strohl, 2011). The group advocated for inclusion of the topics in the United States Medical Licensure Examination® (USMLE®): sleep and circadian biology, and diagnostic strategies in narcolepsy, restless legs syndrome, insomnia, and sleep apnea (Strohl, 2003). The USMLE® is sponsored by the Federation of State Medical Boards and the National Board of Medical Examiners®, and “assesses a physician’s ability to apply knowledge, concepts, and principles, and to demonstrate fundamental patient-centered skills, that are important in health and disease, and that constitute the basis of safe and effective patient care” (USMLE, 2012).

The committee began by articulating the need for sleep education, and then created educational objectives to define sleep medicine program development in undergraduate medical education (Strohl, 2003). Four core competencies emerged, which included: explain the putative nature of sleep; discuss the ways disorders of sleep and circadian rhythm contribute to symptoms and signs; perform a sleep history; initiate measures to improve sleep and reduce sleepiness (Strohl, 2003). Although there have been improvements in the sleep medicine education offerings at the undergraduate level, overall, there is still a wide gap in sleep medicine knowledge and skills across physicians.

Residency

Residency education is notoriously lacking in sleep medicine education, especially since the American Board of Medical Specialties and the ACGME did not even recognize

Sleep Medicine as an independent specialty until 2005 (ABMS, 2012). Currently, none of the primary specialties (internal medicine, surgery, family medicine, obstetrics-gynecology) have topics on sleep disorders in their required curriculum (Strohl, 2011). According to Dr. Bradley Vaughn with UNC Hospitals, sleep is the most asked about topic when he teaches neurology to primary care physicians.

In 1948, the ACGME established Clinical Neurophysiology as a subspecialty under neurology, which encompasses training in sleep recordings, but no requirements for experience or competency were addressed (Strohl, 2011). The ACGME specialties of Pulmonary and Pulmonary Critical Care Medicine, in 1988, began to include requirements that sleep testing and sleep disorders topics be included in those fellowship programs (Strohl, 2011). Since 1988, Emergency Medicine is the only other ACGME specialty that explicitly includes sleep knowledge as part of its curriculum (Strohl, 2011).

In a recent survey of residency programs, teaching of sleep medicine occurs most frequently in medicine (27.1%), psychiatry (25.9%), neurology (19.3%), and pediatrics (7.2%) (Namen et al., 2001). In these programs, the average time devoted to sleep medicine education is less than 4.8 hours. In another survey examining medical specialty textbooks (i.e. internal medicine, psychiatry, neurology, and pediatrics), less than 2% of the textbook content included sleep medicine (Teodorescu et al., 2007).

According to Dr. Bradley Vaughn, the word “sleep” was not included in the neurology residency program requirements until 2001, when he and a colleague worked to change the program requirements to include sleep. The American Board of Psychiatry &

Neurology (2009) now requires physicians to demonstrate knowledge of sleep medicine, which is considered a core competency for both Psychiatry and Neurology. In 2009, there were only 70 Sleep Medicine programs in graduate medical education (Quan, 2009). As of December 2012, there are 74 ACGME accredited Sleep Medicine programs with 163 on-duty residents (ACGME, 2012). The Sleep Medicine subspecialty is listed under Internal Medicine with the ACGME.

In particular to neurology residency programs, a 2010 survey created by a task force from the American Academy of Neurology (AAN) revealed that 20% of the neurology programs do not offer a sleep medicine rotation (Avidan, Silber, & Vaughn, 2001). 31% of these programs have no faculty with sleep medicine experience. Approximately one third of these programs do not meet the current Accreditation Council for Graduate Medical Education (ACGME) requirements for sleep education, resulting in patients being under-diagnosed and missing therapeutic opportunities (Avidan, Silber, & Vaughn, 2011).

Feasibility of Sleep Medicine Education Delivered via Supplemental E-Learning

Sleep medicine education is lacking in both medical school and in residency training. The focus of this research surrounds supplemental sleep medicine education for medical residents only. The following discussion is on the feasibility of delivering this education via e-learning, with implications for mobile e-learning.

Medical residency education traditionally includes didactic lectures, but there are documented limitations with this model when no experts are available in the growing number of subspecialties relevant to medical residency education, limited human and financial

resources, legal concerns, and new technologies (Dietrick et al., 2010; Cook et al., 2009; Marks et al., 2011; Gisondi et al., 2010; Kopp et al., 2011; Skye et al., 2011; Gold et al., 2004; Kash et al., 2009; Yanni et al., 2009; Baker et al., 2010; Cook et al., 2005; Burnette et al., 2008; Gold et al., 2005; De Silva et al., 2010; Ross et al., 2011; Erickson et al., 2009; Cook et al., 2008; Bensalem-Owen et al., 2011; Branzetti et al., 2010; Roche et al., 2007; Kang et al., 2009; & Peters et al., 2008). The ACGME has also set a maximum on resident duty hours, which limit adding new teaching time (Bell et al., 2000); however, a supplemental e-learning or mobile learning program would not violate the ACGME guidelines, which only limit on-site hours.

E-learning is the gaining of new knowledge or skills through electronic instruction or study, which may include computer and/or internet-based learning, and/or learning through audio and video vignettes. With the advent of high-speed networks, intranets, and programs for building highly interactive multimedia software, many types of e-learning technologies already exist in residency education, including simulated patient case studies for clinical learning, web-based video/audio, online tutorials, CDs and DVDs, and other forms of electronic learning (Gisondi et al., 2010; Loffler et al., 2011; Wolbrink & Burns, 2011). The biggest advantage of e-learning is that it facilitates training not constrained by time, location, or availability of specific faculty.

Little knowledge exists concerning e-learning or mobile learning in medical resident education; however, the few studies that do exist from a literature review found that e-learning was beneficial in bridging the knowledge gap and the portability made it superior to

the traditional face-to-face model of teaching and learning (Dietrick et al., 2010; Cook et al., 2009; Marks et al., 2011; Gisondi et al., 2010; Kopp et al., 2011; Skye et al., 2011; Gold et al., 2004; Kash et al., 2009; Yanni et al., 2009; Baker et al., 2010; Cook et al., 2005; Burnette et al., 2008; Gold et al., 2005; De Silva et al., 2010; Ross et al., 2011; Erickson et al., 2009; Cook et al., 2008; Bensalem-Owen et al., 2011; Branzetti et al., 2010; Roche et al., 2007; Kang et al., 2009; & Peters et al., 2008). Studies of residents have also found that the same learning objectives can be met in less time through the use of e-learning. (Cook, Dupras, Thompson, & Pankratz, 2005; Bell, Fonarow, Hays, & Mangione, 2000). In one study, 73.9% of the residents stated they would make changes in their behavior or practice as a result of completing e-learning modules (Yanni et al., 2009).

In particular to Sleep Medicine, a recent study found that medical students who completed a self-paced, web-based sleep medicine online module demonstrated marked post-performance improvement on the Dartmouth Sleep Knowledge and Attitude Survey (Salas, 2012). This study concludes that a self-paced learning module is effective for teaching medical students about sleep medicine. All of the above studies demonstrate that the use of e-learning and mobile learning in medical residency education, are promising methods for understanding how residents experience online supplemental sleep medicine education; as well as promising for understanding the overall feasibility, educational impact, and applicability of the module in this research.

Residents are known for being self-directed, and the traditional model revolves around apprenticeship (situated/authentic learning), which includes strong social presence.

All of these constructs are also well-known and accepted forms of e-learning. It is a natural fit for these three constructs in medical resident education, with strong evidence mobile applications are a potentially effective delivery method.

For these reasons, three e-learning constructs are suggested for the supplemental Sleep Medicine e-learning module. These include online social presence, self-directed e-learning, and situated/authentic learning online. These constructs are applicable, especially as mobile e-learning applications, since residents are constantly on the move. The mobile nature of these constructs works with them, as they move from patient to patient, as they already work with mobile devices to submit prescriptions and write medical notes, and as they communicate with colleagues. Details of these e-learning constructs relevant to this research are discussed in detail in Chapters 2 and 3.

Definition of Terms

Sleep Medicine – a medical specialty devoted to the diagnosis and treatment of sleep disorders

e-learning - gaining new knowledge or skills, or modifying behavior through *electronic* instruction or study. In the context of this study, e-learning includes web-based learning.

mobile learning – learning with a variable physical location, variable ways of messaging, and learning by collecting information on the go; and in the case of this study, via mobile electronic devices. Medical residents have been doing this type of “on the go” learning for quite some time and this study adds the support of a technological device.

online social presence - “measure of the feeling of community that a learner experiences in an online environment” (Tu & McIsaac, 2002; p. 131)

self-directed learning – students taking responsibility for their own learning; managing their own tasks, monitoring their understandings, and sustaining their own motivation (Garrison, 2011)

situated/authentic learning online – learning that “focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice” (Lombardi, 2007).

Organization of the Study

This study is presented in five chapters. Chapter 1 identifies the problem and research questions, and describes the rationale and significance of the study. Chapter 2 comprises a comprehensive literature review of sleep medicine education, instructional technology in medical residency education, and e-learning constructs and mobile learning. Chapter 3 describes the methodology of the study. Chapter 4 describes the data analysis. Chapter 5 involves interpretation of the study findings. And finally, Chapter 6 presents the study conclusions and recommendations.

CHAPTER 2

This study is of the experience of neurology residents as they experience an online sleep education module. To carry out this research, it was necessary to critically review the current relevant literature, which is included in this chapter. This chapter is divided into three sections and provides an in-depth literature review of the needs for alternative medical education methods, medical residency and instructional technology, sleep and its evolutionary education, and e-learning and mobile learning relevant to medical residency education.

Needs for Alternative Medical Education Methods

This study looks at e-learning through the lens of sleep medicine in medical residency; however, it is first appropriate to briefly discuss the broad impact and implications of e-learning in medical education. It is no secret that medical education is a lifelong learning process. All medical professionals are responsible for continuing their education and updating their skills on a regular basis, whether they are still in school, or have been practicing for 30+ years. Each area of medicine has different educational barriers, such as those described in a following section specific to neurology residents and sleep medicine. What is common across many areas is that alternative educational methods are needed to help address educational issues, such as feasibility of on-demand or just-in-time education for ongoing learning or continuing education (Pratt, 2002; Harden, 2005; Kamdar, Kessler, Tilt, Srivastava, Khanna, Chang, Balmer, & Auerbach, 2013), lack of time for teaching and

learning (Ruiz, Mintzer, & Leipzig, 2006) and learning gaps (Oetting, 2009; Peters et al., 2008; Heard, Allen, & Clardy, 2002; Kochar, Simpson, & Brown, 2003).

E-learning offers many benefits to the common educational barriers in medical education. Certainly, e-learning is not the complete solution to all education issues, nor is it appropriate for every situation. What is important is that e-learning is cost-effective, time-saving, more convenient for the learner, and can be more customized and up-to-date than traditional methods (Pratt, 2002; Mazzoleni, Maugeri, Rognoni, Cantoni, & Imbriani, 2012). In addition, e-learning is proven to be “learner-centric” in its flexibility to accommodate to the individual learner’s rate of knowledge transfer (Dunn & Armstrong, 2008). Ultimately, e-learning is at least just as effective as traditional educational lectures, which is proven in a variety of medical education contexts (Ruiz, Mintzer, & Leipzig, 2006).

Medical Residency Education and Instructional Technology

In the United States, medical residents are physicians who hold a medical degree (i.e. MD, DO, MBBS, MBChB) and are pursuing graduate study in a particular residency program. Residency programs are offered in several specialty areas in medicine and last from three to seven years, during which time residents practice medicine, perform research, and participate in educational experiences under the supervision of physician faculty at the sponsoring hospital, health care system, academic medical center, or other approved institution (Accreditation Council for Graduate Medical Education [ACGME], 2012). Physicians are eligible to take board certification examinations in their medical specialty and

practice independently upon successful completion of their residency program (ACGME, 2012).

The Accreditation Council for Graduate Medical Education (ACGME) is the accrediting body for U.S. medical residency programs. Residency programs are offered in specialty and subspecialty areas, such as anesthesiology, dermatology, emergency medicine, family medicine, internal medicine, neurology, obstetrics & gynecology, ophthalmology, pediatrics, psychiatry, surgery, among others (ACGME, 2012).

Many states do not allow physicians to practice independently without completion of an ACGME accredited residency program. Also, physicians can only gain eligibility to take board certification examinations upon completion of an ACGME accredited program (ACGME, 2012). In 2010-2011, there were 8,887 ACGME-accredited residency programs in the United States with 113,142 active students (ACGME, 2012).

The ACGME was born in 1981, when it replaced its forerunner, the Liaison Committee on Graduate Medical Education (established in 1942) (American Medical Association [AMA], 2012). Both of these committees fell under the American Medical Association (AMA) umbrella. The AMA was founded in 1847 to raise ethical standards in medicine and help regulate the practice of medicine, including medical education (AMA, 2012). Formerly, there were only about 30 medical schools in the U.S, and most doctors received their training through apprenticeships in lieu of formal education (Taradejna, 2007). The AMA's current mission is "To promote the art and science of medicine and the

betterment of public health” (AMA, 2012). As of the year 2000, the ACGME became a separately incorporated organization (Taradejna, 2007).

Unique Learning Needs of Medical Residents

Before describing the common challenges medical residents face in their residency education, it is first appropriate to describe the overall approach to the curriculum. The ACGME mandates a set of standards for programs to follow. These standards are aimed at meeting the learning needs of residents. These learning needs culminate into one overarching need, which is to bridge the gap from a basic medical doctor, to gaining the knowledge, skills, attitudes, and performance, enabling them to become board certified and practice medicine independently in their chosen specialty.

Common program requirements.

Medical residency program accredited by the ACGME must adhere to the ACGME standards. The Educational Program standards (section IV of the ACGME standards) define the educational components that must be present in the curriculum. These include: program educational goals; competency-based goals and objectives per assignment; regularly scheduled didactic sessions; delineation of resident responsibilities over the course of the program; ACGME competencies; scholarly activities, including the basic principles of research (ACGME, 2011).

ACGME accredited program education is outcomes based, meaning that individual outcomes explicitly list what the residents will know and/or be able to do as a result of

instruction. Outcomes must be directly measurable and observable. The ACGME competencies include the following (effective July 1, 2002) (ACGME, 2011):

1. Patient Care – Residents must provide compassionate, appropriate, and effective care for the treatment of health problems and the promotion of health
2. Medical Knowledge – Residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiological, and social-behavioral sciences. Residents must also apply this knowledge to patient care
3. Practice-based Learning and Improvement – Residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care based on constant self-evaluation and life-long learning
4. Interpersonal and Communication Skills – Residents must demonstrate interpersonal and communication skills to effectively exchange information and collaborate with patients, their families, and health professionals
5. Professionalism – Residents must be committed to carrying out professional responsibilities and adhere to ethical principles
6. Systems-based Practice – Residents must be aware of and responsible to the larger context and system of health care. Residents must be able to effectively use resources in the system to provide optimal health care

The above competencies are common to all ACGME programs; however, each specialty has additional specifications. Review Committees' exists for each recognized

specialty or sub-specialty. The Review Committees' may add additional standards with respect to the common six competencies.

The most unique aspect of medical resident education is that learning objectives are met by a blended approach. This approach does include traditional didactics, but also includes clinical teaching and supervised patient care (ACGME, 2011). Unlike other fields, residents are required to have a very high level of responsibility for their patients, requiring residents to be very versatile and well rounded in the medical sciences. Medical residency is a true form of interdisciplinary education, in that residents become completely integrated with every aspect of the health-care system.

Learning gaps.

For the purposes of this study, a learning gap is defined as a gap in knowledge, attitudes, and behaviors relative to important areas of medical resident education. There are two identified learning gaps in ACGME medical residency educational programs. These include gaps in the ACGME core competencies and gaps in subspecialty practice areas.

Core competency learning gaps

Residency programs are feeling pressure to emphasize the competency-based curriculum. Surveys are revealing that graduates and program directors of ACGME programs are having difficulty demonstrating competence in all areas (Oetting, 2009; Peters et al., 2008). A national survey of program directors revealed difficulty in meeting the core competencies due to lack of time, lack of support staff, not enough expertise in curriculum

development and evaluation, and lack of funding and resources (Heard, Allen, & Clardy, 2002).

The cutbacks in Medicare funding, reduction in resident duty hours, and the addition of the six core competencies, have primed residency programs to seek new ways of meeting ACGME standards. One such program, with a very large consortium of health care institutions, admitted little emphasis on the ACGME competencies other than patient care and medical knowledge (Kochar, Simpson, & Brown, 2003). This program outsourced a web-based residency management system to help with assessment and bridge the gap, ensuring all six core competencies were met.

Subspecialty learning gaps

Multiple studies state there are gaps in knowledge when it comes to certain subspecialties. Many of these document a very limited number of hours (and sometimes no hours) dedicated to certain high need areas of medical education. These studies include subspecialty areas within:

- Pediatric and adolescent gynecology (Dietrich, Nirupama, De Silva, & Young, 2010)(De Silva, Dietrich, & Young, 2010)
- Family medicine (Cook et al., 2009)(Skye, Wimsatt, master-Hunter, Locke, 2011)
- General internal medicine (Cook et al., 2009)
- Surgery (Cook et al., 2009)(Gold et al., 2004)
- Emergency medicine (Gisondi et al., 2010)
- Neurology (Kash et al., 2009)

- Primary care (Yanni et al., 2009)(Bell et al., 2000)
- Pediatrics (Baker, Klein, Samaan, & Lewis, 2010)(Roche et al., 2007)
- Pediatric emergency department (Burnette, Ramundo, Stevenson, & Beeson, 2009)
- Thoracic surgery (Gold et al., 2005)
- Internal medicine (Ross et al., 2011)(Cook, Beckman, Thomas, & Thompson, 2008)
- Radiation oncology (Erickson, Greer, Belard, Tinnel, & O'Connell, 2010)
- Emergency medicine (Branzetti, Aldeen, Foster, & Courtney, 2010)
- Pathology (Kang, Hagenkord, Monzon, & Parwani, 2009)

Additional noted studies demonstrate further knowledge gaps. Pediatric Hematology/Oncology programs document that many residents will not be able to gain experience in pediatric hematology/oncology early enough in their residency to influence their career decisions, and many times, get no experience at all (Leavey & Jubran, 2012). There is a documented lack of education in risk management in ACGME programs, which is an important educational need of medical residents (Nissen, Angus, Miller, & Silverman, 2010).

Several studies have recognized that very few educational hours (often less than five) are incorporated into curricula, despite ACGME requirements (i.e. sleep medicine and migraine) (Kash et al., 2009). Traditional residency education in certain specialties focuses on conventional procedures, leaving a need for formal training in advanced technologies

(Martin, Kehdy, & Allen, 2005). Lack of dedicated subspecialty hours and limits on the types of procedures residents are exposed to further increases the knowledge gap, resulting in residents having to seek additional training after residency, and even undertreating patients.

There are no minimum numbers of cases required in some specialties related to laparoscopy, and colon and rectal surgery residents are not getting adequate experience with certain subtypes of laparoscopic surgeries (Charron et al., 2007). The same study found general surgery residents have a deficiency in their experience with advanced laparoscopic surgery upon graduation (Charron et al., 2007). A review of literature through the University of Iowa describes multiple studies demonstrating a lack of medical resident knowledge in areas of ophthalmology and related surgeries. In particular, resident experiences in cataract surgery primarily occurred during the third year, resulting in missed early detection and intervention (Oetting, 2009).

In a survey of recently graduated Pediatric Infectious Diseases fellows, many agree there are educational deficiencies in their training of many specialties and sub-specialties, including; gynecology, sexually transmitted disease, travel medicine, ophthalmology, adolescent medicine, urology, transplantation, allergy and immunology, and HIV care (Miltiadis, Litman, Belamarich, & Goldman, 2011). A frequent suggestion by the graduates in the above survey was to increase the amount of education in specific clinical areas (Miltiadis, Litman, Belamarich, & Goldman, 2011). A survey of family practice, and obstetrics and gynecology program directors revealed that many programs provide insufficient education in colposcopy (Spitzer, Apgar, Brotzman, & Krumholz, 2001).

Common Learning Barriers in Resident Education

Traditionally, medical residency education includes didactic lectures, observation, immersion, and apprenticeship. Unfortunately, several barriers have recently emerged, which are challenging the traditional educational format. Limited resources (both human and financial), strict guidelines on housestaff duty hours, human factors, such as sleep deprivation, stress, and burnout are among several of the identified learning barriers in this population. A discussion of these learning barriers follows.

Duty hour restrictions.

It is well documented that the primary learning barriers in medical resident education are the already full curriculum and the limits the ACGME places on the number of hour's residents are allowed for teaching, learning, and patient care combined. The duty hour limits were a result of concerns by the medical community that long hours and restricted sleep had a negative effect on residents' performance (ACGME, 2012). ACGME duty hour standards include the following (ACGME, 2012):

- 80 hour limit on duty hours, averaged over a four-week period
- Moonlighting must count toward the 80-hour maximum
- A minimum of one day free of duty each week, when averaged over a four week period, is required
- Duty periods may not exceed 16 hours in duration for PGY-1 residents and 24 hours in duration for PGY-2 residents and above

- Residents must have a minimum of eight hours free of duty between scheduled duty periods
- The maximum frequency of in-house night float is six consecutive nights
- PGY-2 residents and above may not have in-house call more frequently than every third night, when averaged over a four week period
- At-home call must count toward the 80-hour maximum weekly hour limit

80 hours may appear like a large amount of time, but considering the amount of information and the combination of clinical, research, educational, and other activities simultaneously going on, 80 hours does limit educational activities. Although traditional lectures are still a part of residency education, the advent of the new duty hour restrictions has actually resulted in poor attendance in afternoon didactic conferences (Espey, Ogburn, & Puscheck, 2007). Residents have cited that the timing of scheduled educational sessions, in combination with competing clinical duties, have hindered their ability to attend (Spencer & McNeil, 2009).

The reduction in duty hours results in residency programs “having to cut corners” in educational activities (Goitein, Shanafelt, Wipf, Slatore, & Back, 2005). Specifically, clinical educational experience is limited in the traditional residency education model given the duty hour restrictions (Nothnagle, Anandarajah, Goldman, & Reis, 2011). Several specialties are formally documenting how their educational activities have been limited. For example, in a pediatric residency program, duty hour restrictions are potentially limiting resident exposure

to needed subspecialties early in their training, due to competing interests with program directors trying to meet ACGME standards (Leavey & Jubran, 2012).

Limitations on duty hours make it very difficult to incorporate subspecialty training, especially when using traditional didactic approaches. For example, lack of curriculum time in primary medicine residency programs to include education in substance abuse, which is a high need area (Seale, Shellenberger, & Clark, 2010). For these reasons, adopting novel ways of teaching without interfering with the 80-hour limitations is a viable approach to medical residency education.

Sleep deprivation, stress, and burnout.

Residency education is perhaps the most challenging aspect of all medical education. It is widely known and accepted that medical residency education is a particularly stressful period (Collier, McCue, Markus, & Smith, 2002)(Levey, 2001). Sleep deprivation is known to negatively affect residents with regard to performance, education, and safety; which was the root of the movement to reduce resident duty hours (Barger et al., 2006). Still, even with the reduction to the 80 hour workweek, there is not much time for new instruction.

Several situational stressors are inherent in medical residency education, which include sleep deprivation, excessive workload, inordinate hours, sub-optimal learning conditions, and overbearing responsibilities with inadequate support (Levey, 2001). Stress affects the physical and psychological health of residents. These affects result in decreased professional performance (McCann, Knudson, Andrews, Locke, & Davis, 2011). This gives rise to the needs of support systems for residents to keep their education progressing. The

ACGME does require that residency programs put measures into place to help promote resident well-being, and reduce stress and negative working conditions, with the goal of preventing impairment (ACGME, 2012). However, stress is still a significant and documented problem in residency education.

Residents suffer burnout from working hours and working conditions (Ludmerer, 2009)(Ishak et al., 2009). Burnout is a state of mental and physical exhaustion, in this case, due to a combination of long hours, caseload, among other factors. Research has identified a relationship between resident stress and burnout and medical errors (West, Tan, Haberman, Sloan, & Shanafelt, 2009). Even with the ACGME reduction in duty hours, burnout still prevails (Cedfeldt, English, Youssef, Gilhooly, & Girard, 2009). Burnout can cause decreased concentration, among many other devastating effects, which impact a residents learning (Ishak et al., 2009).

Stress affects resident's overall mental health, which in turn can negatively affect their performance on assessments (Beckman, Reed, Shanafelt, & West, 2012). Since residency programs are competency based, a strong emphasis is placed on assessments. Medical knowledge and clinical performance assessments are primary in demonstrating competence, and scores may be influenced when residents are suffering from stress and burnout (Beckman, Reed, Shanafelt, & West, 2012).

Lack of resources and content experts.

Medical residency training has evolved greatly in recent years due to the introduction of a multitude of subspecialties. Traditional teaching methods are being challenged because

of a lack of content experts and limited resources. It is documented that there are very few hours, and sometimes no hours dedicated to certain high need subspecialty areas of medicine in several medical residency programs (Avidan, Silber, Vaughn, 2011; Dietrick, Nirupama, & Young, 2010; Marks et al., 2011; Kopp et al., 2011; Skye et al., 2011; Kash et al., 2009; Baker et al., 2010; Cook et al., 2005; Burnette et al., 2008; De Silva et al., 2010; Ross et al., 2011; Bensalem-Owen et al., 2011; Branzetti et al., 2010; Roche et al., 2007; Cook, et al., 2009; Gold et al., 2004; Yanni et al., 2009; Gold et al., 2005; Erickson et al., 2009; Kang et al., 2009; Bell et al., 2000; Gisoni et al., 2010; Cook et al., 2008; Peters et al., 2008). These studies also document that residents do in fact lack knowledge in these areas.

In addition to limited human and financial resources, other issues are hindering resident education, including legal concerns and the rapid expansion of knowledge and technology (Marks et al., 2011). Another problem arising from a lack of teaching resources and experts is that the lack of subspecialty experience early in a resident's career can narrow residents career decision base (Leavey & Jubran, 2012). A survey of obstetrician-gynecology residents found that 77% reported two or less teaching sessions in primary care, in which 85% of these residents will eventually practice (Spencer & McNeil, 2009). A cited reason was limited faculty time and resources. Residency programs recognize these issues, but traditional curriculum redesign is expensive, takes a great deal of time and expertise, and considered impractical.

The volume of new medical information is ever expanding, placing demands on residents to have access to, synthesize, and practically apply an enormous amount of

information (Nothnagle, Anandarajah, Goldman, & Reis, 2011). Traditional residency models of education cannot possibly cover all of this information, creating yet another educational barrier for today's practitioner. Primary Care has documented this as a hindrance and has identified a need for primary care practitioners to have diversity of knowledge and skills (Nothnagle et al., 2011).

In family medicine residency programs, it has been cited that faculty development is needed in certain high need areas, such as substance abuse (Seale, Shellenberger, & Clark, 2010). Faculty numbers are considered inadequate to meet the basic educational needs in this subspecialty. Also, there is limited faculty that could be considered mentors or role models.

International diversity can be an issue when a significant number of residents are international students, without standard education and limited or no access to specific subspecialties (Seale et al., 2010). These residents may not have access to standardized diagnostic instruments. Furthermore, residency programs that also have limited access to these instruments for subspecialty practice further limits residency learning. Since 2004, approximately 40% of residents in family medicine residency programs are international, which increases the heterogeneity of the group, making a "one size fits all" curriculum ineffective (Nothnagle et al., 2011).

An interesting finding in light of the reduction in resident duty hours is that not all the extra time now available is used for sleep (Baldwin, Daugherty, Ryan, & Yaghmour, 2010). This suggests that residents are using their extra time for other activities because they believe they are meeting their sleep needs. This supports the idea of residents utilizing some of this

new time for supplemental educational activities to make up for the limitations in subspecialty education.

Instructional Technology as a Means to Address Learning Needs and Barriers

A Medline search was performed to identify research regarding medical resident education and the implementation of instructional technology. The search was limited to human studies only and was limited to English language literature from the United States. The following terms and phrases were searched in the PubMed database in July-August 2012:

- Medical resident education technology
- Resident education instructional technology
- Mobile medical resident education
- mLearning or m-learning
- mobile learning
- e-learning medical resident education
- e-learning resident education
- eLearning or e-learning
- e-learning medical student
- electronic learning resident education
- web-based resident education
- internet-based resident education
- computer-based resident education

- online learning modules resident education
- Online education resident
- Distance education resident
- Web-based learning environments resident
- Web-based learning resident
- Online learning resident
- Distance learning resident

Within each search, titles and research abstracts were reviewed and all pertinent articles were downloaded and reviewed. The references of articles were also reviewed to identify additional relevant research. 37 relevant articles were identified from the above search methods. All 37 articles were fully reviewed and results are described below and grouped according to dominant themes.

Web-based teaching.

Due to lack of exposure in the fields of Pediatrics and Obstetrics and Gynecology (OB/GYN), a web-based teaching tool was implemented to provide OB/GYN residents in a large university-based program with education in these areas (Dietrich, De Silva, & Young, 2010). The web-based educational system was used as a supplement to a one-month rotation in Pediatric and Adolescent Gynecology (PAG). 20 case studies were included, covering basic educational topics in PAG. Residents reportedly spent about 14 minutes per case. Residents completed pre and post-tests, which revealed a statistically significant personal improvement in five out of six cases ($P = 0.0002$) (Dietrich et al., 2010). All residents also

self-reported that the cases enhanced their learning and they would complete future supplemental web-based programs.

To help educate residents in treating hyperglycemia (an identified subspecialty need area) and to reduce the time and resources required for delivering multiple lectures, a computer-based training (CBT) curriculum was developed to address educational needs in this area (Cook et al., 2009). The CBT program consisted as a series of lectures in seven modules, which resided on the institution's intranet, and can be accessed remotely. The modules included audio/visual lectures with interactive case studies, and residents reportedly spent an average of 30 minutes per module. Results from a resident survey after completion of the modules indicated overall acceptance from residents, and that residents considered the modules to be valuable to their practice (Cook et al., 2009).

Computer Enhanced Visual Learning (CEVL) was a tool utilized for web-based education for urology residents to learn ultrasound grading in neonatal hydronephrosis (Marks et al., 2010)(Maizels et al., 2009). Tutorials were web-based and included multimedia and interactive cases. Residents' pre and post-test scores demonstrated a mean improvement of 18% (95% CI, $P < 0.002$) (Marks et al., 2011).

A web-based educational program was developed to address educational needs of internal medicine residents with regard to advanced procedures (i.e. placement of central venous and arterial lines), in which it is documented there is limited educational exposure (Grover, S., Currier, P., Elinoff, J., Katz, J., McMahon, G., 2010). A randomized study of internal medicine residents across three residency programs was conducted to evaluate the

effectiveness of the web-based educational program. Two educational modules included videos (approximately 10 minutes each), procedure written summaries, and articles. The web-based education was associated with statistically significant improvements in residents test scores ($P = .01$, $P < .001$), improvement of residents' knowledge of procedures, and the modules were well-accepted by residents (Grover, 2010).

To promote curriculum standardization and improve resident learning, a web-based learning portal was implemented in 33 General Surgery residency programs (Schmitz, Risucci, Plass, Jones, & DaRosa, 2011). The portal was designed for resident self-study and contained educational content for 700 topics, including textbooks, imaging, procedure videos, and practice exams. A survey was conducted to predict how residents would use the portal, which revealed that the rationale for implementing the web-based portal was accepted and supported by residents and program directors (Schmitz et al., 2011).

Achieving Competence Today – ACT was a four-week active learning course utilizing web-based materials to teach systems-based practice and practice-based learning and improvement to Internal Medicine residents (Peters et al., 2008). Learning was primarily self-directed, and residents were provided with readings, web links, cases, and exercises via the web. Overall, residents held positive attitudes toward the new learning experience. Resident knowledge and self-assessed competency were significantly higher for the group utilizing the ACT program as compared to the control group (Peters et al., 2008). Web-based modules were developed as a supplement to resident rotations identified as needing additional educational opportunities, in particular, musculoskeletal examination,

procedures and approaches, and mind-body medicine (Skye, Wimsatt, Master-Hunter, & Locke, 2011). The modules included embedded case presentations and video demonstrations, which were built with web-authoring software. Each module required 10-60 minutes to complete. Survey's revealed that most residents accepted and found the modules effective (Skye et al., 2011).

A web-based neurology resident educational program was developed to meet the ACGME outcomes project and provide measurable improvement of headache medicine (Kash et al., 2009). The web-based program included five interactive headache cases and simulated computerized clinical encounters. Pre and post-test scores demonstrated significant improvement of resident knowledge and performance through use of the web-based system ($P < .001$) (Kash et al., 2009).

An internal medicine residency program constructed web-based modules and conducted a study to compare the web-based teaching format to a traditional teaching format (Cook, Dupras, Thompson, & Pankratz, 2005). The web-based educational modules included journal articles, clinical tools, and patient handouts. Each module had sections on epidemiology, screening and diagnosis, initial evaluation, management, complications and comorbidities, and a bibliography. In the end of course questionnaire, 78% of the residents preferred the web-based format. Test scores improved for both formats with no significant difference ($P = 0.24$), except that residents spent less time meeting the same objectives with the web-based modules (Cook et al., 2005). Overall, 72% of the residents agree the web-based modules are efficient, useful, and more convenient than traditional didactics.

To examine the effectiveness of asynchronous, web-based learning for pediatric emergency medicine, a web-based tool was developed and piloted with a large group of residents (Burnette, Ramundo, Stevenson, & Beeson, 2009). The web-based curriculum consisted of 21 lectures voice-over presentations, each approximately 20 minutes. Residents believed the web-based lectures were useful and liked how they could view lectures on their own time, and choose the lectures they felt they would benefit the most from. Pre and post-test improvement was 6.2 percent for the web-based lectures, versus 1% for those viewing no lectures (95% CI) (Burnette et al., 2009).

Since most medical schools do not include palliative care training – citing lack of resources and experts, a clinical rotation observation combined with a web-based learning program was used with internal medicine residents to provide basic competency in palliative care (Ross et al., 2011). The program included 19 topics in six units. Presentation format of the units ranged from interactive case-based to text-based. Residents favored the web-based program and believed it was valuable and relevant. Pre and post-test scores demonstrated a significant increase ($P = 0.0292$) (Ross et al., 2011).

A study was conducted to evaluate the effectiveness of using a web-based application sharing software for radiation oncology residents (Erickson, Greer, Belard, Tinnel, O'Connell, 2010). The sessions were synchronous, using Adobe® Connect, and residents had remote access to take turns using standard three-dimensional radiation treatment planning software. Instructors were able to immediately give feedback and demonstrate proper

techniques. In concluding surveys, residents rated the program as effective for learning (Erickson et al., 2010).

To help teach residents in a variety of complex patient cases, a web-based educational program was developed and implemented with a large group of internal medicine residents (Cook, Beckman, Thomas, & Thompson, 2008). The web-based modules were designed to offer complex cases with multiple solutions to help residents appreciate the complex environment they work in. Four web-based modules contained common ambulatory medicine topics, and included standard cases, evidence-based information, and self-assessment questions. Resident surveys indicated that residents did not like the diversity and ambiguity of the faculty, but that they did feel the cases reflected reality and helped them reinforce what they have learned, although, pre and post-test scores revealed no significant differences in learning ($P = 0.09$) (Cook et al., 2008).

