A Conceptual Framework to Guide the Design, Delivery and Evaluation of Quality Mobile Learning Experiences

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Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements
for the Doctorate in Philosophy degree in Education

Faculty of Education

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Acknowledgements

When I started out on my doctoral degree, I was excited at the prospect of another four years of research and development in my academic life. Little did I know the amount of work, time and dedication that it would take to get to the point of submitting this thesis. I have been truly blessed with all of the support that I have received along the journey, and I have met and collaborated with a remarkable group of people.

To begin, there is my thesis advisor, Dr. Colla MacDonald. Her wealth of experience and endless enthusiasm have kept me on track and motivated throughout the entire process. She has always been accessible whenever I had a question or difficulty, and her dedication to the success of her students is second to none. I know that without her guidance my academic and professional career would not be where it is today. For that I am eternally thankful.

In addition, my thesis advisory committee and their various areas of pedagogical expertise were critical in producing this mixed methods study. Dr. Christine Suurtamm's knowledge of qualitative analysis enriched the description of the stories and experiences of study participants. Here understanding of the doctoral research process and procedures also aided me through the many hurdles along the way. Dr. David Trumpower's quantitative mind guided me through the intricacies of the factor analysis and helped produce a much more reliable conceptual framework. Dr. Emmanuel Dupláa's understanding of research methodology and attention to detail helped organize the structure of the articles in this thesis. Together, their thoughtful feedback and genuine encouragement made them a dream committee with which to work.

Finally and most importantly, my family was my foundation throughout this entire journey. My daughter Christie and son Will were very patient when dad had to work in the evening, on the weekend or occasionally during summer vacation. They accepted my choice to undertake this PhD and never complained about my business or absences along the way. Knowing they were sacrificing as well kept me motivated and determined to finish this challenge. There's no time for procrastinating when there are children involved!

To my wife Katherine, I don't think I can ever repay her for her loving support and consideration over the past four years. She always understood why I wanted to do this, never questioned my absences or dedication, and was always there to listen if I had to vent my frustrations or disappointments. I am very lucky to call her my wife, and I will forever be in her

debt for all of the extra work and hours she has put in to support this endeavor. Without her many sacrifices, this would not have been possible.

Abstract

Mobile learning has the pedagogical potential to provide informal, context-based educational experiences that can teach practical and applicable workplace skills and behaviors. The goal of this study was to examine the learning experiences and outcomes of healthcare professionals as they participated in a mobile learning activity designed to teach them the technical and procedural skills for facilitating clinical consultations via videoconference. The primary research question was: How does the use of a curriculum framework to design mobile learning experiences impact the learning experiences and outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?

Informed by a systematic review of the mobile learning literature, this dissertation proposed a conceptual framework to guide the implementation and evaluation of mobile learning based on five dimensions of instructional design: content, structure, delivery, usability and communities of practice. Physicians, nurses and healthcare administrators voluntarily participated in this pragmatic, mixed methods study. Their quantitative and qualitative feedback was utilized both to assess the validity of the proposed mobile learning experience conceptual framework as well as its quantitative and qualitative evaluation tools.

The study found that informal, contextual mobile learning content can promote communication and collaboration among healthcare professionals, and provide them with hands-on learning experiences that can be easily situated in a specific workplace environment. Delivery was identified as perhaps the most critical element in increasing motivation and interactivity among participants, and communities of practice after the learning activity were found to increase collaboration and provide opportunities for problem-solving. The structure of embedding the informal mobile learning experience within a formal, didactic online learning course was also found by participants to provide the right mix of background knowledge and practical application to produce meaningful learning outcomes.

Overall, the mobile learning experience conceptual framework synthesizes best practices in the literature and proposes innovative methods for the design and evaluation of effective mobile learning.

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List of Acronyms and Abbreviations

MLE – Mobile Learning Experience: The name for the mobile learning activity in this study.

MLE1 – Mobile Learning Experience 1: This was the mobile learning activity that included all of the best practices for content, delivery, structure, usability and communities of practice identified in the literature review.

MLE2 - Mobile Learning Experience 2: This was the mobile learning activity that included the best practices for content, structure, usability and communities of practice, but did not include the recommendations for delivery, namely the interactive activities or guidance through the simulation (avatar host).

MLE3 - Mobile Learning Experience 3: This was the mobile learning activity that included best practices for content, delivery, structure and communities of practice, but did not include the recommendations for usability, namely the navigation buttons (previous and next, table of contents), the intuitive interface (progress bar, large buttons for mouse or touchscreen use), or simple graphics (identifying a task or checklist activity).

CoP – Community of Practice: The participation in an activity system (in this case online discussion forums) in which participants share understandings and observations about what they are doing and what that means for their workplace community.

CoP1 – Community of Practice 1: The first community of practice in this study was the mobile learning experience discussion forum, where participants could have an ongoing discussion while working on a common problem: preparation for a clinical consultation via videoconference.

CoP2 – Community of Practice 2: The second community of practice was reaction survey 2, where participants posted answers to a series of questions in a discussion forum in Moodle after they had completed their first telemedicine appointment.

CHAPTER 1: Introduction

Preamble

This dissertation reviews best practices identified in the literature for designing interactive, context-based mobile learning. The best practices are then synthesized into a mobile learning conceptual framework that is utilized to design mobile learning experiences for inclusion in an online course for healthcare professionals. Based on the learning experiences of the study participants, the elements and design of the conceptual framework are evaluated and revised with the goal of both refuting and supporting prior research on mobile learning design and implementation.

The dissertation consists of five chapters. Chapter 1 is an introductory chapter and it addresses the review of literature and the research design and methods. The next three chapters are developed as stand-alone publishable articles (Chapters 2-4). Chapter 5 is the final chapter and provides an integrative conclusion for this research study. Chapters 2-4 are the article chapters, and each has distinct research questions that may be read independently from one other. Each of the article chapters is prefaced with a title page that provides the article title, the intended journal of publication, and an abstract structured according to the headings. For ease of navigation, references and appendices related to the stand-alone articles (Chapters 2-4) appear with the chapter. The structure of the dissertation is outlined in more detail later in this paper.

This study examines how the use of a curriculum framework to design mobile learning experiences impacts the learning outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes. This chapter begins with an overview of the current use of online and mobile learning in healthcare professional education, and explains the framework for the larger research study.

The next section presents a description of the research problem, followed by an in-depth review of the literature. The literature review addresses current themes in mobile learning instructional design including recommendations for content development, methods of delivery, ease of usability, informal structure of mobile learning applications, and the implementation and orientation of communities of practice. The study's conceptual framework is then presented to demonstrate how it is grounded in the best practices identified by the literature review. The research questions are also outlined, followed by a presentation of the research design and methods.

Online and Mobile Learning for Healthcare Professionals

The curricula in healthcare education has changed since the year 2000, with more demands on medical educators due to changes in healthcare delivery and technology (Ozuah, 2002), and with a more competency-based focus that emphasizes learning outcomes (Leung, 2002). “Traditional instructor-centered teaching is yielding to a learner-centered model that puts learners in control of their own learning” (Ruiz, Mintzer & Leipzig, 2006). Online learning has been a viable option for healthcare education in that busy professionals can choose the time and place of training, and this has led to a dramatic increase in the adoption of online learning programs by healthcare organizations in recent years (McIntosh-Scott, Gidman & Mason-Whitehead, 2010). In addition, online medical education programs have been shown to have comparable learning outcomes to traditional face-to-face instruction (Curran & Fleet, 2005; Moule, Ward & Lockyer, 2010).

Mobile learning has been identified as an excellent modality for delivering instruction to healthcare professionals (Zolfo et al, 2010), as it can promote learner autonomy, provide low-cost and flexible access to information, and offer a flexible format for stimulating collaboration (Sharples, Arnedillo-Sanchez, Milrad & Vavoula, 2009). In addition, increasing learner motivation and developing problem-solving skills are strengths of mobile learning (Hwang & Chang, 2011), and both of these have been identified as critical elements for promoting lifelong learning in clinical practitioners (Holzinger, Nischelwitzer & Meisenberger, 2005). There is, however, a need for more focused research on how mobile learning can be implemented in healthcare education. “There are several studies assessing the practical use of mobile devices and handheld computers in the medical education setting, but what is lacking to date is the underpinning pedagogic basis for the use of such technology” (Davies et al., 2012, p. 1). It is the aim of this study to identify best practices for the design of a mobile learning experience conceptual framework to help inform the implementation of successful mobile learning into healthcare education contexts.

The Research Problem

"Despite the significant potential of mobile technologies to be used as powerful learning tools in higher education, their current use appears to be predominantly within a didactic, teacher-centred paradigm, rather than a more constructivist environment" (Herrington & Herrington, 2007, p. 4). This is partly due to the fact that many instructional designers and educators view mobile devices simply as tools for delivering content, rather than focusing on the learner experience and how mobility, context and social interactions can advance education (Traxler, 2007). While there is potential for mobile devices to provide rich multimedia experiences and location-specific learning, "…the challenge for educators and designers is one of understanding and exploring how best we might use these resources to support learning" (Naismith, Lonsdale, Vavoula & Sharples, 2005, p. 1). In particular, there is a need for more research in the theory of instructional design of mobile learning environments (Cochrane, 2010; Elias, 2011). This includes how to include mobile environments in regular online curricula (Pfeiffer, Gemballa, Jarordzka, Scheiter & Gerjets, 2009), a need for the development of theoretical frameworks to guide evaluation of mobile learning effectiveness (Park, 2011), the development of pedagogical environments for mobile learning (Keegan, 2005), and how to utilize emerging mobile technologies in concert with classroom instruction (Aubusson, Schuck & Burden, 2009). "It is therefore evident that the design and implementation of mobile learning applications has not stabilized since its theoretical and philosophical underpinnings are just in the making" (Muyinda, Lynch & Mugisa, 2007, p.25).

There are several conceptual frameworks that have been developed for mobile learning. Some focus on the implementation of technology and ease of navigation, such as the framework proposed by Botha, Cornje and Ford (2007). Another framework categorizes mobile learning into five broad categories based on learning contexts: free, formalized, digital, physical, and informal (Frohberg, 2006). The majority of proposed mobile learning frameworks such as FRAME put a premium on social interaction between students while engaging in mobile learning activities (Koole, 2009). The framework suggested by Park (2011) takes social engagement a step further and incorporates it with transactional distance theory. Another predominant focus among frameworks is the context within which the mobile learning is occurring (Naismith, Lonsdale, Vavoula & Sharples, 2004). Despite recent research, much work is needed in order to understand how to synthesize all of the above mentioned elements (learning context, social interaction, usability, delivery, and learning environment structure) into a framework that advocates for the effective design, delivery and evaluation of mobile learning. This is critical because there is great potential for mobile learning to be used to create the pedagogical environment where cognitive activities can be engaged in order to produce desired learning outcomes (Laurillard, 2007).

Research Study Goals

This pragmatic mixed methods study will address the gap in the literature identified by (Laurillard, 2007) for a curriculum framework to guide the learning environment structure, content, delivery, usability, and social interactions of a quality mobile learning experience. This will be accomplished by synthesizing information from the literature and designing a curriculum framework for effective mobile learning. This study will implement and test the curriculum framework in several mobile learning experiences in order to establish best practices associated with designing and delivering mobile learning to achieve desired learning outcomes. These best practices will include methods for designing instructional material, delivering content, facilitating navigation, and combining mobile learning and online learning. Communities of practice (or social interaction) for mobile learning will also be examined by allowing learners to share and post comments to a discussion blog during the mobile learning activities as well as after they have had the chance to apply the knowledge in a real world situation.

Research Study Structure

For the purpose of this study, mobile learning will be referred to as a mobile learning experience, which refers to a learning activity that the participants perform on their mobile device (laptop, tablet or phone), in a specific physical context or location, and that is embedded in a formal online learning environment. The study will explore how mobile learning experiences impact the learning experiences and outcomes of physicians, nurses and healthcare professionals as they participate in the Ontario Telemedicine Network's (OTN) videoconference equipment training course. The course was offered online through OTN's Training Centre, and included both online and mobile learning content.

Online Learning. The course was divided into a total of 7 modules. Modules 1-3 were completed online, followed by the mobile learning experience in module 4, and then the course was completed with modules 5-7 online. A detailed description of the structure and delivery of each module can be found in Table 1 below.

The first three modules presented an introduction to clinical videoconferencing, the videoconferencing equipment and the mobile learning experience itself. Participants could access these first three modules via their personal computers. Module 4 was a simulation that participants completed using their personal mobile device (laptop, tablet or phone) within the physical context of their clinical videoconference studio. The simulation utilized an avatar as host, and guided participants through an interactive screencast that covered all of the clinical procedures and protocols for presenting a patient via videoconference. Participants were prompted to perform activities and answer questions via a checklist activity. They also had access to helpful documents, guides and a discussion forum to ask questions and post learnings. At the conclusion of the mobile learning experience, participants were automatically emailed their completed checklist, which informed them of their readiness to perform clinical activity via videoconference. Participants then returned to their personal computers to complete two final modules which covered supplementary material and assessment. Details of all six modules of the course can be found in Table 1, including whether the module had an online or mobile structure, a summary of the content, and the delivery modality for each module. It should be noted that since this study focused on the design, evaluation and revision of a conceptual framework for mobile learning experiences, the vast majority of this content was contained in module 4, which comprised the mobile learning experience. Data for the study was also collected in module 7, which included the final quiz, reaction survey and community of practice 2.

Table 1

Online/Mobile Module Structure, Content and Delivery Modality

Online/Mobile Module Structure	Module Content	Module Delivery Modality
Activities Prior to Mobile Learning: Online Equipment Course	Module 1: Introduction to the Equipment a) Equipment Terms and Concepts b) Equipment Operation	- Video of live host presenting the videoconference equipment - PDF reference guides and checklists for equipment operation

	Module 2: Introduction to the Remote Control a) Features of the Remote Control b) Functions of the Remote Control	- Screencast of remote control features and functions - PDF reference guides and checklists for remote control operation
	Module 3: Mobile Learning Experience Orientation a) Explanation of Mobile Learning Experience b) Consent for Mobile Learning Experience	- Screencast of mobile learning experience features and functions - Online consent form
Mobile Learning Experience	Module 4: Mobile Learning Experience a) Setting up the Clinical Videoconference Room b) Operating the Videoconference Equipment c) Orienting the Patient to the Clinical Videoconference Appointment d) Facilitating the Appointment	- Avatar host presents all learning tasks and checklist activities - Tasks “pulled” from resource by learner - Checklist “pushed” to resource from learner - Discussion forum access for Community of Practice 1 - Navigation and index features
Activities After Mobile Learning: Online Equipment Course	Module 5:Videoconference Etiquette and Privacy a) Videoconference Etiquette b) Privacy and Videoconferences c) Troubleshooting Tips and Tricks	- Etiquette video of videoconferencing best practices - Photo slide show of privacy best practices - Screencast of common troubleshooting techniques - PDF reference guides
	Module 6: Supplemental Material (Optional Based on Equipment at Member Site) a) Hooking up a Laptop Computer b) Manual Dialing Using the Global Address Book	- Video of host presenting laptop and address book - PDF reference guides for laptop operation and manual dialing
	Module 7: Assessment a) Final Quiz b) Course and Mobile Experience Post-Program Survey c) Reaction Survey 2	- Online quiz and reaction survey - Summary PDF reference guide - Reaction Survey 2 for Community of Practice 2

Mobile Learning. In order to examine the effectiveness of the mobile learning conceptual framework, three versions of the mobile learning experience were produced for this study. Mobile Learning Experience 1 (MLE1) included all of the best practices for content, delivery, structure, usability and communities of practice (CoP) identified in the literature review. MLE1 is presented later in this paper. Mobile Learning Experience 2 (MLE2) included best practices for content, structure, usability and CoP but did not include the recommendations for delivery, namely the interactive activities or guidance through the simulation (avatar host). The goal was to identify the importance and impact of mobile learning delivery on the learning experiences and outcomes of participants. Mobile Learning Experience 3 (MLE3) included best practices for content, delivery, structure and CoP but did not include the recommendations for usability, namely the navigation buttons (previous and next, table of contents), the intuitive interface (progress bar, large buttons for mouse or touchscreen use), or simple graphics (identifying a task or checklist activity). The goal was to identify the importance and impact of mobile learning usability on the learning experiences and outcomes of participants. Participants were randomly assigned to each group with the following breakdown: MLE1 had 121 participants, MLE2 had 92 participants, and MLE3 had 94 participants.

Literature Review

In order to inform the creation of a conceptual framework for the design and evaluation of mobile learning experiences, the literature review in chapters 2-4 will focus on examining the following themes (as identified in the discussion above) in the mobile learning literature:

1. Mobile Learning Delivery: transactional distance theory, the ubiquitous nature of cell phone technology and how they relate to content delivery for mobile learning.
2. Mobile Learning Structure: informal mobile learning experiences and how they can be structured effectively in order to fit in formal learning environments.
3. Mobile Learning Content: situated, contextual learning and constructivist, collaborative learning and how both contribute to the design and evaluation of mobile learning content.
4. Mobile Learning Usability: the factors and importance of ease of usability in making mobile learning accessible for learners.

5. Mobile Learning Communities of practice: communities of practice and how they can promote communication and collaboration both during and after a mobile learning experience.

Through the examination of these five themes, a conceptual framework for mobile learning will be developed that will focus on teaching context-specific material that results in practical learning outcomes.

Literature Review Summary for Chapter 2: Mobile Learning Delivery and Structure

Keywords for the literature review search included “mobile learning,” “mobile learning structure,” “mobile learning context,” “mobile learning delivery,” while searching the educational databases of ERIC, Canadian Research Index, ProQuest Dissertations and Theses, as well as a Google open search. Over 1010 hits were received with 378 being relevant to this study. In the end, 143 journal articles, conference proceedings, government documents, dissertations and reports were reviewed for this paper. Particular attention was paid to how mobile learning content can be structured and delivered so as to facilitate practical, reliable and desired learning outcomes. The detailed literature review on mobile learning delivery and structure can be found in chapter 2. A summary of the key themes and supporting research for this review can be found in Table 2 below.

Table 2

Chapter 2 Literature Review Topics and Supporting Research

Literature Review Topic	Supporting Research
Transactional Distance Theory and Mobile Learning Delivery	Collective and Individual Mobile Learning (Koole, 2009; Saba, 2005)
	Benefits of Technology for Everyday, Situated Learning Contexts (Gu, Gu & Laffey, 2011)
	Context-Aware Computing (Moran & Dourish, 2001)
	Mobile Hierarchy of Productivity, Flexible Access, Capturing Data, Communication (Gay, Rieger & Bennington, 2002)
	High Transactional Distance Individualized mLearning (Park, 2011)
	Push and Pull Delivery Methods (Elias, 2011)
	Avatars and Content Delivery (Clark & Mayer, 2008; Kapp, 2012)
Structure of Informal Mobile Learning in Formal Learning Environments	Contextual, Real-World Knowledge Acquired Informally in the Field (Comas-Quinn et al., 2009)
	Inquiry-Based Learning Allows Learners to Access Authentic Problems and Solutions (Shih, Chuang & Hwang, 2010)
	Inquiry-Based Learning Best When Guided by Instructor and Hands-

	On Activities (Colburn, 2000)
	Guided Participation (Evans & Johri, 2008)
	Link Informal with Formal Learning through Pre, Main and Post Activities (Bo-Kristensen et al., 2009)
	The TASK Model (Taylor, Sharples, Malley, Vavoula & Waycott, 2006)
	Pre-Activities Provide Cognitive Base and Orientation (Hsu & Chen, 2010)
	Main Activities is Mobile and Inquiry-Based (Hsu & Chen, 2010)
	Post Activities and Cognitive Ownership (Richards & Rogers, 2001)
	Task Model: Control, Context, Communication, Subject, Tool, Objective (Frohberg, Goth & Schwabe, 2009)

Literature Review Summary for Chapter 3: Mobile Learning Content, Usability and Communities of Practice

Keywords for the search included "mobile learning," "mobile learning content," "mobile usability," "mobile learning communities of practice," while searching the educational databases of ERIC, Canadian Research Index, ProQuest Dissertations and Theses, as well as a Google open search. Over 3400 hits were received with 496 being relevant to this study. In the end, 151 journal articles, conference proceedings, government documents, dissertations and reports were reviewed. Particular attention was paid to how mobile learning content can be designed, usability can be maximized and communities of practice can be developed so as to facilitate practical, reliable and desired learning outcomes. A summary of the key themes and supporting research for this review can be found in Table 3 below.

Table 3

Chapter 3 Literature Review Topics and Supporting Research

Literature Review Topic	Supporting Research
Educational Theory and Mobile Learning Content	Authentic Context, Learner Control of Activity (Naismith, Lonsdale, Vavoula & Sharples, 2005)
	Learner Experiences and Applying to a Context (Comas-Quinn, Mardomingo & Valentine, 2009)
	Situated or Contextual Learning (Traxler, 2007)
	Situated Learning Rooted in Pragmatism (Lave, 1990)
	Situated Learning or Situated Cognition (Brown, Collins & Duguid, 1989; Korthagen, Kessels, Koster, Lagerwerf & Wubbels, 2001))
	Engage Learner with Authentic Tasks in Multiple Domains (Barab &

	Roth, 2006)
	Human and Contextual Factors (Valdez, McNabb, Foertsch, Anderson, Hawkes & Raack, 2000)
	Situated Learning is Unintentional, Based in Authentic Contexts, Activities and Culture (Lave, 1990)
Mobile Learning: Key Factors Affecting Usability	Equitable Use, Mobile Efficiency (Wagner, 2005)
	Flexible Use (Gu, Gu & Laffey, 2011; Dean, 2011)
	Simple and Intuitive (Hsu & Chen, 2010)
	Fixed Format of Design (Cassarino, 2003)
	Best Practices for Mobile Learning Efficient Content (Hazael-Massieux, 2013).
	Perceptible Information (Goh & Kinshuk, 2006)
	Richness, Speed (Wagner, 2005)
	Ease of Interactivitiy (Goh & Kinshuk, 2006)
	Technical Considerations for Communication and Support (Elias, 2011)
Mobile Learning and Communities of Practice (CoPs)	Link of Communities of Practice to Situated Learning (Lave & Wenger, 1991)
	Defining CoPs (Wenger, McDermott & Snyder, 2002)
	Heathcare Professional Education and CoPs (Boulos, Maramba & Wheeler, 2006)
	Functions of Virtual CoPs (Gannon-Leary & Fontainha, 2007)
	Virtual CoP Common Orientations (Wenger, White & Smith, 2009)
	Levels of Interaction within CoPs (Booth, 2011)
	CoPs for Collaboration and Problem-Solving (Johnson, 2001; Wick, 2000)

Literature Review Summary for Chapter 4: Mobile Learning Conceptual Frameworks

Keywords for the search included “mobile learning,” “mobile learning frameworks,” “mobile learning conceptual frameworks,” “online learning conceptual frameworks,” while searching the educational databases of ERIC, Canadian Research Index, ProQuest Dissertations and Theses, as well as a Google open search. Over 1900 hits were received with 295 being relevant to this study. In the end, 132 journal articles, conference proceedings, government documents, dissertations and reports were reviewed. Particular attention was paid to how the five dimensions of mobile learning identified in chapters 2 and 3 can comprise the foundation for a conceptual framework that facilitates practical, reliable and desired learning outcomes. A summary of the key themes and supporting research for this review can be found in Table 4 below.

Table 4

Chapter 4 Literature Review Topics and Supporting Research

Literature Review Topic	Supporting Research
Elements of Mobile Learning Conceptual Frameworks	Summary of Mobile Learning Conceptual Frameworks (Botha, Conje & Ford, 2007; Frohberg, 2006; Koole, 2009; Park, 2011)
	Comparing and Distinguishing Mobile Learning from Online Learning (Brown, 2005; Traxler, 2007)
	Mobile Learning and Spontaneous, Flexible Learning (Harris, 2001; Brown & Haag, 2011)
	Open and Distributed Learning (Khan, 2009; Calder & McCollum, 1998)
	Distributed Learning and Learner Control (Ellington, 1995)
	Enable Instruction and Activities (Franklin, 2011)
	Guided Participation (Evans & Johri, 2008)
	Push/Pull Activities and Mobile Learning (Elias, 2011)
	Inquiry-Based Learning (Shih, Chuang & Hwang, 2010)
	Mobile Learning Usability Best Practices (Hsu & Chen, 2010; Marcotte, 2010)
	Global E-Learning Framework and Mobile Learning (Khan, 2009)

Mobile Learning Experience Conceptual Framework

The conceptual framework designed in this study named the Mobile Learning Experience Framework drew upon the best practices of all the existing mobile learning frameworks identified in the literature review. A table summarizing the key themes from the literature review can be found in Appendix II. The Mobile Learning Experience Framework went beyond pulling the best practices of all existing frameworks by also adding two variables not yet seen in any of the currently available frameworks: incorporating informal mobile learning experiences within online learning environments, and utilizing mixed methods research to evaluate the practical learning outcomes of learners. This study focused on the creation of a framework because a framework is a system of rules, ideas or beliefs that is used to plan or decide something, or “a plane of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena” (Jarabeen, 2009, p. 51). Frameworks also exhibit a capacity for modification as well as place an emphasis on understanding instead of prediction, both of which can lead to a thorough comprehension of the topic being researched (Jarabeen, 2009).