Podcasting technology was used in a web-based format to teach electroencephalography monitoring to a group of anesthesiology residents in a study to determine the effectiveness of this teaching tool (Bensalem-Owen, Chau, Sardam, & Fahy, 2011). Lecturers were recorded and formatted for the web and uploaded to iTunesU for residents to view independently. Participating residents were given pre and post-tests, and a majority had increased scores after viewing the podcast ($P = 0.034$) (Bensalem-Owen et al., 2011).

Due to a lack of targeted didactics during emergency medicine resident rotations, an online curriculum was tested to see if it would be accepted by residents, and be useful for

knowledge transfer (Branzetti, Aldeen, Foster, & Courtney, 2010). Two groups participated in the study, one with access to the web-based curriculum, and one without. The web-based curriculum consisted of six 20-30 minute, narrated lectures in an audio/video format. Over 80% of the residents accepted and approved of the web-based curriculum, and there was a significant increase in knowledge of emergency medicine after completion of the web-based curriculum (Branzetti et al., 2010).

A lack of resources, experts, and time prompted the creation of a web-based training program for residents in pathology informatics (Kang, Hagenkord, Monzon, & Parwani, 2009). Field experts recorded didactic lectures and hands-on laboratory sessions, which were incorporated on a web site along with a list of textbook readings and self-assessments. There were a total of 7 modules, which could be accessed in any order. On average, post-test scores increased by 24.3%, and an overall positive response to the web-based modules (Kang et al, 2009).

A study comparing knowledge, learning efficiency, and learner satisfaction between web-based and print-based educational materials was conducted with a large group of family medicine and internal medicine residents across four universities (Bell, Fonarow, Hays, & Mangione, 2000). The web-based materials contained hyperlinks to sets of learning resources organized by objectives, which also included tutorials and simulations with graphic models. The post-test scores did not significantly differ between the test and control groups; however, the group using the web-based curriculum demonstrated a 28% better learning efficiency

with 30% less study time ($P < 0.001$) (Bell et al., 2000). The users of the web-based system were also more satisfied with their learning than the control group.

Computerized tutorials.

A standardized multimedia computer tutorial was developed to educate pediatric residents in childhood learning disorders (Bridgemohan, C., Levy, S., Veluz, A., Knight, J., 2005). Resident's perceptions were explored in response to the computerized tutorial and compared to a facilitated case discussion. The study involved residents working in groups of 2-3 for 30-40 minutes at computer stations linked to interactive websites, and used the case-based tutorials to work through patient cases. Results revealed that residents enjoyed the computerized tutorial and believed the knowledge gained will improve and change their future practice (Bridgemohan et al., 2005).

A documented deficient curriculum in nutrition-related education sparked the development of a computer-based CD program covering topics of oral rehydration therapy, calcium, and vitamins, and was piloted with a sample of pediatric residents (Roche, Ciccarelli, Gupta, Hayes, & Molleston, 2007). A series of 20-30 minute nutrition modules were created, which contained a topic overview, background, physiology, treatment/management, parent education, self-assessments, and web links. Post surveys revealed the residents believed the computer-based instruction to be effective; and the residents who completed the computer-based series had significantly higher post-test scores than a control group ($P = 0.0005$) (Roche et al., 2007).

Learning management system.

A learning management system was developed and implemented with anesthesiology interns beginning their residency training (Chu et al., 2010). The system blended e-learning, such as video lectures, text, and group interaction, and allowed virtual mentorship via a learning management system. The video podcasts lasted approximately 30 minutes with pre and post quizzes. Resident surveys reveal the educational program was useful and accepted by residents (Chu et al., 2010).

An anesthesiology residency program conducted a study comparing traditional didactics to e-learning utilizing a learning management system – BlackBoard Vista (Kopp & Smith, 2011). The curriculum consisted of four web modules, two were interactive case-based with multimedia and two were traditional textbook style. Pre and post-test scores revealed increases in scores for both modules, and nearly all residents agreed that web-based learning should be used in resident education (Kopp & Smith, 2011).

An online supplementary pediatric primary care curriculum was created for medical residents to help increase knowledge transfer for identified high need primary care topics (Baker, Klein, Samaan, & Lewis, 2010). The education was delivered via the Blackboard e-learning platform and consisted of modules with presentations, online readings, hyperlinks, clinical cases, animation, streaming audio/video, and quizzes. On average, each of the 20 learning modules took less than 60 minutes to complete. Pre and post-test scores demonstrated a significant increase in knowledge among the residents ($P < .001$), and most

residents believed the online learning was effective and had positive attitudes (Baker et al., 2010).

A web-based system was developed and implemented for thoracic surgery education (Gold et al., 2005). The web-based curriculum contained 75 learning modules in 13 sections with audio/video presentations, summary, frequently asked questions, references, self-assessment, and a critique. The curriculum was given to residents the year prior to their matriculation. The study lasted three years and saw an increased usage over the three year period, with surveys demonstrating strong resident satisfaction (Gold et al., 2005).

Third and fourth year residents in a large university program participated in web-based computerized case series aimed at increasing knowledge in adolescent gynecology (De Silva, Dietrick, Young, 2010). The case series included 20 case presentations, with an average completion time of 5.5 minutes, and was self-paced. Cases included patient history, physical examination, laboratory values, imaging, questions, discussion, and references. Post-test scores were 20% higher than pre-test scores ($P < .05$) (De Silva et al., 2010).

E-Learning.

Challenges in implementing public health education, in particular – completing death certificates, in resident education prompted the creation of an e-learning program to address this need (Hemans-Henry, Greene, & Koppaka, 2012). Internal medicine, general surgery, and emergency medicine residents participated in an e-learning course lasting approximately one month. The course included case-based exercises and test questions, and was

administered via learning management system. Pre and post test scores significantly improved for the two groups involved ($P < .01$ and $P < .001$) (Hemans-Henry et al., 2012).

Physicians across multiple specialties report inadequate training in end-of-life care. A comprehensive curriculum in Palliative and End-of-life Care for Emergency Medicine (EPEC) was adapted into an Emergency Medicine residency program (Gisoni et al., 2010). The curriculum consisted of 14 modules, half synchronous with traditional lecture, and half asynchronous with electronic media. Pre and post-test scores improved for both groups, with no significant differences (95% CI), demonstrating effectiveness of the e-learning program (Gisoni et al, 2010).

An Internet CD-ROM thoracic surgery e-learning system was implemented to test resident acceptance and educational impact (Gold et al., 2004). The course contained 75 learning segments with textbook and case-based navigation. Average resident time spent using the e-learning system was 1.45 hours per week. Residents rated the system as valuable and superior to traditional reading, and there was a positive correlation between exam performance and use of the e-learning system (Gold et al., 2004).

Resident and physician indicated lack of confidence in chronic nonmalignant pain prompted the development of a university based e-learning resource, which was piloted at 13 different residency programs across several institutions (Yanni et al., 2009). The curriculum was composed of six modules delivered via a website, which included text and case-based assessments, tabbed resource pages, and extensive references and web links. The pre and

post-test results demonstrated only nominal improvement, however, ease of use and course content were highly rated among residents and reviewers (Yanni et al., 2009).

Mobile learning.

Mobile education or mobile learning is a relatively new area of study in medical residency programs. Very few studies exist looking at mobile learning for this population. The relevant studies are described next.

In 2011, a national study was conducted across Radiology programs in regard to mobile technology and education (Korbage & Bedi, 2012). Program Directors were emailed and asked to encourage their residents to participate in a survey. The survey included questions about residents study habits, access to mobile devices, and preferences for electronic versus print resources. The survey found that 74% of the residents used smart phones and 37% used tablets. Residents surveyed spend the same amount of time studying from electronic resources as they do print resources, with 80% of residents admitting they prefer electronic resources if they were provided with mobile devices from their departments (Korbage & Bedi, 2012).

Due to limited resources, The University of Pennsylvania partnered with the University of Botswana to explore the role of smartphone based mobile learning. Residents used Android-based myTouch 3G Smartphones equipped with cameras. The Smartphones were loaded with point-of-care and drug information applications, telemedicine application for connecting with a mentor, and e-mail/Internet access. The survey's administered to these

residents after a pilot with the Smartphones revealed that the residents effectively utilized the Smartphones, both at bedside, and at home via self-directed learning (Chang et al., 2012).

Citing resident work hour restrictions as a problem for resident exposure to certain procedures, a mobile learning application was created to train anesthesia residents on chest tube insertion (Davis et al., 2012). The mobile application was a 3-minute video viewable on an Apple® iPod Touch. Study results revealed that residents who used the mobile application scored better on the skills checklist than those who did not use the application (Davis et al., 2012). Favoring a Just-In-Time learning concept, the mobile application was deemed useful for enhancing and standardizing this type of education, especially for residents to access the information directly before a procedure.

A comparison study between two groups of orthopedic residents was performed utilizing mobile tablet (iPad®) devices for one group, and traditional print materials for the other group (Tanaka, Hawrylyshyn, & Macario, 2012). The instruction consisted of journal articles for both groups. The group utilizing the mobile tablets also had access to online textbooks and links to peer reviewed Internet sites. Overall, the residents accepted and favored the mobile curriculum (Tanaka et al., 2012).

A neurosurgery residency program cites educational challenges due to limitations of graduate medical education, and utilized a website and iTunes U to broadcast recorded lectures (Gonzalez, Dusick, & Martin, 2012). Didactic sessions and case discussions were performed in traditional fashion and then recorded and uploaded to a digital library.

Residents were provided with mobile tablets with access to the lectures, along with additional

teaching tools. Overall, the study revealed that resident's exam performance significantly improved ($P = .04$) (Gonzalez et al., 2012).

A radiology residency program introduced a mobile personal digital assistant (PDA) educational system and conducted a study to determine its educational impact (Nishino et al., 2004). Through the PDA, residents had access to the department's Intranet, cases, differential diagnosis, acute contrast reaction management, advanced cardiac life support, algorithms, protocols, and guides. After implementation of the mobile device system, residents increasingly utilized the PDAs. Within six months, the digital books and references increased as residents' first choice from 0% to 16% ($+ = .125$) (Nishino et al., 2004).

Simulation.

Simulation programs are being used in multiple medical resident specialties and subspecialties as a means to give residents experience when actual patient cases may be limited. Simulation programs are found to be an effective tool for increasing resident knowledge and skills in fields, such as pediatric gynecology (Loveless, Finkenzeller, Ibrahim, & Satin, 2011). Surgical residency programs are finding success with implementing simulation programs for surgeries, and are reporting resident compliance (Fernandez et al., 2010).

Section Conclusion

Medical resident education is very challenging and new barriers exist, which further challenge the structure of the programs. These challenges include limits on the number of resident hours dedicated to education, lack of content experts, lack of resources; and stress,

burnout, and sleep deprivation of residents. Over the past few years, many new endeavors are underway to overcome these barriers, and instructional technology is a novel, but increasingly popular tool used in these programs. Methods, such as e-learning and web-based learning have been found to accomplish the same learning objectives in less time in resident education, and are not constrained by time, location, or availability of space or specific faculty – hence not interfering with the required resident duty hours. Overall, instructional technology is an effective method for overcoming barriers associated with medical residency education. In particular, new ways of using technology, such as with mobile devices appear to be very promising for use in medical resident education.

Sleep Medicine: Its History and Evolutionary Education

Since the beginning of time as we know it, sleep is integral to the health and wellbeing of all living creatures. This section explores sleep medicine as a discipline, as well as how sleep medicine education evolved in higher education. A discussion of the adequacy of today's educational requirements in sleep medicine, as well as a discussion of the feasibility of using e-learning in sleep medicine education follows. First, however, it is most appropriate to travel back in time to set the stage – to the roots of this fascinating, mysterious, and quickly evolving discipline.

Historical Perspective of Sleep

Sleep has interested man since the beginning of time. Some of the earliest philosophies in human history, such as the Rishis of India, describe states of waking consciousness and dreaming (Harvard, 2012). Ancient writings, like the ancient Chinese

proverb “He holds nothing back from life; Therefore he is ready for death, as a man is ready for sleep, after a good day’s work”, attributed to Lao Tzu, often compare sleep with death. Opium was widely used in history, as far back as the Sumerian age, for treatment of insomnia, suggesting it is was the first hypnotic medication (Pollak, Thorpy, & Yager, 2009).

The ancient Egyptians practiced hypnosis and dream interpretation (Harvard, 2012). Ancient Greeks and Romans have powerful sleep deities, such as Hypnos (the Greek god of sleep), Somnus (the Roman god of sleep), and Morpheus (the Greek god of dreams) (Merriam-Webster, 2012). The ancient Egyptian physician Artemidorus of Daldis wrote the major work on dreams, *Oneirocritica*, which functioned as a dream interpretation manual (Barbera, 2008). The ancient Egyptian papyrus, Chester Beatty, has a strong focus on dream interpretation (Kirsch, 2011). Ancient Chinese viewed physiology as a humoral system and the patient’s dreams were as important in diagnosis as their symptoms (Pollak, Thorpy, & Yager, 2009).

There are many theories of sleep, spanning throughout history. The first theory of sleep recorded was in the sixth century B.C. by Alcmeon, a contemporary of Pythagoras (Kleitman, 1963), in which he attributes sleep to anemia caused by venous congestion. Aristotle theorized that sleep was a result of heat rising from digestion (Aristotle, 1908).

Sleep Rituals Across Cultures

Sleep is like “putty—some cultures stretched it out, some chopped it up, and others, like our own, squeezed it into one big lump.” ~ Jeff Warren – *The Head Trip*

Sleep comes in many flavors. Our familiar ritual, after dark, we go into our bedrooms,

change into our sleeping attire, cut off the lights, and climb into bed. Then suddenly awaken by the alarm in the morning. The twist - our ritual does not apply to people outside of the modern Western world. And actually did not apply to the inhabitants of Western Europe as recently as 200 years ago.

Many societies exhibit polyphasic sleep patterns. Some of the patterns are characterized by lengthy daytime sleep. According to Dr. Bradley Vaughn, in the 1800's, writings refer to first and second sleep. People would go to sleep when the sun went down, and arise during the night for a social period before retiring for a second sleep period. A biphasic sleep pattern is still a norm in South America, Africa, Asia, and in countries around the Mediterranean Sea (Jenni & O'Connor, 2005).

Traditional societies, such as farmers, herders, and tribes in Paraguay, Africa, Pakistan, and Indonesia utilize group sleep, where shared sleep spaces feature constant background noise, domestic animals, fires maintained for warmth and protection from predators, and other people's close-by activities (Bower, 1999). Group sleep is considered safe sleep by these societies because someone will always be up and will warn others of danger or emergency. The Gebusi (rainforest dwellers) of New Guinea also have communal sleep rituals. Women, girls, and babies crowd together in a community house and sleep on mats while the men and boys sleep on wooden platforms in an adjacent community house (Bower, 1999).

The practice of training children to sleep alone through the night is only about 150 years old, and principally a western practice (Thevenin, 1987). Ours is one of a few cultures

where it is considered socially unacceptable for infants and children to sleep in the same bed or room as their parents. In fact, other countries, like Guatemala, Vietnam, China, Italy, India, and Japan, view this practice as merciless and child neglect (Jenni & O'Connor, 2005; Davies, 1995; Thevenin, 1987). Prior to the late 1700's, cosleeping was the norm in all societies (Davies, 1995).

Napping often has a negative connotation for adults in our culture, but many other cultures embrace napping as the norm. "Siesta Cultures" refer to societies in which nap or rest time at the heat-filled midday and society essentially shuts down during this time as businesses, government offices, and social activities close during that time (e.g. Italy, Mexico, Spain) (Jenni & O'Connor, 2005). In Japan, "inemuri" (i.e. to be present and sleep), is socially acceptable where people nap in situations not typically meant for sleep, such as at work, during conferences, at social events, in trains, etc. (Steger, 2003).

What Sleep Is and Why We Do It

Two questions researchers, physicians, and the public still largely ponders are: What is sleep and why do we do it? There have been multiple theories on sleep throughout history, and sleep theories will likely continue. The answers, however, remain a mystery.

What is sleep?

According to Dr. William Dement (1997), one of the founding fathers of Sleep Medicine, "The crucial event that occurs as we fall asleep is an abrupt shut down of the neural processes that allow us to perceive the world around us. At one moment we are awake, and can see and hear. A fraction of a second later we are asleep, and we are completely blind

and completely deaf. Another way of saying this is that sleep is a behavioral state of complete perceptual disengagement from the environment. Sleep is an active process in which sensory stimulation is blocked or modified in some way such that we cease to be conscious of the world around us. In fact, research over the past couple of decades has decisively established that the sleeping brain is an active brain. Because so many people believe that sleep occurs when the brain is ‘turned off,’ I like to say, ‘If that is your image of sleep, then hear this, ‘the brain never sleeps!’”

According to the American Academy of Sleep Medicine (2012), “Sleep is much more than a gentle ‘pause’ from your daily activities. It is an active state that helps maintain and renew your mental and physical health. Behind the curtain of sleep at night, your brain controls important functions that set the stage for the next day. Muscles are repaired. Breathing, heart rate, blood pressure, and hormone levels are regulated. New information is processed, and memories are formed. Sleep is essential for your health and is the most valuable part of your day. After a good night's sleep, you will feel, think, and perform your best.”

Why do we sleep?

According to the National Institutes of Health (2003), “Sleep is not just something to fill time when a person is inactive. Sleep is a required activity, not an option. Even though the precise functions of sleep remain a mystery, sleep is important for normal motor and cognitive function. We all recognize and feel the need to sleep. After sleeping, we recognize changes that have occurred, as we feel rested and more alert. Sleep actually appears to be

required for survival. Rats deprived of sleep will die within two to three weeks, a time frame similar to death due to starvation.”

In an interview with CBSNews (2008), Matthew Walker (University of California Berkeley), states “One thing that’s clear is that sleep is critical... And it's not just rats: every animal studied so far needs sleep, from the elephant right down to the fruit fly. But that's as far as the similarities go. Some animals sleep 20 hours a day, others only two or three. And still others sleep with half their brains at a time, all making it hard to figure out what exactly it is about sleep that makes it so essential, and that, in terms of evolution, makes it worth the risks.”

The Beginning of Sleep Medicine as a Discipline

The following outline, adapted from the Division of Sleep Medicine at Harvard Medical School (2008) and from many other resources, traces and highlights the history of Sleep Medicine as it has transformed as a discipline.

Ancient civilization: 800 B.C. – 200 A.D.

- ~500-450 B.C. Alcmaeon, a Greek philosopher/physician is credited with the first documented sleep theory. He claims that sleep is a loss of consciousness resulting from blood draining from the vessels on the body’s surface. (Kirsch, 2011).
- ~400 B.C. Hippocrates, in *Corpus Hippocraticum*, theorizes that sleep is caused by blood retreating to the inner regions of the body, hence why sleepers feel cool to the touch.
- ~400 B.C. Androstheneas (Alexander the Great’s scribe), gives the first documented

reference of the circadian rhythm as he describes the leaf movements of the tamarind tree.

- ~350 B.C. Aristotle writes his opus “On Sleep and Sleeplessness” where he describes sleep as a means for physical renewal (Kirsch, 2011). He attributes the initiation of sleep as a direct result of warm vapors that rise from the stomach during digestion, and that “a person awakes from sleep when digestion is complete”.
- ~162 A.D. Galen, a Greek physician, is the first to believe consciousness resides in the brain, as he was first to experimentally observe the brain.

For the next almost 2,000 years, the scientific community essentially ignores sleep science. Sleep science becomes one of the most under-researched disciplines. “It’s one of the great ironies of science really, the fact that the phenomenon of sleep — which is essential to our health and survival, and which totally occupies one-third of our lives — has, until relatively recent times, received no respect at all from the world of serious science. Previous generations of scientific thinkers regarded sleep as nothing more than a monolithic loss of consciousness; an important function, but not one worthy of serious scientific study.” – Discovery Health (2012).

The Renaissance: 1400-1599

Sleep theories continue to focus on sleep being triggered by lack of blood/oxygen or accumulation of toxins in the body. Centuries will pass before scientists make the connection that the brain is in control of sleep and wakefulness. The Renaissance offers little toward the understanding of sleep.

- 1584 *The Haven of Health* – Thomas Cogan continues to advocate for Aristotle’s theory that sleep is initiated by heat rising in the body from digestion (Cogan, 1588). He theorizes that certain foods promote sleep more than others (i.e. meat, milk, and wine).
- 1598 William Shakespeare – He often references sleep and dreaming, as in the famous Hamlet quote, “To sleep, perchance to dream...” Nightmares and insomnia are common sufferings of Shakespearian characters (Fogan, 1989). In *Henry IV*, Shakespeare describes some of the respiratory disturbances during sleep, such as Cheyne-Stokes breathing and obstructive sleep apnea. These sleep/breathing patterns will not be officially recognized for centuries.
- 1400-1599 “hygiene” - Continuing from the twelfth century and often associated with Hippocrates, physicians and scientists continued to believe that the Galenic six “non-naturals”, which are “air, movement and rest, food and drink, sleep and vigil, inanition and repletion, and affections of the mind” are the critical external factors affecting sickness and health (Snider, 2008; Dannenfeldt, 1986). These factors are considered “hygiene”.

The Enlightenment: 1600-1799

The origin of sleep is still a debate during this time, but major changes are on the way. Previously, dreams were considered sacred and only interpreted by holy people, but this age brought new trends. The intellectual class began self-observing and documenting their dreams. For others “sleep is less an intellectual exercise and more an exercise in futility.

Obstacles to sleep are abundant. The poor and laboring classes especially suffer chronic sleep deprivation. Weary servants must rise frequently during the night to meet their employers' demands" (Harvard, 2008). Sleep was a challenge for everyone, even the higher social classes because of drafty dwellings, noxious chamber pots, the proliferation of lice, bedbugs, fleas, and vermin.

- 1650 Birth of Neurology – British physician Thomas Willis and colleagues localize consciousness to the brain. He writes the first major work on the brain “The Anatomy of the Brain”, where he describes how different mental functions are handled by particular regions of the brain. His groundbreaking writings have many opinions about sleep, and describe narcolepsy, insomnia, and sleepwalking (Kirsch, 2011).
- 1737-1798 Luigi Galvani, an Italian physician, discovers that the nervous system and muscles contain natural electricity. This discovery is revolutionary and paves the way to measuring the electrical activity of the brain during sleep.
- 1769-1821 Napoleon Bonaparte prescribes “six hour sleep for a man, seven for a woman, and eight for a fool” (Harvard, 2008).

The Industrial Age: 1800-1899

The Industrial Age initiates major changes in views of sleep, as gas lighting, the incandescent light bulb, and the coil spring mattress are invented. Excessive sleeping is now viewed as lazy and the bedroom has become a private place. The new inventions and sleep views result in people sleeping three hours less per night, on average.

- 1830 The Philosophy of Sleep is published. In it, Robert MacNish describes that sleep

is the state between wakefulness and death and concludes, “Sleep is temporary metaphysical death...” (MacNish, 1834).

- 1836 *The Pickwick Club* – Charles Dickens accurately describes obstructive sleep apnea (OSA) 100 years before the medical community recognizes it as a disorder. OSA was originally named Pickwickian syndrome after the book's character (Joe), who is overweight, excessively sleepy, and chronically snores (Cosnett, 1992).
- 1853 Bromide was produced specifically for inducing sleep (Kirsch, 2011).
- 1862 Kohlschutter published the first depth-of-sleep curve (Kohlschutter, 1862). This curve was one of many that eventually demonstrate that sleep is cyclic and the deepest sleep occurs during the first half of the sleep period (Kleitman, 1963).
- 1868 German psychiatrist Wilhelm Griesinger documents fluttering eye movements during dreaming, which will be later formally identified as Rapid Eye Movement (REM).
- 1875 English scientist Richard Caton is the first to record electrical potentials on the surface of the brain using a voltmeter (Caton, 1987).
- 1880 Discovery of Narcolepsy – Narcolepsy was first described as a distinct disorder in 1880 by French neuropsychiatrist Jean-Baptiste Edouard Gelineau after observing a group of patients with an irresistibility to sleep. He called it “narcolepsie”, Greek for “sleep seizure” (Gelineau, 1880).

1900-1949

New theories in neurological research, such as that the neuron is the anatomical and

functional unit of the nervous system, are emerging with the advent of new technologies. The brain is now being recognized for its role in controlling sleep and wakefulness. Public awareness of the need for sleep is beginning to increase.

- 1903 – The first “sleeping pill”, Barbitol, is introduced and quickly becomes popular for those suffering with anxiety and insomnia.
- 1913 – The modern sleep science pioneer, Henri Pieron, publishes *Le Probleme Physiologique du Sommeil*. This book is one of the first to describe the physiological characteristics of sleep (Pieron, 1913).
- 1925 – First sleep laboratory opens at the University of Chicago by Nathaniel Kleitman the “father of modern sleep research”. Here, he studies circadian rhythms, sleep deprivation, and sleep/wake regulation.
- 1929 Electrical activity of the human brain was first recorded by Hans Berger in Germany, which was the first human electroencephalogram (EEG) and demonstrated the differences in brain activity during sleep and during wakefulness (Berger, 1929).
- ~1930-1937 Nathaniel Kleitman is perhaps the first physician who conducted in-depth studies to identify characteristics that are indicators of quality of sleep (Kleitman, 1937), and the first to recommend establishing regular sleep/wake habits (i.e. sleep hygiene).
- 1932 The term “parasomnia” was first coined by H. Roger, to describe sleep disturbances that are not regularly classified, such as nightmares, night terrors, somniloquy, somnambulism, enuresis, among others (Roger, 1932).

- 1937 Davis, Harvey, and Loomis were the first to classify sleep stages with EEG which were designated as A-E, starting with the initiation of sleep and moving through the sleep states to deep sleep (Davis, Davis, Loomis, Harvey, & Hobart, 1937; Loomis, Harvey, & Hobart, 1936, 1937, & 1938); Kleitman, 1963). From the very beginning, EEG has been used to study sleep (Adrian & Matthews, 1934; Adrian & Yamagiwa, 1935; Berger, 1931).
- 1938 The studies in Mammouth Cave, where subjects lived in absolute darkness with only artificial light, revealed the human circadian rhythm is slightly longer than 24 hours and that humans adjust to the 24 hour cycle (Kleitman, 1963).
- 1945 – a Swedish physician (Karl-Axel Ekbom) first defines Restless Legs Syndrome (RLS), which is an "uncomfortable urge to move the legs that is worse at rest and bedtime, and is temporarily relieved with movement that disrupts sleep" (Ekbom, 2009; Shepard et al., 2005; Harvard, 2008).

1950 – Present

The need for physicians trained in sleep medicine evolved over about the past half-century, likely due to our major lifestyle changes with the advent of technology advances (i.e. electricity and social/economic reasons) as well as scientific and medical advances (Shepard et al., 2005). Ultimately, the discovery of EEG was the beginning of the development of Sleep Medicine as a modern discipline (Shepard et al., 2005). However, the discipline of sleep medicine was not clearly visible until the 1980's (Dement, 2008).

- 1951 Rapid Eye Movement (REM) sleep was formally identified by Nathaniel

- Kleitman at the University of Chicago, and was correlated with dreaming (Aserinsky & Kleitman, 1957).
- 1956 – Obstructive sleep apnea is classified by the symptoms of obesity, excessive daytime sleepiness, periodic apnea, and twitching.
 - 1957 – William Dement and Nathaniel Kleitman describe the human sleep cycle with alternating and increasingly deepening NREM stages and REM cycles (Dement & Kleitman, 1957). This description of the human sleep cycle has been the basis of most sleep literature until modification in 2007 (Shepard et al., 2005).
 - ~1957 – Dement reorganizes the previous five sleep stage sleep classification of 1937 by the numbering of four distinct sleep stages, numbered 1-4 (Kleitman, 1963).
 - ~1953 The first all-night polysomnograph recording was performed by Dr. William Dement, who is known in the sleep community as the “Father of Sleep Medicine” (Morton, 2010).
 - 1964 The first Sleep Disorders Center was established at Stanford University under the direction of Dr. William Dement. Only five centers were performing overnight sleep studies by 1975, which included Montefiore Medical Center in New York, Ohio State University, Baylor College in Houston, University of Cincinnati Medical Center, and the University of Pittsburgh Medical School (Shepard et al., 2005).
 - 1966 Gastaut characterizes obstructive sleep apnea during polysomnography, as he records multiple physiologic parameters, such as breathing, heart rate, and brain activity. He documents repetitive upper-airway obstruction ending in arousal

- (Gastaut, Tassinari, & Duron, 1965). This discovery was linked to sleep fragmentation and daytime sleepiness. A new world opened up for sleep medicine as epidemiologic studies began to uncover the vast amounts of people affected by this disorder.
- 1968 Drs. Allan Rechtschaffen and Anthony Kales co-authored the text “A Manual of Standardized Technology Techniques and Scoring Systems for Sleep Stages of Human Subjects” (Rechtschaffen & Kales, 1968). This manual was used across the country to compare polysomnography data in a standardized fashion. The manual was the official sleep scoring manual in sleep medicine until 2007, and is considered one of the most influential sleep medicine publications in history.
 - 1972 - The suprachiasmatic nucleus (a cluster of approximately 50,000 neurons located in the hypothalamus) is identified as the body’s internal circadian clock. (Harvard, 2008).
 - 1972 Tracheostomy is now being performed as treatment for obstructive sleep apnea.
 - 1975 - The American Academy of Sleep Medicine (AASM), was established in 1975, with Dr. Dement as its founder and first president (AASM, 2012). The AASM was originally called the Association of Sleep Disorders Centers (ASDC), and underwent another name change in 1987 to the American Sleep Disorders Association (ASDA) (Shepard, et al., 2005). There are currently 10,000 individual members and 1,500 sleep center members.
 - 1975 – William Dement and Mary Carskadon develop the daytime test, the Multiple

- Sleep Latency Test, to identify or rule out certain sleep disorders, such as the presence of narcolepsy.
- 1980 – Colin Sullivan developed CPAP as treatment for obstructive sleep apnea, which is still the gold standard for treating obstructive sleep apnea (Sullivan, 2010).
 - 1986 REM sleep behavior disorder was formally described in by Schenck, Mahowald and colleagues (Schenck, Bundlie, & Ettinger, 1986), and is where people are abnormally not paralyzed during REM sleep.
 - The APSS published what is probably the first detailed definition of Sleep Disorders Medicine in 1986, which read “Sleep Disorders Medicine is a clinical specialty which deals with the diagnosis and treatment of patients who complain about disturbed nocturnal sleep, excessive daytime sleepiness or some other sleep related problem” (APSS, 1986).
 - 1989 Rechtschaffen et al., (1989), demonstrated that sleep is a biologic necessity for life in experiments with rats, who all died within 2-3 weeks of total sleep deprivation. Just prior to death, the rats developed skin lesions, gastrointestinal erosions, hypothermia, and ultimately sepsis.
 - 1989 –Principles and Practice of Sleep Medicine is published, which is the first comprehensive textbook for Sleep Medicine.
 - 1990 The first edition of the International Classification of Sleep Disorders (ICSD-1) was published (ASDA, 1990). This 400 page book contained all clinically recognized sleep and arousal disorders, and was considered the official diagnostic manual (ICSD-

- 1, 1990). The latest edition, (ICSD-2), was published in 2005 (Sateia, 2005).
- 1992 The AASM published the first sleep medicine practice parameters in the journal SLEEP.
 - 1993 The National Institutes of Health establishes the National Center on Sleep Disorders Research, citing an estimated 70 million Americans are affected by sleep disorders.
 - 1995 The American Medical Association (AMA) officially recognized Sleep Medicine as an independent practice specialty (Shepard, Buysse, & Chesson, 2005).
 - 1997 The Accreditation Council for Graduate Medical Education (ACGME) accredited the AASM as a sponsor for physician continuing medical education.
 - 1999 Over 200 accredited sleep disorders centers and laboratories are in the US and the AASM has over 7,000 members.
 - 2007 The AASM publishes the “AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specification”, which is the first update to the 1968 manual of sleep scoring.
 - 2012, there are estimated 3,000-3,500 sleep labs operating in the US (MarketData, 2012) and over 2,000 sleep centers accredited by the AASM (AASM, 2012).

The Beginning of Sleep Medicine in Higher Education

Physicians in research clinics, and research scientists at universities conducted much of the history discussed previously. It was not until 1975 that Sleep Medicine officially moved away from being only “experimental”; as insurance companies began recognizing it’s

significance and began reimbursing for sleep services (Shepard et al., 2005). This marks the beginning of the development of Sleep Medicine education in medical education.

1978, the American Board of Sleep Medicine (ABSM) was born and the first certification in sleep medicine was given with twenty-one candidates earning the certification (Shepard et al., 2005). Candidates passing the exam earned the title of Diplomate of the American Board of Sleep Medicine. This exam was administered for 28 years and 3,445 individuals earned certifications. In 2007, the exam was replaced by the Certification Examination in Sleep Medicine, sponsored by the American Board of Internal Medicine (ABMS) (Quan, et al., 2008).

In 1989, sleep medicine and research were translated into the medical curriculum through formalized fellowship training programs with the American Sleep Disorders Association (ASDA), which is now the AASM (Shepard et al, 2005). Before this, sleep medicine education was unstructured and loosely offered through pulmonology and neurophysiology fellowships (Shepard et al., 2005). Prior to 1989, the only structured and focused sleep medicine education was offered in a few universities; in particular Stanford University, the University of Pennsylvania, the University of Chicago, and Harvard University.

As discussed in Chapter 1, the Sleep Academic Award program through the National Heart, Lung, and Blood Institute was developed in 1996 with a goal of developing model curricula for sleep medicine for use in medical education (Strohl, 2011). The following comprise the published outcomes of the Sleep Academic Award program:

1. Development of sleep medicine core competencies, primary for undergraduate medical education (Strohl, 2003; Strohl, 2011)
2. Definement of sleep medicine program development at the medical school level (Harding, 1997; Strohl, 2003)
3. Surveys of medical schools and physicians on sleep education (Crisostomo, Merritt, Roe, Foley, & Basner, 1999; Rosen, Mahowald, Cesson, Doghramji, Goldberg, Moline, Millman, Zammit, Mark, and Dement, 1998; Boehlecke, DeVellis, Fisher, & Martinolich, 1999; Sockrider, Maguire, Haponik, Davis, & Boehlecke, 1998; Haponik, Frye, Richards, Wymer, Hinds, Pearce, McCall & Konen, 1996; Goldberg, DiPhillipo, Baran, Mindell, Curran, and Fry, 1997; Ware, Turner, Ullian, Karlson, and 1999)
4. Identification of a need for sleep education in graduate medical education (Strohl, 2011)
5. Inclusion of sleep medicine topics in the United States Medical Licensure Examination (USMLE, 2012, Strohl, 2003)
6. Revision of the National board examinations in psychiatry, pediatrics, otolaryngology, and pulmonary medicine to include sleep medicine questions (Strohl, 2011)

Clearly, the Sleep Academic Award program outcomes helped plant the seeds for sleep medicine education in the medical curriculum, but concrete examples of curriculum interventions have barely come to fruition; and sleep education initiatives in graduate

medical education are mostly untapped. To date, the National Heart, Lung, and Blood Institute still lists the "Curricular Resources" of the Sleep Academic Awards as "Under Development" (NHLBI, 2013). This is what sets apart this research from previous research in sleep medicine education. Previous research and initiatives of the Sleep Academic Award program identified aspects and curriculum topics that are appropriate for inclusion in medical education, specifically undergraduate. This research actually puts a real curriculum to the test in a neurology residency program, using a novel approach (e-learning with mobile learning). This research helps move from the conceptual to the practical application.