A diagram of the Mobile Learning Experience Conceptual Framework can be found in Appendix III, and this demonstrates how this research was situated within the literature. The framework guided the design, implementation and evaluation of the mobile learning experiences and is based on the following five elements: Content, Delivery, Usability, Structure, and Communities of Practice and how these elements contribute to learning outcomes. The first four elements (usability is referred to as “service”) are key components of the Demand-Driven Learning Model (MacDonald, Stodel, Farres, Breithaupt & Gabriel, 2001), which was an early conceptual framework for online learning. The Demand-Driven Learning Model was later revised into the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009), which was designed to act as a quality standard to guide the design, delivery and evaluation of online healthcare education.

The theoretical foundation of this study was grounded in pragmatism, as it provided a practical, comprehensive lens for examining how both the contextual elements of situated learning and the collaborative elements of constructivism contribute to the learning outcomes of the mobile learning experience. To do this, participants were presented with practical, applicable information that worked within a specific learning context. The learning outcomes as examined by content, usability, structure, delivery and communities of practice were evaluated using both quantitative surveys and qualitative surveys and interviews that were adapted from the W(e)Learn framework (MacDonald, et al, 2009) companion evaluation tools, which were designed to implement and evaluate online learning for healthcare professionals (MacDonald, Archibald, Trumpower, Casimiro, Cragg & Jelley, 2010).

The content of the mobile learning experiences was based on situated and constructivist learning. Participants were physicians, nurses and allied healthcare professionals that were learning to use videoconferencing equipment for the facilitation of clinical consultations via videoconference. The content was pragmatic in that it was outcome-oriented, where participants were required to develop specific skills, understand processes and identify future steps and key takeaways. The specific content of the mobile learning experiences guided the participants through all of the technical and clinical process steps from when the patient arrives, through patient preparation, presentation, diagnosis, and follow-up scheduling.

Content. Content was served in a situated fashion, where mobile devices were utilized in a context-aware environment. According to the mobile hierarchy proposed by Gay et al. (2002), the learning continuum fell between content intensive and communication intensive. This is because the content was served on a mobile device (phone, tablet or laptop) in order to provide flexible physical access via interactive prompting and just-in-time instruction, and allowed the participants to capture and integrate data that they learned in the specific context and activity.

Delivery. According to Park's (2011) High Transactional Distance Individualized mLearning Model, the individual participants received the content and controlled their learning process in order to master it and the interactions mainly occurred between the individual participant and the content. Specific tasks to complete and skills to master were "pulled" by the participant via the mobile device. These included instructions on preparing the patient, preparing the room and videoconference equipment, presenting the patient, facilitating the consultation, and organizing follow-up activities. Questions during the learning activity allowed information to be "pushed" by the participants from the learning environment during the activities and later compiled into detailed summaries of the mobile learning experience. These questions focused on items required for the clinical consultation, the preparedness of the clinical space, and the successful operation of the videoconference equipment. The mobile learning experience compiled a summary of these questions so that the participants could identify gaps in their knowledge, technical skills and processes.

Communities of Practice. For the purpose of this study there were two distinct communities of practice, each with its own orientation and level of interaction. The first was the mobile learning experience discussion forum. It was designed with a blend of the open-ended conversation/project infrastructure orientation, where participants could have an ongoing discussion while working on a common problem: preparation for a clinical consultation via videoconference. This CoP (CoP1) adopted a many-to-many level of interaction, as peers were encouraged to share knowledge, difficulties, solutions and support. The second CoP in this study was reaction survey 2 (CoP2), where participants posted answers to a series of questions in a discussion forum in Moodle after they completed their first telemedicine appointment. This community adopted a project infrastructure/content collection orientation where participants could solve problems based on workplace best practices and collect useful resources and information on the subject of clinical videoconferencing. This community was designed with a shared development level of interaction in mind, where participants built knowledge together.

Usability. Technical usability was a key component of the conceptual framework, as the literature indicated that participants would abandon the activity if it is difficult to use. Participants provided answers to questions via short texts or check boxes in order to ensure mobile efficiency. Content was packaged into a short mobile learning experience of 20 minutes or less, with avatars and audio files providing the instruction in order to minimize bandwidth use and download times. Navigation involved three levels or less in order to minimize scrolling, and symbols were used for all menus and tabs. Usability of the mobile learning experience was designed to detect the type of device the participants were using (iPhone, Blackberry, Android, tablet, laptop), as well as the browser they were employing in order to ensure display consistency. Pages were designed to load and play quickly by minimizing file sizes, responses were short to ensure ease of interactivity, and participants were encouraged to text, email or audio record their observations in order to support their learning.

Structure. Finally, the informal learning tasks with the mobile devices were carefully structured within the formal learning environment of each online course. First, participants completed the “Pre” activities online, where they were given an introduction to the key technical and clinical points of presenting a patient via videoconference, as well as orientation as to how to use the mobile devices for the learning activity. The “Main” activity involved the mobile learning experience in a context-specific environment (the clinical videoconference studio), where participants utilized inquiry-based learning in order to acquire specific skills, respond to questions and identify future tasks for completion. The “Main” activity was designed to build (scaffold) upon the learning from the “Pre” activities and allowed the participants to take control of the learning activities in an authentic context. Finally, the participants returned to the online environment for the “Post” activities. In the “Post” activities the participants augmented their knowledge by being presented with other case studies and detailed information, accessed supplementary and optional material specific to their clinical area of practice, and completed final quizzes and reaction surveys. Thus the mobile learning experience comprised the meat of the online learning course, with the introductory “Pre” activities setting the stage for the authentic, context-based “Main” activity, followed by the cementing of the new knowledge in the “Post” activities.

Research Questions

The major question driving this research was:

How does the use of a curriculum framework to design mobile learning experiences impact the learning experiences and outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?

The sub-questions developed from the literature review were:

1. How does the content of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants’ learning experiences and outcomes?
2. How does the delivery of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants’ learning experiences and outcomes?
3. How does the usability of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants’ learning experiences and outcomes?
4. How does the structure embedding an informal mobile learning experience within the formal learning environment of an online course for healthcare professionals impact the effectiveness as measured by the participants’ learning experiences and outcomes?
5. How important are pedagogical design, content delivery, usability and structure to learners? Can this inform the development of a conceptual framework for the development of mobile learning activities?
6. What are the participants’ perceptions of community of practice during the mobile learning experience?
7. What are the participants’ perceptions of community of practice after the mobile learning experience?

Methodology

Research Approach

Understanding learning in a mobile environment is often difficult and dependent upon the context in which the mobile learning experience is located (situated or contextual learning), as well as the perspectives of the varied experiences of the individual learners (constructivist learning). This complex interaction of elements made this environment suitable for a pragmatic, mixed methods research approach, in particular because pragmatism has been identified as ideal for answering varied and complex research questions that may include a variety of pedagogical perspectives and learning theories. Johnson and Onwuegbuzie (2004) call upon research methodologists and empirical researchers to consider utilizing pragmatist philosophy in their work because it

> offers a practical and outcome-oriented method of inquiry that is based on action and leads; iteratively, to further action and the elimination of doubt; and it offers a method for selecting methodological mixes that can help researchers better answer many of their research questions (p. 17).

Creswell and Garrett (2008) agree that pragmatism allows the researcher to put the focus on the research question as well as the different methods that can be employed to answer the question. This is important because Tashakkori and Teddlie (2003) argue that the research question has become the critical link in practical, pragmatic research, even more important than the methodology or paradigm being employed. In order to evaluate the learning objectives and effectiveness of the conceptual framework for mobile learning experiences in this study, data collection must mirror the ideals of pragmatism. It should be both specific and generalizable, and present an accurate picture of the situation. In fact pragmatists advocate for the integration of quantitative and qualitative methods within a single study (Creswell, 1995). Pragmatic researchers should utilize the strengths of both techniques in order to better understand complex, social phenomena (Sieber, 1973).

Several researchers have suggested theoretical and practical means for combining pragmatism with mixed methods research. On the theoretical level, Morgan (2007) suggests a pragmatic alternative to the key issues in social science research methodology. It attempts to combine various qualitative and quantitative approaches and merge them into a pragmatic approach. With regards to the relationship to the research process, Morgan recognizes both the importance of subjective and objective inquiry, and advises an intersubjective response. This is the pragmatic response to the perceived notion of incommensurability of competing paradigms. "In a pragmatic approach, there is no problem with asserting that there is a single 'real world' and that all individuals have their own unique interpretation of that world. Rather than treating incommensurability as an all-or-nothing barrier between mutual understanding, pragmatists treat issues of intersubjectivity as a key element of social life" (p. 72). The fact that pragmatism is primarily concerned with accurately answering complex research questions makes it the perfect research paradigm for this study.

Finally, on the issue of inference from data, Morgan (2008) argues for a pragmatic approach of transferability. He believes knowledge is neither solely context-bound nor generalizable, but that researchers should focus on "…what people can do with the knowledge they produce" (p. 72). This view of intersubjective inquiry and transferability of knowledge provide a sound theoretical base for pragmatic mixed methods research, namely combining the best of both research methods in order to produce applicable and reliable knowledge that works in real-world environments. So constructivism and situated learning principles were employed to design the collaborative, practical, context-based content of the mobile learning simulations while pragmatism was used to design, evaluate and develop the conceptual framework.

Much like pragmatism, many of the strengths and benefits of mixed methods research centre on the enhanced results that the combination of techniques produces. It allows for a better understanding of a research problem by unifying trends within the quantitative data with specific, contextual details from the qualitative data (Hanson, Creswell, Plano Clark & Petska, 2005; Mertens, 2003; Punch, 1998). This comparison of the two forms of data means a more complementary and complete understanding of the research problem (Happ, Dabbs, Tate, Hricik & Erlen, 2006; Stange, Crabtree & Miller, 2006; Feilzer, 2010), allows for the contrasting of the different forms of data, and the researcher can often uncover a unique variance that would have been missed if only using one method (Jick, 1979; Williamson, 2005; Giddings & Grant, 2006). The qualitative data can be used to create theoretical models that can be tested by quantitative surveys, and conversely, instrument-based measurements can be tested and examined by field-based observations and information (Green & Caracelli, 1997; Giddings & Grant, 2006).

Researchers can also "…expand the breadth and range of the investigation by using different methods for different inquiry components" (Onwuegbuzie & Leech, 2006, p. 480). Finally, mixed methods research can provide stronger, more vigorous evidence for a conclusion through triangulation and corroboration of various forms of data (Johnson & Onwuegbuzie, 2004; Miller & Fredericks, 2006).

In order to answer the identified research questions and understand the various learning outcomes, this study used a convergent parallel mixed methods design. This allowed for the quantitative and qualitative results to be compared or related and a more complete interpretation and understanding of the results to be obtained (Creswell & Plano Clark, 2011). Qualitative data consisted of open-ended questions in the equipment course evaluation surveys as well as focus group interviews with participants. The quantitative data consisted of the course evaluation surveys and final quiz scores. The convergent parallel mixed methods design can be seen in Appendix IV, where data collection, analysis, results and interpretation are summarized.

It is important to note that the course evaluation surveys were based on the five factors identified in the conceptual framework for this paper: Content, Usability, Delivery, Structure, and Communities of Practice. Therefore one final quantitative analysis was performed during this study known as Principal Component Analysis to identify the strength of the questions in the conceptual framework. For example, were there alternative ways of organizing the questions in order to make the survey results more reliable and relevant? Perhaps the organization of the questions could be improved because they did not relate or load onto the themes or factors for which they were intended. The questions could then be rearranged into new categories that would more accurately reflect the learner's feedback and online educational experience.

Principal Component Analysis (PCA) was chosen as the statistical technique for this study because PCA is known as a method of data reduction that can describe the variability among observed elements with regards to a lower number of unobserved variables that are called factors (Tabachnick & Fidell, 2001). PCA is used to find optimal ways of combining variables into a small number of subsets or factors. In this sense, PCA can be used to determine if a survey question is actually positively related to the question a researcher wants to answer, thus allowing the researcher to re-word or reorganize the survey questions to make them more reliable and relevant. PCA achieves this by ranking the factors according to their contribution to the global variance (Ringer, 2008).

Participant Recruitment

Participants in this study were healthcare professionals (registered nurses, nurse practitioners, physicians, administrators) participating in the Ontario Telemedicine Network's Telemedicine Coordinator training program. The mobile learning experience was situated in 12 online Videoconference Equipment Training Courses, where participants were taught how to utilize videoconference equipment to facilitate clinical consultations. Each participant was asked to fill out an online demographic questionnaire prior to beginning the course. Participants also filled out a post-program survey upon completion of each course, and reaction survey 2 after their first clinical appointment. There were approximately 50 learners registered in each of the 12 courses. All 600 learners were approached to take part in this study. A total of 307 agreed to participate and subsequently completed both the demographic questionnaire and post-program survey. Twenty-five participants were interviewed regarding their experience in the online and mobile learning experiences. Each participant in the study was sent a letter of introduction (Appendix V).

Description of the Online Resources

The purpose of this online resource was to provide healthcare professionals with the technical skills, process knowledge and etiquette tips to facilitate effective telemedicine clinical consultations via videoconference. The online course was one hour in length, and engaged participants with a variety of activities including digital video segments, interactive PDFs, written content, and checklists. For the simulation portion of the online course, participants were provided with the mobile learning experience, which was approximately 20 minutes in length.

Three versions of the mobile learning experience were produced, and participants were randomly assigned to one of the three versions. Mobile Learning Experience Version 1 (121 participants) was created as guided by the Mobile Learning Experience Framework proposed in this study and included all of the identified best practices for designing mobile learning content, usability, structure and communities of practice. Mobile Learning Experience Version 2 (92 participants) controlled for content, usability, structure, and communities of practice but did not include any of the delivery features of the framework. Content was served as a screencast only with no “push and pull” interaction with the participants. Mobile Learning Experience Version 3 (94 participants) controlled for content, delivery, structure, and communities of practice but not include any of the usability factors in the framework. Usability did not include any mobile recommendations regarding screen resolution, navigation or richness. This isolation of delivery and usability allowed for a better understanding of their importance to the mobile learning experience as well as the creation of the Mobile Learning Experience Framework proposed in this study.

Participants were also provided access to a discussion forum (CoP1) to post questions, reflections and comments at any time during the mobile learning experience. This allowed participants to collaborate, share challenges and solutions as well as learn from each other, thereby reinforcing the constructivist principles of the situated learning environment. Participants were also asked to post to a discussion forum (reaction survey 2 or CoP2) after their first clinical telemedicine appointment and post a comment regarding the effectiveness of the mobile learning experience in preparing them for the appointment. Questions for reaction survey 2 can be found in Appendix XI. The online courses were created on the Moodle learning management system that is utilized by the Ontario Telemedicine Network (OTN) and situated on encrypted servers at the head office in Toronto, Ontario. Participants took the courses as part of OTN’s telemedicine certification program. There were 12 different versions of the course, as there are 12 types of videoconference equipment on OTN’s network. Participants were from healthcare organizations across Ontario that are members of OTN. An outline of the course can be found in Appendix VI.

Procedures

The convergent mixed methods design was used to examine the overall effect of the mobile learning conceptual framework on learning outcomes, as well as the effect of each of the five elements (content, delivery, usability, structure, communities of practice) on the learning experiences of study participants. This was done by triangulating the data (both quantitative and qualitative) from the 12 courses where participants took the mobile learning experiences. The convergent design afforded an excellent context for the triangulation of data, and therefore added to the validity of the results of this research. In addition, quantitative data from the mobile learning courses was used to perform a PCA to ensure the questions associated with each of the five factors of the conceptual framework were valid and applicable. There were three methods of data collection employed to address the research questions: two online surveys, the discussion forums (CoP1 and CoP2), and focus group interviews.

Data Collection

Data collection occurred over a three month period from December 1, 2013 to March 1, 2014. Quantitative and qualitative sources of data included the following:

Demographic Survey

The demographic survey was completed online prior to the commencement of the online course, and collected basic demographic data, the participants' online experience, their exposure to mobile learning, and their attitudes towards online learning. This gave an idea of the technical experience of the participants and allowed the researcher to identify if this experience had any influence on the learning outcomes achieved by the participants. A copy of the demographic survey can be found in Appendix VIII.

Discussion Forum

The discussion forum (also known as CoP1) addressed the identified importance of constructivist learning principles when designing mobile learning content. CoP1 was designed as an open-ended collaboration tool for participants. When participants accessed the forum, the following guiding question was posed: "Please list any questions or comments you may have about this equipment simulation and/or about this mobile learning activity." Specifically, the forum allowed participants to share information, post challenges and propose solutions to common problems. This provided participants with the opportunity to both build on their prior knowledge as well as provide a valuable resource of qualitative data as to the participants' experiences. The forum was accessed through a "Discussion" icon available on the mobile learning experience interface.

Post-Program Survey

The second survey was a post-program survey that employed a five point Likert scale and was completed online after the completion of each course (Appendix IX). The post-program survey is adapted from the W(e)Learn Post-Module Survey utilized by MacDonald et al. (2010). Questions were divided into five sections to provide a quantitative evaluation of the Content, Delivery (W(e)Learn calls this Media), Structure, Usability and Learning Outcomes of the mobile learning experience. The survey also included six open-ended questions on the participants' learning experience that produced qualitative data for analysis. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html.

Reaction Survey 2

Reaction Survey 2 (also known as CoP2) was a post to the discussion forum and was completed by the participants after their first clinical telemedicine appointment (Appendix XI). This provided valuable insight on how the participants built upon their prior knowledge and applied this new knowledge in the workplace. Reaction Survey 2 also provided qualitative data on the constructivist learning that comes from both the discussion forum and the mobile learning experience itself.

Focus Group Semi-Structured Interviews

Four focus groups with a total of fifteen participants from MLE1, one focus group with a total of five participants from MLE2 and one focus group with a total of five participants from MLE3 were interviewed within two weeks of completion of the online equipment course. The purpose of the interviews was to gain a greater insight into the personal learning experiences of the participants in each of the simulations. The interviews took approximately 30 minutes, and were guided by a set of interview questions that were open-ended and developed with the influence of questions in the Survey Instrument for the Communities of Inquiry Framework (Garrison, Anderson & Archer, 2000). The interviews were taped and subsequently coded with learners' permission (Crichton & Childs, 2005). The interview questions can be found in Appendix X.

Data Analysis

It is the goal of the mixed methods researcher to ensure that data analysis accurately corroborates the opinions and experiences of the participants in a study. Stainback and Stainback (1988) describe corroboration as important since it increases the probability that a study's findings will be thought of as important and credible by others. According to O'Donoghue and Punch (2003), an excellent method to determine corroboration is by utilizing triangulation analysis, which they define as a "…method of cross-checking data from multiple sources to search for regularities in the research data" (p.78). Triangulation of data sources can provide a more accurate and detailed picture of the situation that is being studied (Altrichter, Posch & Somekh, 1996). Denzin (1978) defines several types of triangulation, one of the most reliable of which is the convergence of multiple sources of data. This involves the collection and comparison of several forms of data at different times during the research process. The strength of convergent mixed methods research is that it provides the researcher with a greater number of methodological tools at their disposal. In particular, they can then employ these tools to answer a greater range and diversity of research questions (Greene, Caracelli & Graham, 1989), and follow emerging questions rather than limiting their research to questions that are amendable to a single method (Stange, Crabtree & Miller, 2006).

Data from the post-program survey, the discussion forum, reaction survey 2 and the focus group interviews were triangulated to increase the rigor of this study. SPSS Data Analysis was used to produce descriptive statistics from the quantitative reaction survey questions. In vivo coding along with inductive and deductive reasoning was used to produce a list of codes from the interview data. The descriptive statistics from the quantitative results and the list of codes from the qualitative results were both organized into key themes. These key themes were then triangulated to produce both combined and contradictory key themes that could be used for course revisions and publication. A visual diagram of this process can be found in Appendix IV. Any other emergent themes within and among the data were also coded. The writing adopted a narrative tone as this best captured the experiences of the participants, and direct quotations were included when relevant.

In addition, the quantitative statistics from the evaluation surveys from the mobile simulation courses was analyzed using Principal Component Analysis. This entailed taking a measure of sampling accuracy, performing a factor extraction, drawing a scree plot and utilizing a rotated component matrix. All of this determined how accurately the evaluation survey questions related to the five elements of content, delivery, usability, communities of practice and structure in the mobile learning conceptual framework. PCA assessed how reliable and relevant the survey questions were, and dictated what changes were required to increase the validity of the questions and framework.

Validity

The validity of this research was primarily supported by the triangulation of three different forms of data: the course evaluation surveys, two discussion forums and the focus group interviews. Patton (2002) states that triangulation strengthens research by combining different types of methods or data. The convergent mixed methods design allowed for the simultaneous comparison of both quantitative and qualitative data. As well as the triangulation of the data, any disconfirming information was included in the research report in order to confirm validity.

Ethical Considerations

Careful measures were taken to ensure that no participants were harmed as a result of this study. Confidentiality of participants was maintained at all times. The participants were volunteers so they were not, therefore, considered a population that is vulnerable or at risk because of the study. All the transcripts and recordings from the interviews are being kept on the researcher’s secured computer under password protection, and answers on the online surveys are kept on a secure server. Learners in OTN online courses who did not volunteer to become participants in this study were flagged in the learning management system and their data was not included in any of the research.

Study Limitations

The limitations can be divided into two main groups: the mechanical limitations (or processes of carrying out the research), and the methodological limitations (or difficulties with creating and justifying knowledge claims). Perhaps the biggest issue with the mechanical weaknesses in mixed methods research is the lack of practical techniques for combining qualitative and quantitative data (Happ et al., 2006). Although there have been some excellent guides developed recently, the establishment of mixed methods techniques and designs are clearly in their adolescence (Creswell & Plano Clark, 2011). “Researchers may not have sufficient skills and training in data collection, analysis and interpretation of diverse findings to use a multi-method approach” (Williamson, 2005). This limitation was mitigated by collaboration with professors on the thesis committee that are experts in both qualitative and quantitative data analysis. In addition the researcher took 2 courses on qualitative research and 2 courses on quantitative research as part of his PhD program of study.

A second limitation in this case was time. Designing and implementing data collection techniques and performing data analysis can be an extremely time-consuming process (Happ et al., 2006), particularly compared to a single-method study (Johnson & Onwuegbuzie, 2004). By using a convergent design and collecting both quantitative and qualitative data simultaneously, the data collection and analysis was streamlined as much as possible.

Theoretical and Practical Contributions

The goal of this study was to determine the relationship between the design factors of mobile learning experiences and the associated conceptual framework and the learning outcomes. This is an area of research that is desperately lacking in the literature (Cochrane, 2010; Elias, 2011).

Findings from this study provided information regarding the relationship (if any) between mobile learning experiences and learner outcomes. Moreover, the findings from this study provided information that led to the identification of best practices in the design of mobile learning for online resources. Therefore the results of this study contributed to both the theoretical knowledge and common practices of utilizing mobile learning and a mobile learning design framework in a way that enhances the interactivity of online educational environments and leads to positive learner outcomes.

Structure of the Dissertation

This first chapter is an introduction, and provides a literature review of the best practices for mobile learning, namely content, delivery, structure, usability and communities of practice. These best practices will be synthesized into a mobile learning experience conceptual framework that was utilized to design the mobile learning experience for participants in this study. The second chapter studies the impact of structure and delivery on mobile learning by examining, comparing and evaluating the learning experiences of participants in MLE1 and MLE2. The third chapter studies the impact of content design, usability and communities of practice on mobile learning by examining, comparing and evaluating the learning experiences of participants in MLE1 and MLE3. The fourth chapter focuses solely on the experiences of participants in MLE1 and evaluates and revises the mobile learning experience conceptual framework. The fifth chapter is a conclusion that summarizes the study findings and also compares participant experiences between MLE2 and MLE3. Overall, the goal is to further the research into identifying best practices for designing interactive, engaging mobile learning experiences that can provide practical, applicable simulations and problem-solving activities in real-world contexts. Each chapter is presented along with a brief description, the purpose of the chapter with regards to the entire research study, and the research questions that each chapter addresses. A summary of the chapters is presented in Table 5.