In 1990, Dr. Dement published an article citing a fear of losing the field of somnology (Dement, 1990). He stated there is a huge need for training physicians, and that only about 10-15 were being systematically trained in sleep disorders medicine (Dement, 1990). There was no formal medical school education prior to 1990.

According to Dr. Bradley Vaughn, another pioneer in sleep medicine at the University of North Carolina at Chapel Hill, the field of Sleep Medicine originated through several specialties, including neurology, psychiatry, psychology, and pulmonology. Since there were no formal educational programs prior to 1990, people interested in sleep medicine essentially had to train on the job. They had to try and network with the few others in the country studying sleep at that time.

In 2003, the AASM applied to the ACGME for the establishment of ACGME Sleep Medicine educational programs. First approved in 2004, the ACGME now accredits Sleep Medicine Fellowship programs. The fellowship programs are available for physicians who

have completed their residency in Internal Medicine, Neurology, Pediatrics, Otolaryngology, or Psychiatry (need ref, Shepard et al., 2005). The ABMS approved sleep medicine certification in 2005, preceding the development of the ABMS Certification Examination in Sleep Medicine in 2007 (Quan, 2008).

Dement (2008) notes that in 2008, no medical existed with a department of sleep medicine. He also notes that only a few have divisions of sleep medicine (e.g. Harvard University in the Department of Medicine, University of Pennsylvania in the Department of Medicine, Stanford University in the Department of Psychiatry, and the University of Michigan in the Department of Neurology). By 2008, very little systemic teaching of sleep medicine existed in the almost 4000 colleges and universities (Dement, 2008).

E-learning Constructs and Mobile Learning

E-learning's impact on medical education is widespread and e-learning applications are commonly found in multiple types of medical education (i.e. nursing, physician continuing education, allied health, public health, and others). However; e-learning is a relatively new and emerging concept in medical resident education (the population of interest). Medical residency educational programs have recently begun to adopt e-learning primarily due to the limitations in educational and clinic hours set forth by the American Council for Graduate Medical Education (ACGME). This section discusses e-learning constructs relative to medical resident education, as well as how these constructs can be used to analyze and understand mobile learning in this population.

Constructs of E-learning

To set the stage, learning can be defined as two-fold: “knowledge or skill acquired by instruction or study” and “modification of a behavioral tendency by experience” (Merriam-Webster, 2012). Since there is no general consensus to what e-learning actually is, for purposes of this study, e-learning may be defined as gaining new knowledge or skills, or modifying behavior through *electronic* instruction or study. Electronic instruction or study materials come in many forms, which may include:

- Computer based
- Mobile device based
- Electronic media such as audio/video/images
- Web-based

There are many constructs of E-learning, which are ever changing. Three constructs have been selected (online social presence, self-directed learning, and situated/authentic learning online) as a focus for this study. Online social presence was selected because of the emerging nature of online medical education. Self-directed learning and situated/authentic learning were selected because, aside from their role in e-learning, they have been common place in traditional medical resident education. These constructs will be discussed as follows.

Online social presence.

Technology is culturally neutral, however, the social context of the technology when used in online education can make or break knowledge transfer and behavior change (McIsaac & Gunawardena, 1996). Social presence can be defined as the “measure of the

feeling of community that a learner experiences in an online environment” (Tu & McIsaac, 2002; p. 131). McIsaac and Gunawardena also describe social presence as perception of being a “real person” when communicating with technology (1996). Social presence is a very influential construct, which varies by technology, but is important for enhancing student satisfaction and perceptions of learning (McIsaac & Gunawardena, 1996).

High social presence in online environments gives students feelings of connectedness, while students often feel disconnect when social presence is low (Baker, 2010, p. 5-6). In a traditional face-to-face setting, instructor presence is the instructor being physically “seen”, while online social presence revolves around action (Blignaut & Trollip, 2003). Instructors must “actively participate” to be “seen” (Picciano, 2002). Online social presence can be developed through accessible communication channels, consistency of interaction patterns and feedback, discussion moderation, and content expertise (Baker, 2010, p. 6).

Online social presence can be further delineated into instructor presence and learner presence. Instructor or teaching presence is defined as “the design, facilitation, and direction of cognitive and social processes for the realization of personally meaningful and educationally worthwhile learning outcomes” (Shea, Pickett, & Pelz, 2003, p. 65). Shea et al., define learner presence as “the ability of students to project themselves socially and affectively into a community of inquiry” (2003, p 65). Heuer and King (2004) define roles for fostering online instructor presence, which include:

- Planning – course management, including technology troubleshooting and clarifying expectations

- Modeling – model expected behaviors and interactions
- Coaching – provide students with encouragement, motivation, and support

Stone and Chapman (2006) identify three constructs of instructor presence as viewed by instructors: course content, instructor role, and student needs. Their data concluded instructor presence is facilitated online through the instructor's role as content provider and subject matter expert; unique teaching materials; creation of individual learning objects; high levels of instructor immediacy and feedback; variety of media formats; and facilitating self-directed learning (Stone & Chapman, 2006). Although more research exists pointing to the importance of instructor presence in online courses, students' perception of student presence is also an influential factor. Russo and Benson (2005) found a significant correlation between student perceptions of their classmates' presence and their self-reported satisfaction with their learning.

It is widely known in educational research that developing a sense of community is critical for student success in higher education, especially in an online environment (Pascarella & Terenzini, 1991; Tinto, 1997; Shea, Li, & Pickett, 2006). Online learning-communities “allow participants to actively engage one another in ideas and perspectives they hold to be educationally worthwhile, exciting, and provocative” (Shea, Li, & Pickett, 2006, p. 177). Tu and McIsaac identify social context, online communication, and interactivity as primary factors useful for establishing online community (2002). Evidence is

mounting that teaching presence is very important in the development of an online learning community (Shea, Li, & Pickett, 2006, p. 175).

Interaction is critical for learning to take place and is critical in online social presence. Even John Dewey references that learners must interact with their learning environment for education to take place (Dewey, 1916). Intimacy and immediacy are two components of social presence that are critical for interaction to take place in the online environment (see Figure 1) (Tu & McIsaac, 2002, p. 131-132). This is due to the lack of traditional social cues (i.e. facial expression, eye movements, posture, appearance, verbal and nonverbal cues) in the online environment versus a face-to-face environment. Within these components lie the three dimensions of social presence: social context (i.e. topics, privacy, social processes, and relationships), online communication (i.e. attributes and applications of online language), and interactivity (communication styles and engagement in activities) (Tu 2000, 2001).

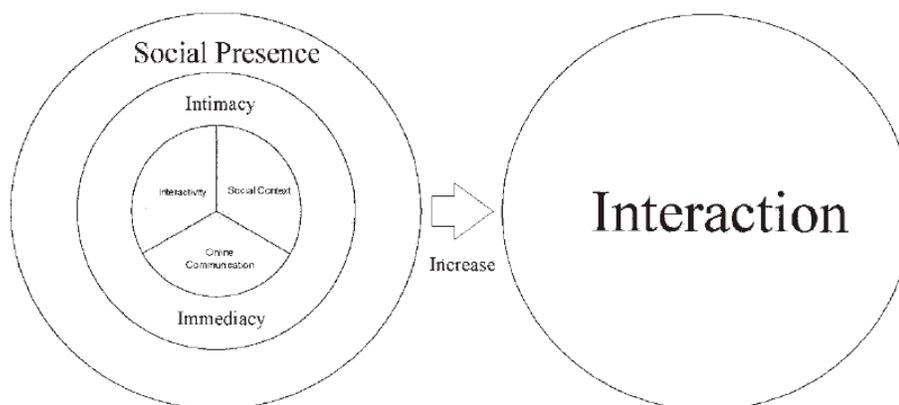


Figure 1 Social Presence and Interaction (Tu and McIsaac, 2002, p. 132)

Teaching presence (stemming from the community of inquiry model) facilitates active learning and online community through effective instructional design, teacher facilitation, and direction of students' cognitive and social processes (Anderson, Rourke, Garrison, & Archer, 2001; Garrison et al., 2000); Shea, Li, & Pickett, 2006). Shea, Li, & Pickett found that students are more likely to report "higher levels of learning and community" when teachers have a strong teaching presence (Shea, Li, & Pickett, 2006; p. 184-186). The student reported level of learning was actually higher in online courses as compared to face-to-face courses. Baker's study provides further evidence of a positive relationship between instructor presence and student motivation, and affective learning and cognition (Baker, 2010, p. 18).

Six factors are particularly important when designing instruction for distance learning, and in particular, online instruction, as seen in Figure 2. Social presence is as important in effective design as is any other factor. These factors are not meant to function independently, and are interconnected and interact with each other (McIsaac & Gunawardena, 1996).

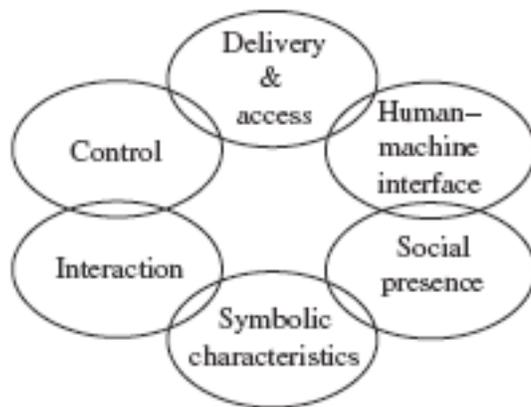


Figure 2 Factors Impacting Selection and Use of Distance Education Technologies (McIsaac & Gunawardena, 1996).

Self-directed E-learning.

Self-directed lifelong learning is widely accepted as integral for physicians.

Development of self-directed learning skills is fostered during residency and even prior during medical school. The nature of self-directed e-learning is a natural fit for medical residents, since physicians ultimately must have these lifelong learning skills (Li, Patemiti, Co, & West, 2010; Nothnagle, Goldman, Quirk, & Reis, 2010).

Being self-directing is one of the core assumptions about adult learning, as stated in the most well known adult learning model, andragogy (Knowles, et al., 2011). Self-directed learning incorporates monitoring understanding, managing tasks, and sustaining motivation; and self-directed learning can infer tremendous responsibility and control to the learner in an online environment (Garrison, 2011). The Internet has promoted a self-directed and self-motivated sense of learning, which has been called the “Google-isation” of learning because

learners can search for their own information for life, work, and school (Addison, 2010).

Self-directed e-learning can also refer to learning environments where the instructor and other students are not regularly accessible, hence motivation is key for success (Kim & Frick, 2011). These types of environments are typically “work at your own pace” courses.

E-learning and the online environment are ideal for empowering students to be self-directed learners. Students are able to take this responsibility for their learning when they understand (Garrison, 2011):

- Successful class learning competencies
- Their prior learning base and their “distance” from the class goals
- The effectiveness of their ongoing efforts to master the course competencies

Situated/authentic learning online.

Traditional higher education is not very authentic – meaning that the instruction does not reflect what people do in the real world and in real work places. Tasks and activities are highly abstract and decontextualized – a very fragmented approach (Lebow & Wager, 1994; Herrington & Herrington, 2006).

Adult life is full of situations that require adjustments, such as family life, work life, community life, etc. Lindeman (a pioneer in adult education theory who was also influenced by John Dewey’s progressivism) theorizes that adults learn through situations (andragogy’s approach) instead of by subjects (pedagogy’s approach) (Lindeman, 1926; Knowles, et al., 2011). This idea stems from a history of great teachers, who viewed learning as a “process of mental inquiry” instead of “passive reception of transmitted content” (Knowles, et al., 2011).

These great teachers include Confucius, Lao Tse, Jesus, Cicero, Euclid, Quintilian, Aristotle, Socrates, and Plato.

Authentic learning and its approaches, such as situated learning, are the answers to the problem of re-constructing real-life, real world learning. However, no consensus exists on what exactly encompasses authentic learning (Frey, Schmitt, & Allen, 2012). There are multiple ideas, theories, and themes for authentic learning, which will be described next, but truly, authenticity is in the eye of the beholder.

Some of the arguments for authenticity include real-world contexts, and in contrast, the idea that maximum fidelity (real or simulated situations) is not particularly effective for learning in the novice (Herrington & Herrington, 2006). Other arguments include that true authentic learning environments are impossible to design; and authenticity is not “in the learner, the task, or the environment, but in the dynamic interactions among these various components...authenticity is manifest in the flow itself, and is not an objective feature of an one component in isolation” (Barab, Squire, & Dueber, 2000, p. 38; Herrington & Herrington, 2006). And finally, the notion that authenticity in a learning environment relates more to the physical than the cognitive (Herrington, Oliver, & Reeves, 2003).

In an objective sense and relative to medical education, authentic learning typically “focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice” (Lombardi, 2007). Herrington and Oliver (2000) identify nine critical characteristics of authentic learning based on constructivism and situated learning theory, as described below:

- Authentic context should reflect how knowledge will be used in real life – the context should be “all embracing” to provide “a sustained and complex learning environment” (Herrington & Herrington, 2006)
- Activities should be authentic – activities can create the focus for the whole course of study; activities “can be the course” (Herrington, Reeves, Oliver & Woo, 2004)
- There must be access to expert performances and processes should be modeled – similar to apprenticeship
- Multiple roles and perspectives should be enabled
- There must be opportunities for collaborative construction of knowledge
- Meaningful reflection should be enabled through a learning environment with authentic context and tasks
- Opportunities for articulation should be included, particularly for the “public presentation of argument to enable defense of the position” (Edelson, Pea, & Gomez, 1996; Lave & Wenger, 1991; Herrington & Herrington, 2006)
- Coaching and scaffolding by teachers, and by students should be provided with a collaborative approach
- Assessment should be authentic through collaboration and seamless connectivity to the learning environment

From an online learning perspective, situated/authentic learning still encompasses all of the above, but there is a shift from activity driven learning to more socially driven

learning. Authentic learning brings together multiple disciplines and perspectives, ways of working, habits of mind, and community (Lombardi, 2007). The following strategies have been derived from Herrington and Oliver's (2000) critical characteristics above as design recommendations for applying situated learning theory to the learning environment:

- Design for social activity and interactive learning
- Foster intentionality and goal-setting in learning
- Employ role differentiation to foster multiple perspectives
- Ensure that learning becomes a constructive social experience
- Foster metalearning
- Enable student autonomy and a sense of ownership
- Balance both personal and interpersonal orientations in creating a motivating climate for learning

Many types of online tools are very useful in utilizing an authentic learning approach, with medical education in mind. Journals, portfolios, and blogs are useful for online reflection (Herrington & Herrington, 2006). Video clips of experts performing tasks in their own real environment are useful (Herrington & Herrington, 2006). Making real scientific reports available to students, if that is the end product, offer modeling and scaffolding (Herrington & Herrington, 2006). Collaborative construction of knowledge is very important in distance learning, and discussion boards and chat rooms can be used for group problem solving. Reflection is very important in authentic learning, especially for online learning because reflection is a social process (Kemmis, 1985), and collaboration is key.

E-learning Constructs as a Means to Analyze and Understand Mobile Learning

Mobile phone subscriptions number almost 6 billion worldwide, and Internet access from mobile devices outnumbers access from traditional computers by 2:1 (UNESCO, 2012). Mobile learning devices most certainly outnumber desktop and laboratory computers on campuses in higher education (Mason & Rennie, 2008). These devices commonly include laptops, tablets, smart phones, and other handhelds. It is important to note that mobile learning (as described previously) and e-learning are different constructs, with mobile learning being more concerned with physical location, ways of messaging, and collecting information on the go, than e-learning, which is concerned specifically with electronic devices used for learning.

Medical residents in particular are avid mobile users as they are constantly on the move (Kho, Henderson, Dressler, & Kripalani, 2006). In hospitals and clinics, they are routinely paged, access electronic medical records from mobile devices as they move from patient to patient, and perform various tasks, such as submitting prescriptions and writing medical notes via mobile devices. Anyone can spend an hour in a hospital observing resident physicians and will see their mobile use in action. The question is not whether or not mobile education is useful for medical resident education; the question becomes, how can mobile devices be used most effectively for medical resident education?

As discussed earlier, self-directed learning, online social presence, and situated/authentic learning are useful e-learning constructs. These actually mirror traditional

medical resident education. This section will compare and contrast the usefulness of these constructs in the context of mobile learning.

The biggest strength of using mobile devices in learning is that so many people already use them, residents in particular. The on-demand nature of mobile learning connects formal educational experiences with informal, situated learning experiences (Mason & Rennie, 2008). Residents most certainly follow this “on-demand” model as they are following multiple patients at any given time. They must be able to access information on-the-fly, and be able to quickly and easily move between cases and re-focus.

Laurillard (2002) and Salmon (2000), identified that an affective climate for learning focused messaging is one of the top three online learning features valued by students. Wei, Chen, and Kinshuk (2012) found that user interface and social cues have a significant effect on social presence. The design of the interface or “App” is extremely important in the usefulness of a mobile learning application, and can “make or break” it. We know that online social presence is valuable in mobile learning, but can only be useful with a good interface design.

Constructivism tells us that real learning is “messy” and complex”, and for life-long learning to take place, our classroom should embody this “fuzziness” (Mason & Rennie, 2008). Mobile devices lend themselves to mirroring the way people really learn. They are not usually accessed in a linear fashion, that is, students probably won’t access a “course” for a set time during pre-specified days. Access can be random, on-demand, and the content can be accessed on a “use as you need” basis. This combination of self-directedness and mobile

learning does embody the “fuzziness”. Add to that online social presence, and it adds even more to the complexity, and (embrace the madness), even better represents how people really learn.

Authentic learning’s best application with regard to mobile learning is the rapid access or recording of information within the field experience (Garrison, 2011). Abstract conceptualization (i.e. learner content sharing), a learning strategy derived from Kolb’s Experiential Learning Model, is a strategy to tailor learning situations to reflect “real-life” situations (Kolb, 1984; Goel, 2011; Knowles et al., 2011, p. 197). Adults tend to seek knowledgeable and supportive “helpers” in their learning endeavors, as opposed to relying fully on teachers (Knowles, 1978). What this means is that the traditional apprenticeship model, which is still used in residency education today is perfectly authentic or “real-life” learning. This type of learning is very self-directed, but the use of mobile devices gives access to the “helpers”, that residents may not otherwise have easy access to as they are all dashing from place to place in an inconsistent manner – perhaps rarely crossing paths. Using this triad of e-learning constructs can help to understand how mobile devices, and ultimately mobile learning can best be used in supporting learning.

Being self-directed is important for students to be able to monitor and regulate their learning in online learning environments (Garrison, 2011). Residents have a great deal of responsibility in providing individual care for patients, and also fulfilling their role as peer teacher, further increasing the need for them being self-directed. Mobile learning does lend itself very easily to self-directed learners, as discussed earlier; however, self-directed e-

learning comes in several flavors – some more useful than others in this context. The self-directed e-learning approach where instructors and peers are not readily accessible can dampen social presence, which is influential on motivation, satisfaction, and ultimately the overall learning community. Not all self-directed e-learning courses are setup this way, however. The most useful approach is to include a strong social presence with self-directed learning approaches. Online social presence by way of social media goes hand in hand with mobile technologies, which is already commonplace. There is the ability to text, email, post to networking sites, surf the web, and record audio/video most anytime and anywhere (Garrison, 2011).

E-learning Framework

An e-learning framework is the conceptual framework for this study. This framework is described next along with the implications on how it is used to support explaining how the residents experience the online supplemental sleep education module. Establishing a framework is critical in this study, due to a very open research question, and the fact that e-learning comprises countless components and theories. This framework is a lens to view the phenomenon of study, and helps guide data collection and analysis.

E-learning facilitates training not constrained by time, location, or availability of specific faculty. This flexibility enables residents to complete supplemental educational modules on their own time; hence not conflicting with the Accreditation Council of Graduate Medical Education (ACGME) mandated limitation of 80 hours per week (ACGME, 2011). A significantly larger number of residents can be reached via e-learning (Baker, Klein, Samaan,

& Lewis, 2010; Ross et al., 2011; Yanni et al., 2009), and perhaps even more so with the combination of mobile learning.

Residents are known for being self-directed and the traditional model revolves around apprenticeship (situated/authentic learning), which includes strong social presence. All of these constructs are also well-known and accepted forms of e-learning. It is a natural fit for these three constructs in medical resident education, with strong evidence mobile applications are a potentially effective delivery method.

For these reasons, the theoretical framework includes the three e-learning constructs above, which when combined will help explain the resident experience with the online module. These constructs are described in detail earlier in this chapter, and this section explains these constructs as a frame for the data collection in this study. The constructs are applied to the content of the online module, and made accessible via Internet, and in particular, accessible as a mobile application - while residents are mobile. Residents are constantly on the move (as described in Chapter 2), and the mobile nature of this design works with them, as they move from patient to patient, as they already work with mobile devices to submit prescriptions and write medical notes, and as they communicate with colleagues. The framework is as follows:

Online Social Presence

Social learning makes sense because textbook patient cases are few and far between, and residents may be underexposed to certain topics because of a lack of patients at their facility with those conditions. Using mobile devices to connect to a network of peers and

instructors can enhance learning and further engage residents, as they share experiences and see through the eyes of many, fulfilling the educational gaps. This wouldn't require much additional time or effort since mobile devices are very common for physicians, plus, mobile applications are usually very simple and straightforward – as simple as the iconic pager residents carry.

Research demonstrates that students can feel alienated and isolated in online environments, which can be reduced by enhancing the online social presence (Wei, Chen, & Kinshuk, 2012). Therefore; immediacy is key in online social presence, which includes consistent interaction, accessible communication channels, substantive feedback, and content expertise (Baker, 2010, p 18). Even though most of the e-learning that takes place with medical residents is asynchronous, mobile applications can help instructors and students to give and receive more immediate feedback. Instructors and students have the ease of checking messages and posts for short spurts multiple times a day. This follows the simple texting model that is so popular today. It gives people that immediate contact and feedback to know what is going on with who, where, when, etc. No longer do people have to wait until the end of the day or the week to catch up with their family, friends, etc. It only makes sense that this model may work well in teaching and learning also.

As part of online social presence, immediacy facilitates instructor to student interaction, enhancing learning and student satisfaction (Roberson and Klotz, 2002). Wei, Chen, and Kinshuk (2012) found evidence that social presence significantly impacts learning interaction and ultimately, the learner's perception of achieving the learning outcomes in an

online course. Mobile applications can further aid in this by allowing participants to quickly and easily access discussions and materials. The advantage is that learning and participation can take place multiple times per day and in small chunks, instead of sitting down once a week or so to “catch up”.

It may be possible that online social presence is important only in the student-instructor relationship and student-student interaction is not necessary – as implied by Stone and Chapman (2006). As Mandernach, Gonzales, and Garrett (2006) indicated, classroom teaching involves talking discussion. Online instruction must include instructor participation in the threaded discussions for the course to be an online learning experience. The online social presence construct is important for active participation between students and instructors, and empowers students to be in control of their learning. Stone and Chapman (2006) found that instructor presence, instructor-student interaction, and an active instructor as content provider are all heavily dependent on one another. Mobile learning can make this easier by ease of access, anytime-anyplace, etc.

Self-directed E-learning

Self-directed learning is “ironically, highly collaborative”, where the learners collaborate both with their instructor and their peers (Guthrie, Solomon & Rinehart, 1997; Temple & Rodero, 1995; Abdullah, 2001). Mobile learning lends itself very easily to collaborative learning. Mobile applications allow for synchronous, and asynchronous talk, video, and discussion board communication. It is quick and easy to use mobile devices for communication, which will work well for busy residents in-between patients.

Stone and Chapman (2006) emphasize that instructors can sustain their online presence by promoting self-directed learning. Online instructors should embrace the “facilitator of learning” role as they design and deliver instructional content. This connectedness of online social presence and the self-directed nature of medical resident education opens another window for mobile learning. As an example, mobile devices can allow access and inputting of data while residents are in the field (Lombardi, 2007). Residents are in control of their learning, and using mobile devices to do so; while at the same time, having immediacy of contact with their peers and teachers.

Situated/authentic Learning Online

Lave and Wenger (1991), originators of the situated learning notions, proposed that learning is a “process of participation in communities of practice”. The “community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice...an intrinsic condition for the existence of knowledge...thus, participation in the cultural practice in which any knowledge exists is an epistemological principle of learning” (Lave & Wenger, 1991:98). This notion, aligning with online social presence and authentic learning, is an opportunity for mobile learning to enhance the community of practice in the already apprenticeship model. Residents have direct access to an entire community of other residents, also learning in their own real-world situations. This can bridge a gap between departments, institutions, regions - even worldwide.

Authentic learning is best when it happens within the real world situation. Medical residency education is one of the unique opportunities where this actually happens, since residents are learning essentially “on the job”. Mobile learning is the perfect complement to bring in collaboration and reflection, right into the heart of the authentic learning environment.

Real learning is messy and not linear (as stated earlier) – hence online, mobile applications with authentic approaches can provide the ability for residents to collaborate with peers, link to other resources flexibly, explore competing solutions and diverse perspectives and outcomes, and become immersed in the “real-world culture of the activity” (Jones, 2006:178). Knowledge creation truly is collaborative, and mobile learning can help bridge the time gap, allowing residents to become stepping-stones for each other.

Conclusion

The availability of high-speed networks, intranets, e-learning management systems, and multimedia software, many types of e-learning technologies already exist in residency education, including simulated patient case studies for clinical learning, web-based video/audio, online tutorials, CDs and DVDs, and other forms of electronic learning (Gisondi et al., 2010; Loffler et al., 2011; Wolbrink & Burns, 2011). Studies of residents have found that the same learning objectives can be met in less time through the use of e-learning. (Cook, Dupras, Thompson, & Pankratz, 2010; Bell, Fonarow, Hays, & Mangione, 2000).

E-learning and mobile learning in residency education facilitates training not constrained by time, location or availability of specific faculty. This flexibility enables

residents to complete supplemental educational modules on their own time; hence not conflicting with the Accreditation Council of Graduate Medical Education (ACGME) mandated limitation of 80 hours per week (ACGME, 2012). A significantly larger number of residents can be reached via e-learning (Baker, Klein, Samaan, & Lewis, 2010; Ross et al., 2011; Yanni et al., 2009), and perhaps even more so with the combination of mobile learning.

Residents are known for being self-directed and the traditional model revolves around apprenticeship (situated/authentic learning), which includes strong social presence. All of these constructs are also well-known and accepted forms of e-learning. It is a natural fit for these three constructs in medical resident education, with strong evidence mobile applications are a potentially effective delivery method.

CHAPTER 3

This chapter describes the overall design and methodology of this research. The purpose of research with the research question and relevant previous research are described next. Following is an overview of qualitative research, and then specifically, case study methodology and an e-learning framework as they pertain to this research. Finally, this chapter includes details on how the research design will be carried out, through description of the research context, selection of participants and sites, data sources, issues of rigor, and data analysis.

Purpose of Research

The research goal is examining the educational experience of neurology residents as they participate in a supplemental sleep medicine e-learning module. There is an identified learning gap in the subspecialty practice area of sleep medicine among many medical residency education programs, as described in Chapter 1. Common learning barriers include the ACGME duty hour restrictions (ACGME, 2011), sleep deprivation, stress, and burnout (Collier, McCue, Markus, & Smith, 2002; Levey, 2001; Barger et al., 2006), and lack of resources and content experts (Avidan, Silber, Vaughn, 2011; Dietrick, Nirupama, & Young, 2010; Marks et al., 2011; Kopp et al., 2011; Skye et al., 2011).

The overall research question is:

How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning?

Ultimately, the intended outcome and future application of the research is to provide preliminary evidence of the ways sleep medicine education through e-learning and mobile learning may or may not be a feasible and an effective supplement within neurology residency education. The future implications deriving from the research goal include an understanding of the outcomes of the following research sub-questions:

- What are the pedagogical issues of the online module with regard to specific e-learning constructs and mobile learning?
- What are the strengths and areas for improvement in the overall resident educational experience?
- What is the usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents?

Qualitative Research as Methodology

Qualitative research is a general term – a way of knowing, where researchers use their senses to collect, organize, and interpret information about individuals (Lichtman, 2010). Qualitative research does not include standard rules or protocols for how the research question should be investigated. This is the beauty of qualitative research, is it an art and a science (Cronbach, 1982; Patton, 2002). Qualitative inquiry is detailed and open, not constrained by predefined categories (Patton, 2002). Who reads qualitative research? Typically, the same type of people who write it – scholars, policymakers, or others trying to understand some phenomenon or problem (Patton, 2002). This section will provide an overview of the qualitative research process relative to the goals of this study.

“Innovators are told: ‘Think outside the box.’

Qualitative scholars tell their students: ‘Study the box. Observe it. Inside. Outside.

From inside to outside, and outside to inside. Where is it? How did it get there?

What’s around it? Who says it’s a ‘box’? What do they mean? Why does it matter?

Or does it? What is *not* ‘box’? Ask the box questions. Question others about the box.

What’s the perspective from inside? From outside? Study diagrams of the box. Find

documents related to the box. What does *thinking* have to do with the box anyway?

Understand *this* box. Study another box. And another. Understand *box*. Understand.

Then you can start thinking inside *and* outside the box. Perhaps. For awhile. Until it

changes. Until you change. Until outside becomes inside—again. Then start over.

Study the box.’” — Halcolm’s *Laws of Inquiry as cited in Patton, 2002*

Why Qualitative Methodology

This research uses a qualitative approach because the basis for the inquiry lies in the experiences of the medical residents as they complete the supplemental sleep medicine education module. Qualitative researchers aim for finding meaning in a phenomenon, as opposed to attempting to measure, control, or simply watch it. Qualitative research in its basic form provides analytical, empirical, and rich, descriptive results, to help answer the research question, “*How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning?*”

Quantitative methods can tell us many useful facts and figures regarding this research, but quantitative studies are numerous in medical education, and we do not need to

know statistics regarding e-learning in medicine – we already know this (see literature review). Qualitative methodology is choice because, on the other hand, it reveals the human dimension of this educational phenomenon (Soltis, 1990) – a path few qualitative researchers have taken in this context. Ultimately, the purpose of qualitative research relative to education and this study is using interpretation and narrative description to inform our deep understanding of education in sleep medicine (Soltis, 1990; Eisner, 1990). The setting for qualitative research is real-life, and the researcher in no ways tries to influence the phenomenon of interest (Patton, 2002).

Epistemology in Qualitative Research

The use of qualitative inquiry spans decades, and its uniqueness and allure can be attributed to the fact that there is no (and probably never will be) a consensus about how qualitative research should be carried out (Eisner & Peshkin, 1990). Likewise, qualitative research attracts many theorists and has roots in multiple philosophies. The wealth of influences is limitless, and qualitative inquiry is still evolving. These influences are often referred to as epistemologies, meaning what constitutes “truth” and acceptable knowledge – and arguments over “what is” and “what isn’t” have been ongoing for over 200 years (Grbich, 2007). Epistemology has many definitions, and for purposes of this research, it is defined as “the study of the nature of knowledge and justification” (Schwandt, 2001, p. 71). Epistemology influences and modifies methodology, which justifies method, and ultimately justifies the knowledge produced (Figure 1)(Carter & Little, 2007).

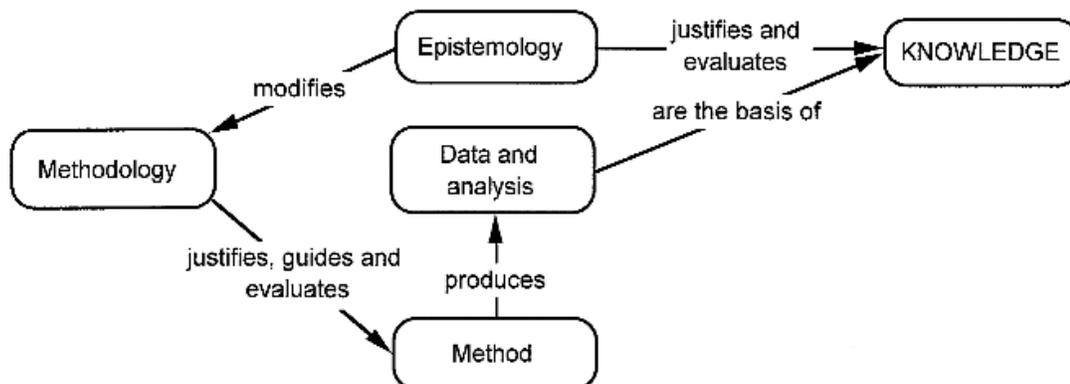


Figure 3 Relationship Between Epistemology, Methodology, and Method (Carter & Little, 2007)

Researcher as Instrument and Reflexivity

Unlike quantitative inquiry, the research instrument in qualitative research *is* the researcher. This makes that person's skills, rigor, and even personal life of utmost importance and influential to the research (both positive and negative) (Patton, 2002). The researcher must refrain from judgments on the raw qualitative data, which should only include direct quotes and description (Patton, 2002).

Qualitative research involves reflexivity, whereby researchers must continuously ask themselves and reflect on the question "What do I know and how do I know it?" (Patton, 2002). Similar to the knee-jerk reflex, reflexivity involves "bending back on oneself" (Lichtman, 2010). This involves great self-awareness and the ability to critically self-reflect.

"He who knows others is wise. He who knows himself is enlightened." – Lau Tzu

Subjectivity in Qualitative Research

Traditional quantitative research's hallmark is objectivity. Qualitative research has a much different focus, that of subjectivity. Objectivity involves the researcher completely separating themselves from the research, that is, staying on the outside where their own views and biases are not influential. This is not possible in qualitative research, or even in quantitative research. The reality is that traditional quantitative research faces the notion that true objectivity cannot possibly exist, which is the "fiction of objectivity" (Breuer, Mruck, & Roth, 2002). Qualitative researchers recognize that they cannot truly separate themselves from the research.

The subjective approach of the qualitative researcher is important because the nature of qualitative inquiry is to understand human behavior and culture "from the point of view of those being studied" (Bryman 1988, p. 46). Hence qualitative researchers must be intimately connected to the research, versus the objective approach of standing back and collecting data from a large sample for the sake of generalizability and predictability (Gelo, Braakmann, & Benetka, 2008). The dichotomy between explanation and comprehension probably best highlights the subjectivity/objectivity debate. Explanation represents the quantitative approach of our own observations of facts through regularities and their connections; and in contrast, comprehension represents the qualitative approach of reconstructing how someone else observed the above and made their own connections (Kockeis-Stangl, 1980).

Researchers are as much insiders as outsiders (as you can see in my positionality and subjectivity statement), and I fully believe that the researchers inner being is reflected in

every piece of the research. Especially since the researcher is the “instrument”, their biases and views from most certainly influence the research, both negative and positive.

Researchers are in essence “filters” to which data is collected, analyzed, and interpreted (Lichtman, 2010). The key is the researcher’s ability to identify these influences and leverage out their impacts, making these visible to those who will read or take part in the research.

This influence is not necessarily a flaw of qualitative research. It is important to remember that qualitative researchers are often very passionate about their topic (I most certainly am), which will help them dig deeply for meaning versus a superficial approach. I view this subjectivity as a definite strength of the qualitative inquiry.

To conclude this section; in qualitative research, once the research question has been identified, the literature review completed, and an epistemological stance taken, next steps include identifying frames and framing, position and power of the researcher, position of the reader, and defining the research design approach (Grbich, 2007). The positionality and frame for this research is provided by the theories and concepts in my own discipline (sleep medicine), which is embedded in my positionality and subjectivity statement at the end of this chapter. The next section will detail the qualitative methods and approaches used in this research.