Table 5

Chapter, Description, Purpose, and Research Objectives

Chapter	Description	Purpose	Research Questions
Introduction	Provides an introduction and detailed overview of the dissertation including a review of key concepts, literature review, presentation of the conceptual framework and an outline of study methods.	Present an overview of the study and a description of how the chapters integrate all components of the research study.	
Chapter 2 Article 1: Structure and Delivery for Mobile Learning Experiences	Utilizing a mixed methods study design (convergent parallel), participants' experiences in MLE1 and MLE2 are compared and	Identify, implement and evaluate the effectiveness of best practices from the mobile learning literature for the structure and delivery	1. How does the structure of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences

	contrasted to provide a description of their learning experiences and outcomes.	of mobile learning.	and outcomes? 2. How does the delivery of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes?
Chapter 3 Article 2: Content, Usability and Community of Practice Considerations	Utilizing a mixed methods study design (convergent parallel), participants' experiences in MLE1 and MLE3 are compared and contrasted to provide a description of their learning experiences and outcomes.	Identify, implement and evaluate the effectiveness of best practices from the mobile learning literature for the content and usability of mobile learning. The use and impact of two communities of practice will also be examined and evaluated.	3. How does the content of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes? 4. How does the usability of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes? 5. What are the participants' perceptions, interactions and usage of a community of practice during the mobile learning experience? 6. What are the participants' perceptions, interactions and usage of community of practice after the mobile learning experience?
Chapter 4 Article 3: Toward a Conceptual Framework to Guide the Design, Delivery and Evaluation of	Utilizing a detailed literature review in combination with a mixed methods study design (convergent parallel), participants'	Design, implement and evaluate a mobile learning experience conceptual framework based on identified best practices from the	7. How does the use of a curriculum framework to design mobile learning experiences impacts the learning experiences and outcomes of healthcare

Quality Mobile Learning Experiences	experiences in MLE1 were utilized to design, implement, and evaluate a conceptual framework for mobile learning experiences. A factor analysis was also performed to determine the validity and accuracy of the conceptual framework's evaluation instruments.	mobile learning literature. Present a revised conceptual framework based on study findings.	professionals with regards to developing workplace skills and understanding clinical processes? 8. How important are content design, content delivery, usability, communities of practice and structure to participants? How can feedback from the experiences and learning outcomes of participants be used to evaluate and revise the mobile learning experience conceptual framework?
Chapter 5 Integration of Results and Discussion	Presents the collective findings and discusses the broader implications of the dissertation for practice and future research. The strengths and limitations of this dissertation are also presented.	Synthesizes findings from the study including those that support, refute or present new findings for the mobile learning literature.	

Conclusion

This dissertation explores the design, implementation and evaluation of a conceptual framework for mobile learning experiences through the learning experiences and outcomes of healthcare professionals. It adds to the developing research on mobile learning, particularly with regards to implementing a hybrid formal/informal combination of online and mobile learning, and its creation of a conceptual framework to both design and evaluate mobile learning experiences.

As will be outlined in the subsequent chapters, this research suggests that mobile learning experiences can produce positive learning outcomes for healthcare professionals, including participation in contextual learning, timely access to content, opportunities for communication and collaboration, the development of technical skills, and adoption of new learned behaviors. Ultimately, it will be demonstrated that mobile learning experiences show great potential as satisfying and effective educational environments for healthcare professionals.

Contributions to the Field of Education

Through examining the learning experiences and outcomes of healthcare professionals as they participate in a situated, contextual mobile learning experience, this study provides several contributions to the field of education. To begin, several findings supported themes identified in the literature for effective, interactive mobile learning design. The study found that the “pull” and “push” activities advocated by Elias (2011) are key for mobile learning delivery, that the pre, main and post activities recommended by Bo-Kristensen et al. (2009) are an ideal structural format for a mobile/online hybrid course, and that asynchronous communities of practice (Wenger et al., 2009) were well-suited for content collection and collaboration after a mobile learning activity.

The principles of self-directed, lifelong learning proposed by Candy (1991) and supported by Knowles (1989) were also found to be supported by the mobile learning experience. Participants felt that they had control of the mobile learning experience, and that it was flexible to use and provided interactivity. This led them to view it as productive and produced positive learning outcomes including high participant satisfaction and the development of new skills.

This study showed that effective mobile learning design can lead to behavioral change in the health care workplace. The findings demonstrated that participants adopt new behaviors when case-based storytelling aligns with real-world experiences (Bubenzer, 2011), when participants capture and integrate information from the field, receive social support, and blend “heads down” or guided use of the mobile device with experiences in a specific context (Cahill et al., 2011).

Finally, the mobile learning conceptual framework and evaluation tools designed by the literature review were evaluated and revised based on the learning experiences of participants.

The result is a reliable conceptual framework for mobile learning design and evaluation that is based on best practices in the educational literature, and that can be applied to real-world teaching strategies to produce positive learning experiences and practical learning outcomes.

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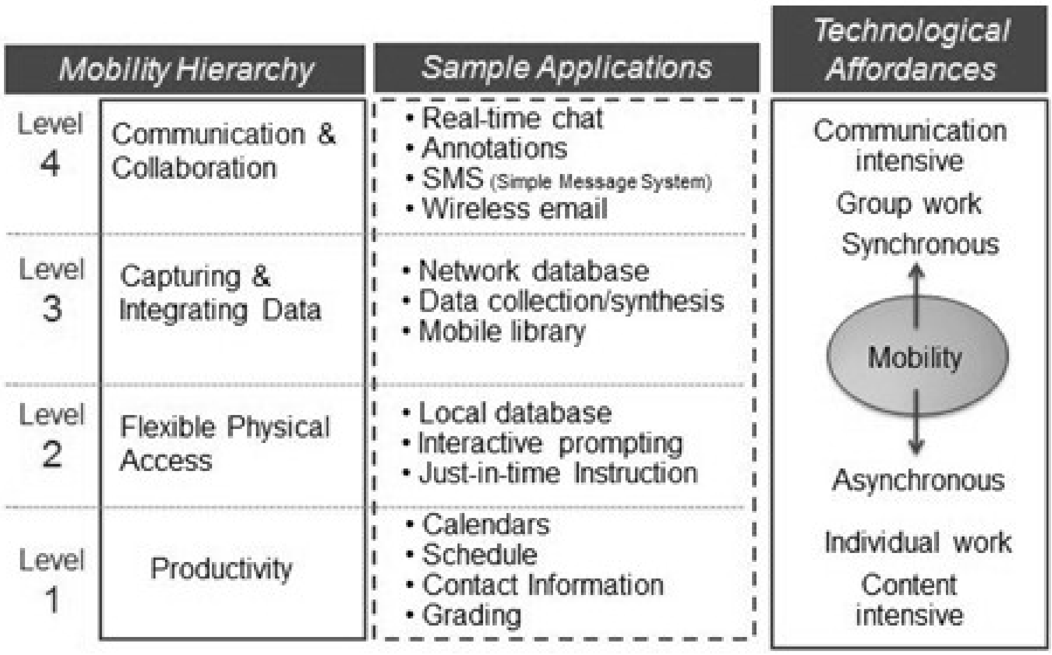
Appendix I: Mobile Hierarchy, Sample Applications and Technical Affordances



Taken from: (Gay, Rieger & Bennington, 2002)

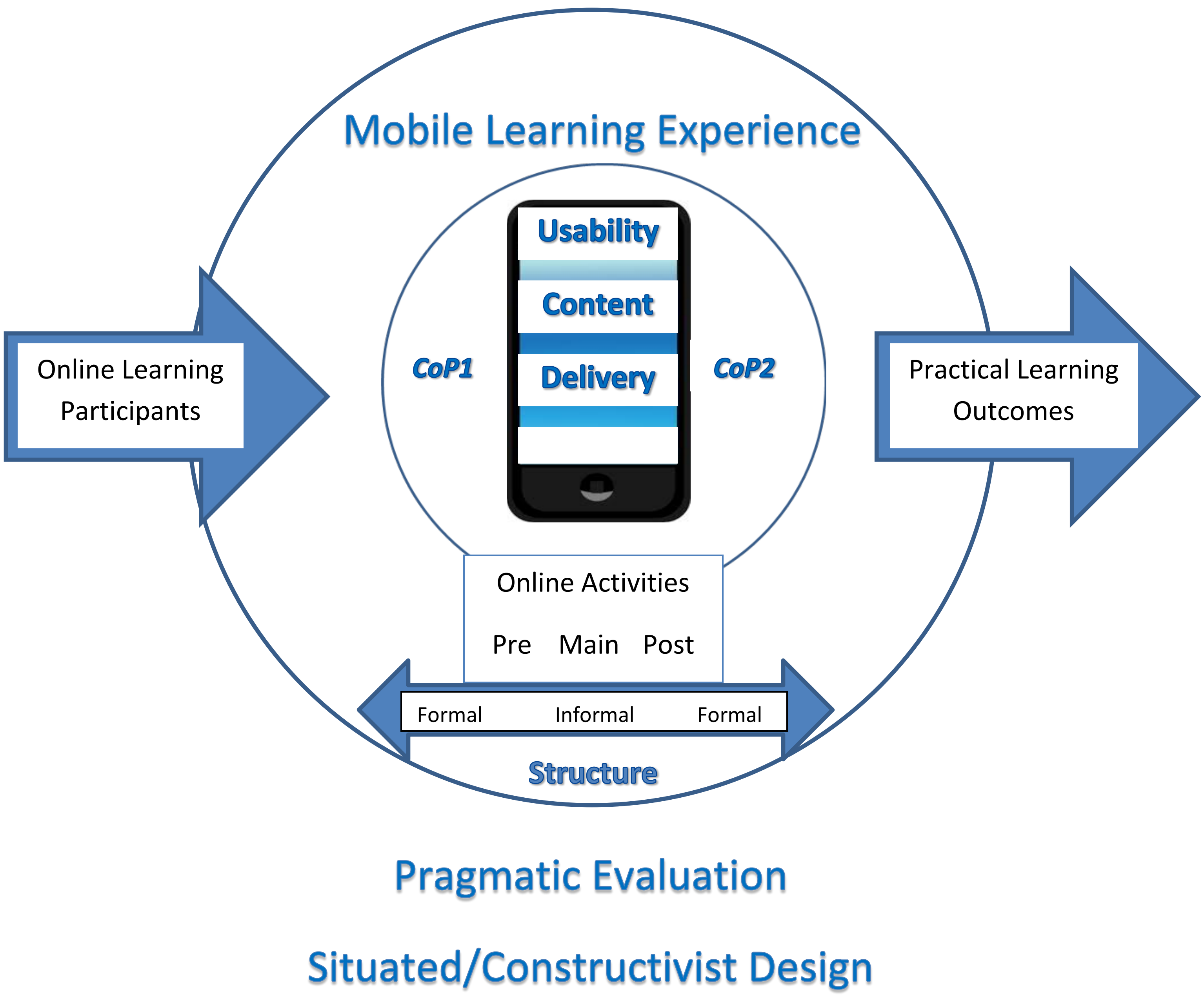
Appendix II: Literature Review Key Topics and Supporting Research