Methods and Approaches

A few of the many influences on qualitative inquiry include constructivism, (Lincoln & Guba, 2000), interpretivism (Schwandt, 2000; & Crotty, 1998), and grounded theory (Clarke, 2005; Glaser & Strauss, 1967; Strauss & Corbin, 1998; Creswell, 1998). Also included are

various phenomenological traditions (Giorgi, 1985; Moutsakas, 1994; Valle & Halling, 1989), and case study approaches, (Stake, 1995; Yin, 2002). All of these epistemological approaches and methods have an overarching goal of dealing with questions about what is and isn't truth; and how that knowledge of truth came about. Concepts are chosen, based on positive impact relevant to the research question. In the next section, I continue with a discussion of constructivism and of case study – the chosen research design approaches.

Constructivism.

Constructivism is the epistemological approach for this research because answering the research question requires viewing reality as dynamic. Constructivism explores how the neurology residents make sense of and construct their own understandings of their online module experience. Ultimately, the residents' perceptions of the online module are the most important factor.

Constructivism is the dominant epistemology for this research, although other influences are likely to emerge. The research focus explores how residents interpret and make sense of their experiences, and how their constructed understandings fits within the context of their social environment (Guba & Lincoln, 1994). In this position, reality is fluid and changing, and is viewed as socially and societally embedded in the mind (Grbich, 2007). To the constructivist researcher, “it matters less whether a chair is 36 inches high and 47 years old than that one person perceives it as an antique and another views it as junk” (Rubin & Rubin, 2005).

“Knowledge consists of constructions”, and the process in this research is iterative, in that I become increasingly informed as knowledge accumulates and constructions become more sophisticated (Guba & Lincoln, 1994). Resident physicians likely have multiple realities with very different experiences with the online module – likely due to the self-directedness of the module, plus the self-directed nature of resident physicians personalities. Aligning with the research question, the primary focus of constructivism is an in-depth understanding of the problem, understanding and identifying the related issues, while also suggesting recommendations and solutions (Grbich, 2007).

Case study methodology.

This research uses case study methodology. This section describes case study, and explores its goals and nature relevant to this research. The e-learning module is the “case” of study, and will help describe, understand, and explain the phenomena that come about from the research goals. These three tenets (describing, understanding, and explaining), are central to qualitative research (Tellis, 1997). This section concludes with a discussion of the rationale for why the e-learning module is the most appropriate “case”.

Case study description. Case study is very common in education, and is defined as a qualitative method for examining a particular group, event, program, or even a process (i.e. the case) (Lichtman, 2011). A case study can involve a single case or multiple cases, and in either fashion, case study investigation is in-depth and multifaceted, uses multiple data resources, and produces evidence with great detail (Orum, Feagin, & Sjoberg, 1991). The next subsection explains the overall goals of case study.

Goals of case study. Case study is an important qualitative method for “capturing and reporting individualized outcomes” of how participants change during some program (Patton, 2002). This is a primary reason why case study is the choice method for helping answer the research question, *How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning?* With this in mind, Orum, Feagin, & Sjoberg (1991) describe the fundamental tenets of case study, which include:

- Grounding of observations and concepts about social actions and social structures in natural settings studied at close hand
- Information is gathered from multiple sources over a period of time, leading to a holistic study of the phenomenon, the surrounding complexity, and meanings
- Researchers can examine the continuity of change in lifeworld patterns through time and history
- Theoretical innovation and generalization are encouraged and facilitated

The overarching goal of case study is the pursuit of a holistic understanding of how people are engaged in sociological interrelated activities (Feagin, Orum & Sjoberg, 1990).

Case studies “give a voice to the powerless and voiceless”, as researchers consider all relevant groups and interactions, and not just those with power (Tellis, 1997). The point of studying the particularity and complexity of the single case of the e-learning module is to understand “its (the case’s) activity within important circumstances”, which includes the e-

learning framework and the actual neurology resident experience (Stake, 1995). The next subsection describes the specifics of how case study is carried out in relation to this research.

Nature of case study. By nature, case study is an “empirical enquiry that investigates a contemporary phenomenon within its real-life context” (Yin, 1994, p. 13). An in-depth understanding of a phenomenon and its context, without the researcher explicitly controlling or changing variables is a focus of case study (Cavaye, 1996). The nature of the case is highly variable, and it can be simple, complex, and anywhere in between. In this research, the case is more complex as it is studied around a multi-faceted e-learning framework. The definement of case study and its components are described next.

Boundaries. Case-study design often begins with drawing boundaries. Boundaries are “what is” and “what is not” considered a case. Boundaries draw the attention to the case as an object instead of a process (Stake, 1995), and define the e-learning module as the case, which emerged because the module is the instance I “want to be able to say something about” (Patton, 1980). Boundaries can be identified by (Lichtman, 2011)

- Who or what to study
- What aspect of the whole to study
- Reasonable time period

In addressing the “who” or “what” to study, the unit(s) of analysis, or the object of study, is what the case actually is (Yin, 2003). The case can be “an individual, a program, an institution, a group, an event, [or] a concept” (Merriam, 1988). In this research, the object of study is a single case of the actual e-learning module, with “nested” or “layered” cases,

which are the individual participants – as described by Patton where a single case study is made up of the smaller cases, which are the individual stories (Patton, 2002).

Reasonable is the key word in determining the time period for conducting a case study. “It is impossible to interview everyone, observe everything, and gather all the relevant materials in a case” (Merriam, 1988). I continuously acknowledge that the time period in this research will vary as case study research takes regular turns in unexpected directions (Stake, 1995).

Etic and emic perspectives. Etic and emic perspectives are important to recognize in case study. The etic issues are researcher issues, brought in from the outside; and the emic issues are those from the inside – the “actors” belonging to the case (Stake, 1995). These issues are inherent regardless of the nature of the case. Stake (1995) identifies three types (“natures”) of case study, intrinsic (need to learn), instrumental (need to gain a general understanding), and collective (use of multiple instrumental cases). Yin (2003)’s approach describes three overlapping strategies – exploratory (develop a hypothesis for further study), explanatory (explore operational links over time), and descriptive (describe the phenomenon when it is predictive about outcomes) case studies. This research aligns with Yin’s “descriptive” approach since the goal is to capture the entire experience of the residents.

Case study components. Yin (1994) identifies five components important for case studies: study questions; propositions (if any); unit(s) of analysis; logic linking data to propositions; and criteria for interpreting findings. Yin’s components are used in this research, as they align with Yin’s “descriptive” studies. Each of the components discussed

next, include a rationale for how they fit within this research, except for unit(s) of analysis, which was discussed previously under “boundaries”, and logic linking data to propositions, which is not necessary in this research because the study points of the research question are clear and the actual research topic is the study of “exploration” (Yin, 2003).

Research questions in case study often address the “how” and the “why” as related to the experience of a phenomenon, to explore operational links over time, and to understand the bounded system (Yin, 2003). The research question about the medical resident experience is an appropriate “issue” question; where the “issue” is intimately related to the context we wish to achieve meaning, versus an “information” question (Stake, 1995). The research question in this study identifies with the issue of the experience of an online supplemental sleep medicine educational program.

In this research, criteria for interpreting findings foreshadow data analysis (Yin, 2003). In this research, the criteria include using a descriptive framework (see the E-learning framework below) for organizing the case study. This framework guides the selection of relevant themes, which are analyzed and compared in categories (Rowley, 2002). Ultimately, a description of the case emerges from the multiple data sources. The next section identifies the e-learning module as the case in this research, with rationale.

The E-Learning Module as the “Case”

In this research, the focus is the e-learning module as resident physicians experience it. The nature of the research aligns more with Yin’s “descriptive” studies, as a goal is to capture the entire experience. The “aspect of the whole” of the study is multi-faceted,

including the educational impact of the online module, feasibility issues and pedagogical constructs specific to e-learning and mobile learning, strengths and areas for improvement of the module, as experienced by residents; and usefulness, application, and takeaways as described by the residents. Residents will complete the online module over a one-month period, and proceeding interviews occur during the following month.

Case study methodology with the e-learning module as the case emerged as natural fits, once the research question was finalized. The research question revolves around a inquiry of lived experience as participants embark on and complete a journey (the online module), which embodies the nature of case study as described above. Case study is appropriate because of its roots in medical education and the parallel with current practice (as discussed in the evidence based practice section). The actual e-learning module is the “case”, or the unit of analysis. This conclusion was drawn after careful consideration and the fact that at the end of the research, the e-learning module is the instance I “want to be able to say something about” (Patton, 1980).

Case study is very common in medical research, teaching, and learning. In fact, some of the earliest and most natural examples of case study are in law and medicine, where “cases” are a majority of the student work (Tellis, 1997). Today, case studies are liberally placed in the curriculum of many medical residencies, nursing, allied health, or other healthcare related programs.

The term “Evidence-Based Practice” is a trending form of case study in medical practice and training. This concept very much aligns with the tenets of case study, and the

research utilized is often from other case studies. An accepted definition for Evidence-Based Practice is “the conscientious, explicit and judicious use of current best evidence in making decisions about the care of the individual patient. It means integrating individual clinical expertise with the best available external clinical evidence from systematic research.” (Sackett, 1996).

The distinction to note between Evidence Based Practice and case study methodology in this research revolves around rigor. In Evidence-Based Practice, case study is usually not a full research study. Yin makes the distinction between case study research and case study teaching methods, as the teaching purpose is for illustrating a particular situation and may not include full details (Yin, 1994). This research is not a debrief, rather can be held to all of the rigorous standards as a full research study. The standards of rigor for this research are discussed toward the end of this chapter.

The steps in the Evidence-Based Practice model include (Duke University & UNC Chapel Hill, 2010):

- Assess the patient – a clinical problem or question arises from the care of the patient
- Ask the question – derive the clinical question from the case
- Acquire the evidence – conduct a search and select the appropriate resource(s)
- Appraise the evidence – appraise for its truth and usefulness in clinical practice
- Apply – integrate the evidence with clinical expertise, patient preferences, and apply it to practice
- Self-evaluation – evaluate your own performance in the care of the patient

The materials, relevant to achieving the goals of this research, and aligning with case study approach are discussed next.

Materials

The e-learning module (titled Sleep Science 101) is accessible via Piazza.com. Participants are encouraged to access Sleep Science 101 via the Piazza mobile application, which is available for smart phones and tablets. Sleep Science 101 is also accessible via web browser on desktop laptop computers. “Piazza is a free platform for instructors to efficiently manage class Q&A. Students can post questions and collaborate to edit responses to these questions. Instructors can also answer questions, endorse student answers, and edit or delete any posted content. Piazza is designed to simulate real class discussion” (<https://piazza.com>).

There is one instructor for Sleep Science 101 (a Sleep Medicine fellow) and a technical support person (myself). The instructor facilitates the online discussion, while I am accessible if the residents need technical assistance. Residents have use Sleep Science 101 for a three-week period and they are encouraged to access the module as often as they desire, or as their schedule allows. A content expert, who is a board certified sleep physician, is accessible to the residents via phone and email. This physician does not participate in the online discussion, as not to influence or inhibit responses from the residents.

Piazza functions as the learning management system for Sleep Science 101. Participants have an individual username and password to access the module. Piazza claims FERPA compliance in its Terms of Use located at https://piazza.com/terms_of_use.html.

Sleep Science 101 contains three learning components (Part 1, Part 2, and Part 3) as described and depicted next.

Sleep Science 101 E-learning Module

Part 1 - Streaming video lecture series. This section contains video lectures totaling 325 minutes (about 5 ½ hours). Lectures are linked or “pinned” within Sleep Science 101 and are accessible anytime and in any order, paralleling with **self-directed learning**. Video lectures are organized into a topical outline, which is loosely based on the pre-existing curriculum and the ACGME program requirements in Sleep Medicine (ACGME, 2012). The outline is listed next.

Sleep Science 101 Module Topic Outline with Video Lecture Content

1. Sleep Physiology and Medications (52 minutes)

<http://player.vimeo.com/video/25026618>

a. Sleep physiology

i. Wake

ii. NREM

iii. REM

b. Medications

i. Wakeful medications

ii. Sleep onset medications

iii. REM suppression

2. Sleep Disorders Overview (49 minutes) <http://player.vimeo.com/video/25064869>

- a. Introduction to sleep
 - b. Excessive daytime sleepiness
 - c. Insomnia
 - d. Circadian rhythm disorders
 - e. Parasomnia REM Sleep Behavior disorder
3. Polysomnography Part 1 (24 minutes) <http://player.vimeo.com/video/26971250>
- a. Overview of Polysomnography
 - b. Overnight polysomnography
 - i. Diagnostic
 - ii. Therapeutic (CPAP, bilevel, PAP)
 - iii. Split protocol
 - iv. Parasomnia
 - c. Multiple Sleep Latency Test
 - d. Maintenance of Wakefulness Test
4. Polysomnography Part 2 (26 minutes) <http://player.vimeo.com/video/26971311>
- a. Defining respiratory events
 - b. Obstructive Sleep Apnea (OSA) severity criteria
 - c. History and physical exam in OSA investigation
 - d. Capnography
 - e. Transcutaneous blood gas and oxygen saturation measures
 - f. Transcutaneous CO₂ monitoring

- g. Hypoventilation
 - h. Cheyne Stokes breathing
 - i. Respiratory rules for children
 - j. Limb movements
 - k. Behavioral monitoring
 - l. Gastro-esophageal pH.
 - m. Penile tumenesnce
 - n. Interpretation and data recording
5. Circadian Rhythm Sleep Disorders (13 minutes)
- <http://player.vimeo.com/video/26126848>
- a. Delayed Sleep Phase Disorder
 - b. Advanced Sleep Phase Disorder
 - c. Irregular Sleep/Wake Rhythm
 - d. Non-entrained (Free Running) Type
 - e. Jet Lag
 - f. Shift Work Disorder
6. Insomnias (13 minutes) <http://player.vimeo.com/video/25269898>
- a. Pathophysiology
 - b. Primary Insomnia
 - c. Secondary Insomnia
 - d. Adjustment (Acute) Insomnias

- e. Psychophysiological Insomnias
 - f. Insomnias due to other conditions
 - g. Pharmacology
7. Hypersomnias (8 minutes) <http://player.vimeo.com/video/25272237>
- a. Narcolepsy
 - b. Idiopathic Hypersomnia
 - c. Recurrent Hypersomnias
 - d. Kleine-Levin Syndrome
 - e. Menstrual-related Hypersomnia
8. Sleep Related Breathing Disorders (13 minutes)
- <http://player.vimeo.com/video/25307066>
- a. Cardiovascular pathophysiology of sleep apnea
 - b. Central Sleep Apnea
 - c. Obstructive Sleep Apnea
 - d. Hypoventilation/Hypoxemic Syndromes
9. Parasomnias (38 minutes) <http://player.vimeo.com/video/25301949>
- a. Evaluating parasomnias
 - b. Disorders of Arousal from NREM Sleep
 - i. Sleepwalking
 - ii. Sleep terrors
 - iii. Confusional arousals

- iv. Sleep related eating disorder
 - c. REM related parasomnias
 - i. Nightmares
 - ii. Sleep Paralysis
 - iii. Hypnagogic Hallucinations
 - iv. REM Sleep Behavior Disorder
 - d. Exploding Head Syndrome
 - e. Psychogenic States
 - i. Panic Disorder
 - ii. Sleep Related Dissociative Disorders
 - iii. Conversion
 - f. Nocturnal Seizures
 - g. Management of parasomnias
- 10. Sleep-Related Movements (20 minutes) <http://player.vimeo.com/video/25361072>
 - a. Motor disorders in sleep: benign
 - i. Hypnic jerks or sensory starts
 - ii. Excessive Fragmentary Myoclonus
 - iii. Benign sleep myoclonus of infancy
 - iv. Hypnic foot tremor
 - b. Movement disorders in sleep: possible pathological associations
 - i. Rhythmic movement disorder

- ii. Bruxism
 - iii. Catathrenia
 - iv. Periodic limb movements
- c. Management of movement disorders

11. Sleep and Epilepsy (31 minutes) <http://player.vimeo.com/video/26125211>

- a. Epilepsy and sleep overview
- b. Effects of sleep on epilepsy
- c. Effects of epilepsy and medications on sleep
- d. Sleep disorders in epilepsy

12. Restless Legs Syndrome (RLS) (38 minutes)

<http://player.vimeo.com/video/25309295>

- a. Review symptoms and criteria for RLS
- b. Epidemiology
- c. Pathophysiological findings
- d. Clinical approach
- e. Therapeutic options

Next are screenshots of the mobile version and the browser-based version of the video lectures.

The screenshot displays the Piazza LMS interface for the course "SLEEP SCIENCE 101". The top navigation bar includes "Q & A", "Course Page", and "Manage Class". The main content area is titled "note" and "Video Lectures".

Video Lectures
 Available video lectures are listed below. Following each link are the topics contained in that lecture

- Sleep Physiology and Medications (52 minutes) <http://player.vimeo.com/video/25026618>
 - Sleep physiology
 - Wake
 - NREM
 - REM
 - Medications
 - Wakeful medications
 - Sleep onset medications
 - REM suppression
- Sleep Disorders Overview (49 minutes) <http://player.vimeo.com/video/25064869>
 - Introduction to sleep
 - Excessive daytime sleepiness
 - Insomnia
 - Circadian rhythm disorders
 - Parasomnia REM Sleep Behavior disorder
- Polysomnography Part 1 (24 minutes) <http://player.vimeo.com/video/26971250>
 - Over
 - Over
- Mult
- Main
- Polysomno from Mary Ellen Wells [PLUS](#) [VCL](#)
 - Defin
 - Obst
 - Hist
 - Capr
 - Trans
 - Trans
 - Hypo
 - Chey
 - Resp
 - Limb

An embedded video player is shown, displaying a lecture titled "Sleep Physiology and Medication" from Mary Ellen Wells. The video is at the 51:32 mark. The player interface includes a progress bar, play/pause button, and the Vimeo logo.

At the bottom of the page, there is a status bar showing "Average Response Time: N/A", "Special Mentions: Whoa! Student answered Screening tools in 18 sec. 1 day ...", and "Online Now: 1".

Figure 4 Sleep Science 101 – Browser Based Video Lectures

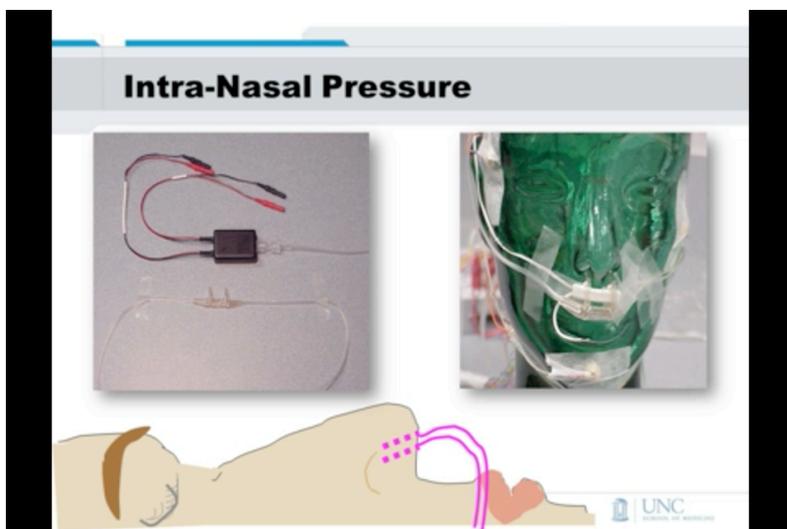
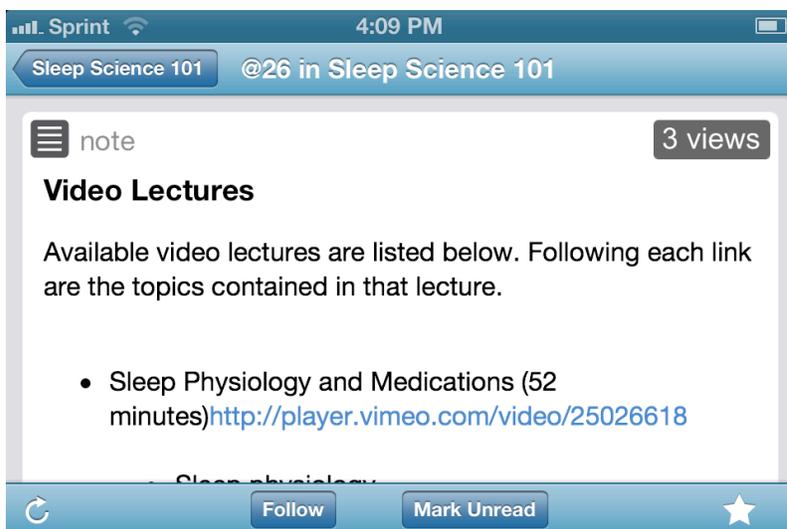


Figure 5 Sleep Science 101 – Mobile Based Video Lectures

Part 2 – Online discussion board. The discussion board is accessible anytime and via any Internet capable device. Residents type their questions/responses and view other questions/responses from their peers and instructor. The discussion is ongoing and in real-time. Online social presence (via instructor and student) as a vehicle for teaching and learning is the focus in this component. Please refer to the “Procedures” section of the

“Research Design” to view an example of the online discussion forum in action. Next are screenshots of the mobile version and the browser-based version of the discussion board.

The screenshot displays the Piazza Q&A interface for the course SLEEP SCIENCE 101. The main content area shows a question titled "Screening tools" asking for commonly used sleep disorders screening tools. A student has provided an answer mentioning the Epworth Sleepiness Scale and asking for other suggestions. The interface includes a sidebar with a list of topics, a question history bar, and a bottom section with response statistics and a student mention.

Question: Screening tools
What is the most commonly used sleep disorders screening tool?

Student Answer: Many use the Epworth Sleepiness Scale (<http://www.stanford.edu/~dement/epworth.html>), but there are several others. I'm not familiar with the others, can someone else add to this?

Instructor Answer: Click to start off the instructors' answer

Followup discussions: Resolved / Unresolved
Student (1 day ago) - I have used the Stop-Bang questionnaire.

Statistics: Average Response Time: N/A | Special Mentions: Whoa! Student answered Screening tools in 18 sec. 1 day ... | Online Now: 1 | This Week: 2

Figure 6 Sleep Science 101 – Browser Based Discussion Board



Figure 7 Sleep Science 101 – Mobile Based Discussion Board

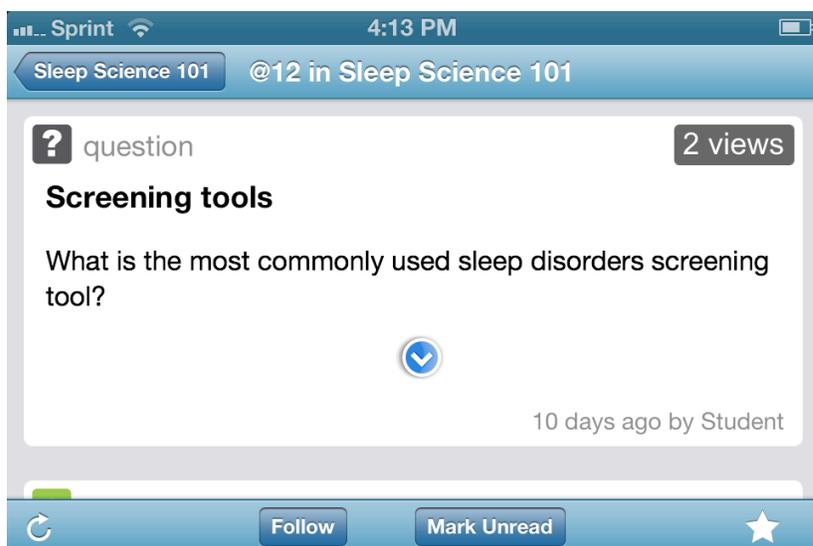


Figure 8 Sleep Science 101 Mobile Based Discussion Board

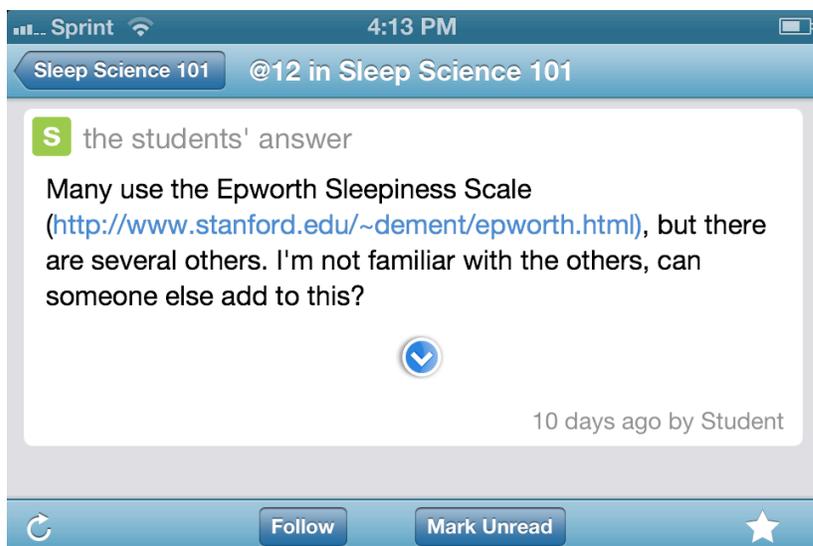


Figure 9 Sleep Science 101 – Mobile Based Discussion Board

Part 3 – Authentic resources. The resources section is comprised of links to sleep education websites, links to questionnaires for residents to use with their patients, and research articles. All of these resources parallel with **authentic/situated learning** approaches. Residents direct themselves or refer each other to resources that apply to the real-world context of what they are doing at that time. The following resources are included:

1. Sleep Medicine e-Journals -
<http://guides.lib.unc.edu/content.php?pid=170599&sid=1436551>
2. American Academy of Sleep Medicine Practice Guidelines -
<http://www.aasmnet.org/PracticeGuidelines.aspx>
3. Sleep Medicine and Neurology e-books -
<http://guides.lib.unc.edu/content.php?pid=170599&sid=1436552>
4. PubMed - <http://www.ncbi.nlm.nih.gov/pubmed?otool=uncchlib>

5. Patient Questionnaires

- a. Epworth Sleepiness Scale - <http://www.stanford.edu/~dement/epworth.html>
- b. STOP-BANG Questionnaire (Screening for obstructive sleep apnea) -
<http://www.sleepapnea.org/assets/files/pdf/STOP-BANG%20Questionnaire.pdf>
- c. Berlin Sleep Questionnaire -
<http://www.sleepapnea.org/assets/files/pdf/Berlin%20Questionnaire.pdf>

Next are screenshots of the mobile version and the browser-based version of the resources.

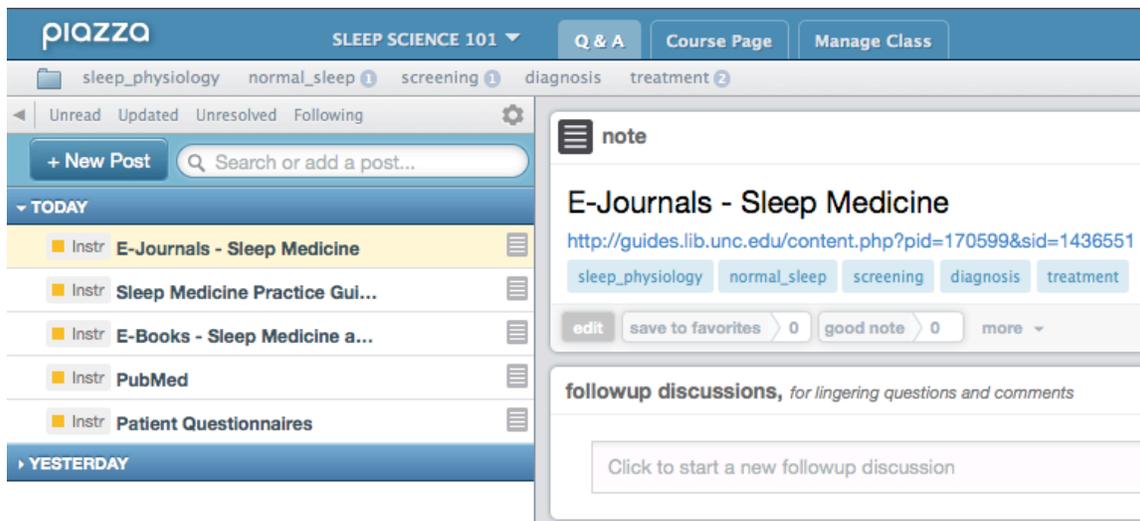


Figure 10 Sleep Science 101 - Browser-Based Resources

The screenshot displays the UNC Health Sciences Library website. At the top left is the UNC logo and the text "UNC HEALTH SCIENCES LIBRARY". To the right is a dropdown menu for "HSL site". Below this is a navigation bar with links: Home, Resources, Guides (highlighted), Services, About the HSL, and News & Events. Further right are links for Hours, Ask a Librarian, and My I. The main heading is "Sleep Medicine & Neurodiagnostics". Below this is a row of category buttons: Databases, Books, Journals (highlighted), New on Pubmed, Media, Patient & Professional, Writing Tools, and Grants. The page is divided into two columns. The left column has a section "e-Journal Subjects" with a list of links: Sleep Medicine e-Journals, Neurodiagnostic e-Journals, Neurosciences e-Journals, Neurology e-Journals, Neuroimaging e-Journals, and Neurophysiology e-Journals. Below this is a "Find More E-Journals" section with a search box labeled "Search by Journal Title", a "Search" button, and radio button options for "starts with", "contains", and "is". A note below the search options states: "PubMed's Journal Database will find the full journal title for a journal abbreviation." The right column has a section "Sleep Medicine e-Journals" with a list of links: Behavioral sleep medicine, FOCUS journal for respiratory care & sleep medicine, Journal of Clinical Sleep Medicine, Journal of Sleep Research, Open sleep journal, Sleep, Sleep & Biological Rhythms, Sleep & breathing : international journal of the science and practice of sleep medicine., Sleep and hypnosis : an international journal of sleep, dream, and hypnosis., Sleep Medicine, Sleep medicine and psychophysiology, Sleep Medicine Clinics, Sleep medicine reviews, Sleep review, and Find More Journals.

Figure 11 Sleep Science 101 – Browser Based Resources

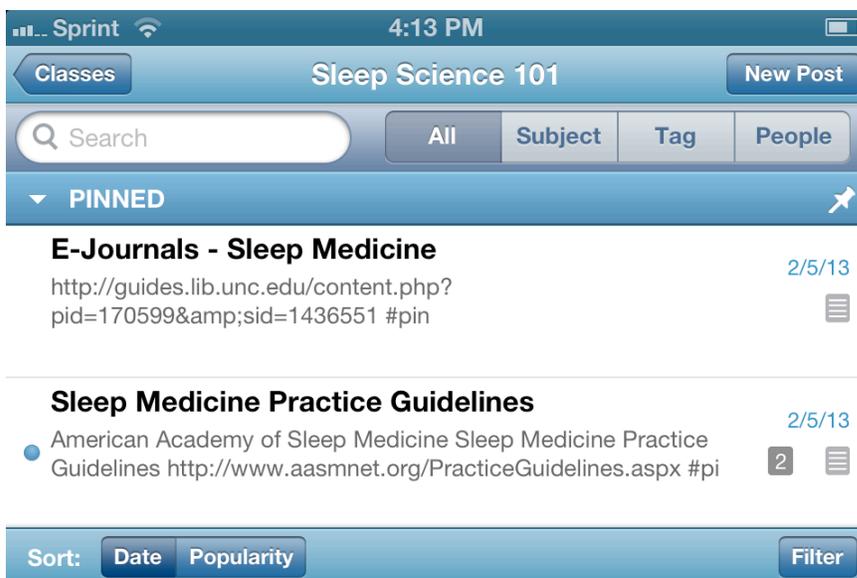


Figure 12 Sleep Science 101 – Mobile Based Resources

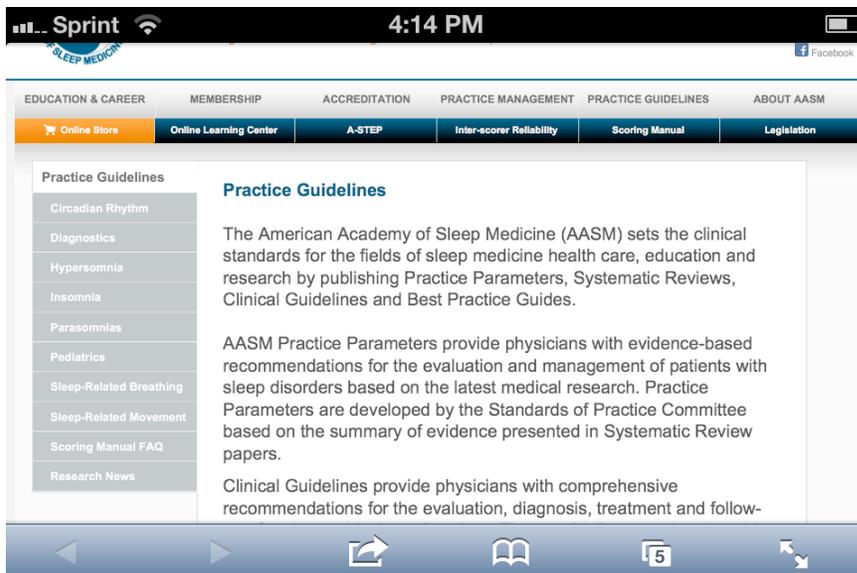


Figure 13 Sleep Science 101 – Mobile Based Resources



Figure 14 Sleep Science 101 – Mobile Based Resources

The module is built with the goal of non-linear learning. Content is presented in a format where residents can access what they need, when they need it. This is in contrast to the linear approach, where learners are instructed to complete certain parts in a particular order. Residents may access all of the information, some of it, or none of it at all. Content includes audio/video lectures, links to relevant journal articles and/or book chapters and websites, and the discussion forum. All of the content is accessible from most devices with Internet access, and the mobile application is available to cater to the mobile nature of residents.

The situated/authentic approach to the module design is in the resources available to the residents through the module and through the discussion forum. Within each section of the module, relevant journal articles are included. These articles represent real situations and research, and residents will be able to access these as they work through their own authentic

cases (i.e. their patients). The authentic environment is enhanced through the discussion forum, where the residents discuss with their peers and faculty, the issues they deal with in their own patients with regards to sleep medicine.

E-learning Constructs as Applied via Mobile Learning

As discussed in Chapter 1, the three e-learning constructs comprising the framework for this research can be used to analyze and understand mobile learning. The ways in which the constructs are used in this research with respect to mobile learning and medical residents include the following:

1. Online social presence is demonstrated through the online discussion board and immediacy of feedback and interaction between residents, instructors, facilitators, and peers; which is useful for enhancing student satisfaction and learning. Online discussions and module content are available on mobile devices for residents to utilize between patients, during consults, and any other appropriate location
2. Self-directed E-learning is demonstrated by the always available and self-guided format of the module. The module is available on mobile devices to cater to the mobile nature of residents. The module structure is not linear, in that residents access the educational topics and resources in any order, or as they encounter these topics in their own practice
3. Situated/authentic learning is demonstrated through the module resources, which include real studies on sleep medicine diagnosis, therapeutic interventions, research, etc. These resources are accessible via mobile device and residents can

access them anytime in their practice

E-learning Framework as Applied to This Research

As described in Chapter 2, the e-learning framework acts as a lens to examine the experience of the neurology residents as they go through the e-learning module. It is also a guide for how the data is collected and the overall study is designed. As the data is collected, this framework is continuously referenced to ensure the interview questions represent the concepts in the framework, and guides the analysis of the discussion forum and documents.