Literature Review Topic	Supporting Research
Educational Theory and Mobile Learning Content	Authentic Context, Learner Control of Activity (Naismith, Lonsdale, Vavoula & Sharples, 2005)
	Situated or Contextual Learning (Traxler, 2007)
	Situated Learning Rooted in Pragmatism (Lave, 1990)
	Engage Learner with Authentic Tasks in Multiple Domains (Barab & Roth, 2006)
	Human and Contextual Factors (Valdez, McNabb, Foertsch, Anderson, Hawkes, & Raack, 2000)
	Situated Learning is Unintentional, Based in Authentic Contexts, Activities and Culture (Lave, 1990)
Transactional Distance Theory and Mobile Learning Delivery	Benefits of Technology for Everyday, Situated Learning Contexts (Gu, Gu & Laffey, 2011)
	Context-Aware Computing (Moran & Dourish, 2001)
	Mobile Hierarchy of Productivity, Flexible Access, Capturing Data, Communication (Gay, Rieger & Bennington, 2002)
	High Transactional Distance Individualized mLearning (Park, 2011)
	Push and Pull Delivery (Elias, 2011)
Mobile Learning: Key Factors Affecting Usability	Equitable Use, Mobile Efficiency (Wagner, 2005)
	Flexible Use (Gu et al., 2011)
	Simple and Intuitive (Hsu & Chen, 2010)
	Perceptible Information (Goh & Kinshuk, 2006)
	Richness, Speed (Wagner, 2005)
	Ease of Interactivitiy (Goh & Kinshuk, 2006)
	Technical Considerations for Communication and Support (Elias, 2011)
Structure of Informal Mobile Learning in Formal Learning Environments	Contextual, Real-World Knowledge Acquired Informally in the Field (Comas-Quinn et al., 2009)
	Inquiry-Based Learning Allows Learners to Access Authentic Problems and Solutions (Shih, Chuang & Hwang, 2010)
	Inquiry-Based Learning Best When Guided by

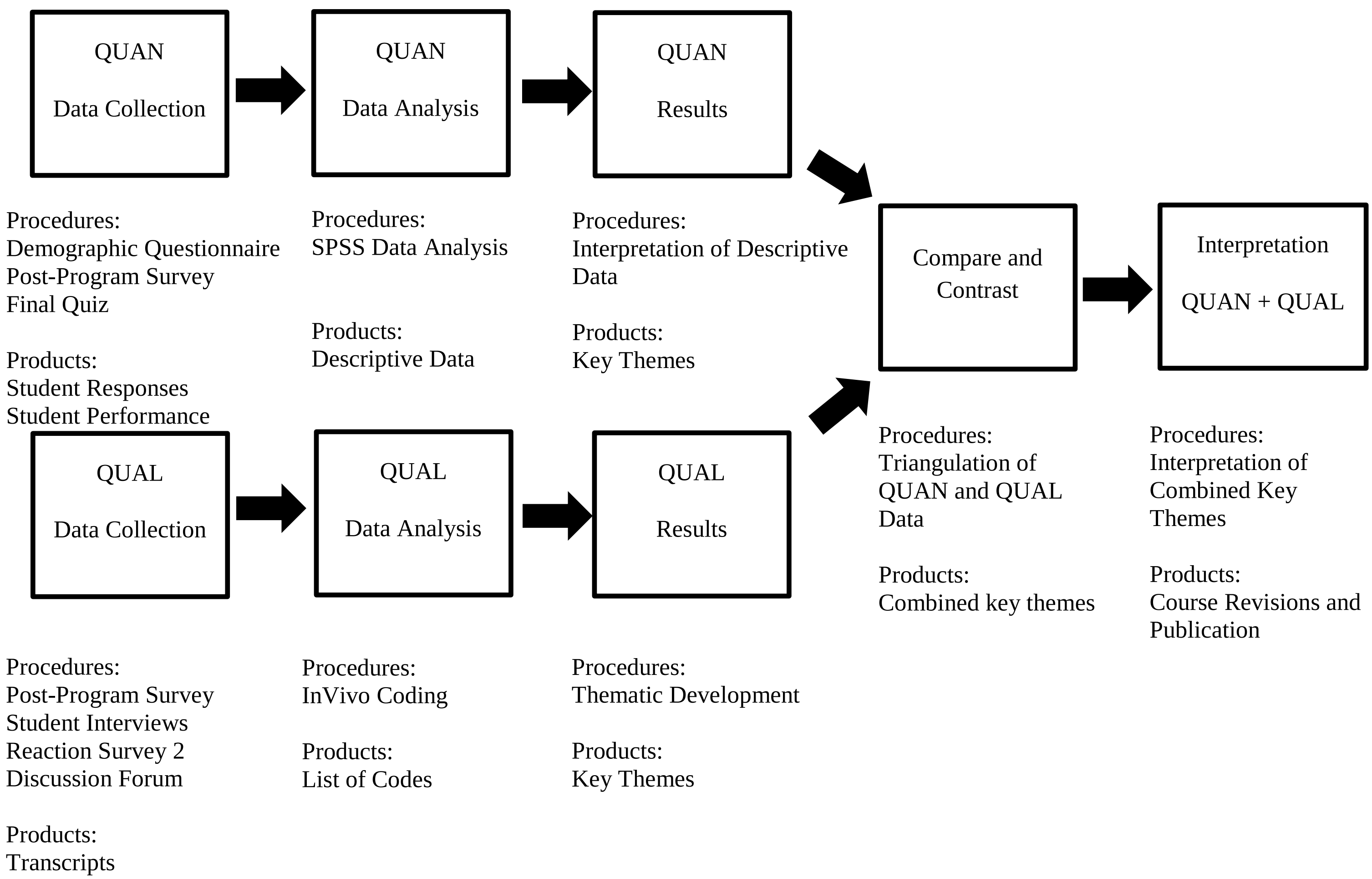
	Instructor and Hands-On Activities (Colburn, 2000)
	Guided Participation (Evans & Johri, 2008)
	Link Informal with Formal Learning through Pre, Main and Post Activities (Bo-Kristensen et al., 2009)
	Pre-Activities Provide Cognitive Base and Orientation (Hsu & Chen, 2010)
	Main Activities is Mobile and Inquiry-Based (Hsu & Chen, 2010)
	Post Activities and Cognitive Ownership (Richards & Rogers, 2001)
	Task Model: Control, Context, Communication, Subject, Tool, Objective (Frohberg, Goth & Schwabe, 2009)

Appendix III: Mobile Learning Experience Conceptual Framework

Elements adapted from the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009)



Appendix IV: Convergent Parallel Mixed Methods Design



Adapted from: (Fuji, Paschal, Galt & Abbott, 2010, p. 243)

Appendix V: Introductory Letter

Université d'Ottawa · University of Ottawa

Faculté d'éducation Faculty of Education

Hugh Kellam
PhD candidate
Faculty of Education
University of Ottawa

December 2013

Dear Physicians, Nurses and Allied Healthcare Professionals Utilizing Videoconferencing Services of the Ontario Telemedicine Network,

Re: OTN EQUIPMENT TRAINING MOBILE LEARNING RESOURCE

Please find below some information regarding the OTN equipment training mobile learning resource, and a description of how it pertains to my research.

Introduction

The mobile learning experiences include in this online learning resource will provide you an opportunity:

- to undertake a learning simulation in your telemedicine studio that will walk you through the technical processes during a clinical videoconference;
- to undertake a learning simulation that will present best practices for presenting patients via videoconference;
- to compile a list of technical and clinical gaps that may exist at your site; and
- to collaborate and learn from other healthcare professionals as they participate in the same simulation.

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Université d'Ottawa · University of Ottawa
Faculté d'éducation Faculty of Education

Access

The resource can be accessed on OTN's eTraining Centre. Participants will be emailed details of its precise location.

An Invitation to Participate in a Research Project

As a PhD candidate at the University of Ottawa, I am conducting research to develop an understanding of how the design and implementation of mobile learning experiences affect learning outcomes in an online educational resource. My project is entitled "A Conceptual Framework for Mobile Learning Experiences: Marrying Informal Flexibility with Formal Stability". Results of this study will contribute to both the theoretical knowledge and common practices of creating and utilizing mobile learning experiences in a way that enhances the interactivity of online educational environments.

Participation in this research project is voluntary. If you agree to participate, you will be asked to sign two copies of the consent form. One is for you and the other is to be mailed to me in the self-addressed, stamped envelope provided.

At no time during this study (during interviews, course surveys or discussion forums) should a participant divulge or use any patient names or patient health information.

By participating in this study, you will be invited to:

- complete two short surveys (1 before using the resource, 1 after);
- possibly participate in a 30 minute individual face-to-face interview (approx. 2 weeks after completing the resource);
- give consent for the researcher to read and use the transcripts from the online resource logbooks and individual interviews for research purposes.

If you have any questions about this process or the online resource, please do not hesitate to contact me at hkell094@uottawa.ca

Your time and consideration is very much appreciated.

Sincerely,
Hugh Kellam
PhD candidate
Faculty of Education
University of Ottawa

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Appendix VII: Equipment Training Course Outline

Note: Outline will be the same for all 12 equipment courses.

Appendix VI: Videoconference Equipment Course Outline

“Pre” Activities

Course Overview (Screencast with Avatar)

Unit 1: Introduction to the Equipment

a) Equipment Terms and Concepts (Screencast with Avatar)
b) Equipment Operation (Screencast)

Unit 2: Introduction to the Remote Control

c) Features of the Remote Control (Screencast with Avatar)
d) Functions of the Remote Control (Screencast with Avatar)

“Main” Activities

Unit 3: Simulation

a) Choice of Mobile Learning Experience or Live Simulation
b) Mobile Learning Orientation
c) Live Simulation or Mobile Learning Experience

“Post” Activities

Unit 4: Videoconference Etiquette and Privacy

d) Videoconference Etiquette (Video)
e) Privacy and Videoconferences (Slide Show)
f) Troubleshooting Tips and Tricks (Screencast with Avatar)

Unit 5: Supplemental Material (Optional Based on Equipment at Member Site)

c) Hooking up a Laptop Computer (Video)
d) Manual Dialing Using the Global Address Book (Video)
e) Equipment Video Demonstrations (Video)

Unit 6: Assessment

d) Final Quiz
e) Course and Mobile Experience Reaction Survey

Appendix VII: Data Sources, Collection and Timeline for Research Questions

Major Research Question	Data Collection	Timeline
How does the use of a curriculum framework to design mobile learning experiences impact the learning outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?	Demographic Questionnaire	Prior to course
	Course Evaluation Survey	Upon course completion
	Semi-Structured Interviews/Discussion Forum	Within 2 weeks of module completion
	Reaction Survey 2	After the learner's first clinical telemedicine appointment
Sub-Questions	**Data Collection**	**Timeline**
1. How does the content of a mobile learning experience for healthcare professionals impact the effectiveness as measured by the learning outcomes? 2. How does the delivery of a mobile learning experience for healthcare professionals impact the effectiveness as measured by the learning outcomes? 3. How does the usability of a mobile learning experience for healthcare professionals impact the effectiveness as measured by the learning outcomes? 4. How does the structure of a mobile learning experience for healthcare professionals impact the effectiveness as measured by the learning outcomes?	Course Evaluation Survey	Upon course completion
	Semi-Structured Interviews/Discussion Forum	Within 2 weeks of module completion
5. How important are pedagogical design, content delivery, usability and structure to learners? Can this inform the development of a conceptual framework for the development of mobile learning activities?	Course Evaluation Survey	Upon course completion
	Semi-Structured Interviews	Within 2 weeks of module completion
6. What are the participants' perceptions of community of practice during the mobile learning experience? 7. What are the participants' perceptions of community of practice after the mobile learning experience?	Course Evaluation Survey	Upon course completion
	Semi-Structured Interviews	Within 2 weeks of module completion
	Reaction Survey 2	After the learner's first clinical telemedicine appointment

Appendix VIII: Demographic Questionnaire

Please complete the following questions. All responses will be kept confidential.

1. Gender: Female _____ Male_____
2. Please indicate your profession: ___________
3. Please indicate your age:_________

4. How often do you use mobile devices (phones or tablets) to find information for personal interest and/or essential needs? Examples could be Internet browsing, playing online games, shopping, finding medical information, finding help with hobbies etc. Please circle the most correct response.

   1= none
   2= not often
   3=sometimes
   4=often
   5=always

5. a. Is this the first mobile learning experience or course you have taken? (yes / no)

   b. If you answered no, how many mobile learning courses have you taken? _______

5. What types of online experiences have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

participated in threaded discussions	1	2	3	4	5
real-time chat	1	2	3	4	5
listened to podcasts	1	2	3	4	5
co-created wikis	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
simulations	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

6. What types of experiences with mobile devices (phones or tablets) have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

texting	1	2	3	4	5
facebook posts	1	2	3	4	5
accessing email	1	2	3	4	5

accessing web pages	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
sharing audio/video files	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

7. Would you consider your online learning experiences positive?

1 = strongly disagree

2 = disagree

3 = neutral

4 = agree

5 = strongly agree

8. Rate your exposure to online learning on a scale of 1-4. Please circle the most correct answer.

    1= I have never used online learning before
    2= Once before
    3=Several times before
    4=Often

9. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?

1 = strongly disagree

2 = disagree

3 = neutral

4 = agree

5 = strongly agree

(Adapted from Archibald, D. 2008)

Appendix IX: Post-Program Mobile Learning Experience Survey

For the following questions, the available response options are: Strongly disagree, Disagree, Agree, Strongly agree, Not applicable

Content

The content is of appropriate depth and breadth
The content is well organized
The content is context-specific
The content effectively presents technical skills that I can apply in my workplace
The content effectively presents clinical skills that I can apply in my workplace
The content effectively guides me through the activities
The content is applicable for my professional life
The content is authentic

Usability

In this program it was easy to "navigate" through the content.
The instruction is divided into clear and logical sections
Uploading and downloading material was fast and efficient
Presentation of material utilizes aesthetically pleasing graphics
Content was displayed in a consistent fashion on my mobile device
Pages loaded quickly
Interactivity was efficient when posting to and accessing the discussion wall
The mobile learning experience was interactive and productive due to its usability

Delivery

The resource respects my experience and current knowledge
The delivery allowed me to control my learning environment
There is flexible access to support tools, information, help, and online communication
The delivery of the information promotes a flexible learning environment
The delivery allowed me to capture and integrate information
The resource promotes communication among learners
The resource promotes collaboration among learners

Structure

The introductory online learning modules prepared me for the mobile learning experience
The mobile learning experience kept my interest
The mobile learning experience motivated me to learn
The mobile learning experience engaged me in the learning experience
The material follows a logical progression
The mobile learning experience provides opportunities for problem-solving experiences
The mobile learning experience provides opportunities to apply material learned

The online modules supported the mobile learning experience after it was completed
I enjoyed the combination of online learning with the mobile learning experience

Outcomes

The online/mobile course is interesting
The online/mobile course is valuable
As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine
As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques
As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context
The mobile learning experience allowed me to learn information that I could not have accessed through an online course
The mobile learning experience made the learning environment more motivating and engaging

Please complete the following statements:

1. The most valuable aspect of the mobile learning experience was….

2. The design or delivery of the mobile learning experience could be improved by…

3. What, if anything, did you learn in the mobile learning experience that you will apply in your professional life?

4. What value (if any) did the discussion wall add to the learning resource?

5. How did you access the mobile learning experience?
    a. From my mobile phone
    b. From my tablet
    c. From my personal computer

6. How could or should a mobile learning experience be used in an online learning resource (such as this)?

(Adapted from MacDonald, C. J., Stodel, E. J., Thompson, T-L., & Casimiro, L. (2009)

Appendix X: Semi-Structured Interview Guide

For learners to read before the interview:

Thank you for agreeing to participate in this interview. The purpose of the interview is to obtain a deeper insight into the data collected from the online survey you completed after completing the online equipment training course. Specifically, these questions will be about the mobile learning experience portion of the course.

We are going to be audio-taped so that I can refer back to this discussion when I write my final report. During this discussion and when I write the report we will be using pseudonyms to protect your identity. No one else but my supervisor and I will listen to the audio recording. Please speak in a loud clear voice so the recorder picks-up what you say.

Sample Questions:

1. Was this an authentic learning resource?
2. Did the content of the mobile learning experience teach you new processes or skills? If so, what are they?
3. Was the mobile learning experience easy do use? What did you think about the navigation and layout?
4. Do you think the mobile learning experience contributed to the online course? If so, how?
5. Did you find the feedback list helpful that you received after the mobile learning experience? How? Explain?
6. Did the discussion forum in the mobile learning experience contribute to your learning? How? Explain?
7. Explain how you would compare this mobile learning experience to the conventional classroom?
8. Will the mobile learning experience help you apply the knowledge created in this course to your work related activities?
9. What, if anything, was missing from this mobile learning experience? Please give examples.

Appendix XI: Reaction Survey 2: After Your First Telemedicine Appointment

Congratulations on the completion of your first telemedicine appointment. Please answer the following 2 questions relating to how the mobile learning experience prepared you for the telemedicine appointment.

1. Did you find that the mobile learning experience taught you knowledge and skills that you were able to apply in your first telemedicine appointment?

2. What were the most valuable knowledge and/or skills that you learned in the mobile learning experience?

3. Were there any knowledge or skill gaps that you didn't learn in the mobile learning experience that you required in the telemedicine appointment?

4. Do you find value in posting to this forum?

5. Do you find value in reading the posts of other learners in this forum?

Chapter 2: Article 1

Structure and Delivery for Mobile Learning Experiences:

Marrying Informal Flexibility with Formal Stability

Article for Submission to:

International Journal of Mobile Learning and Organization

Candidate: Hugh Kellam

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February 20, 2015

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Introduction

Mobile learning has been defined as wireless devices and technologies that are used by a learner as they participate in an educational experience (Traxler, 2007). Mobile learning is mediated through devices such as laptops, netbooks, tablets and cell phones (Peters, 2007). Many researchers have focused on the mobile nature and technical usability of these technologies, but it is equally important to consider the learning contexts, activities and opportunities that mobile devices afford the learner (El-Hussein & Cronje, 2010). Mobile devices provide unique design requirements that need innovative, customized approaches in design and delivery in order to create structured learning material (Haag, 2011). According to Berking, Haag, Archibald and Birtwhistle (2012):

> Mobile Learning represents an emergent way of thinking that implies a paradigm shift, and at the very least requires new design strategies based on sound concepts, considerations, decisions, and guidelines are driven by the particular design strategy used in the mobile learning experience and its underlying learning theory, not simply by the features of the mobile device. (p. 1)

For many researchers, it is the structure and delivery of mobile learning that are identified as the critical components of effective pedagogical design. “Mobile learning design is the design of a mobile learning course taking into account what needs to be delivered, how it will be done and the structure of such a delivery” (Stanton & Ophoff, 2013, p. 502). Mobile learning can be structured to bridge the informal and formal learning environments of contextual learning and the traditional classroom as long as educators keep in mind the learners’ needs, circumstances and abilities when structuring and delivering the mobile learning material (Kukulska-Hulme, 2010). Some researchers emphasize the importance of not getting caught up in the technological challenges and capabilities of mobile learning, but rather to examine contextual factors when designing the structure of the learning content. According to Pachler, Bachmair and Cook (2010), mobile learning:

> …is about the processes of coming to know and being able to operate successfully in, and across, new and ever changing contexts and learning spaces. And it is about our understanding and knowing how to utilize our everyday life-worlds as

> learning spaces. Therefore, in case it needs to be stated explicitly, for us mobile learning is not primarily about technology. (p. 6)

In addition to structure, delivery factors such as learner activity, feedback, scenario-based activities and sequential context are also vital for effective mobile learning (Brown & Voltz, 2005). While there are already an abundant variety of educational applications and resources available for mobile learning, there is less experience in how to effectively deliver these mobile activities (Cheon, Lee, Crooks, & Song, 2012). Bray, Epstein, Hill and Thomas (2006) describe learning via the web to be the overlapping of two spheres of existence: physical and digital. With regards to mobile learning, further investigation into these two spheres is required, "…but what can be controlled is what and how we deliver learning into these two spheres to influence the user's interaction within these overlapping spheres" (Stanton & Ophoff, 2013, p. 507).

The purpose of this paper is to identify, implement and evaluate the effectiveness of best practices from the mobile learning literature for the structure and delivery of mobile learning experiences. A "mobile learning experience" refers to an informal learning activity that the participants perform on their mobile device (laptop, tablet or phone), in a specific physical context or location. The structure of this informal learning experience was deployed as an interactive mobile activity within the format of a formal online learning course. Participants received introductory information in the online course, were prompted to perform the mobile learning experience in the field, and then returned to the online course for follow-up activities. In addition, two versions of the mobile learning experience were randomly assigned to participants. Both versions had the identical hybrid of informal mobile and formal online structure, but one had its methods of delivery informed by best practices from the mobile learning literature, while the second did not. This isolation of the delivery method provided a more focused examination of how important the factor of delivery was to the learning experiences and outcomes of participants. The mobile learning experiences were deployed in the Ontario Telemedicine Network's online videoconference equipment training course which was accessed by physicians, nurses and healthcare professionals at medical organizations across Ontario.

Literature Review

The Informal Structure of Mobile Learning

Informal learning environments have the potential to support formal learning environments such as classrooms and lecture halls since much of the real-world, contextual knowledge that individuals acquire about their jobs, social groups or learning environments are acquired informally in the field through interaction, observation and trial-and-error (Comas-Quinn, Mardomingo & Valentine, 2009). There are differing definitions for formal and informal learning in the workplace, with Livingstone (2001) drawing a clear line between organized, formal activities with well-defined learning objectives and informal, unintentional and fluid informal learning activities. Billet (2001) even suggests that there is no such thing as informal learning as he sees learning as ubiquitous in human activity and that it takes place predominantly outside of formal educational environments. The online portion of the course was considered formal as it had the five features of formal learning as defined by Eraut (2000): a prescribed learning framework, an organized learning package, the presence of a designated teacher, the award of a qualification, and specific learning objectives/outcomes. The learning in the mobile learning experience in this study was closely aligned to the definition of informal learning of Beckett and Hagar (2002) in that it was contextual, activity and inquiry-based, and activated by individual learners.

"Inquiry-based learning is a concept which encourages teachers to allow learners to get in touch with authentic situations, and to explore and solve problems that are analogs to real life" (Shih, Chuang & Hwang, 2010, p. 51). Despite its perception as "open learning," however, inquiry-based learning is most effective when guidance is provided by the facilitator (Kirschner, Sweller & Clark, 2006), preferably in the form of open-ended questions and learner-centred, hands-on activities (Colburn, 2000). Evans and Johri (2008) recommend what they call "guided participation" for inquiry-based mobile learning environments. This involves such principles as setting rules, providing spontaneous and formative feedback, team-based learning, mentorship roles as well as informal interactions. The environment is open for exploration but has a designed pedagogical framework with planning, monitoring and evaluation during learning. "A support tool incorporating goal-lists, hints, prompts, cues and templates is needed to support the cognitive regulation skills of students during a fluid dynamic task" (Shih et al., 2010, p. 51).

In this study, the formal learning environment of the online classroom was supported by the inquiry-based, guided participation activities of the mobile learning experience. Bo-Kristensen et al. (2009) advise forming links between formal and informal learning environments by creating three types of activities: pre-activities, main activities and post-activities. "Pre-activities" can take place in the classroom or online learning environment prior to the mobile learning experience. These activities provide the cognitive base for the informal learning activity by allowing learners to identify what they already know, orienting them to the mobile technology, formulating key fieldwork questions, and constructing basic skills and knowledge (Hsu & Chen, 2010). Activities or teaching strategies include readings, case studies, teacher lecture and even pre-learning questionnaires and assessments to identify the knowledge level prior to the activity (Shih et al., 2010). The "main" activity involves the mobile field inquiry, and is where new knowledge is presented in an inquiry-based activity. Examples include field observations, guided questions, collection of data, interviews with local people, and digital and in-person collaboration with colleagues (Hsu & Chen, 2010). Finally, the new knowledge should be brought back to the formal learning environment, where "post" activities ensure that the new knowledge is stored in the learner's long-term memory and apply the acquired information in a new situation. This results in cognitive "ownership" of the new information (Richards & Rogers, 2001). Activities here can include reports, presentations, online portfolios, questionnaires, tests and group projects (Bo-Kristensen et al., 2009). In this study, this three step approach was employed for the overall structure of the course, so that the formal online learning environment set the groundwork and then cemented the learning for the inquiry-based mobile learning experience, which followed the pedagogical principle of guided participation.

The Demands of Delivery

Gay, Rieger and Bennington (2002) developed a conceptual framework for mobile learning that was based on a mobile hierarchy of four levels of objectives: productivity, flexible physical access, capturing and integrating data, and communication and collaboration (Appendix I). It demonstrated how content can be delivered along a spectrum that ranges from asynchronous and content intensive to synchronous and communication intensive. Park (2011) contends that mobile learning should provide opportunities across this spectrum since students can consume and create information both "…collectively and individually" (Koole, 2009, p. 26). Students should therefore have a variety of tools and tasks delivered to them during a mobile learning experience in order to take advantage of this flexibility of interaction between the content and the learner.