Research Design

This section details the procedures for carrying out this research. I begin with a brief introduction of the medical resident experience and relevant information to establish the context for this study, and then describe the particular site selected for this study, as well as the participant selection methods. Data sources for this research include, interviews, online participant observation, and documents, which are discussed next. Finally, a discussion on issues of rigor in the research design concludes the research design section.

Participant Context – The Life of the Medical Resident

Medical residency is a very special and challenging time in a physician's life. This section will hopefully paint the picture of "what it's like" to be a medical resident in the context of this research. Think back (or forward) to your late 20's, early 30's. What were you doing at that time? Well, for many, we were (or will be) in a career, with perhaps families and children, and independent with our own busy agendas. For medical residents, the first piece to strip away is the personal agenda, which includes most free time. Being a resident is

like being owned by the program. Most waking hours (and many sleeping hours) are spent within the walls of the hospital or clinic. This adds up to about 80 hours per week caring for patients, while under supervision by physician faculty; participating in clinical education, and participating in research activities (ACGME, 2012). All three of these activities are intertwined together. The patient care is everyday, and residents will follow several patients at a time. Residents are constantly juggling the care of the patient, while consulting with books, peers, and other avenues of information to care for their patients. Residency is the ultimate apprenticeship.

If you think about learning, many of us have a hard time concentrating during an entire one hour class, especially when we have family responsibilities and jobs. Residents have these responsibilities, but there is no room for them to be weary. Learning is a continuous process – days, nights, and weekends. Throughout the three years in the neurology residency program, residents must participate in inpatient rotations, including Emergency Room consults and night float; grand rounds; clinic rotations, including subspecialty areas and triage clinic; and may select from the 19 different elective areas (sleep medicine is one) to practice in.

The second piece of life to take away is the “settling down”. When many of us are establishing our families, making friends, planting seeds, and growing roots in our own communities, residents are shuffled away to schools in all parts of the country. Physicians going into residency are “matched” to a school, which may or may not be what or where they

had hoped. They then have to pick up everything, including their families, and move. What a challenge for the spouse and children!

The challenging hours and working conditions do not last for a few months, no, much longer. Residents usually spend between three and seven years in their residency program. As you can see, the path to become a specialized and board certified physician is long, winding, with many bumps and holes.

There are currently 8,887 ACGME accredited medical residency programs throughout the US, and currently 130 of those programs offer a neurology specialty (ACGME, 2012). Preliminary studies have found that approximately 1/3 of neurology residency programs accredited by the ACGME have no faculty with sleep medicine experience, and offer less than three hours of sleep medicine education per year (Avidan, Silber, Vaughn, 2011). As a result, less than half of the neurology residency programs currently meet the ACGME educational standards in sleep medicine.

As discussed in Chapters 1 and 2, medical residents have very unique learning needs, and previous research (see Chapter 2), yields promise for e-learning and mobile learning for meeting these learning needs, and offering a new means for meeting ACGME standards. The ACGME standards are designed to bridge the gap between the basic practice of medicine and the ability to practice independently in specialty practice areas. The unique approach in medical resident education is that learning objectives are met by blending traditional didactics, clinical teaching, and supervised patient care (ACGME, 2011). This creates an opportunity for the e-learning constructs of situated/authentic learning, self-directed learning,

and online social presence (discussed in Chapter 2), to be used in medical resident education, since they are closely related to the current medical resident educational approach. Gaps in knowledge of ACGME competencies (in particular sleep medicine in neurology residency programs), restrictions in duty hours, and lack of resources and content experts are among the unique learning needs of medical residents that are driving factors for this research.

Given this context of the medical resident experience, there are several meanings for this particular research. First, medical residents are extremely busy and often in a hurry. This means that participation in the online module may suffer. Second, medical residents may feel pressured to complete the module if they are aware (and they probably are) of the ACGME sleep medicine knowledge gaps. This pressure may affect the genuineness of their experience, versus completing the module simply because they want to. Finally, a possible positive meaning for this research is that the e-learning framework closely mirrors some of the unique learning needs of medical residents. This may encourage participation by the residents.

Institution/Site Selection

The site selection includes one institution with a neurology residency program accredited by the ACGME, which is selected based on convenience (Patton, 2002). The institution is the University of North Carolina at Chapel Hill (UNC-CH). This institution is my home institution, and provides me with the adequate resources I need, as well as easy access to the participants. This site volunteered for this research. I have already had time to

become acquainted with the people, spaces, schedules, and issues with this institution, which is another reason this site is desirable (Stake, 1995).

With recent budget cuts, the neurology residency program at UNC-CH has become one of the statistics, with a decrease in the number of sleep medicine education hours from five to three. UNC-CH does have sleep medicine faculty, a sleep rotation, and a sleep fellowship. However, these are optional for the neurology residents. These factors make UNC the ideal location for this research, primarily because the residents invited to participate represent each individual year of the residency experience. The residents in their first year do not have any sleep education, the residents in their second year have little or no sleep education, and the residents in their third year have at least some sleep education. I believe this will yield rich results from both perspectives. A description of the institution follows:

UNC-CH School of Medicine (SOM): The SOM is a nationally recognized research institution. The UNC Health Care System is a state owned not-for-profit integrated health care system based in urban Chapel Hill, and the SOM functions alongside and within this system. Patient care, leadership, and education are the key interrelated areas provided by the SOM. The curriculum is innovative, integrated, utilizes state-of-the-art facilities, and provides support for the numerous clinical, teaching, and research faculty. SOM attracts the very best students and trainees from highly diverse backgrounds. Established in 1879, the SOM has 1,380 full-time faculty, and enrolled 765 MD students for the 2011-2012 school year.

UNC-CH Department of Neurology: The Department of Neurology is within SOM, and is one of 19 clinical departments. The Department of Neurology operates the UNC Sleep Disorders Center, a unit of UNC Hospitals, through its Division of Sleep Medicine. Over 30 faculty comprise the Department of Neurology and represent the subspecialty areas of epilepsy, sleep disorders, movement disorders, neuromuscular diseases, cerebrovascular diseases, pediatric neurological disorders, behavioral neurology, dementia, headache, and neuropsychology. Educational programs include medical education, residency education, and fellowships.

UNC-CH Neurology residency programs: Two residency programs are available in the Department of Neurology, which include adult and child neurology. Both programs are ACGME accredited and approved by the American Board of Psychiatry and Neurology (ABPN) for Board Eligibility in Neurology, including special competence in Child Neurology. These programs offer broad based training in clinical neurology, with emphasis on academic neurology and clinical practice. The Adult Neurology residency program is the program for this study, which lasts three years, with an additional preliminary (intern) year. Five residents are accepted to the programs each year, for an enrollment total of 15 residents during the primary three years.

Participant Selection

Neurology residents are the participants for this research. Neurology residents are a focus in the research problem, hence will provide rich information relevant to the purpose of this study. Qualitative inquiry typically focuses on a small sample, as compared to

quantitative inquiry; and this sample is selected “purposefully” (Patton, 2002, p 230).

Purposeful sampling is “based on the assumption that one wants to discover, understand, gain insight; therefore one needs to select a sample from which one can learn the most (Merriam, 1988, p 48). My goal is to have 20-30 contact hours with the respective participants, which will drive the number of participants.

Criterion sampling is the sampling strategy for this research. This sampling strategy is appropriate because all of the potential participants who meet the predetermined criteria (listed below) are equally important in contributing to the purpose of this research. Relative to the study purpose, the neurology residency program has residents from across the country, and each resident had the possibility of being selected from one of any of the ACGME neurology residency programs in the US, just as any neurology resident in the US had a possibility of being selected to attend the institution selected here.

Criterion-based sampling involves the researcher creating a “recipe of the attributes essential to one selected unit and proceed[s] to find or locate a unit that matches the recipe” (Goetz & LeCompte, 1984, p. 77). Criterion-based sampling is useful in qualitative research for purposes of quality assurance (Miles & Huberman, 1994). Quality assurance is another primary reason criterion sampling is the strategy of choice. To ensure the study purpose is met, and the data collected has quality and integrity, the participants meet the criteria as follows:

- Inclusion of participants while they are enrolled in a neurology residency program

- Resident physicians must be enrolled in a neurology specific residency program
- Resident physicians will have limited (less than five hours) sleep medicine education within their neurology residency program, and/or, resident physicians will have completed an elective rotation in sleep medicine

The neurology residency program in this study has a total of 15 neurology residents (i.e. 5 residents each in years 1, 2, and 3 of the residency program). These residents are recruited to participate via an email invitation, requesting volunteers. The opportunity to participate in this research is open to all residents in any year of their neurology residency program. A copy of the email invitation is included in Appendix A. The goal is to have a range of between 5 and the full 15 participants. Demographic information has no impact on whether or not a volunteer is selected to participate in the study. If the number of participants is less than 5, I recruit with a second email. If the second email is to no avail, I attend one of the resident meetings in person and ask for volunteers. Worst-case scenario, where I do not have 5 participants from this institution, I explore contacting other neurology residency programs. As an incentive, residents completing the research are given a \$25.00 gift card.

Procedures

Before the module begins, the researcher (myself) schedules a face-to-face session with the participants and the sleep medicine fellow. During this session, residents are provided with a detailed demonstration of the sleep education module via overhead projector. A simulated discussion forum will be conducted during the session to model how the online

discussion forum works. At the conclusion of the demonstration, residents are able to download the mobile version of the module and are given individual tutorials on their device by the researcher, if needed.

The following describe the procedures the residents will use during the module, and my actions as researcher. First, the participants are given access to the module with a login. Next, I give them instructions on how to access different parts of the module and how to contact me for technical help. Residents are told they can access the module from anywhere (with Internet access), and at anytime, and are encouraged to use the mobile application. The links and resources within the module are straightforward and accessible in any order. The online discussion is a little more complex, which is described next.

Here is an example of how the online forum and corresponding online participant observation works. On day one of the module, the participants and sleep medicine fellow login to the online module to respond to the first discussion prompt. I login to observe as researcher and online participant observer. The first discussion prompt includes participant introductions. Based on information given in the introductions, the sleep medicine fellow interacts with the participants and post further prompts, while encouraging the residents to post their own prompts and respond to others, as in conversation. A snapshot of the discussion may follow a format like the following:

1. Resident 1 - I am seeing a 45 year old male patient with a history of congestive heart failure. He is also complaining of excessive daytime sleepiness. Should I be concerned about an underlying sleep disorder?

2. Sleep Fellow – Yes, you could ask him in more detail about his sleep history. Let us know what he says.
3. Resident 2 – You can also give him this quick patient questionnaire (link to STOP-BANG questionnaire for sleep disordered breathing).
4. Resident 1 – Here is what he said... His questionnaire indicates the possibility of sleep disordered breathing. What are the current guidelines for a patient like this?
5. Resident 3 – Here is a link from the module with the American Academy of Sleep Medicine Practice Guidelines... This was helpful for me last week with one of my patients who presented with excessive daytime sleepiness.
6. Sleep Fellow – In addition to the guidelines, here are a few other considerations for diagnosis and treatment...

The idea is for all to participate together, in discussing sleep medicine issues that they are currently encountering in their patients, discuss screening techniques, treatment options, long-term management of sleep disorders, and any other topics the facilitators and participants deem important to discuss relative to sleep medicine. This discussion forum continues throughout the weeks of the online module. The participation of each individual varies. In my case, I visit the discussion forum three times per day (morning, afternoon, and evening) to collect data. If participation in the discussion forum becomes lacking, the sleep

fellow sends emails to the participants to encourage participation, and to inquire why participation has been limited.

Data Sources

This section discusses the data sources for this research, which include interviews, online participant observation, and artifacts. Each of these are discussed in detail, as they are quite different. Data in qualitative research is typically empirical in nature, which means it is derived from experience or experiment. This means that data sources greatly vary, as they have different origins and are produced from different types of knowledge (Hamel, Dufour, & Fontin, 1993).

There are many sources of data useful in qualitative inquiry, and this research focuses on three of the most common, as they are relevant to this study; which include, interviews, observations (“online participant observation” for this research), and documents (Patton, 2002). Interviews tend to be individual and include open-ended questions targeting the individual’s experiences, perceptions, and other personal characteristics. The data includes long quotes to capture context and the person’s point of view. Observations of the human experience and are conducted via fieldwork, resulting in rich and descriptive field notes (Patton, 2002). Documents (called “artifacts” in this research) are examined and the types are limitless. Some examples of artifacts/documents might be public records, written prior interviews, photography or art, letters, etc. In this research, I examine participant access logs through the learning management system (see “Artifacts” below). A researcher can also create artifacts/documents for purposes of investigation, which is the case in this research

(Merriam, 1988). In qualitative research, it is most important that multiple sources of data are used (see “Triangulation” below), and to converge these on the same set of facts or findings (Yin, 2003).

I collect data in the following order, according to source: online participant observations; artifacts; interviews. A rationale is provided for why each data source is selected. The details for each data source are described in the following section.

Online participant observation.

“A fieldworker should be able to sweep the floor, carry out the garbage, carry in the laundry, cook for large groups, go without food and sleep, read and write by candlelight, see in the dark, see in the light, cooperate without offending, suppress sarcastic remarks, smile to express both pain and hurt, experience both pain and hurt, spend time alone, respond to orders, take sides, stay neutral, take risks, avoid hard, be confused, seem confused, care terribly, become attached to nothing...The nine-to-five set need not apply.” – *Halcolm’s Fieldwork Laws*

Online participant observation is a data source to explore the e-learning constructs of online social presence, self-directed learning, and situated/authentic learning. Residency is a team effort, relying on immediacy from teachers and peers. To mirror the team approach and online social presence, the online module includes an online discussion forum, from where my observations will take place. This observation is comprised of two data sources – researcher journal and transcripts. These two online participant observation sources are detailed as follows.

Researcher journal. Online participant observation takes place not only through the evaluation of transcripts, but also while I am online, as I observe discussion board activity. The activity I observe is recorded in the researcher journal. This type of observation has the strengths of covering the event as it occurs in real time, covering the context of the event, and providing insight into the behaviors and motives of the participants (Yin, 2003). These strengths help in establishing the meaning of the participants' experiences with the online module, and are the primary reasons why online participant observation is chosen as a data source.

The method of this online participation observation is not traditional, in the sense that it is synchronous and asynchronous. This is, however, the nature of e-learning and mobile learning, and should not come as a surprise. As the residents work through the online module, interactive discussions take place. These discussions are via an online discussion forum accessible via any device with Internet access. Discussion forums are built to handle multiple users at any given time. This means that residents can and do participate in discussion at any given point during any 24-hour period. Residents can and do view and post discussion before, during, and after patient consultations.

Artifacts.

Access logs in the learning management system are the documents of choice for evaluation in this research and are relevant in examining the e-learning constructs of online social presence and self-directed learning. The logs contain valuable information on exactly what areas of the module the residents interact with. Logs also list the frequency, time of day,

and duration of time residents spent with different components of the module. Access logs as documents have the strengths of being exact (i.e. containing details of events), precise, and insightful into the technical operation of the e-learning module (Yin, 2003). Comparing the access log with the online participant observations helps in creating a description and provide empirical and analytical data for how residents perceive their experience in relation to what was observed and the hard data of what they actually did.

This information is very helpful in examining what residents actually did as compared to their perceptions. The access logs also drive interview questions, such as inquiring about the “why” or “why not” in specific events. Events include whether or not a resident spent a great deal of time, or very little time in a specific section of the module, or in the module as a whole.

The access logs are distinct from the discussion forum, as each contains completely different information. These two data sources do however work together because the access log will confirm to what extent the participants interacted with the discussion forum. Just because a participant is not posting on the discussion forum, does not mean they are not reading the other posts. The access log tells this information, and also drives interview questions about why the participant only viewed certain sections and not others, or why they choose only to read and not reply to posts.

Interviews.

Individual interviews are the primary source of data collection in this research and are relevant for collecting information on all three e-learning constructs (target concepts of

inquiry are listed at the end of this section with respect to e-learning construct). An interview is basically “a conversation between two or more people where one or more of the participants takes the responsibility for reporting the substance of what is said” (Powney & Watts, 1984, p.2). Interviewing is highly qualitative in itself because talk is human nature and is the “quintessential participative human experience” (Kalekin-Fishman, 2002).

Interviewing the participants individually is appropriate for this study because I am not simply trying to count how often participants access the e-learning module or to measure if their test scores increased after completing the module. I want to know what the participants *think* about the e-learning module, and want them to explain, give examples, and/or describe their experiences (Rubin & Rubin, 2005). Interviews are widely used in qualitative research because of their flexibility, portability, and capacity for producing data in great depth and detail (King, 1994).

The goal of the qualitative interview is to understand the topic from the participant’s perspective, also understanding how and why they came about their perspective (King, 1994). While there are different types of qualitative interview strategies, King (1994) describes the following characteristics of interviews that help meet this goal, and are present in these interviews:

- Low degree of structure imposed by the interviewer
- Preponderance of open questions
- Focus on specific situations and action sequences in the world of the interviewee instead of on abstractions and general opinions

In this research, the interviews have a semi-structured design, because as patterns unfold from the data collected from online participant observation and the documents, a series of specific questions develop (Rubin & Rubin, 2005). Qualitative interviews (as opposed to quantitative interviews), are often semi-structured, or even unstructured. An interview is considered semi-structured, in that the main questions are identified in advance to ensure the research question's main components are covered; follow-up questions are to expand the themes, concepts, or events the interviewee introduces; finally, the probes help regulate the depth of the interview and keep it on the subject by asking for examples or clarifications (Rubin & Rubin, 2005). Each of the participants are unique, and communicates in very different ways. Participants are given opportunities to elaborate in the interviews, and even drive in the questioning. The interview goal is to have a conversation, and interview questions are customized for each person according to what they know, data patterns from the documents and online participant observations, and to help them feel most comfortable (Rubin & Rubin, 2005). This follows with the constructivist principles that there is not one universal truth, standard definitions do not apply, and simply counting "yes" and "no" answers only gives a small part of the story (and probably not the most useful part). The interview protocol and questions are included in Appendix B.

As discussed above, the interview questions emerge after patterns are identified from the other data sources. In other words, the interviews are the final source of data to be collected. Conducting the interviews last is especially important, since the interviews are the primary source of data for this study. Analyzing and synthesizing the artifacts and the online

participant observation drives the interview questions, and helps ensure all of the relevant issues are brought out in the interviews. I also have a better sense of “knowing” the person, which helps in establishing rapport. With regard to rapport, it is important to note that, although I know the participants through my teaching in the module, I limit the relationship to ensure there is no danger of participants being misrepresented or influenced. During the interviews, I act professionally, as I do in teaching – that of being friendly, but not a friendship (Seidman, 2006). I refrain from certain activities, such as sharing too much of my own experiences, or any other information I think may not be appropriate for the situation.

Interviews are face-to-face. To conduct the interviews, emails or phone calls are made to the participants within one week after completion of the e-learning module. I conduct a 30-45 minute interview with each participant (aligning with the 20-30 contact hours), and these are completed within 30 days of completion of the e-learning module. The interviews take place in a conference room in the Clinical Neurophysiology Laboratory. This conference room is reserved for each interview, so there are no interruptions. The conference room is considered neutral territory, and is in a convenient location for the residents and myself. Residents are also very familiar with the room, in that they attend conferences, and give presentations there. I believe this adds to their comfort level, which is why I selected this room to conduct the interviews. Also, I do not conduct more than three interviews per day, to prevent fatigue.

Interviews are recorded with a digital audio recorder, after permission is received from the participant. In the case a participant does not agree to the recording, I take notes.

The interviews are transcribed within one week of completion, to ensure I record any interruptions in the interview, or other instances that may not be revealed through the audio recording. I transcribe the interviews. The transcript includes the level of detail for the analysis and interpretation, which includes direct quotations distinct from summaries and interpretations (Rubin & Rubin, 2005). The transcription also includes time markers, to ease returning to the original recording for further analysis when warranted. After each interview is transcribed, I write a summary of the interview, including the participants name (or pseudonym), time, date, location, length of interview, the main points of the interview, and any emerging concepts, themes (Miles & Huberman, 1994, p. 53; Rubin & Rubin, 2005).

Overall, the three types of data sources are used with the common goal of making meaning of the experience of the neurology residents as they participate in the sleep medicine e-learning module. Each data source is unique and provides very different information, yet complements the other data sources. To examine online participant observation, evaluating the access logs is critical to see what is going on behind what the participants are actually typing (i.e. to see those who are only watching). Interviews are individualized, and questions are built from the data gathered from the documents and the online participant observations. It is the combination of these data sources that provides full and rich information to answer the research question. The following are target concepts of inquiry for the interviews with respect to each e-learning construct:

Table 1 E-learning Constructs

Online Social Presence
Residents use scaffolding, using each other as stepping-stones - how did this manifest, if at all?
Coaching provides encouragement, motivation, and support - was coaching evident and how was it perceived?
Modeling of expected behaviors and interactions – what is the perception of the facilitator and content expert actions?
A sense of community is critical for student success in an online environment – is this an evident experience?
Immediacy is key in social presence – how was this experienced, and did mobility play a part?
Self-directed E-learning
Self-directedness is a core assumption about adult learners and is embedded into medical resident education – what was it like in the module, how did the online or mobile nature of the module impact you?
Tremendous learner responsibility and control over the learning environment – how “in control” and responsible for your learning did you feel?
Situated/authentic Learning
All cases are real, contextualized and require personal adjustments
Andragogy approach (adults learn through situations)
Dynamic interactions between learners, tasks, and environment
Expert performances are modeled (like apprenticeship)
Multiple roles and perspectives with collaborative knowledge construction
Meaningful reflection on how knowledge is used in real life

Data Analysis, Interpretation, and Reporting Methods

This section describes the approach for transforming the collected data into findings that readers can understand and relate to. The overall analysis approach is first defined. Details are then provided for how the data are classified, connected together, and ultimately the approach for the interpretation of the data and reporting. This approach closely mirrors the analytic framework set forth by Baptiste (2001), which involves defining the analysis, classifying the data, making connections between data, and conveying the message.

Analysis Defined

Analysis is the continuous process of identifying analysis goals and the steps taken with the data up to and through the reporting process. In this research, data analysis is occurring simultaneous with data collection, due to the nature of naturalistic inquiry and emerging themes (Patton, 2002). Parts of the analysis have already been defined in the data collection sections. A linear approach is not used in the data analysis. The steps in the analytic framework, are iterative (Baptiste, 2001). If during the analysis phases, gaps are uncovered, additional data are collected.

The analysis is influenced by my own philosophical beliefs and views, and the context and design of this research, which it is important to note that these factors stay fairly stable (Baptiste, 2001). The previous considerations were discussed in detail earlier in this chapter, and the details provided here are to help provide transparency in this research. Constructivism (as discussed previously) is the driving paradigm of the analysis, and the guide of my philosophical beliefs and views. The constructivist approach in the analysis focuses on dependability and confirmability (Lincoln & Guba, 1985).

During the data collection process, data analysis simultaneously takes place. Bogdan and Biklen's (1982) suggestions for simultaneous data analysis are followed, which include asking analytic questions to help direct the data collection and analysis process, planning data collection according to previous data analysis, making observer comments and memos on demand, and testing out ideas and themes on participants. The analysis is complete when all of the data sources are exhausted and no new themes or concepts are emerging (i.e.

saturation). Once the simultaneous data collection and analysis are complete, the intense analysis begins (Merriam, 1988). This involves bringing together all of the data for categorization and interpretation, as is described next.

Classifying Data

Data classification involves tagging the data and then grouping tagged data (Baptiste, 2001). This is important so the data are organized in a scheme that makes sense and so specific data can be easily located (Merriam, 1988). Identifying the puzzle pieces from the data collected, that appear to support the study purpose is the essence of tagging. This is an arduous process of determining what to include, and what to discount or reject. Each tag includes a label of a word, phrase, or theme that is meaningfully related to the data. Those tagged data with similar characteristics are grouped into categories (themes). Note again, that this process is iterative. Tagged data may be re-defined, categories may be refined, and so on. This entire process is the coding process, and is complete when the data has become completely exhausted, and no new themes are emerging.

Coding Structure and Procedure

In this data classification, I first read and re-read the case record from beginning to end. During the reading, I keep a log of margin notes, online participant observations, and questions. These notes illuminate the most striking and notable aspects of the data (Goetz & LeCompte, 1984). The margin notes help direct where the data can be used (Patton, 2002). This initially organizes data into topics and helps to separate it. This process also includes tagging, labeling and grouping of the data and notes, as described in the previous paragraph.

This process is pre-coding (step 1 below). Once pre-coding is complete, a profile is created for each participant. After profiling each participant, the next step is the first-level coding.

The first-level of coding (steps 2 and 3 below) aims at developing the organizational structure of themes and patterns. Coding starts with pre-conceived codes tied to the framework (i.e. issues of online social presence, self-directedness, and authenticity, as well as the research questions). Open-coding is also used for the first-level of coding, and involves analyzing the raw data that does not appear to conform to the e-learning framework, which opens the data to all possibilities (Strauss & Corbin, 2008). Specifically, open-coding is the “naming and categorizing of phenomena through close examination of data” (Strauss & Corbin, 1990). The initial pre-coding is revisited and an initial list of categories and central ideas are created. Member checking is done after the first-level coding (see “Issues of Rigor”). A systematic process is not necessarily followed during this first-level coding process, however, basic questions are asked to help represent the data in a theoretical and analytic way. These questions include (Charmaz, 2003, pp. 94-95):

- What is going on?
- What are people doing?
- What is the person saying?
- How does structure and context support, maintain, or influence the participants actions/statements?

The second level of coding (steps 4 and 5 below) involves applying the e-learning framework to the initially coded data. The list of categories and central ideas are modified

based on re-reading the data with the e-learning framework application. The initial lists are modified according to the fit within the framework.

Codes are next analyzed for convergence and divergence (Guba, 1978). This next phase of coding is the third level, where categories are moved to concepts (step 6 below). Codes are reviewed to identify where they fit together, and this is documented. The codes are also reviewed to find where they differ, allowing patterns and categories to be further differentiated, and actually connecting information together (Patton, 2002). Coded data with the same labels can be retrieved and combined to exemplify phenomena, ideas, explanations, or activities; which helps to create an organized structure of data and aids I further analysis and comparisons (Gibbs, 2007).

The overall coding process for this research is demonstrated below, and based on Lichtman's recommendations (2010):



Figure 15 Coding Process

- Step 1: initial coding (pre-coding). Going from the responses to some central idea of the responses “commenting”
- Step 2: revisiting initial coding (first-level coding)
- Step 3: developing an initial list of categories or central ideas (first-level coding)

- Step 4: modifying your initial list based on additional rereading (second-level coding)
- Step 5: revisiting your categories and subcategories (second-level coding)
- Step 6: Moving from categories to concepts (third-level coding)

The Codebook Defined

The codebook is developed from a combination of the data collected from the individual interviews, the discussion forum online participant observation fieldnotes, and the e-learning module usage documents. General categories and subcategories are extensively included as a master code list. The master code list includes a hierarchical arrangement with definitions for codes and notes about the coding scheme (Gibbs, 2007). The codebook is computerized.

Connecting Data

Searching for meaning is often pattern recognition and looking for consistency (Stake, 1995). Connecting the data is more than simply listing the final list of categories or themes. This is when the themes are related to one another to construct the overall picture of the phenomenon (Baptiste, 2001).

Conveying the Findings

Thick and rich descriptions are the foundation of the write-up, so that the reader can understand the phenomenon (Patton, 2002). The interpretation is the other distinct piece of the write-up. Interpretations answer the “how” in the research question. The approach for organizing and reporting the data is two-fold, and includes illustrating how the participants

experience the e-learning module; and an analytical framework approach of illuminating key issues in the e-learning module experience (Patton, 2002, p 439).

Ethical Issues

Ethics in qualitative research is not only not putting the participants at risk, but is the “infinitely more complex challenge of doing good...and it is, as well, the identification of what constitutes proper behavior in the range of roles, settings, and circumstances where qualitative researchers are apt to find themselves” (Eisner & Peshkin, 1990, p 243). A major implication of constructivism is that values are important and critical for creating inquiry outcomes, therefore ethics is intrinsic (Guba and Lincoln, 1994). The following discussion covers ethics as applied to this research, which includes the planning of the research, data handling, and data reporting

Planning.

In the planning, I first gain approval from the Institutional Review Board (IRB) at NCSU for this research. The IRB reviews the research plan to ensure it meets the requirements for protecting the participants’ anonymity and confidentiality. The research does not commence until all requirements for the IRB are met.

Participants are included on a volunteer basis. Participants sign an informed consent stating that any personal identifiable information is not publically available with the understanding that the name of the site is publically available. Participants can also freely withdraw their consent and cease their participation in the research. In the case of

withdrawal, all of that participants data are removed. Participants also reserve the right to not answer interview questions.

Data handling.

Participants all have pseudonyms, and all data is de-identified. Any files with original names are de-identified by replacing the name with their pseudonym. Pseudonyms are gender neutral. Collected data will be housed on a computer used only by me, and password protected. Handwritten data and computer files are stored in my personal office, which is locked when I am not present. Backup copies of the data will be made and also kept in my office.

As I communicate with the residents, I recognize that I am not authorized to give medical advice for patient diagnosis, treatment, or management, and do not intend to violate this rule as I correspond with the medical residents. I view myself as the module facilitator and resident inquiries of that nature will be deferred to an appropriate source.

Data reporting.

Protecting the anonymity and confidentiality of the participants is of highest priority. All items with confidential information are accessible only to me. In the reporting, all confidential information is coded and represented in a way that offers no connection to an individual participant. All of the data analysis and reporting is done without identification of individual participants.

To conclude this section, ethical issues are inherent in all research, and I do my best to ensure this research is as ethical as possible, because I believe ethically sound research is

fundamental. To provide transparency, each of these instances regarding ethics are documented in the research log and discussed as appropriate in the data analysis and findings. The issues of rigor relative to this research are discussed in the next section.

Positionality and Subjectivity

This section was created in order to understand how my background has influenced my perceptions of both education and sleep medicine. My statement also serves as the basis for understanding how my background and influences will affect my research interests and methodology choices. As you will see, I am very passionate about and deeply connected to my research topic, both professionally and personally, which will have positive and negative effects on every aspect of my research. My intent is to provide transparency (Flick, 2008) and establish context through my autobiography and assumptions from which I interpreted data based on my own background and experiences (Laverty, 2003 & van Manen, 1990). The purpose is not to reflect the accuracy of my past, instead, I attempt to answer this question with regard to my research: “What are the consequences my story produces?” (Ellis, Carolyn, & Bochner, 2000).

Personal History

I will begin my personal history with a step back – way back. My parents and friends often remind me of how I did and still do hum and sing during sleep, which I later learned was actually a recognized sleep disorder (a parasomnia called Somniloquy). My Dad still tells me how, as an infant, he witnessed me stopping breathing multiple times during the night. He said this happened all of the time and he lost so much sleep himself by just

standing over my crib saying, “hurry up and breathe”. He said it seemed like several minutes in between breaths. Imagine the stress on my little cardiovascular system! Now I know that the deadly disorder “sleep apnea” has similar characteristics and does occur in infants. I often wonder: Would my life have turned out any different if my sleep issues had been recognized and dealt with? Will I eventually have health consequences down the road that may be linked to my childhood issues? I may never know the answers to those questions, but I believe others deserve the power of that knowledge. Empowering physicians with that knowledge has the power (I believe) to transform how our society views sleep, which is my motivation.

I began my career in medicine as a technologist in Greenville North Carolina at 19 years old, while I was working on my bachelor’s degree at East Carolina University. After completing my degree in computer science, I continued as a full-time technologist for the next seven years and assisted in the diagnosis and treatment of patient’s with neurological, sleep, and behavioral disorders. During those years, I earned registries in Electroencephalography (R.EEG T. #3697) and nerve conduction studies (R. NCS T. #477) and then I decided to go to graduate school and I completed my master’s degree in instructional technology with a focus in distance education.

I began teaching computer courses at my local community college in 2004, and became deeply involved in designing instruction at the college level. Two years later, a full-time position opened in an Electroneurodiagnostic Technology educational program and I applied and got the job. When I began as program director of Electroneurodiagnostic Technology at Pamlico Community College (PCC) in July 2006, the program was struggling

with only two students and a problem with program director retention. My first priority was to rebuild the curriculum, which included building new course content, recruiting clinical affiliates, hiring faculty, and securing equipment.

As I rebuilt the curriculum, I investigated the educational needs in North Carolina and listened to the needs set forth by the professional associations. A huge need was uncovered for registered and practicing sleep technologists in North Carolina and across the nation. Sleep medicine was barely covered in my existing curriculum, and I decided to revise the curriculum to have a much heavier emphasis in sleep medicine to help meet the needs of my state. The next hurdle was accreditation because sleep technologists must hold a professional registry to practice, and programmatic accreditation is a main pathway enabling graduates to sit for their boards.

I then initiated accreditation by the Committee on Accreditation of Allied Health Education Programs (CAAHEP). My program received accreditation by CAAHEP approximately six months later – the first in North Carolina and the 12th in the nation to receive the accreditation. This accreditation enabled graduates to sit for the sleep technologist registry examination offered by the Board of Registered Polysomnographic Technologists (BRPT), helping to fill the huge need in North Carolina for registered sleep technologists. Also, while I served as program director, I recruited over 30 students, many who lived out of state and completed the coursework virtually using distance education courses I created.

After two years of serving as program director at PCC, The Department of Allied Health Sciences at The University of North Carolina at Chapel Hill recruited me to create a

baccalaureate degree in neurodiagnostics and sleep science (NDSS). During this time, I also completed my own professional registry in Polysomnography (RPSGT #13602). The NDSS program is the first of its kind in our state, nation, and the world. I took on this huge responsibility because sleep medicine is very near and dear to my heart and I long for more people to become educated in sleep. I am responsible for delivering this program online to meet student demand, and I am pursuing a research degree to help me effectively do this, and serve my field in a greater capacity. My ultimate goal is for the program to help fill the demonstrated need for leaders, educators, managers, and researchers in sleep technology.

As a native of NC I have witnessed first hand the challenges we are facing with healthcare delivery and access. NC has one of the fastest growing populations with sleep disorders and I am actively trying to promote awareness of these deadly disorders. As I was creating the NDSS program, which focuses on sleep technology, I had the pleasure of working with Dr. Bradley Vaughn, who is the Vice Chair of Neurology at UNC Chapel Hill, the Director of the Sleep Disorders Center at UNC, and is one of the primary stakeholders in the NDSS program. He has provided the vision for the program and helped me see that the need for sleep medicine education spans far beyond sleep technologists.

With over 70 million American's suffering from sleep disorders, there is no doubt that education in sleep medicine is critical. The field of sleep medicine is relatively new and quickly emerging, and there is now a very clear need for sleep medicine education in medical residency education. This is especially true for neurology residents (the focus of this study), where there is an enormous incidence of sleep disorders.

Influential Conceptions of Myself as Researcher and My View of Medical Residency

This subsection describes the four primary conceptions I identified that may influence this research. These conceptions of myself and my view of medical residents are described as follows:

- I am in a unique position in that I must teach “up” and “down”. As an educator of sleep technologists, I am teaching content that I have already mastered to entry-level technologists who typically have not also mastered the content. During the research, I teach sleep medicine content that I also learn alongside the residents. Some of the material I am familiar with, but other material is not necessarily within my regular scope of practice. This is however consistent with a common view of medical education, “do one, teach one” (referencing procedures or tasks). Not having mastered some of the sleep medicine content affects how I view resident knowledge and skill acquisition as a result of the module. I do record in the research log, instances where my non-mastery of materials and concepts is an issue. These issues are addressed in the write-up of the data analysis, with careful consideration and reflection of how each issue does or does not affect my interpretations and findings.

I am viewed as both an outsider and an insider. An insider because I share a love of caring for people and am employed in healthcare. I am also an outsider because I am not a resident physician (the subjects of interest for this research), but am a technologist and an educator. Technologists work along side physicians, but are

not as involved in the overall picture of the person's health (i.e. technologists do not diagnose, make referrals, or recommend treatment). This insider/outsider perspective influences every aspect of this research, including the way the module is designed, the way the data is collected, the analysis, and my recommendations. To ensure I do not waiver from my position as a technologist and educator, and not into the scope of practice of a physician, I clarify in my findings and recommendations that my views and interpretations are not medical advice and should be viewed in the context of a non-physician role.

Since I am not a physician, ethical dilemmas arise with regard to patient diagnosis and treatment. Ethical dilemmas and concerns are always persistent in everyday research practices, and most certainly in qualitative research, the everyday ethical issues or "ethics in practice" are of particular concern (Guillemin & Gillam, 2004). I recognize that I am not authorized to give medical advice for patient diagnosis, treatment, or management, and I do not intentionally violate this rule as I correspond with the medical residents. I view myself as the module facilitator and resident inquiries of that nature are deferred to an appropriate source. Each of these instances are documented in the research log and discussed as appropriate in the data analysis and findings.

- My experience brings strength to the research, but there are apparent blind spots. As a technologist, my experience is limited with regard to long-term patient following of sleep disorders. Typically, I see the patient to run a

- diagnostic study and the patient may or may not come back for therapeutic intervention. It is not uncommon for me to never see that patient again, therefore I do not see the long-term result of treatment of their sleep disorder or the effects if they are non-compliant. The physician does however follow the patient long-term and is intimately involved in their care. I have knowledge of these concepts based on professional literature and anecdotal evidence from sleep medicine professionals. This potential blind spot influences my interpretation of the research findings, in particular how I interpret the residents experiences and opinions. I also understand that there may be other blind spots that I am not aware of, that became evident during the course of the research. This means that my perspective of truth and reality may be viewed differently through readers varied lenses. To increase the credibility of my research and minimize bias, data collection procedures are rigorous, systematic, cross-checked, and cross-validated with sources (as described in the data collection section) (Patton, 2002:p545).
- A gap exists in sleep medicine education. As exemplified in Chapters 1 and 2, sleep crosses all medical disciplines, however; sleep medicine is either not recognized or under recognized in many areas of medical education. Pre-existing knowledge of this gap makes me more apt to view the inclusion of sleep medicine education in residency programs as especially critical for patients' health and well-being.

Another potential issue is the selection of the sleep medicine content that attempts to fill this knowledge gap. To ensure the content selection is ethical and unbiased, qualifiers are built into the research with regard to the sleep medicine module content. A sleep medicine expert (Dr. Bradley Vaughn), who is also a professor in an ACGME accredited neurology residency program, oversees the selection of the content for the sleep medicine educational module. The ACGME has set forth a standard for the inclusion of sleep medicine education within neurology residency programs. Any recommendations that result from this research are compared to and reflect the ACGME sleep medicine standards.

The frame of my own life experience may limit the understandings I interpret and construct/impose (Grbich, 2007). This is relevant to the sleep medicine education gap, because my direct experience with the gap for physicians is limited through only reading previous research and hearsay from others in the field. I have brought in Dr. Vaughn just for this reason. He does have direct experience of witnessing the gap in action. This is a strength of the research as he participates in the online module.

- Epistemology and reflexivity – My interpretive framework is encapsulated by my epistemological, ontological, and methodological assumptions. As such, I am “bound within a net of epistemological and ontological premises which – regardless of ultimate truth or falsity – become partially self-validating (Bateson, 1972, p 314; Denzin & Lincoln, 2005). Ontology can be defined as the “study of being in general” (Simons, 2012). Epistemology can be defined as the “study of

knowledge and justified belief” (Steup, 2012). I believe that knowledge is not entirely truth, and likewise, not entirely belief. It is a combination of the two. I also believe it is not possible to fully separate myself from my research.

I do understand that my findings and interpretations do not reflect the views of all medical residents. “Speaking for others” is increasingly criticized and may be viewed as unethical (Alcoff, 1991-92). It is common knowledge that researchers simply cannot sustain neutrality. Although, I know that I cannot completely separate myself from the research, as I am intimately connected in my own life; I try my best to maintain an awareness of the participant voice and ensure that voice shines through. One way I ensure this is through member checking, whereby participants review a synopsis of the first-level coding of the group. However, it is important to note that there are interpretive differences between fact and opinion, due to the nature of subjectivist subject matter. My “social” location is important in how I represent the participants, but it is important to note that I do not feel my location privileges me in any way compared to residents and should not overtly “oppress” them (Alcoff, 1991-92). My voice is that of the “passionate participant” (Lincoln, 1991) as I facilitate the “multivoice” reconstruction (Guba & Lincoln, 1994). As I reconstruct the diverse and multiple perspectives, I demonstrate an appreciation of the perspectives of the participants and strive for fairness as I depict their views and values (Patton, 2002).

Reflexivity is a process I employ in the research where I continuously reflect on myself in response to others, and subject my actions and my researcher role with

the same rigor and scrutiny as any other aspect of the research, including the methods, participants, and context (Mason, 1996). As Hertz (1997) notes, reflexivity involves active interpretations of “What do I know?” and “How do I know what I know?”. My ability to step back and “critically reflect” my interpretations and how I am constructing knowledge from my data directly affects the quality of the research (Guillemin & Gillam, 2004). I understand that my interpretations are filtered through my own lens of sleep technologist culture (Shope, 2006), from which I examine. Documentation of the processes described above and steps taken are included in the research log.

Issues of Rigor

“Truth is stranger than fiction, but it is because Fiction is obliged to stick to possibilities; Truth isn’t.” ~ Mark Twain

In this research, four methods are used to ensure the research is rigorous. These include triangulation, member checking, reflexivity, and an evidence trail. Each of these methods are discussed below.

Triangulation

Triangulation is defined as the use of multiple sources of evidence, and can help deal with issues arising from the validity of the construction of case study (construct validity) and reliability of case study evidence (Yin, 2003). Triangulation is important in data collection since the qualitative information collected via direct, systematic measurements. The advantages of triangulation in qualitative inquiry include the ability to investigate a broad

range of attitudes and behaviors, and most importantly, to develop “converging lines of inquiry”, which means that findings and conclusions arising from the research are more “convincing and accurate” when their basis is in more than one source (Yin, 2003). Data source triangulation is the protocol that is utilized. This involves checking the consistency of different data sources with consistent methodology (Patton, 2002). In this protocol, I examine the case to see if it remains the same at different times and as circumstances change (i.e. participant interactions change or other patterns change) (Stake, 1995). I also examine the participant data for where they converge and diverge, as discussed earlier. This is evident in the research log.

Member Checking

Member checking is utilized in this research. Member checking is defined as when the participants are asked to review a synopsis of the first level coding of the group. Through member checking, the participants “help triangulate the researcher’s observations and interpretations” (Stake, 1995). Having participants “react” to the descriptions and conclusions in the first-level coding helps reveal a great deal about the completeness, fairness, and perceived validity of the information (Patton, 2002, p. 560). Member checking is important in this research to ensure that researcher predispositions and biases are not influencing the synopsis or the interpretation of the interviews.

In this research, member checking is done after the first level of coding (see the data analysis section). The process involves the participants being requested to review a synopsis of the first level coding of the group, and provide feedback in the form of a reaction. In

member checking, I am not interested in looking for truth, and do not ask the participants to evaluate the synopsis for truth. There is not enough convincing evidence that providing entire transcripts provide helpful information, therefore, I do not provide the entire transcripts to the participants. Revisions from the participants are reviewed for inclusion in the final draft of the first level coding, which is documented in the research log.

Reflexivity

Reflexivity is an important aspect of rigor or trustworthiness of the data, which is discussed in my positionality and subjectivity statement. Reflexivity is a hallmark of the constructivist epistemology, as relevant to this research. Reflexivity is an iterative process, and I proactively take steps to ensure my reflexivity. Based on my positionality and subjectivity statement, the steps I take include: maintaining awareness of participant voice, ensuring it shines through (verify with member checking); striving for fairness through self-reflection as I depict participant views and values; ensuring my social location and position does not privilege me in any way compared to the residents (verified with a physician and sleep medicine fellow overseeing the module and acting as facilitator). The research log documents the continual process of connecting and understanding how my own experiences and background affect the research (Patton, 2002).

Evidence Trail

The log of this research demonstrates an evidence trail by clear cross-referencing from procedures to evidence, which is the ultimate “chain of evidence” (Yin, 2003). The log enables readers to move from section to section without becoming lost in the research.

Demonstrating that the findings are kept within context is a goal of the evidence trail, and the goal and purpose of using the evidence trail in this research.

Research Timeline

The research timeline is as follows:

- January/February 2012 - Pre-planning (IRB, participant recruitment, module setup)
- February/March 2012 – Data collection and analysis (running the online module, data collection from online discussion, ongoing analysis)
- March/April 2012 – Data collection and analysis (interviews and analysis of documents)
- April/May 2012 – Write-up

Strengths and Limitations

The following are the strengths and limitations of this research:

- As listed in my positionality and subjectivity statement, my experience is both a strength and a limitation in this research. My own life experience is a strength because I already have extensive experience with online education and in working with neurology residents. I also work directly in sleep medicine education. These are strengths because I am very familiar with the context of all aspects of this study. This experience is also a limitation because there are certain areas of sleep medicine practice that I am unfamiliar with. For this reason, I have brought in

content experts to participate with the neurology residents in the educational module.

- Online participant observation is a strength of this research, which is described in the data collection section. It is a strength because the events during the online discussion are covered in real-time, revealing insight into behaviors and motives of the participants (Yin, 2003). The context of the online discussion is covered, and this provides additional information to guide data collection during the interviews. For example, if a participant does not participate in the online discussion, I am able to inquire “why” during the subsequent interview.
- The module materials were not assessed for quality, which is a limitation of this research. For example, module lectures and videos were not evaluated in any way to determine if their quality (i.e. length, interactivity, etc.) had an impact on participant motivation to use them.

Generalizability

Generalizability is a final issue discussed relative to this qualitative inquiry and to qualitative inquiry in general. Generalizability in qualitative research, particularly in case study, provokes skepticism. How can a single case be generalizable? The notion in this research is that a generalizability link can exist through “vicarious experiences” (Stake, 1978; Donmoyer, 1990). Langer (1953) describes how narrative can create a virtual reality, and our imagination is part of the basis for scientific discovery (Donomoyer, 1990). Donomoyer

(1990) describes three advantages of case studies with regard to generalizability and as advantageous to direct experience:

1. Accessibility – case study can take us where we might not otherwise go
2. Seeing Through the Researcher’s Eyes – case study allows us to see things that we might not otherwise see
3. Decreased defensiveness – Vicarious experience is less likely to produce defensiveness and resistance to learning

Vicarious experiences are extremely important in medicine, perhaps more so than in other fields. Part of this belief is that human bodies are in fact comprised of basically the same elements, with mostly similar functions. And, single-case studies do hold much weight in the medical research community. Think of it this way – on a busy highway, one person wrecks and dies from something preventable. This tragic event probably will not result in an immediate change to the highway. Usually, it takes multiple “cases” to prove a change is needed. Medicine, however, is very intimately connected in personal lives, business and industry, politics, etc. The result of a few cases, or even a single case can be quite drastic. National news coverage, immediate removal of drugs from shelves, enormous lawsuits, and even breakthrough treatments can result from just one case.

This is recognized in education as a popular method called “scaffolding”. There is a wealth of truth to the old saying in life to “learn from others mistakes”. Allowing a child to be burned and scarred in a fire, just to teach them that fire is hot is primitive. We are not primitive; we are progressive.

Generalizability is not an overt goal of this research. However, is important to note for the sake of generalizability; that this research studies the “what is”. The “what is” refers to the typical, common, and ordinary (Schofield, 1990).

“Even if you are a minority of one, the truth is the truth.” ~ Mahatma Gandhi

CHAPTER 4

The purpose of this study is to answer the question, *How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning*. This chapter is a discussion of the three specific research questions and the evidence I have from the data to answer the questions. The findings are grouped as “Finding” #1, #2, and #3, which represent the three research questions. A qualitative analysis software program (Atlas.ti) was used to code the data and identify themes and categories. Findings are dense with quotes from the participants, which is meant to represent patterns that emerged in the research and that precisely show evidence of the main points.

A total of nine neurology residents participated in the research. Their experience in sleep medicine ranged from zero to approximately two weeks. Participants from each level of residency were represented (i.e. PGY1, PGY2, PGY3, and PGY4). All of the participants had some previous experience with online learning and/or with using mobile applications.

Sleep 101 was a self-paced module lasting three weeks and was offered on the Piazza platform, which is a mobile application. Eight out of nine residents actively participated in the module. Three residents accessed the module almost every day, three residents accessed the module on four to seven separate days, and two residents accessed the module one to two separate days. Seven residents accessed the module via the mobile application on their phones and tablets. All residents accessed at least one of the video lectures and three residents accessed resources associated with the module. Four residents actively contributed

posts to the discussion board, and all eight residents read at least two discussion board conversations, with six of the eight residents reading at least 50% of the discussion board conversations. The findings are listed next.

Research Question #1 - What are the pedagogical issues of the online module with regard to specific e-learning constructs and mobile learning?

Finding #1 – The pedagogical issues of the online module with regard to e-learning constructs include:

Online Social Presence

- 1. Positive, non-intimidating coaching through online discussion encourages residents in learning**
- 2. A function of online community is to keep things interesting, but is more a “spoke” than a “hub” for learning**
- 3. Modeling provides practical and contextual information**
- 4. Discussion forums are most appropriate for non-urgent topics**
- 5. The facilitator did influence learning in a positive way via scaffolding**
- 6. Lack of foundational knowledge prevented discussion**

Self-Directed E-Learning

- 7. Resident prefer to be in control of their learning, reflective of their perceived self-directedness**

Authentic/Situated Learning

8. **Authentic/situated learning is facilitated through the mobile e-learning module.**
9. **Of the resources available in the module, the lectures and online discussion were utilized most, with the patient questionnaires, practice parameters, and journal links viewed as a “nice to have”**

Mobile Learning

10. **Residents prefer the mobile nature of the e-learning module**

Introverted Learning Style

11. **Residents introverted nature governed how they used the module**

Each of these issues will be discussed next within the context of the e-learning framework used during the data collection.

Online Social Presence. Several teaching methods were employed during the module to help reveal teaching and learning issues around online social presence. These teaching methods included coaching, community, immediacy, modeling, and scaffolding. Resulting pedagogical issues that emerged are exemplified as follows.

Pedagogical Issue #1: Positive, non-intimidating coaching through online discussion encourages residents in learning. Facilitator and Peer encouragement through discussion was evident throughout the online discussion forum, which took place in the module. One resident mentioned that positive coaching would encourage residents a little more. The resident states:

I think I'm that way. I think I would give off information I know for the junior residents. I think it [the online discussion] would be useful to have – I don't know if people would use it, but to have it would be interesting. (Sylvia)

Another stated:

I did notice one of the residents posted, maybe a couple of different times, maybe "enjoyed reading the comments" or "found that interesting" and I thought that was nice just to show that yes, they were lurking, but they were actually reading through the comments and maybe getting something from it, which encouraged me to, as much as I could, to continue to respond or contribute. And I remember once or twice when I responded, Brittany said, "yes, you are correct", and then she even added additional information based on my response. (Pete)

An additional issue regarding coaching is that all of the residents appreciated the fact that their overarching supervisor (in this case, medical director) was not a participant in the online discussion. Rather, residents believe the Sleep Fellow is a better fit and made the discussion less intimidating. This is best represented by Grady's statement, "not having your superior there; to be able to look at what you may mistakenly assume or think", as he discussed the facilitator of the discussion forum.

Lawrence liked that the medical director was not participating in the online discussion and thought the Sleep Fellow was a better fit as facilitator, but also offered an opinion on a possible benefit of the opposite. He states:

There are a lot of things on there, just in terms of if you are going to ask a question or make a comment that you'd have to articulate it in a way that puts a little bit more thought into it, as opposed to just sort of, you know, really thinking about it without worrying necessarily about someone who's potentially evaluating you, you know, or going to hire you in the future, or whatever else. It's just nice to have that separation. I do think that not having him as part of the module, sort of facilitated things, in that way. However, that being said, I guess, if there was someone, you know, an authority figure checking in on it, perhaps that would have been a motivating fact to participate more and put more thought into it. So, I guess it could go both ways. (Lawrence)

Pedagogical Issue #2: A function of online community (i.e. forum discussions) is to keep things interesting, but is more a “spoke” than a “hub” for learning. Keeping the learning and topics interesting in the module is a view shared by most of the resident participants. The sheer volume of information residents are exposed to on any given rotation can be overwhelming and residents are skilled at sifting and choosing the pertinent information. Interest level is a key factor in how these residents approached the ancillary learning in the module.

Several residents referenced that interest was a driving factor in what they chose to look at in the discussion and in particular, cases that are not typically seen or listed in textbooks. This recurring theme is best expressed by Lynn's suggestion, “Putting more of the interesting stuff of sleep medicine in the discussion board (the uncommon cases).” Kai brought up that the online community helped gain and maintain his interest, and therefore

helped keep him engaged in the module through his peers building on the discussion by providing authentic examples, resources, and opinions. He stated:

Somebody would bring up a particular topic, or have specific questions about the case and then other classmates or colleagues would chime in and give answers or give articles and redirect them this way, or give examples of different patients, or where they could go to gather more resources, such that especially if somebody had already reviewed it, researched it, that they could just provide the link to it and say “hey, this is what I found”. So, that was helpful. (Kai)

Although the online community may be useful for learning in the sense that it can help stimulate the residents’ interest through discussion of unusual examples of patients with sleep complaints, the discussion forum is not central or even critical in the functionality and usefulness of the module. An online e-learning module can be compared to a “hub” and “spoke” wheel model, where there is a centralized learning “hub” and various spokes or nodes with separate functions, but are supported by the hub. In some modules, the online community is central to the learning, in that the topics and/or questions are first brought up in discussion and students break out via the “spokes” (i.e. resources, books, small groups, etc.), yet return to the “hub” with their answers or follow-up questions. In Sleep 101, the online community was merely a “spoke” instead of a centralized learning “hub”. This is partly due to the fact that most of the residents either minimally participated in the online discussion, or merely “lurked”, which is also discussed in detail in another section. Christine states:

I wouldn't worry too much about trying to build up a forum. I feel like that's going to be doomed at this point. Because I think that most people that are going to use this are going to use it in a sporadic and independent fashion. I feel like when you are trying to do peripheral learning, when you are otherwise doing other stuff, that's when I feel like that those (forums) are not going to be used as much. (Christine)

Pedagogical Issue #3: Modeling provides practical and contextual information.

Teaching by experience was regarded as important for learning, which was seen “in the way that responses were phrased” by the facilitator. Johnny mentioned that the facilitator used modeling, as a teaching tool as she described how she handled certain patient situations when he stated, “[Brittany] would talk about how she would treat certain patients that she had in clinic” (Johnny). When asked if that was helpful, Johnny said, “I think so, again it provides more practical information than a lot of the typical lectures provide” (Johnny).

The facilitator would often initiate discussion, or try to intrigue the residents with questions relating to actual patients or experiences she had. These questions were used as a stem for the discussion, and could branch in a variety of directions. Christine stated, “I think it's useful to have some questions like that as a starting point.”

Pedagogical Issue #4: Discussion forums are most appropriate for non-urgent topics. Residents viewed the time with which their questions and concerns received a satisfactory response. However, the overwhelming consensus was that the online discussion at this point would not be as useful for urgent questions needing a quick response. Part of this

issue is due to the fact that there were only a few people accessing the discussion forum.

Kree gave an example:

It [online discussion forum] might be a nice way to ask a non urgent question.

Actually in medical school our psychiatry attending had a forum like that and that actually got used a lot. It was similar, you could ask questions to him and anybody could post. On the day of exams, he would sit in a coffee shop all day and answer our questions. (Kree)

On the flip-side, one resident mentioned it may be a benefit to use the discussion board strictly for non-urgent issues. Johnny states:

Yes, it seems like a good idea [to have multiple attending physicians participating in the discussion], but I wouldn't expect it to be fast responses. If it were something I needed to know quickly, I would probably use other means. But, I guess on the other hand it would be good too, because a non urgent thing you don't want to bog down their inbox or send them another page. (Johnny)

Pedagogical Issue #5: The facilitator did influence learning in a positive way via scaffolding. Residents acknowledged that the facilitator did try to encourage scaffolding. For example, Johnny stated:

Yes, I did see that, some and um, it was mostly Brittany the facilitator asking questions and then sometimes she would answer her own questions and then every now and then people would add on um and I think that was a beneficial way to think about the topics in the module as opposed to just having a lecture on them. (Johnny)

Although the scaffolding was minimal, it did take place in the online discussion. For example, Lynn stated:

Brittany had posted a video, then a YouTube clip of someone being interviewed that had it [Kluver-Bucy Syndrome], so I watched that, and based on what they talked about in the video, found a journal article by one of the researchers in that video... so I then posted that journal article with the link. (Lynn)

A different resident also discussed how the facilitator encouraged residents to build up the discussion. Instead of using the discussion forum and including peers via scaffolding; that resident went an independent direction and in essence appeared to learn by building his own knowledge trail. This resident stated:

There were suggestions about other articles or videos to view, I think in particular, Klein Levin - this unique hypersomnia that a female had. That was interesting to look at that and the other videos and subsequently I would watch one video and then another. (Kai)

Christine brought up a contrasting, yet important point about residents self-directed nature inhibiting scaffolding as a learning mechanism. She stated:

I think some people depend upon that a lot. I think it looks like the way that this was setup, that the platform is pretty well suited to that, but I think for a lot of the questions that were potentially raised here, I'm not sure how much those would end up being used, particularly in a residency setting, because a lot of times I feel like

when people have a question, they think “well, I could figure this out as well as anybody else”, and what you need to do is just go and do it. (Christine)

Pedagogical Issue #6: Lack of foundational knowledge prevented discussion. All of the residents accessed the discussion forum regularly during the module, but the participation was very limited. Throughout my observations each day, I did see that the residents were accessing the individual threads each time a question was posed or a reply was posted. When I asked the residents about this phenomena, a common theme appeared, which was that sleep medicine was relatively a new field for them, and their knowledge was so limited that they did not feel qualified to answer any of the discussion questions. This issue is best represented by the following statement:

Once again, looking back at the discussion board, it didn't have a lot of use. It was good that Brittany kept putting out prompts. It was good that the discussion board was still there and available and the prompts kept coming out, but I didn't feel qualified to respond to them, or really, I didn't have time because I had to get through the basic stuff. I felt like I had to get through the basic stuff first. (Lawrence)

This comment also parallels with the fact that most of the residents were on intensive rotations that did not allow them much time to go through most of the “basic” information. The issue of rotation will be discussed in a later section.

The issue of context is another area partly responsible for the discussion forum floundering. Context is also discussed in detail later, but this issue relating to foundational

knowledge is best embodied by Lynn's comment on why residents participated very little in the discussion. She stated:

People just don't know. There were zero sleep lectures this year. People are busy and they just want to do a quick thing, but when it comes to when a question is posed, if they really don't know the answer readily, they are unlikely to do research to answer it if you are not already invested in sleep. (Lynn)

Self-Directed Learning. The second area of the e-learning framework is self-directed learning. The associated pedagogical issue is discussed next.

Pedagogical Issue #7 - Residents prefer to be in control of their learning, reflective of their perceived self-directedness. Residents admit to being self-directed learners, and actually prefer that style. Sylvia felt that neurologists in general are self-directed when it comes to their learning. Pete mentioned, "I don't like too much structure." Christine states:

In residency, it's that most of us do things on our own. I think that in more general terms, I think about undergraduate courses where there are often times a sizeable number of people that really want to study together and use other people for that. And even when I was in college I typically studied by myself, I didn't use study groups, but that's a personal style. (Christine)

Being in-control of learning and self-pacing were common themes among the residents. Christine states:

I like that there is the ability to be self-directed to look for specific areas of interest or areas that you know that you don't know about, or that are relevant to a particular

patient. I like that, sort of being able to pick and choose; I think that's useful.

(Christine)

It can be inferred from two different resident's comments that preferences for self-control and self-direction appeared to strengthen as they progressed in their education. This is important in the consideration of the timing of the online module. Kai states:

I think as a beginner it's easier if you have a little bit of a guided approach and then as you progress throughout the residency, I think it's easier to say, "Hey, well I already know that, I need to learn specifically about this." (Kai)

Referencing medical school, which is just before residency, Pete states, "You can't really [during medical school], sort of meander through the material at your own pace, with your own interest, because you're very test directed, and that is your goal, whereas here, it's what you want to know more about." These comments tie in to the opinion expressed by Christine in Pedagogical issue #5, when she discussed that resident's self-directed nature helped them to learn and look up information for themselves without relying on a facilitator or scaffolding.

Authentic/Situated Learning. The third area of the e-learning framework is authentic/situated learning. The associated pedagogical issues are discussed next.

Pedagogical Issue #8: Authentic/situated learning is facilitated through the mobile e-learning module. A "real" learning experience that is within context is important to residents with regard to an online module. Through this module, residents agreed that the learning experience was more real, as compared to traditional lectures. Johnny states:

I would say [this module is] definitely more [real] than a typical lecture style learning and for like one reason is there is no time limit on the questions you can ask or the discussions you can have, like as opposed to a lecture you may have five minutes at the end to maybe ask a question that may be relevant to your own patients or to ask any type of question whereas in this situation you're not limited by time to do like real-world application of what you've learned. (Johnny)

When asked if the knowledge gained from the module was useful for real life, Kree states, "Oh, absolutely. First of all just knowing that the resources are there for the tough questions. That's fantastic. The lectures as well." Kree goes on to explain that the benefit of the online discussion was that "it allowed us the chance to bring in, 'I saw this patient', this is as real as it gets." Grady agrees with a statement, "It was all very clinically driven". Lynn adds to this point with her statement, "A lot of it was practical and able to be employed in the clinic."

Pedagogical Issue #9 – Of the resources available in the module, the lectures and online discussion were utilized most, with the patient questionnaires, practice parameters, and journal links viewed as a "nice to have". Residents did use the video lectures and the online discussion, but most stated they did not have a chance to use any of the other resources. The primary reason was a lack of time due to rotation, which will be discussed in detail later. It is important, however, to note that the residents did not feel those resources were useless. Most of them agreed that the resources are useful to have, are situation dependent, and that they would likely use them when appropriate situations arose, or if they

were working in a subspecialty clinic (i.e. only seeing patients with sleep related issues). Context appears to be an important factor in the opinion of these residents regarding when and how they would use resources in a supplemental module. Context is a major recurring theme throughout the rest of the findings.

Two residents did note that they in fact did use patient questionnaires and did look up articles relative to the module, but they did so in another platform. The platforms included the Health Science Libraries PubMed portal and catalog. Kree states:

I accessed the forum a lot. I didn't get to go into some of the documents, the textbook links and other things that were there - I wanted to. I perused them at the beginning, but just due to the work schedule that I'm on right now, I just did not have the time to delve in them like I wanted to. Now, I'm glad I know they are there so I can go back into them. (Kree)

Lynn discussed using the patient questionnaires (i.e. Stop Bang and Epworth Sleepiness Scale) in a different mobile application. She stated that she pulled up those questionnaires on her mobile device, right in the patient room. The difference is that the mobile application she used automatically calculated the patient's score and interpreted the results. The Sleep 101 mobile application did not have this capability.

Mobile Learning. The fourth and final component of the e-learning framework is mobile learning. The pedagogical issue is discussed next.

Pedagogical Issue #10 – Residents prefer the mobile nature of the e-learning module. Mobility was an important factor governing the way the residents used the module.

All but one of the residents used the module on a mobile device. The one resident that did not use a mobile device still used the module in a mobile fashion by accessing it on a computer while he was in-between patients and during down time. Residents used the module at completely different, and sometimes random times. Many used it during their regular work duties, and others used it outside work. For example, Kree states, “I accessed the videos at all sorts of different types - at work, on the elliptical at home, I mean, you name it I was using it.”

Several residents mentioned that the mobile aspect of the module is critical, and that they would indeed use it in between patients as appropriate situations arose. Actually, several residents in this group already use mobile applications of this nature. Sylvia mentioned she would use e-learning applications like the module, not just for sleep medicine, but also for any other area of medicine and prefers modules like Sleep 101, which are more specific to her interest areas. In particular, she stated:

I have like an epilepsy thing on my phone. I have an app that I sometimes use and it is a little more helpful as far as the medications. They are more specific than if you had a general medications app. (Sylvia)

Introverted Learning Style. A theme independent of the e-learning framework emerged, and involves the concept of introversion. The pedagogical issue associated with this theme is discussed next.

Pedagogical Issue #11 – Residents introverted nature governed how they used the module. Throughout the conversations with the residents, a very common theme emerged,

which is that this group of residents displayed characteristics of introversion. This was self-admitted by several, and was evident during my observations of the discussion board use. The statistics of discussion board use also confirm this finding. This is a major implication of the usability of the online discussion and the module as a whole.

“Lurking” was a common theme around the online discussion. Residents did regularly monitor the online discussion, but appeared hesitant to post questions or replies, which has already been mentioned earlier in the findings, and is referenced again later in the findings. Sylvia’s comment embodies this introverted nature as she talks about using the online discussion forum:

Maybe it’s just me. Maybe I don’t learn that way. Don’t feel comfortable just chatting about random stuff on a forum. Maybe I’m a more independent learner. I’m a little bit more closed off. I’m not as social of a person, maybe that’s - seems a little out there for me. (Sylvia)

The introverted nature did not mean the residents were opposed to the “social” aspect of the module. In fact, residents do use other forms of social media and interact with them in a similar way they did with this module. Kree mentions, “I would read and get a ton of information, but didn’t post anything,” as he talked about a student/doctor network social media portal he uses. Sylvia mentions, “I have facebook, but I’m more of a facebook stalker. I don’t actually do anything on it, you know, I just see what everyone’s doing like look at their baby pictures.” Lawrence stated, “I’m not someone who likes to speak up or post things

or whatever, just to - I'd rather hear what other people are saying." Christine states, "My guess is that that [discussion] is not going to catch on."

Research Question #2 – What are the strengths and areas for improvement in the overall resident educational experience?

Finding #2 – The strengths of the e-learning module include that it is flexible, uses multimedia, is practical, and is easy to use. The areas for improvement listed are the timing of the module, length of content, addition of prompting and reminders, and adding more contextual content.

A discussion of the specific strengths and areas for improvement follows:

Strength #1 – Flexibility. Residents pointed out several areas where the module was flexible, which are as follows:

Mobile. Mobility of the e-learning module was beneficial to these residents in several ways. First, residents are mobile learners, by nature of the medical residency and the fact that they are constantly moving from patient to patient. The mobile nature of the module fit well within the residents' day. Second, residents often have "chunks" of time that they can devote to learning, such as during down-time, while waiting for an attending, in-between patients, etc. The mobile module was easily accessed during these "chunks" of time. Third, mobile devices worked well as the gateway between the residents and the content. All but one of the residents carried a mobile device on them at all times, and enjoyed the fact that they could access the module as they move about. Kree states:

That's something that can be done on the phone [Sleep 101], you don't have to sit there and dedicate to watching because we are very mobile people. And most of us have the attention span of a two year old. (Kree)

Accessible anytime and anywhere. The flexibility of the module was another strength. This includes the module being accessible anytime and anywhere, and the mobile nature of the module further strengthens this point. Accessibility allowed residents to skip around to content that interested them. Johnny stated, "It's nice for the videos. You can go back and watch them over and over and pick up more the second time around." Kree states, "It impacted me positively in being able to dip in and dip out of the app and lurk about." His statement about accessibility also references an introverted nature.

Non-linear. The fact that the module was non-linear was a major strength, which was also referenced earlier with regard to residents' self-directedness. Lawrence states, "I like the fact that it was, we were independent to figure out, you know whether or not we wanted to access the resources, or see the lectures, or participate in discussions. It was flexible." Lynn stated that "it's crucial it's crucial that you can move at your own pace and have access to these sort of materials and lectures and just move how you feel comfortable" simply because of the sheer volume of information they are trying to cover in residency.

Some of these residents take a non-linear approach to learning in general. Grady stated, "I always, when I look at a book, I always take the chapter that I feel I can tackle in the time that I have." He went on to praise the fact that the module was non-linear. Also, Johnny stated, "I like that it was easy to access and you could do anything in any order. And

at any time - there were no time limits on things.” Kai liked that he could “stop it if I need to leave and come back to this point, or say ‘this is where I want to go next’ and be able to structure what I want to do, that was a lot easier.”

Strength #2 – Multimedia. Traditional lecture and text-based learning resources are staples in medical residency, but this group of residents had high praises for the use of multimedia. The videos were highly regarded because they add interest and context. Johnny stated, “the video that she linked to YouTube was really helpful because it was not at all what I was expecting after hearing the lecture. I wasn’t picturing at all what this patient had.” He went on to add that the videos add “authentic” content to the module and were helpful.

A streaming server (Vimeo) was used to house the videos, as depicted in the image below. This worked well because residents were not downloading and saving the videos to their devices and computers, rather, they were watching them on-demand. Kree stated, “Vimeo worked really well”, and Lynn stated, “videos were great quality.” The consensus was – the more multimedia, the better.



Figure 16 Video Used in Sleep Science 101 and Housed on Vimeo.com

Strength #3 – Practical. The practical nature of the module was recognized and regarded as a strength by the residents. Practicality is connected with contextual learning, which is a common theme throughout the findings. Practicality is also referenced within the modeling and authentic/situated learning findings. For example, Johnny stated that the “discussions provided more practical information than a lot of the typical lectures.”

Practical information is useful in current and real situations, as in the assessment and treatment of residents’ actual patients. Lynn states, “I think it’s practical stuff that you can start using immediately. I’ve already used some of that knowledge [from Sleep 101].” Kai explains:

I think it is definitely going to help me with my clinic patients. Being able to recognize symptoms of either sleep disorders or different techniques of Obstructive

Sleep Apnea; now when I read a report and they talk about positional, I sort of know what that means more than just having them come back here, I can say “your sleep latency was worse when you were laying on your back versus laying on your side, maybe you need to try this when you go to sleep.” (Kai)

Strength #4 - Easy to use. In general, residents viewed the e-learning module as easy to use. Kree states, “I like the format, I mean it was easily accessible. It was easy to download. I think most of it was pretty self explanatory. The menus were, everything was very intuitive, so that was a big plus for it.” Although the residents were given a brief introduction on how to use the module, none felt they needed much direction, and could have independently learned how to download and use the module. Johnny states: “I guess it was easy to use...self-explanatory and you didn’t have to lookup how to do things within the module.”

The module was setup so that all of the content was accessible from a single screen (see image below of the module interface). The online discussion, links to the resources, and other links were accessible with one click or “tap”. Residents viewed this as a strength and it made the module much easier to use. Kai states, “And to have access to everything all within one general area was easier.”

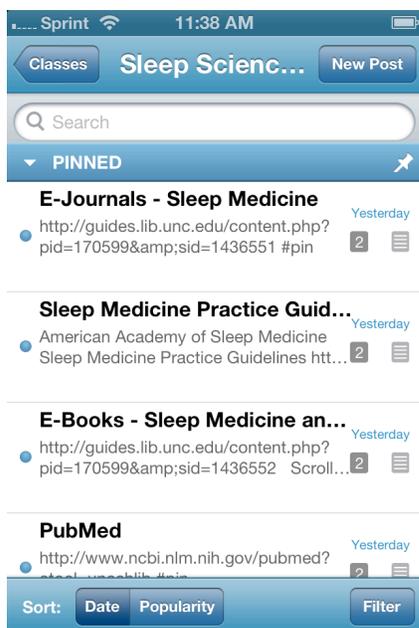


Figure 17 Sleep Science 101 Interface as Viewed on an iPhone.

Area for Improvement #1 – Module timing. Mobile modules may need to run over extended periods or continuously to meet differing and changing time demands of residents, rather than be scheduled to run over a fixed period of time. Evidence supporting this theme is discussed next.

Certain rotations are more time intensive than others. A major finding is that residents do want to have this module included in their residency education, but there is no perfect set time during the four-year residency for this module to be offered. Residents had two main recommendations. One recommendation is to lengthen the module from the existing three weeks to a longer period. Johnny stated:

At least two months because you have to give people on rotations - you could be on a rotation for two months where you are working 80 hours a week for four weeks and

those people are going to have no time to do that, so at least if you did it two months you would give those people a chance to maybe be on a less intense rotation.

(Johnny)

Pete stated:

It felt great to have the freedom to learn when I had the chance. I just wish there were more time to do so. I don't know how you address that. Maybe increasing the time span of the module to four weeks and just remember to be motivated to start at the beginning and pick at it when you can. (Pete)

The other recommendation is to have the module running continuously for residents to be able to use it in an independent fashion. For example, Grady stated:

It would be nice if you could have access to all of those modules independently, at any time." "some residents are, for instance on rotations that don't really allow any time, and sometimes you are doing something like that for four weeks and you are just so tired at the end of the day, that even if you really wanted to do something, you just really couldn't. And, so if we only left it out there for four week, then that particular person will have completely missed out on the chance, even though they really wanted to look into it, but there's just no time. (Grady)

Christine also stated:

I think that there is useful and sort of interesting information that's there that will be applicable to issues that come up with patients. But in this particular little segment of

time I didn't use that, but I do think that if this is available for years at a time, that you could go use it as a resource, that it actually could be useful. (Christine)

Both of the above recommendations for improvement are conflicting. Future module developers will have to contend with these issues and make decisions about the most feasible and effective way to time the module. Also, an important design consideration is that extended or ongoing modules, that people can access anytime, would make discussions on core topics challenging. Core topics would become moving targets.

Applicability of module resources is dependent on the rotation. Residents viewed their rotation as a major driving factor for application of the module information, not only because of the time issue, but also because of the types of patients that are seen on different rotations. Pete and Lawrence both agreed they would have used the module more had they been on different rotations. Another common theme was that the module would get used more during residents elective rotation, which may be a less intense rotation. When discussing when the module should be offered, Johnny stated, "...especially maybe more in the outpatient clinic setting because the rotations I was on when this was going on were inpatient and it's totally different."

Rotation and time issues, also tie into Pedagogical issue #9, where residents only used the lectures and discussion forum, but none of the other resources. Johnny stated, "I didn't really go into the other resources, although I appreciated the fact that they were available if I had a specific question, but didn't need them in this short of period." It is likely this resident

would use the resources if the module were extended over several months, lending enough time for patients with sleep issues to present in their clinic.

Area for improvement #2 – Length and delivery of content. Residents preferred shorter videos, between 10 and 20 minutes. Chunking is an important concept brought up by several residents as a way to emphasize important facts and topics in digestible pieces. This is important since residents are accessing the module in a sporadic fashion in the small “chunks” of time they have between tasks. Also, having module content available in a variety of multimedia formats would be helpful. Participants noted:

It would be helpful if they were shorter because I was trying to watch them on my downtime on night float and it’s hard to get even a 30-minute chunk of time where you are not interrupted. Shorter videos would be better. (Johnny)
If they were 13 minutes or less, I was watching them [and] I went back and watched it multiple times. (Grady)

Our attention span is really limited, and sleep deprivation only makes it worse, so I think 20 minutes is kind of tops... I would look at the list of lectures and the first thing I would look at is how long do they last. And yes, some of the topics that were most interesting to me maybe, or that I would be most benefited from learning were the longer topics, but the time that realistically I had to devote to it at any given time during my trip was more limited, so I ended up watching some of the shorter lectures that were probably not as high yield to me as a resident, but at least that I knew I could finish. (Kai)

Chunking the videos into smaller pieces or pulling out the important parts and housing them independently was another evident theme of the residents' learning styles and preferred way of getting information, as described in the following quotes:

I find that most of my peers and I are sort of the group that we need chunks, we need 'these are the five things I need you to take away from this lecture'. Because we mentally filter through so much information every day. The less is more approach is good. (Kree)

If it were broken into chunks, it would be easier to remember where you were." She stated this because she took a little different approach and would pause videos and go look up a related article, then come back where she left off. (Christine)

Lynn also mentioned chunking with authentic video "tidbits" would be useful. Referencing the longer, denser lectures, Pete stated, "I wish that all modules had that degree of informational richness, and I think that breaking up into smaller chunks would make that more digestible."

Including audio lectures was another suggestion by two residents, which strengthens the support for m-learning. This is due to the fact that some residents felt hindered by having to listen to and watch the lectures. Their mobility would be less hindered if they only had to listen to the lectures, as in podcasts while they are waiting in line, traveling, exercising, etc. Participants suggestions include:

I think the video lectures were helpful. I was talking with another resident that it might be helpful to have just some audio lectures because the video lectures require you to be sitting and watching the video, whereas the audio lecture you could put in your headphones and listen to while you are out and about.

(Lawrence)

I don't know if an audio component only, instead of just the video. I know I sometimes listen to the neurology podcasts and sometimes that's easy to listen to walking to my car in the parking lot, or I can even listen to it in my car on the way home. (Kree)

Area for Improvement #3 - Prompting and reminders. The module was designed for residents to move about independently, which they appreciated, but there was also a consensus that additional prompting and reminders would be helpful to keep residents engaged in the online discussion. Kree stated:

I think part of the problem is that I'd forget about it until I got my email digest and somehow it would be nice if it pinged you immediately like "Hey, there is a discussion going on, or you have got your phone vibrating in your pocket." The same way that Facebook has a banner announcement that someone's commented on your wall, it'd be nice to have a "hey, somebody commented on the discussion you may want to respond to." (Kree)

Kree went on to suggest having the facilitator branch the discussion and have more specific "question and answer" sessions. A "question of the day" for "dealing with sleep

issues in your clinic” was one of his ideas. These specific prompts help bring sleep medicine topics in front of residents, but should only be in small doses or “tidbits” of information.

More direction in the discussion board was also recommended to help give residents reminders, and in some cases, a clear aim to the discussion. One resident agreed that more direction was needed and stated, “I’m not going to respond unless I have to, there’s got to be a burning question”. Basically there should be a “nudge of where [online discussion] should be going.” When asked if discussion with more prompts would help, Kai stated:

Yes, definitely. I think so, because with sleep, you don’t hear about the rare cases with people that come in with a sleep disorder. You sort of hear about the bread and butter, which is sleep apnea, you know restless leg, things like that; that’s what you hear about, but to have the Klein Levin syndrome, it peak your interest in that it’s an individual that’s young, that comes in and they have hypersexuality, they have abnormal behaviors, all the stuff that you are like “oh, ok, this is different, I’ve never heard about this”. It’s not just sleepwalking, it’s not just enuresis, but I need to learn how this fits into the scheme of the whole entire spectrum of sleep medicine. (Kai)

Area for improvement #4 – Contextual content. The ability to access contextual information through examples and cases is important in helping residents learn content by giving them the context to attach the concepts to. This speaks to the practical nature of the module and the timing of the module dependent upon rotation, as previously discussed. Kai stated:

[What] I know about sleep is what I learned in medical school and looking at EEG findings when people are asleep. Besides that, if you don't really have a place you are going to put it, in context to everything else, when it's time for you to pull that resource, where are you going to pull it from, you might have forgotten it by then because you haven't got anything else to attach it to. (Kai)

Participants believed more multimedia (i.e. videos and visuals) would provide more of the real or authentic context to help them learn the concepts in the module. This is because text and lectures may make it difficult to put diseases and disorders into the context of a real patient. When asked about being able to see things in different ways while learning, Johnny said,

Yes, I think that so many things are visual and it's hard to take written or spoken words and make a picture of what is going on in that patient. And it's great if you can see it in your own live patient, but you don't, can't see everything yourself so that is where the video aspect I think would come in handy. (Johnny)

Lynn stated:

It would be cool if videos could be put in [to the forum], just even little links of how a patient looks when they are acting out their - this is an example of a patient acting out their dream, or this is an example of a patient caught in the sleep lab moving around their legs, and this is how it looks when they have restless legs. (Lynn)

Using mobile applications specific to context. Several residents mentioned that they currently use mobile applications during their residency for specific clinical situations, and

they agreed that the module may have more uses if broken into specific applications, such as a separate application or section for medications specific to sleep. The residents mentioned the specific applications would be more useful than the more general applications that are readily available. For example, Lynn and Pete agreed a mobile application specific to sleep medications would be useful and Sylvia discussed a mobile application she recently downloaded and stated:

Medications is the one I've been using and they are specific to epilepsy. You can look at Carmazepine for example and it shows all the interactions with just epilepsy medications. So if you had something for just sleep medicines, you know medications for OSA or RLS, these are your choices. This is good because lot of the seizures medications interact with each other - like "what does it do". I just got this [the app], so I have just used this part and it is just easier than Micromedix [a more general application]. (Sylvia)

Research Question #3 – What is the usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents?

Finding #3 – The usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents include:

- **Mobile e-learning complements residents' learning styles**
- **Residents will access the mobile module in-between patients and potentially, during consults**
- **Online discussion is useful as reinforcement**

- **Sleep 101 is useful for foundational knowledge**
- **Sleep 101 is authentic and practical**
- **Residents would use mobile e-learning modules during and beyond residency**

Each of the above points are discussed in detail next:

Mobile e-learning complements residents' preferences for access to learning.

Participants agree that the mobile aspect of the application is useful in practice. Their perceptions of the usefulness did differ. Most commonly, residents pointed out that the anytime and anywhere accessibility of the e-learning module was most important. Kree states:

I mean the portability of it, that was new, and that was nice, because I always have my phone on me, I mean always, so the opportunity when I wanted to be able to access it whenever I wanted to was nice, and not just to be in front of the computer or something else...it's nice to be sitting at the pedicure chair or somewhere and say "hey I've got a few minutes, let me flip through this" because we are a group of people that we tend to compartmentalize and use whatever little bits of time we get...waiting in line at the grocery store, I did that one day. (Kree)

Christine viewed mobile learning a bit differently, but agreed that mobility is nonetheless important. She describes how mobility to her means having access to the module in multiple locations, versus the module being tied to a single dedicated computer. As Christine explains:

I think it's important that it is mobile meaning at least computer to computer, rather than having like one computer sitting some place and you have to go to that. I don't know how much it would be useful for me on my phone. Could be. I'm not saying it's not, but it didn't end up coming up for me at this time. (Christine)

Another resident describes how he uses the mobile application, but does cite that trying to type on a tablet device is an important drawback regarding the mobile interface.

Johnny states:

I have an iPad, so that made it nice and easy to carry and I could do that anywhere, but most of it I did here on the computer we have here. I use it for everything else I do, so it was just easier to pull it up in the background when I had time...The setup here is desktops, which may change in the future. Because you already have to do so much on it, you end up with two devices...being on the iPad, it just isn't feasible for me to write my notes on it, so I use a desktop for that. It is kind of clumsy, the software we use for work is clumsy on an iPad. (Johnny)

Residents will access the mobile module between patients and potentially during consults. Several residents accessed the mobile module in-between patients. Sometimes it was for a specific patient, and other times, it was for learning during down time. Pete made notes from the module and used them between patients, so in essence, he was carrying and accessing a piece of the module in-between patients. Kree stated:

I accessed it in-between, not specifically for a patient, but cause that's when I had the time, but you also know that the availability is there that immediately after a patient I

could post something, or knowing that if I had a patient coming in with a sleep complaint it would be helpful to be able to post something there and say “look, I know I’ve got this guy coming in, what do y’all think.” (Kree)

Other residents, who did not necessarily access the mobile module between patients, stated that there are aspects of the mobile module that they would indeed access between patients when situations arose. This is where context is important, as discussed earlier. Grady states that he would use patient questionnaires. For example, he states he would use the “Epworth sleepiness scale, things like that. Or screening questions for OSA.”

Another primary use of the mobile e-learning module between patients and during consults is for specific and practical knowledge that is useful immediately. As residents are seeing patients, they can use mobile applications like Sleep 101 to help with specifics about a person’s care, lending to an individual approach for the patient. For example, Lynn stated, “It’s hard to memorize all interactions between meds, it’s hard to memorize what labs you should be monitoring, so those are things that I tend to really like to rely on apps for.”

Kai points out how the mobile module resources, such as the patient questionnaires, can be useful between and even during patient consults. He states:

Yes [patient questionnaires are useful], because I had a patient come in with a sleep abnormality this last week to clinic and luckily I had their questionnaire from last time, so that would be important because I don’t see that many sleep, people with sleep abnormalities and when I do, it would be helpful just to have access to the forms right then without having to go search and look for it, but you know exactly

where it is, going to this one link and saying “ok, here it is, I can print it off and let’s review it.” (Kai)

Pete pointed out another potential use for the mobile module, which is within subspecialty clinics, where physicians are primarily seeing patients with similar conditions (i.e. sleep complaints). The module resources and discussion would be more useful in that case because they are specific and useful for most patients, versus useful few and far between patients. He states:

That’s [the mobile module] really useful if you’ve got a lot of patients with it [specific diseases and disorders] and you are dealing with it all the time. Like if it were something like a particular type of stroke. Unless you are in a type of subspecialty type of clinic, where you are seeing a lot of that, boom, boom, boom, and you need like a refresher, to look at it. (Pete)

Online discussion is useful as reinforcement. Even though the discussion was not frequently used, several residents believe it is useful for reinforcement of concepts and for receiving feedback on specific issues arising during patient care. When asked if residents’ building on one another through discussion helps reinforce what others said, Johnny said, “Yes, it does. It gives you a different way to think about it than you would get in a textbook, which tends to be the same think every time”. Christine also states:

It’s something like when you are considering different types of medications or if there is a specific clinical scenario. You know I do think in some of those situations it would be pretty reasonable that people would end up doing things like that [using

online discussions], like maybe they are trying to figure out between like gabapentin or Ropinirole or something, and just sort of to say “hey, what’s your opinion on this” because a lot of times, it’s not like there is an answer necessarily, then you would be looking for somebody’s clinical judgment, just like what is your experience; especially since most of us don’t have much experience with primary sleep problems or sleep issues. (Christine)

The online discussion component of the module is useful for residents to get practical advice in real situations, which are not typical in textbooks. For example, Kree stated, “it’s another way to bounce something off of other people because there is a lot of hallway chat of ‘hey I saw this guy in clinic and...’ and that’s one more place to get opinions.” Pete offers the advice:

If you had more clinical scenarios to talk over, ‘what would you do’, in this sort of thing, just to see. That would be almost like application of, not really thinking through, but application of knowledge stuff. Or, tricky cases that you’d run into, and that sort of thing. (Pete)

Sleep 101 is useful for foundational knowledge. Since sleep medicine is not typically covered very well in medical school or in residency, using the mobile module as a way to gain foundational learning is a good use for the module, as pointed out by several residents. Christine stated, “For a long time, I had no idea what an AHI [apnea/hypopnea index] was and stuff like that - it was just really basic stuff that I just really didn’t know.” Kai stated:

I think it's important to learn just the basic sleep physiology and then you can add on things on top of that. I'm a very, I'm one of those people that I like to get the foundation and then add on things. I felt that within there. (Kai)

Johnny stated:

I feel like I actually did learn a lot from the video lectures, mostly because it was all new to me so what stands out the most is about the physiology and the medications. Now I feel like I have a better understanding of why some medications are sedating or arousing or cause problems with sleep. (Johnny)

Several residents discuss that the foundational knowledge is particularly useful early in residency, but can also be useful again once they have completed residency and are transitioning into their own clinic. Kree stated, "I think just the knowledge base expansion, especially being early in residency for me was beneficial...I think it was useful and it allowed me to go back to that [prior sleep elective] week and cement some of the things I learned." Kai stated:

I think as a lower level that it is sometimes good to have the foundation first, so you will know, it's sort of hard to know what you don't know. So at least that will give you some aspect of 'ok, here's the world of sleep, or whatever it is', and then this is how you should start to sort of understand this and then once you have the basic knowledge, you can add on these things. (Kai)

Pete stated:

I felt that at the level of experience, clinical experience where I am right now I don't run into a lot of patients with sleep problems. I think it can be very, very different as I transition to actually having my own clinic, which will start next year, and I start running into these things and right now, the way to expand on this question, the way I saw this module, was a way to get foundational information. (Pete)

Christine explains that the module can be useful for practical and foundational knowledge. She stated:

I think in some ways, some of the basics, in terms of the, I don't know, recommendations for the behavioral approaches to like positional dependent apnea, or something like that. Like, how do you actually tell somebody "hey, you should do this, or do that" or put some tennis balls on your back or anything you might come up with. You know, those are the kinds of things that, that's what useful if you work in one of the sleep clinics, you just hear some stuff that you, you sort of hear how an attending might recommend that somebody do that; and that kind of information is often times not necessarily information in a book per say, it is sort of the practical aspects of it... (Christine)

Some residents actually wanted Sleep 101 to be broken down into more basic pieces. Pete mentioned wanting more basic information about sleep medications and waveforms in sleep. Kai stated:

Maybe if they had a “sleep basics”. That would be nice. Like, even if it was a sub folder, like even when it talked about the physiology, and just the bare minimum stuff, just to get your toes wet and then you dive in with the rest of the stuff. (Kai)

Residents would use mobile e-learning modules during and beyond residency.

The consensus is that Sleep 101 and modules like it would be useful for these residents during and beyond residency. Residents see the potential of using modules like Sleep 101 to cover other topics as well. Grady stated:

I think it’s very useful, I think that would be nice to have it available all the time, and it would be nice if we got different topics that are not just sleep medicine, but a lot of things that we don’t really get a lot of training with, like for instance multiple sclerosis or things like that, that unless you do an elective, we don’t really see much of. (Grady)

Pete discussed how useful it is to have modules like this that are topic specific. He stated:

I got to tell you, it was very good to have something like this that only looks at one facet of neurology, because it really directed your attention to it. You could really have the time to sort of get into it. If you’re in med school, it’s tough because you have multiple lectures a day and you’re trying to learn all this stuff just to get ready for the test. (Pete)

Several residents discussed how the module would be useful after residency, when they are practicing. Part of the reason is because during residency, there are a plethora of

resources and other physicians to consult with when residents have questions or have difficult clinical decisions to make. Johnny stated:

I think it would be good especially after residency when you are not in the formal lecture setting and you are not surrounded by attendings who are specialists in everything and I think it would probably be even better when you are out in practice. Right now we have so many resources at our fingertips with the attendings around and we have free access to all the journals because we are in the hospital, but once those luxuries go away something like this would probably be very helpful. (Johnny)

Another use for modules like Sleep 101 is for review. Lawrence and Pete mentioned that they wanted to continue to use the module after the study was over, once they were on a less time-intensive rotation or elective, which speaks to the rotation and time issues discussed earlier. Two participants stated:

I think it would be valuable to offer this at different time points along the four year residency track; where my experience would undoubtedly be different two years from now when I have a lot more patients, and maybe actually spending some time in a sleep lab from a physicians standpoint and with the basics, I'd have a very different relationship to it, I'd probably be much more active in different areas. (Pete)

The ability to archive, go back and remember there was this great lecture that covered this topic and explained it in a way that you had never heard it explained and you just want to go back and hear it again and see it again. So, that's really big to me. And that's not how it's done here at all, there's really no way. You get to lecture that

morning, and if you are there and you are half awake, like maybe you get a few tidbits of information, but there's just always stuff that I just want to press the rewind button and we can't. (Lynn)

Four residents mentioned specific mobile applications they are already using for learning during and in-between seeing patients. For example, Lawrence stated, "I use Epipepsia for example. So, for example, when I'm waiting in line at Starbucks I'll open it up and read an article." Lynn discussed opening the MedCalc mobile application right in the patient room for the Stop Bang and Epworth patient questionnaires. She stated, "Yeah, right in the clinic room. You pull that up and you get a score right at the end. And then I just type that right into my note there in the room." Pete mentions using mobile applications for formulas that he can't remember. Grady stated, "I know that I have for instance, like a NIH [National Institutes of Health] drug scale that's an interactive app, so I can just tabulate things and it just gives me a score at the end."

Takeaways. At the conclusion of the resident interviews, residents were encouraged to describe their overall takeaways from participating in Sleep 101. The takeaways listed were overall consistent with many of the themes identified in the findings. Some of the notable takeaways listed below according to three categories:

Sleep 101 was well-received by participants:

- "I learned a lot of interesting things that made me more interested in sleep"
(Johnny)

- “I think it did a good job of making me appreciate it more, I mean there was some really cool stuff in there to see...I was really impressed...I think it is a great way and a fun way to learn.” (Lynn)
- “[Sleep 101] gives a ‘good start’ and if more modules like this are built, gives better access to resources, helping them to learn more.” (Kai)
- “The elearning that I had before in med school was very much a part of the classroom experience, so it was more of an outgrowth of that, than like a stand alone, spontaneous - so I felt that it was much more anchored to a set time and a set place. Honestly, it was just one more damned thing to do, in addition to the lecture and all the rest of the stuff. But this was very different. I really thought it was a tool I could use to explore things that interested me.” (Pete)

Sleep 101 improved participants perceived knowledge of sleep medicine:

- “Better knowledge of sleep. I really like the experience with the mobile learning. I think there are things that need to be changed about it, but I like the option of being able to go back and forth between the computer and the phone if need be, but I think it has taught me a little bit more about what chunks I need information in, and that I do need smaller bits of information, but when I do get those smaller bits of information, it’s more efficient and a good use of my time.” (Kree)
- “It’s less cryptic now [sleep medicine], than it was.” (Grady)

- “[without the module] I wouldn’t have known what the options were [in treating an actual patient], I wouldn’t have been able to definitively diagnose him with that... So, it was a real success.” (Pete)

E-learning and online learning is still relatively new in residency education, therefore may take time to catch on as a useful learning tool:

For me, the best way for me to learn something [traditional and by doing], so if it was all switching to that [online modules], I’d probably get more use to it and maybe get more out of it if I were sort of forced into technology a little bit more so than I am, but it’s sort of like steak versus fish. I can eat fish, but I prefer steak. (Lawrence)

Finding #4 – Module Statistics and Observations

Triangulation included reviewing the module use statistics and observations during the online discussion forum. Module use statistics were consistent with the number and amount of times residents claimed they used the module resources. My observations also confirmed the amount and nature of the discussion board communications. Example images and description of the statistics are as follows:

Overall module usage. Sleep Science 101 was a self-paced e-learning module lasting three weeks and offered via the Piazza platform, which is a mobile application, but also available on desktop computers. Eight out of nine residents actively participated in the module. The image below gives a visual depiction of the module usage over the three weeks, which is consistent with the resident interviews in the account of module usage. Three residents accessed the module almost every day, three residents accessed the module on four

to seven separate days, and two residents accessed the module one to two separate days. Seven residents accessed the module via the mobile application on their phones and tablets. The module included video lectures, online discussion, and access to online resources, such as e-journals, e-books, practice parameters, and patient questionnaires.

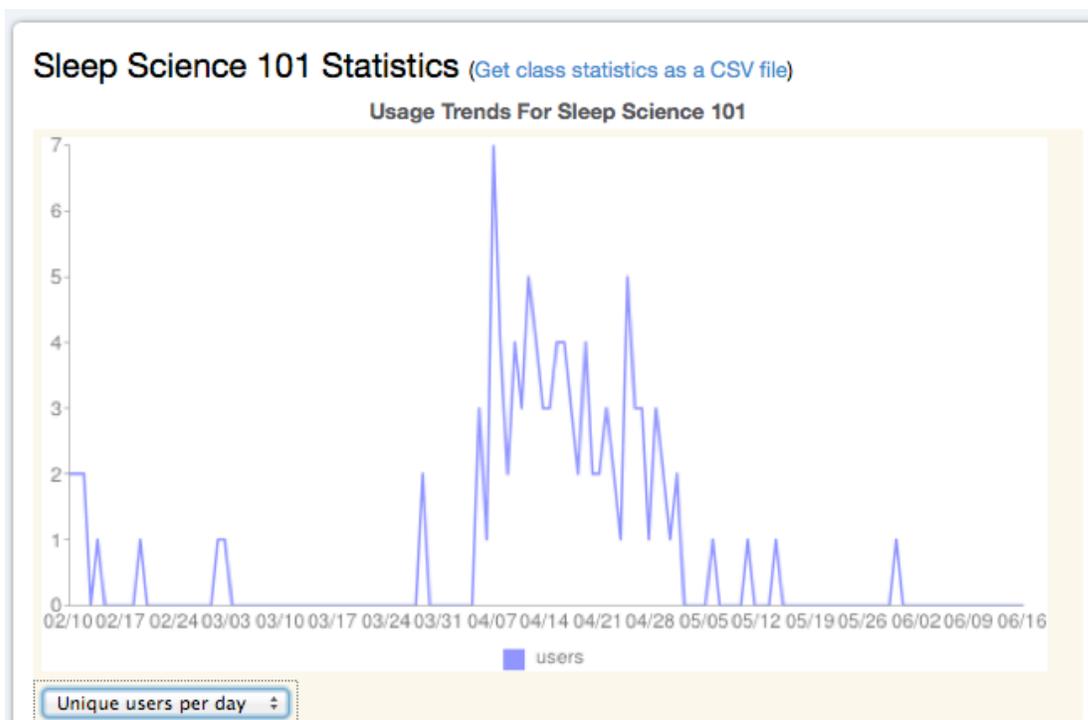


Figure 18 Daily Sleep Science 101 Usage Statistics

Discussion board usage. There were nine unique threaded conversations that occurred on the discussion forum with 19 different posts. Four residents actively contributed posts to the discussion board, and all eight residents read at least two discussion board conversations, with six of the eight residents reading at least 50% of the discussion board conversations. This finding is consistent with the findings from the resident interviews

demonstrating limited discussion board usage, and consistent with the fact that many of the residents “lurked” by reading posts, but seldom replying. A screenshot from the Piazza discussion statistics follows.

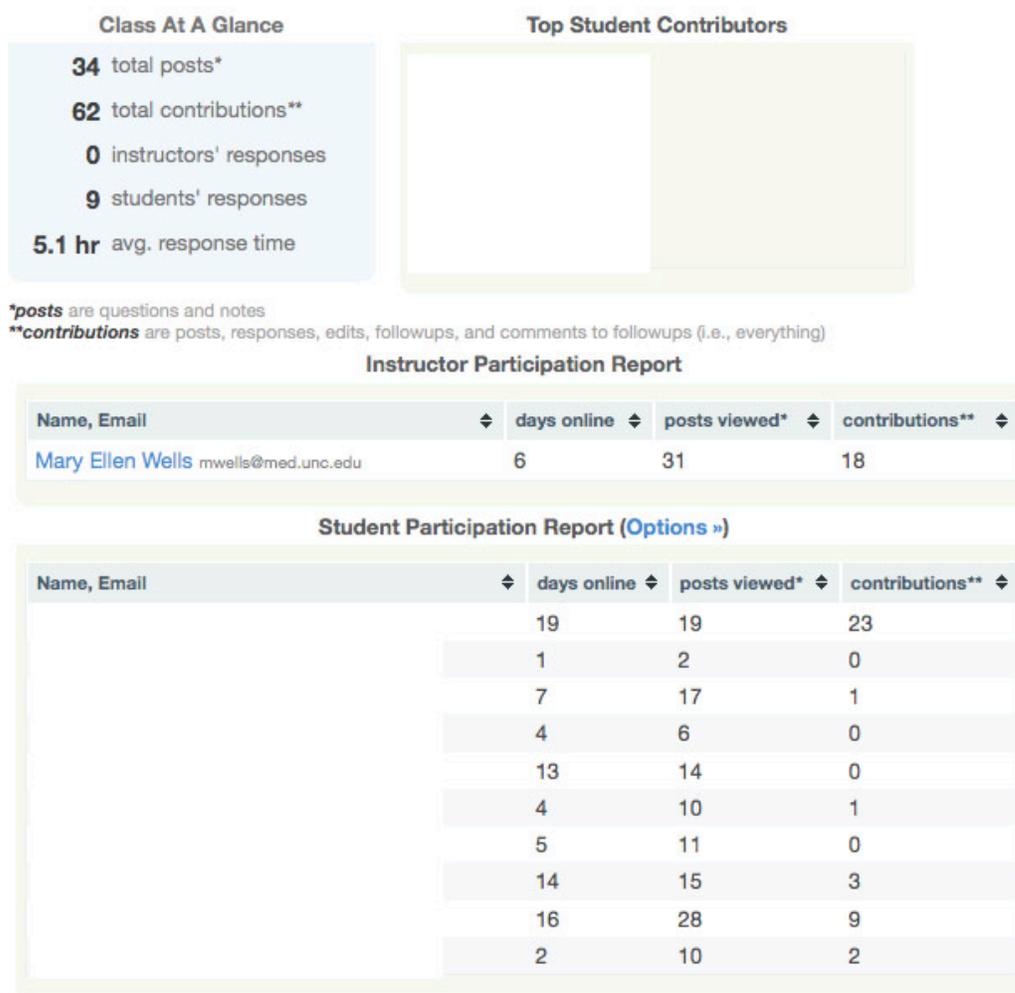


Figure 19 Sleep Science 101 Discussion Forum Usage Statistics

Video lecture usage. There were 12 unique video lectures as a part of the Sleep Science 101 module. Each video was viewed approximately once by each of the eight active

participants, as demonstrated by the image below representing the access log of one of the videos. This finding is consistent with the resident interviews, as the residents did claim to have watched the video lectures.

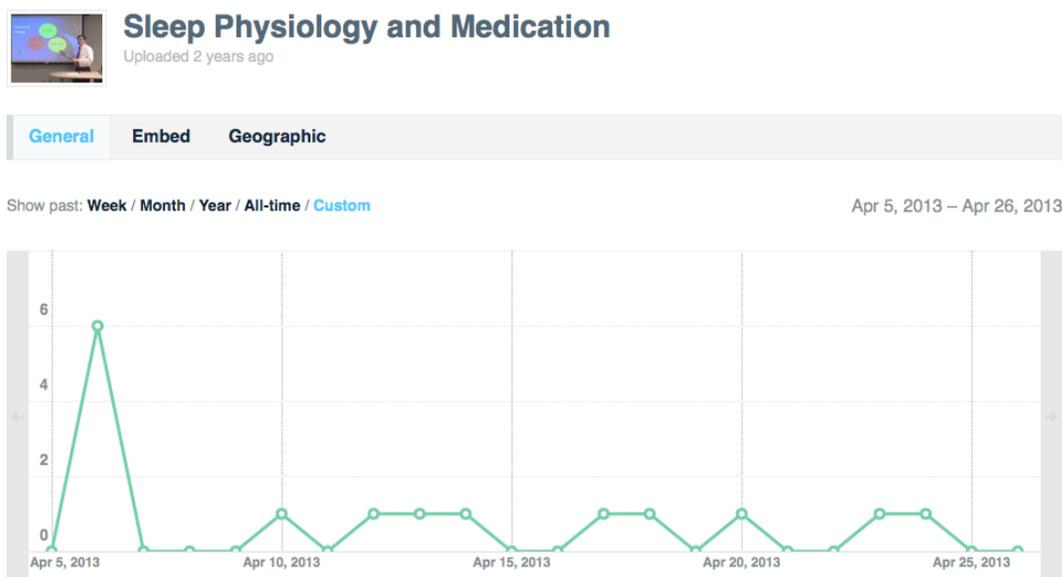


Figure 20 Video Lecture #1 of 12 - Access Log

Conclusion

In summary, the purpose of this chapter is to describe the study findings and answer the research question *How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning*. The findings were organized according to research question and further delineated according to the guiding e-learning framework. Overall, the dominant pedagogical issues revolved around online social presence, self-directed learning, authentic/situated learning, mobile learning, and an introverted learning style. Several strengths of the module were identified, which

include flexibility, use of multimedia, practicality, and ease of use. Likewise, several improvements were identified, which include module timing, content format and delivery, increases in prompting and reminders, and adding more contextual content. There were also several recommendations from participants concerning the usefulness and application of the module, which include, reinforcement of concepts; foundational knowledge; mobile e-learning preference by residents; the module is useful in learning between patients and potentially during consults; and the module is useful in other areas of residency and beyond. Triangulation of participant interviews, analyzing module usage statistics, and observing the online discussion demonstrated consistent findings of the module usage.

CHAPTER 5

The research questions were largely satisfied in the findings presented in Chapter 4, which were organized in categories by research question, producing a narrative. This chapter gives an analytic and interpretive synthesis of those findings by reconstructing the findings for a more holistic understanding. Four dominant themes emerged during the research, which cross all three research questions. The emerging themes guide the organization of this chapter as follows:

- Module timing and delivery presented the biggest issues
- Self-control of learning and non-linear design were large indicators of satisfaction
- Introverted nature of the participants governed their participation
- Context is important and varies according to where residents are in their education (i.e. at the beginning, middle, or end of residency)

This discussion is based on personal ideas, experiences, and intuition, in tandem with consideration of the literature on medical residents and adult education, as referenced in Chapter 2; as well as additional recent and relevant literature. The first research question aimed to identify pedagogical issues specific to the e-learning constructs in the framework and mobile learning. The second research question aimed at identifying the strengths and areas for improvement in the overall resident educational experience. The third research question aimed at identifying the usefulness, application, and takeaways resulting from the module. Following the discussion is a Future considerations section with practical and future recommendations. The discussion, organized by the emerging themes is next.

Module Timing and Delivery Presented the Biggest Issues

Module timing is important because residents are on and off different rotations at different times. There is no set time to offer an online module where all residents will be studying the exact same topics. Therefore, it is important to design the module to be offered such that it is available to residents at a convenient time. For these participants, they are on rotations for at least three weeks at a time, and some rotations are so time intensive, they would not be able to access a module at all during that rotation. Having the module available for several weeks beyond the shortest rotation, and perhaps for even months or years at a time should be adequate to allow every resident a chance to participate. Other recent research exists that confirms a self-paced e-learning module does accommodate various rotations (Kang, Hagenkord, Monzon, & Parwani, 2009). Another recent study provides additional insight by demonstrating that a three week supplemental simulation course improved residents' skills just as effectively as a 6-week supplemental simulation course (Robinson, Schanzer, Cutler, Larkin, Eslami, Arous, & Messina, 2012). This finding suggests that since many rotations are approximately three weeks, it may be effective for modules to last three weeks and be available on-demand, to conveniently last about the same amount of time as each rotation.

In chapter 4, participants offered several suggestions of when the module should be available, ranging from a set period of weeks to ongoing. A major issue with ongoing modules that people can access anytime is that it would make discussions on core topics challenging. This issue runs counter to another suggestion of using prompting to engage

residents in discussions, which presumably would be scheduled to run over a set period of time. Recent research in this area has not come to a consensus on the optimal timing for education in subspecialty fields (Wisniewski, Fournier, Ling, Slack, Babiera, Grubbs, Moore, Fleming, & You, 2013). Future module designers will need to take the conflicting suggestions into consideration and make decisions about the best way to time the module.

The module timing was an overt issue in this research, but this finding is not limited to this module. According to the literature, the timing of traditional didactic lectures is also problematic (Espey, Ogburn, & Puscheck, 2007 & Spencer & McNeil, 2009). Residency is simply a hectic time with many competing educational and clinical duties for stretched-thin residents. There will likely not be an ultimate perfect timing scenario for the online module, which must be considered by future designers.

Foundational Versus Specific Modules

It is important to note that since residents early in their residency may need more foundational modules, the module timing for early residents may not be as critical as modules later in residency, which would be more specific to rotations. For example, a general module covering the generic topic of patient assessment could be offered at anytime during the first year of residency, and would be useful regardless of what rotation a resident was on. Modules offered during the final years of residency would need to be offered on more of an ongoing, or “use as you need” basis. For example, a module specific to sleep medicine may be most useful when residents are on a neurology or cardiopulmonary rotation. In a recent study, iPads were given to PGY-2 through PGY-5 residents and a six month log

of use indicated 88% used their specialty specific resources on a daily or weekly basis (Berkowitz, Kung, Eisenberg, Donohoe, Tsai, & Slanetz, 2013). This finding strengthens the utility of using mobile devices and increasingly specific learning modules as residents progress.

Context is still important in the foundational knowledge modules, and it was suggested that although these can be general, there should also be areas for “practical” tips to help with everyday situations. Foundational modules could vary in length, but the specific modules should last approximately the same amount of time as the respective rotation, and be designed where residents could begin the module at the same timeframe they will be starting that rotation.

Module Length and Chunking of Content

Chunking the module content in small (20 minutes or less), digestible, and on-the-go pieces is important and recommended versus residents having to sit down for a scheduled period of time to learn a topic. Mobile applications would further support and even encourage chunking of content. Another design consideration is to utilize residents’ short blocks of time to deliver facts, useful statements, or helpful hints versus lectures or articles. Designing future modules in this way would encourage residents to use them in-between patients, for example, Kree stated:

Even if it were 10 minute quick hits and there were more of them, I would rather have more, shorter videos than one longer one. It really does help you take advantage of

those “I’ve got a few minutes, let me watch this before my next patient gets here.”

(Kree)

Chunking would work well for lecture based modules, but the social aspect of the module (i.e. discussion board), may not be as useful since there would not be a specific cohort of students starting the module at a certain time. However, if the module were offered where residents could choose when to enroll and the module were open to multiple residency programs with large numbers of residents taking the modules at any given time, the social aspect of the module may be utilized much more.

With regard to module timing and previous research in this area, this research converged with the point that residents prefer shorter “chunks” of learning material. Previous research demonstrates that residents spent an average of 30 minutes or less on particular modules or cases at each sitting (Cook et al., 2009; Dietrich et al., 2010; Chu et al., 2010). This aligns with the constructivism approach of this research, in that the module was designed to accommodate random, briefly chunked, on-demand, and “use as you need” resources. This research is consistent with previous studies demonstrating that residents’ knowledge improved after completion of e-learning modules that were chunked into brief sections and included multimedia (i.e. videos, articles, text, images, and practice exams) (Grover, 2010; Schmitz et al., 2011, Branzetti et al., 2010).

Chunking of information into small, digestible pieces and formatted for mobile devices is a design recommendation, and is consistent with previous literature. A previous large-scale study demonstrated that online lectures that were approximately 20 minutes were

most effective (Burnette et al., 2009). The residents in that study improved on post-tests, and they stated that appreciated the self-directed flexibility of being able to choose the lectures they were interested in. Although this research did not record pre and post test scores, there is already research demonstrating that the use of mobile learning does increase residents' post-test scores (Bensalem-Owen et al., 2011). One study found that residents performed better on skills tests when they used mobile devices to watch brief (3-minute) instructional videos before performing a procedure (Davis et al., 2012). This aligns with the findings in this research and supports the participants' preference for using mobile devices and chunking learning content into brief, manageable pieces of about 20 minutes or less.

Design of the Mobile Application Should Complement Residents Learning Styles and Context

On the whole, the e-learning module appeared to have a design that worked well for the participants perceived learning styles. There are several important design considerations that future module developers should consider (and strengths of this module) for a mobile e-learning application, which include:

- Flexibility
- Mobile
- Accessible anytime and anywhere
- Multimedia
- Practical
- Easy to use

Another important design consideration for the future is that the module should be compact, all-inclusive, and have a streamlined design with little click through. Although there is little research surrounding e-learning or mobile learning in medical residency education, the research that does exist converges with this research, in that portability is a feature of e-learning that makes it superior to traditional face-to-face teaching (Dietrick et al., 2010; Cook et al., 2009; Marks et al., 2011; Gisoni et al., 2010; Kopp et al., 2011; Skye et al., 2011; Gold et al., 2004; Kash et al., 2009; Yanni et al., 2009; Baker et al., 2010; Cook et al., 2005; Burnette et al., 2008; Gold et al., 2005; De Silva et al., 2010; Ross et al., 2011; Erickson et al., 2009; Cook et al., 2008; Bensalem-Owen et al., 2011; Branzetti et al., 2010; Roche et al., 2007; Kang et al., 2009; & Peters et al., 2008).

Useful Teaching and Learning Resources

Of the resources available in the module, the lectures and online discussion were utilized most, with the patient questionnaires, practice parameters, and journal links viewed as a “nice to have”. It appears that part of the reason certain resources were utilized very little, had to do with the residents not being heavily vested in sleep medicine, and most not being on a specific sleep rotation or sleep subspecialty clinic at the time the module was offered. For example, Kree stated: “Those I didn’t [use of the patient questionnaires], but I didn’t really have any appropriate situations to use them in during the module.” This is important because residents may be more apt to use something when they are in a subspecialty clinic. Again, the context of the residents’ rotation and interests is influential on what aspects of the online module are used frequently, seldom, and not at all.

Integrating the online module better with the portals the residents are already using may boost the usage of the different module resources. For example, residents didn't use the journal resources in the module, but they did look up journal articles from another source. Better integration could encourage residents to use the module more if they knew the resources would still be accessible through a familiar interface. As another example, Lynn did use patient questionnaires that were essentially the same as the patient questionnaires in the module, only they were in another mobile application that was a familiar "go-to" application for her. Another consideration is to build the questionnaires to be more interactive and calculate the scores and give interpretation.

Offering the lectures in a variety of formats could also be a helpful way to encourage residents to use the module. These residents found many ways to use the module, and interestingly, many of them used it in a mobile fashion. Mobile use does warrant the lectures to be in formats, such as

- Video - for when residents have a block of time to sit and watch
- Audio – to accommodate residents who are multi-tasking (i.e. waiting in line, driving, etc.)
- Slide download – for when residents need to study particular charts, graphs, and images and take notes

A recommendation for future designers is to build specific resources, especially for upper level residents. This could be an especially useful resource, from a mobile aspect, as well as from an authentic standpoint – and at the same time, staying brief to encourage

residents to use it in their practice during residency and beyond. A recent study found that effective e-learning modules had several specific sections, such as epidemiology, screening and diagnosis, evaluation, management, etc., which is consistent with the preference of these participants for more specific resources (Cook et al., 2005). As an example in this research, Sylvia explains how a medication application could be useful:

If there are dedicated sleep related and sleep related medication spots - for all types of sleep related medication...If you use something else like Hypocrates or Micromedix, it pulls up for any drug, so you have to sit there and think, which ones are for RLS? And then you have to start thinking and you have to look them up individually, but you might could go the other way, like RLS, and then you could click on it and it tell you the meds, so you click on those and see what you'd be monitoring, what they interact with. (Sylvia)

Self-control of Learning and Non-linear Design Were Large Indicators of Satisfaction

The major pattern that emerged with regard to self-directed e-learning is that the participants preferred to be in control of their own learning, reflective of their perceived self-directedness. This group of residents was indeed self-directed and preferred a non-linear approach to the learning materials, but did not prefer to learn collaboratively (i.e. online discussion). As evidenced in the literature, self-directed e-learning modules have been found to be effective teaching methods for medical students and residents, according to knowledge and attitude surveys (Salas, 2012; Peters et al., 2008). This converges with the findings of this study, in that the participants do prefer the self-directed nature of the module. Residents

are stereotyped as being self-directed, and this research confirmed that this group of participants is indeed self-directed. The above findings bring up several major design considerations, which are discussed next.

Flexibility

It is very evident from the findings that the module must be flexible, catering to self-directed learning. Sleep 101 was setup with this in mind, since I predicted residents would appreciate flexibility. The fact that this module was accessible anytime, anywhere, and via mobile devices, was a differentiating advantage of this module versus traditional lecture. This converges with recent literature citing that mobile devices are advantageous because they alleviate residents from the need to carry bulky texts and articles, and offer the flexibility to study during travel (Korbage & Bedi, 2012).

In traditional lecture, when it is over, residents cannot go back and get more information out of it. Online, the lectures can be watched over and over. Also, question and answer time is limited in traditional lecture, but through online discussion in a module like Sleep 101, it is almost limitless. Previous research also confirms that flexibility is key in resident satisfaction in online modules. A study by Kang, et al. (2009), demonstrated that residents' reacted positively to e-learning modules, which were non-linear and included multimedia and also demonstrated improved performance on post-tests.

Module Structure

The timing of the online module is important since residents appear to become more self-directed as they progress in residency. Perhaps a module earlier in residency would have

more structure than a module at the end. For example, a module early in residency may contain basic lectures and resources, aimed at providing foundational knowledge. A module toward the end of residency may have a looser structure and non-linear approach, as residents may have better knowledge of the specific clinical questions they are trying to answer – making it easier to navigate and select resources in a non-linear fashion. No previous research confirmed or contradicted the idea of progressively loosening the structure of supplemental education for medical residents.

Prompting and Reminders

Since Sleep 101 did not use very many prompts and reminders in the module, a question arises whether or not residents would have used the online discussion differently if there were more direction. This group of residents did prefer self-directed learning, but also stated that they appreciated when discussion or learning had a clear aim, and would have liked more prompts and reminders. Previous research demonstrates that prompting and guidelines in online discussion result in the highest levels of collaboration and discussion response rates (Biesenbach-Lucas, 2004; Dennen, 2008). A recent study also found that facilitative prompting “leads” participants to higher levels of collaboration and cognitive engagement (Putman, Ford, & Tancock, 2012). Adding more structure and prompts are recommended for future designers to include.

It seemed apparent that this group of residents had little knowledge of sleep disorders, and therefore felt they had little to offer to the online discussion. This issue seemed two-fold. For one, residents’ lack of sleep knowledge prevented them from asking specific questions

about sleep disorders, in particular, about rare cases. In this case, prompting could be useful as a steering mechanism, particularly because residents are busy and may not have the time to dedicate to problem solving a particular case. Prompting could direct them with specific questions and answers, with experts and senior level residents offering responses on the discussion board. Lynn embodies this issue in her statement:

I could see residents again, being busy - they want to know the answer, but they want someone else to just go ahead and post it, so they can get that information without having to scour the web or book to try and get it, you know, like a quick fix. (Lynn)

Secondly, residents' lack of time was again an issue that seemed to prevent them from spending much time doing any outside research to help them craft discussion board responses. Perhaps this was an issue because most of these residents are not heavily invested in sleep medicine. They participated in the module simply because they had basic or minimal interest in sleep medicine. The online discussion may have been very different with a group of residents who were heavily invested in the topics. That said, the online discussion (being lighthearted in nature), may benefit from prompting and more experts or senior level residents providing more specific discussion points with directed readings, and providing timely answers versus residents looking up the answers for themselves. These residents were self-directed in that they independently accessed the discussion board looking for specific answers, but were not self-directed in that they preferred someone else to provide the answers. However, with more prompting, it is possible that the residents themselves would have done a little more independent research and provided more discussion input.

Introverted Nature of the Participants Governed Their Participation

A major pattern that emerged is that the participants in this study are generally introverted, as evidenced by participants predominantly “lurking” on the discussion forum and by many participants self-proclaiming to be introverted. This finding heavily influenced how they participated in the module. In particular, the participants alone did not take it upon themselves to instigate conversation; therefore a design recommendation is to include a facilitator for discussion forums. The roles of the facilitator and of the discussion, as well as design recommendations are discussed next.

Facilitator’s Role

The positive role of the facilitator manifested through the use of scaffolding, modeling, and coaching; and by the facilitator providing the important contextual and practical information the residents needed. This is an important design consideration since the content and direction of the online discussion is therefore in the hands of the facilitator. Previous research indicates that instructor facilitation does impact how students participate in online discussions (An, Shin, & Lim, 2009).

Another interesting point is the participants appreciate coaching by the facilitator, but prefer the facilitator be more of a peer instead of a supervisor. Discussion boards are unique tools because they encourage a more natural flow of communication and can be very informal. Therefore, since a module like Sleep 101 is not required or necessary for a grade, having a degree of separation between residents and supervisors can encourage learning. This is because residents’ responses may be inhibited or influenced if they believe they are being

watched or evaluated by a superior. Utilizing the module strength of flexibility and usefulness as a tool for reinforcement, the module could allow residents a way to ask about and discuss authentic issues that they might have otherwise brought up. One participant noted:

Perhaps they should be in the module by giving lectures and providing resources, but could inhibit the discussion because residents may be afraid to say or ask what they really want. Having an authoritative facilitator, who was between peer and supervisor, was better. (Lawrence)

Contrary to the above, there is the idea that the online discussion may be different and led by students if there were more student participants, versus the facilitator controlling the content and direction of the discussion. Similarly, previous research indicates that student facilitation in online discussions actually does encourage participation among other students (Baran & Correia, 2009). This group of active participants was quite small (N=8), and several mentioned they were on intense rotations that were not conducive to participating in the module. It is possible that if more residents were a part of the module, that the situation may be very different.

As clearly indicated by previous literature, an aspect of online social presence is teaching presence, and there is growing evidence that teaching presence is very important in the development of online community (Shea, Li, & Pickett, 2006). In this research, the facilitator demonstrated coaching and modeling, as described by the participants, but in a minimal and non-intrusive way. The participants did not express great satisfaction or

dissatisfaction in the facilitator's performance, but there was evidence that the results might have been different if the facilitator had provided more prompts and the discussion was more structured, which is a recommendation for future designers.

Discussion Forum Role

The online discussion forum was barely used, and various reasons were cited. Several mentioned they didn't participate in the online discussion because they were introverted. Several also mentioned that they were on time-intensive rotations, limiting their participation. And still others mentioned that they didn't contribute because they did not have the foundational knowledge of sleep to offer any useful information to the discussion. Each of these issues brings about major design considerations.

The first consideration is that the online discussion is more useful as a secondary learning tool, versus a "hub" for learning. This is consistent with previous literature, citing asynchronous online discussion as an "extension of instructional practices", not the center (Gerosa, Filippo, Pimentel, Fuks & Lucena, 2010; Kayler & Weller, 2007, p. 136). The findings confirm that some participants actually did access the module between patients and potentially during consults. This may be a useful application for the online discussion, especially if the discussion were more structured with prompts and reminders (as previously mentioned), as well as more branches for topics versus a general forum. Another idea is that the module content is not really conducive for using discussion as the primary learning tool. As an example, when talking about a prior experience with an online ethics course, Pete stated:

It [online discussion in ethics course] was trying to take the place of people sitting in a room at a big round table saying “this is our ethical dilemma, let’s talk this out”.

But you really can’t talk out sleep apnea, you have it or you don’t. (Pete)

Previous research does not give a clear indication for what types of content online discussion works best for; however, one study utilizing problem based learning (common in medical education and what may have been seen in the discussion forum if there were more participation) does diverge in that most of the participants were active and worked collaboratively to solve problems in the discussion forum (Chagas, Faria, Mourato, Pereira, Santos, 2012). It is important to note that the online discussions had more structure, participants were studied over three years, and the participants in the study were graduate students enrolled in a health course, but were not medical students. Further research is needed regarding medical students and online discussion use.

The second consideration is that online discussion may be more useful when residents have foundational knowledge about the topic and a vested interest. Previous research indicates that the quality of online discussion is positively associated with familiarity of the discussion topics and advanced preparation (Du, Jianxia, Xu, Jianzhong, 2010). Therefore, a potential timeframe for online discussion around specialty topics, such as sleep medicine, may be during the latter part of residency, or even beyond residency when physicians are practicing in specialty and subspecialty clinics. No relevant research could be identified comparing online discussion in introductory versus advanced courses. It appears that if residents have to look up things right before posting, they tend not to. Also, residents may be

more likely to use a module where they are more invested in the topic. Grady sums this up in his statement:

I think a lot of it is background knowledge, you know you don't really know much about it, so you are limited as to what you can intelligently say... This is almost like an introduction for most of us, to sleep... (Grady)

This brings up a very important point that the online discussion may have been very different if these participants did have a foundational knowledge of sleep medicine.

Little research exists surrounding using online discussion forums in medical education. One study of medical faculty demonstrated that using an online discussion forum failed miserably, with only 8% of the participants utilizing the online discussion (Steinert, McLeod, Conochie, & Nasmith, 2002). However, that particular study is dated. Results may be different now with younger residents emerging from programs of study that increasingly utilize online tools such as discussion forums, yet the reason most frequently cited for not using the online discussion in the Steinert et al. (2002) study was lack of time and competing interests, which is identical to the issues presented in this research.

The third consideration is that the overall goal of the discussion forum should be clearly defined. The discussion forum in this research did not have a clear aim, other than as a trial to see what residents preferred to use it for. The aim of the discussion forum could take many forms, such as for community, for a question/answer forum, etc., but this role should be made clear to the participants and carefully selected by the designers. It is possible that a

discussion forum may not be effective in certain modules, and instead, an expert mentor may be a more effective alternative.

A fourth consideration is that the online discussion may work better when it has a very informal role, as mentioned earlier, primarily for use with non-urgent issues or reinforcement. This is consistent with previous literature, citing that a majority of discussion forum participants post in “exploration”, and a rare few posts integrate “ideas for solutions” (Gao, Zhang, & Franklin, 2012, p 473; Rourke & Kanuka, 2009). Not only did these residents gravitate toward topics that interested them, as mentioned in the findings, they also appreciated when peers tried to add additional interest through an entertainment factor. While talking about what made the discussion interesting, Lynn stated, “keep is lighthearted... then people are more likely to weigh in just because it doesn’t seem as intimidating maybe.” This further supports the idea that the online discussion should take on a more informal role.

With regard to using the discussion forum for non-urgent issues, several participants thought responses, which were usually within 24 hours were satisfactory, but only in the case of non-urgent issues. Perhaps they would view the online discussion even more useful for immediate needs if there were more people in the discussion able to provide answers and carry on discussion. Perhaps having a larger pool of attendings and forums in the discussion would have made the online discussion more appealing to use for more urgent issues or for immediate feedback.

In the literature, social presence and community (especially for online learning) is deemed important for enhancing student satisfaction and perceptions of learning and e-

learning (McIsaac & Gunawardena, 1996; Pascarella & Terenzini, 1991; Tinto, 1997; Shea, Li, & Pickett, 2006), however, that did not appear to be consistent with what actually happened in this research. Several participants did not feel the social aspect of the module was useful at all. Perhaps the participants' self-directed nature consequently inhibited the successfulness of scaffolding from the online social presence. It is unclear that the result would have been any different if the discussion board had more participation, or had a different structure.

**Context is Important and Varies According to Where Residents are in Their Education
(i.e. at the beginning, middle, or end of residency)**

A major pattern that emerged is that the content of the module should represent real situations, within the context of what residents are doing at that moment in time. This may be the critical factor determining whether a resident will use the module in-between patients on their mobile devices. In a recent study evaluating residents learning habits, most of them (81.4%) read in response and in the context to their own encounters with patients in the hospital/clinic setting and preferred an electronic format (Edson, Beckman, West, Aronowitz, Badgett, Feldstein, Henderson, Kolars, & McDonald, 2010). Previous research also demonstrates that residents spend less time meeting the same learning objectives with e-learning modules, and preferred the web based format (Cook et al., 2005).

An important design consideration is that the context of the module should be interesting and relevant (i.e. a cardiology specific module being available during a cardiology rotation). This is in keeping with the finding that authentic/situated learning is facilitated

through the mobile e-learning module. There is also mounting evidence from the literature that using authentic resources (i.e. case presentations) in e-learning modules is effective for teaching residents (Skye et al., 2011).

Another design consideration is that the module design should be practical. These residents are actually already using other types of computerized and mobile applications in the same spontaneous and practical ways – to look up information quickly that will help them right then with a clinical question. As an example, Christine stated:

I think a lot of the things that I think would be most interesting would be those practical things, like “this patient does not like any of the masks that are available”... that is why Up-To-Date is such a useful resource - it is very practical. It’s not meant to be exhaustive, it’s meant to be a quick overview of something that may give you enough information to make a decision. (Christine)

Mobile Modules Could be Useful During Patient Consultations

It is a finding of this research that residents will access the mobile module in-between patients and potentially, during consults, therefore, this module could be useful not only in-between patients, but right in the patient room. In a 2012 survey, 62% of 3000 physicians surveyed admittedly use mobile devices in their practice and many of them using them right at the patient’s side (Manhattan Research, 2012). I actually did get to hear about how the Sleep 101 module was used to assist in a real clinic patient. Pete explained how he used the Sleep 101 information to help him treat a patient in his statement:

I did have one patient, and this is great, that I was able to help, just purely based on the lecture materials that I'd gone through in clinic. They had restless legs syndrome, and I knew what to do. I knew what to prescribe, I knew what the symptoms were, you know, the four criteria were and what the medications to give them were, and I actually knew exactly how to treat this patient. And I gave them the medication and he was symptom free right off the bat. (Pete)

The participants in this research were already using electronic resources for learning, and most of them were already using mobile devices as part of their learning. In fact, all but one resident used smart phones on a daily basis. This converges with a recent national survey of residents, where a majority preferred and were already using mobile devices and electronic resources for learning (Korbage & Bedi, 2012). Findings are consistent with previous surveys, demonstrating that residents accepted e-learning modules and considered them valuable to their practice (Cook et al., 2009). Several other recent studies support these research findings, in that residents accepted and preferred mobile learning, effectively used smartphones at bedside and at home via self-directed learning, and that exam performance improved (Tanaka et al., 2012; Gonzalez et al., 2012; Nishino et al., 2004; Chang et al., 2012).

Future Considerations

Mobile applications and e-learning were only recently introduced into medical residency education, but are no less valuable in this setting compared to other settings that have been using them for some time. Actually, medical residents may benefit from using

these tools even more so that other groups, due to their self-directed nature and mobile style. At this point, I believe it is a matter of giving the residency programs the opportunities to use these tools, which may be the largest complicating factor, considering the challenges these programs face in time and job duty limitations (as discussed in Chapter 2). Kai sums this idea beautifully in his statement:

It is almost like people saying families that have computers in the home, their children fare better in school, like that's automatic, you have access to things at your fingertips, so any downtime you can spend that learning, reading, educating yourself, to me, that's ideal. (Kai)

To conclude, the recommendations for future mobile e-learning module development that emerged from this research are summarized next. These statements are not necessarily meant to be generalizations, but are merely suggestions of ideas that may be useful in residency programs. A summary table of the recommendations listed in this chapter is next, followed by three additional general recommendations and future research recommendations.

Table 2 E-learning Module Design Recommendations

E-learning Module Design Recommendations
Module Content and Resources
Modules content should be real and relevant and should incorporate the context of real patient scenarios, including “practical” information to help residents with everyday situations.
Modules early in residency may be more foundational in nature and modules later in residency may be more specific to rotations with a more flexible “use as you need” schedule.
Build patient questionnaires to be interactive and provide calculations to aid residents during the actual patient consultation.
Build authentic and specific resources for upper-level residents.
Module design should support self-directed learning and have a non-linear design.
Module facilitators should provide prompting and reminders in discussion forums, expert advice, and provide a clear aim for the discussions and other resources within the module.
Online discussion may be more useful as a secondary or informal learning tool for non-urgent issues or reinforcement.
Module Availability and Timing
Design modules to last approximately three weeks, or the length of the shortest rotation, and be available on-demand.
Online discussion will be influenced if modules are available ongoing or at a set time, therefore, designers must individually decide on optimal timing.
Module content should be chunked in small (20 minutes or less), digestible, and on-the-go pieces.
Modules should be portable, flexible and accessible anytime and anywhere, contain multimedia, be easy to use, and be available on mobile devices.
Modules should be compact, all-inclusive, and have a streamlined design with little click through.
Integrate the module through familiar interfaces or portals the residents are already using.
Online discussion may be more useful when residents have a vested interest in the topic and foundational knowledge, such as toward the end of residency or after residency.

Loosen Module Structure as Residents Progress

Evidence from this research, and from previous research suggests that residents become more self-directed as time goes on, or as they progress from medical school to the end of residency. Therefore, mobile e-learning applications for residents during the early years of residency can be more structured with multiple prompts and direction. During the final residency years, the modules can assume a much more self-directed structure, yet retaining some minimal prompts for optional guidance.

The modules in the early residency years can also be more foundational in nature, as discussed earlier. The modules during the final years of residency can be more practical and treatment oriented. It is important to note that if the participants already had the foundational sleep knowledge (only one of them did), the outcome of the online discussion may have been different. For example, Grady stated, “I could have chimed in (to the online discussion), I guess I didn’t really have anything very smart to say, so I just looked into it and never really replied.” (Grady)

Design the Content to be Practical and Specific

Several instances in this research involved participants discussing how the authenticity of the module is important, and they list examples of specific topics or uses for a mobile application in their own practice. Of course, these specifics will vary according to the rotation, and may include medications, treatment options, and others. Pete states, “That’s the next step is to have snippets of polysomnograms, with video if appropriate, in the same way

you can go online now and listen to heart sounds, breath sounds, etc. Examples of pathologies.”

Encourage Mobile E-learning Module Use During and Beyond Residency

These participants agreed, and this is consistent with prior research, in that residents self-report they would complete future supplemental e-learning programs (Dietrich et al., 2010). For example, when asked about how the module helped in learning, Lawrence stated:

Well, I guess just in terms of learning generally, about, more about sleep disorders and so, if in my practice coming up, if I encounter someone with a complaint related to that I think I'll probably, especially if I had more time to actually learn more than I did with it. I think that it would potentially make me a better physician, or more aware of primary sleep disorders than I would otherwise. (Lawrence)

When asked if she would use the module once she was practicing, Christine explains that the module would be helpful, especially if it were topic driven. In the following statement, she discusses how the module could be very useful for fact and opinion, an area that is not necessarily covered in textbooks. She stated:

I think that that (the module after residency) could be helpful. It sort of depends on the topics that would be covered. It's sort of like there's this continuum of journals, things that are sort of topic relevant, little collections of things put out by the American Academy of Neurology, and so it's sort of a variety of different, short summary reviews on different topics, and they are not just articles, they have opinion in them as well. Those kinds of things are actually pretty useful when you just say

“well what’s this person, who’s opinion I well respect, what’s their condensed view of how to manage these particular sets of issues”. I think those kinds of things are useful. (Christine)

Future Research

Non-mandatory professional development courses are needed in many fields, not just sleep medicine. These types of courses, such as in this research, require participants to have a certain degree of motivation. Future studies are necessary to determine the factors that would motivate people to take courses such as these, and therefore help future mobile e-learning designers create non-mandatory professional development courses.

Self-directed learners are “ironically, highly collaborative” (Guthrie, Solomon & Rinehart, 1997; Temple & Rodero, 1995; Abdullah, 2001, p. 2); however, it is unclear whether the critical collaboration is between peers, instructors and students, or both. Stone and Chapman (2006) imply that student-student interaction may not be necessary, and the facilitator-student relationship may be the only important factor.

That said, the outcome of similar research may be very different if the module had been designed differently. Perhaps adding more participants, encouraging instructor-student community, fostering general community with prompting, adding structure, etc., would be useful. Although these participants minimally valued the online community in the module, Pete makes a very interesting statement suggesting possible future uses:

They have things like [clinical “what would you do” scenarios to talk over] that in other disciplines; they have like a “morning report” type of thing, which we don’t

have in neurology. Where somebody presents the case and then says “now, what do you guys think?”. And you see this in infectious disease service has a weekly thing where they bring in two cases that are “weird” that they have seen. It’s the same thing, like a morning report type thing and to a certain degree, that’s a bit like chairman’s rounds. Once a month or so our chairman comes in and there’s a case that’s presented and then he talks through it and, so it’s a bit like that. So if you can, if it’s a tricky case, getting some other heads together - yeah, absolutely, that’s valuable. (Pete)

Conclusion

In summary, the purpose of this discussion chapter is to describe and reconstruct a holistic understanding of the residents experience with the Sleep 101 e-learning module. Research and anecdotal evidence portray residents as generally self-directed learners, who thrive in the apprenticeship (situated/authentic learning) model that is medical residency education. It is also proven in previous research that the aspects of the resident education model can be successfully accomplished via e-learning. tool.

The overall research question was: *How do medical residents describe their learning experience with the online supplemental sleep medicine educational program and mobile learning?* This question was answered through an understanding of the research sub-questions as follows:

- What are the pedagogical issues of the online module with regard to specific e-learning constructs and mobile learning? Answer: Teaching tools and methods should

provide practical, authentic and contextual information; facilitators provide positive influence via scaffolding; modules should cater to self-directed learners; mobile learning is preferred; and online discussion forums may be useful, but only as a supplemental tool

- What are the strengths and areas for improvement in the overall resident educational experience? Answer: The strengths of the e-learning module include that it is flexible, uses multimedia, is practical, and is easy to use; the areas for improvement listed are the timing of the module, length of content, addition of prompting and reminders, and adding more contextual content
- What is the usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents? Answer: Mobile e-learning complements residents' learning styles; residents will access the mobile module in-between patients and potentially, during consults; online discussion is useful as reinforcement; sleep 101 is useful for foundational knowledge; sleep 101 is authentic and practical; and residents would use mobile e-learning modules during and beyond residency

Ultimately, this research provides preliminary evidence of the ways sleep medicine education through e-learning and mobile learning may and may not be a feasible and an effective supplement within neurology residency education. This research aimed at understanding the “why” and the “how” of e-learning from the perception of the participants. For a majority of the participants in this research, who appear to fit the resident stereotype,

the e-learning module was indeed a natural fit for learning and there is strong evidence that mobile applications could be a very effective instructional delivery tool.

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APPENDICES

Appendix A Email Invitation

Dear Neurology Resident,

My name is Mary Ellen Wells and I am a technologist in the UNC Clinical Neurophysiology Lab and am a doctoral student at NCSU. I am asking for your participation in a three-week e-learning module on sleep medicine. There is an identified gap in neurology resident training regarding sleep medicine, and the goal of this research is to examine the educational experience of neurology residents who participate in a supplemental sleep medicine e-learning module. The module is accessible via computer and/or mobile device (i.e. Blackberry, iPhone, iPad) and your own Brittany Chapman will be the facilitator of the module. By choosing to participate, you will have access to multiple video lectures in sleep medicine along with e-books, e-journal articles, and practice guidelines. You will also participate in online discussions with your peers about sleep and how to recognize sleep issues in your patients, as well as discuss diagnosis and treatment options.

The module is self-directed, however, here is a suggestion and time estimates for weekly participation

- View four video lectures (1-4 hours)
- Review 3-4 e-journal articles/e-book chapters/e-resources (1-4 hours)
- Participate in the online discussion 1-3 times daily (15-60 minutes)

At the conclusion of the module, I will ask you to participate in a 30-45 minute individual interview, fitting into your schedule, with me concerning your learning experience.

If you are interested in participating in this research, please reply with the following information (note: your reply only signifies your interest. You will receive an official informed consent form later):

- Name:
- Email address:
- Phone number:
- Year in residency:
- Amount of prior training in sleep medicine (i.e. hours, weeks, months, or "none"):

You will receive a \$25.00 Starbucks gift card at the conclusion of this research study, if you choose to participate and complete the research activities including participating in the three-week module and subsequent interview.

If you would like more information about participating in this research, please call me at 919-843-4673 or email me at mwells@med.unc.edu. I will also hold an information and training session soon, and you will receive an invitation. You can also sign up to participate in the research at the training session. This session will be recorded and available on the web if you cannot attend the session.

Thank you in advance for your consideration of this request.

Mary Ellen Wells, MS, RPSGT, R.EEG T, R.NCS T.
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Appendix B Interview Protocol and Questions

Interview Protocol

After participants complete the three-week module, I email or call them to schedule a 30-45 minute interview within 30 days of completion of the module. The interviews take place in a private conference room in the Clinical Neurophysiology Laboratory. No more than 3 interviews are conducted in a day. Interviews are digitally recorded unless the participant objects. In that case, notes are taken for the interview. Digitally recorded interviews are transcribed and a summary is written, preceding data analysis.

Note: Research questions are in bold followed by the main interview questions. The interview is semi-structured in that the main questions are identified as follows, to ensure the research questions main components are covered. Additional follow-up questions and probes are also asked to expand on information revealed during the interview. Additional questions also emerge after patterns are identified from the other data sources.

Research question #1: What are the pedagogical issues of the online module with regard to specific e-learning constructs and mobile learning? Note: questions specific to e-learning constructs are grouped under that construct.

- Online Social presence
 - Did you experience “scaffolding”, or peers using peers as stepping stones for learning, during the module, and how did it manifest, if at all?
 - Coaching provides encouragement, motivation, and support. Was coaching evident during the module and if so, how did it take place and what were your feelings about it?
 - Modeling of expected behaviors and interactions is another teaching tool. Was modeling evident in the module, and if so, please describe how it took place and your experiences/thoughts with it?
 - Did you experience a sense of community in the online module, and if so, how?
 - Did you feel like your questions and concerns got immediate attention by your peers and facilitators, please explain? Did mobility play a part? Please explain.
- Self-directed e-learning
 - What was it like in the module? Please describe day-to-day your experience.
 - How did the online nature of the module impact you?
 - How “in control” and responsible for your learning did you feel?
- Situated/authentic learning
 - How “real” did you feel like your learning experience was, in other words, did you feel like you could actually use the information to help your patients?
 - Please describe how you interacted with the materials in the module, your peers, and your instructor?

- Since residents are often learning in an “apprenticeship” situation, that is, there is often expert performances modeled, how did you feel this module mirrored or did not mirror the apprenticeship module you are use to?
- Did you feel like you and your peers participated in collaborative learning, and if so, how?
- How do you feel the knowledge you gained (if any) from this module will be useful in real life?
- Mobile learning
 - How did the mobile nature of the module impact you?
 - How (if at all) was the mobile application able to help you as you moved from patient to patient throughout your day?

Research question #2: What are the strengths and areas for improvement in the overall resident educational experience?

- What did you like about the e-learning module?
- What areas do you think can be improved in the e-learning module?
- What do you think could have helped you more in terms of the way the module is built?

Research question #3: What is the usefulness, application, and takeaways resulting from the module, as experienced by the neurology residents?

- At this point, in what ways have your perceptions of sleep medicine changed?
- At this point, in what ways have your perceptions of e-learning and learning using mobile devices changed?
- Is there anything that stood in your way as you tried to complete the module?
- Did you like the module and find it useful?
- Would you use other modules like it during your residency, and even beyond?
- Overall, what are your takeaways from completing the module?