This continuum between individual and socialized learning is a cornerstone of transactional distance theory, which is an educational theory that recognizes that distance is not only a geographical concept but a pedagogical one as well (Saba, 2005; Moore, 1997). Transactional distance theory will help frame the type of distance learning that will be occurring in this study, where the mobile learning experience would be considered to be a Type 2: High Transactional Distance and Individualized Mobile Learning Activity (Park, 2011). As demonstrated in the pedagogical framework in Appendix II:

> Mobile learning activities are classified as type 2 when 1) the individual learners have more psychological and communication space with the instructor or instructional support; 2) the individual learners receive tightly structured and well organized content and resources (e.g., recorded lectures, readings) through mobile devices; 3) the individual learners receive the content and control their learning process in order to master it; and 4) the interactions mainly occur between the individual learner and the content. (Park, 2011, p. 26)

Since there is more psychological and communication space with the instructor or instructional support, creative ways to incorporate teachers and mentors are required for mobile learning activities. Research has shown that avatars, or on-screen characters who guide the learning processes during online instruction, can engage learners to connect and interact with learning content (Clark & Mayer, 2008). Avatars can be effective in a variety of pedagogical roles, including being engaging teachers, mentors, or online friend who can support and guide learners through new materials and lessons (Kapp, 2012). Avatars also provide flexibility as they are available on-demand when the student requires them, can create interest and fun in learning, and can drive higher rates of learning and completion (Oestreicher, Kuzma & Yen, 2010). Researchers have acknowledged the great potential that avatar technology has for a variety of online and educational technologies, but more research needs to be done to see how avatars can add value to the learning experience (Barnatt, 2008).

According to Type 2: High Transactional Distance and Individualized Mobile Learning Activity (Park, 2011), a majority of the learning experience occurs between the content and the learner, so it is important for the content to be delivered in a fashion where the learner can control their own learning process. Elias (2011) describes this balance in the design of the instructional climate as how the learner “pulls” content from the learning activity and “pushes” learning out from the instructional environment. The instructor can set up regular updates, tips, reminders and schedules that can be “pulled” by the learner in order to highlight key skills and tasks to perform or knowledge for the learner to acquire. In addition, the learner can “push” or share their learnings from the mobile activity by using such strategies as discussion forums, image/audio file sharing, and blog posts in order to foster an inclusive, collaborative atmosphere and provide feedback from a context-specific learning environment (Elias, 2011). How the content is delivered or “pushed and pulled,” therefore, was a primary consideration of the design of the mobile learning experience in this study.

Methodology

Theoretical Background

As seen from the examination of transactional distance theory, mobile learning has elements of both situated learning in a specific context, and constructivist learning where learners bring their own knowledge, perspectives and experiences when interacting with the content. Constructivist learning has an element of contextualized process, as knowledge is constructed based on both personal experiences and hypotheses of the environment in which new knowledge or content is presented (Zemelman, Daniels & Hyde, 1993). Learning is not the passive reception of facts, but an active construction of meaning (Piaget, 1977). Utilizing purely constructivist, participatory simulations, however, has led some researchers to question the transferability of skills that students develop, as well as the effectiveness of situated learning environments if the context is not authentic (Naismith, Lonsdale, Vavoula & Sharples, 2005). “The most successful learning comes when the learner is in control of the activity, able to test ideas by performing experiments, ask questions, collaborate with other people, seek out new knowledge, and plan new actions” (Naismith et al., 2005, p. 15). In situated learning theory, learning is embedded in activity, context and culture. New knowledge should be presented in authentic contexts, and social interaction and collaboration are integral to the learning process (Lave, 1988; Brown, Collins & Duguid, 1989). Traxler (2007) notes the importance of situated learning for mobile learning design, since location-specific experiences and activities can be used to provide educational experiences that might otherwise be impossible. Situated learning is also an ideal fit with collaborative or constructivist learning, where learners can share and build on their prior knowledge.

The overlapping of situated and constructivist pedagogical perspectives in mobile learning gives rise to a variety of context-specific research questions. This made this study suitable for a pragmatic, mixed methods research approach, in particular because pragmatism has been identified as ideal for answering varied and complex research questions that may include a variety of pedagogical perspectives and learning theories. Johnson and Onwuegbuzie (2004) emphasize that the pragmatist philosophy is ideal for educational research as it "…offers a method for selecting methodological mixes that can help researchers better answer many of their research questions" (p. 17). So constructivism and situated learning principles were employed to design the collaborative, practical, context-based structure and delivery of the mobile learning simulations while pragmatism was used to evaluate the effectiveness of this design by examining the experiences and learning outcomes of study participants.

Much like pragmatism, many of the strengths and benefits of mixed methods research centre on the enhanced results that the combination of techniques produces. It allows for a better understanding of a research problem by unifying trends within the quantitative data with specific, contextual details from the qualitative data (Hanson, Creswell, Plano Clark & Petska, 2005; Mertens, 2003; Punch, 1998). Researchers also argue that mixed methods can lead to a more comprehensive understanding of the research problem (Bryman, 2006), as well as greater validity and corroboration of results through triangulation (Greene, Caracelli & Graham, 1989). In order to answer the identified research questions and understand the various learning outcomes, this study employed a convergent parallel mixed methods design. This allowed for the quantitative and qualitative results to be compared or contrasted, and a more complete interpretation and understanding of the results to be obtained (Creswell & Plano Clark, 2011).

Study Approach

In this convergent parallel mixed methods case study, 213 healthcare professionals participated in the Ontario Telemedicine Network's videoconference equipment online training program (121 in Mobile Learning Experience 1 and 92 in Mobile Learning Experience 2). The purpose of this online resource was to provide healthcare professionals with the technical skills, process knowledge and etiquette tips to facilitate effective clinical consultations via videoconference.

The convergent parallel mixed methods design can be seen in Appendix V, where the processes of data collection, analysis, results and interpretation are outlined. The purpose of this first section of the mobile learning study was to answer the following two research questions:

1. How does the structure of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes?
2. How does the delivery of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes?

The study was approved by the University of Ottawa's Social Sciences and Humanities Research Ethics Board. Consent letters detailing the requirements of the study were disseminated online and healthcare professionals taking the online equipment course were offered the choice to participate or decline to take part in the study.

Participant Recruitment

Participants in this study were healthcare professionals (registered nurses, nurse practitioners, physicians, administrators) participating in the Ontario Telemedicine Network's Telemedicine Coordinator training program. The mobile learning experience was situated in 12 online videoconference equipment training courses, where participants were taught how to utilize videoconference equipment to facilitate clinical consultations. There were approximately 50 learners registered in each of the 12 courses. All 600 learners were approached to take part in this study. A total of 213 agreed to participate and subsequently completed both the demographic questionnaire and post-program survey. Twenty participants were interviewed regarding their experience in the online and mobile learning experiences.

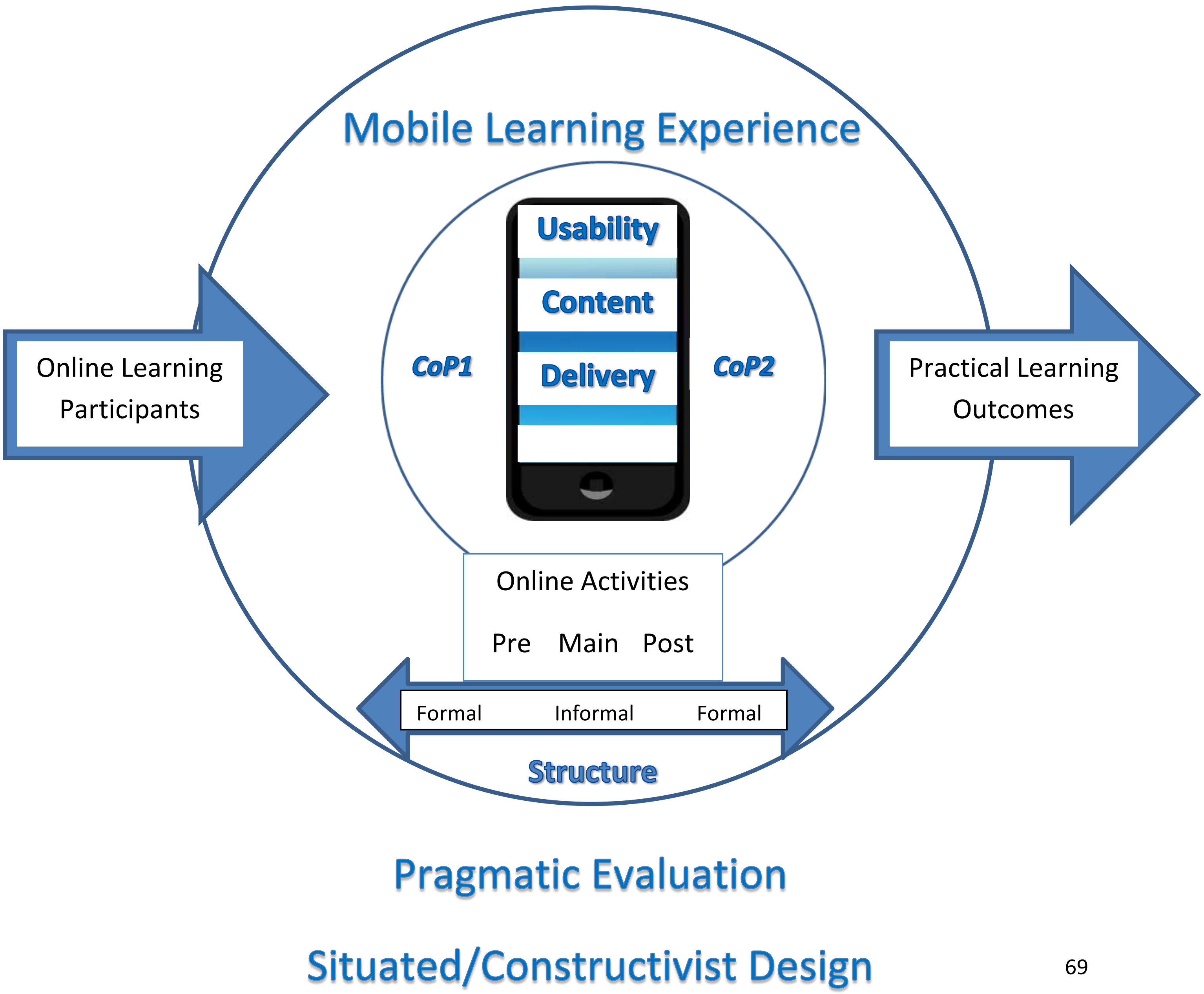
Instruments

Mobile Learning Experience Conceptual Framework. The mobile learning experience was designed and evaluated based on the five dimensions of the mobile learning experience (MLE) conceptual framework. The MLE conceptual framework is grounded in the pedagogical perspectives of situated learning and constructivism, as well as best practices identified in a comprehensive review of literature. The MLE conceptual framework guided the design and implementation of the mobile learning experience based on the following five dimensions: Content, Delivery, Usability, Structure, and Communities of Practice. The MLE framework can be seen in Figure 1 below.

Figure 1

Mobile Learning Experience Conceptual Framework

Elements adapted from the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009)



Evaluation of the MLE conceptual framework was performed utilizing a pragmatic methodology and executed with a convergent parallel mixed methods design. With the exception of Communities of Practice, the other four dimensions (delivery is referred to as "media") are key evaluation components of the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009; Casimiro, MacDonald, Thompson, & Stodel, 2009), which was designed to act as a quality standard to guide the design, delivery and evaluation of online healthcare education. Due to the similarity in its dimensions to the MLE framework, the evaluation instruments of the W(e)Learn Framework were adapted and utilized as evaluation tools for this paper.

The W(e)Learn Framework can be seen in Appendix III, and the Post-Program Mobile Learning Experience Survey adapted from the W(e)Learn Survey created by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010), can be seen in Appendix IV. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html. The survey includes questions for four of dimensions of the MLE conceptual framework: content, usability, delivery and structure. The W(e)Learn Framework also examines three levels of learning outcomes: 1) learner satisfaction, 2) development of new knowledge or skill or changes in attitude, 3) changes in learner behavior. The survey was therefore used to examine both the learning experiences (based on the five dimensions) and the learning outcomes of participants. Experiences and outcomes for the communities of practice were based on qualitative data collected in the discussion forum, reaction survey 2 and the semi-structured interviews.

Online Resource. The online course was one hour in length, and engaged learners with a variety of activities including digital video segments, interactive PDFs, written content, and checklists. The first three modules of the course were consistent for all study participants, and included an introduction to the videoconference equipment, remote control, and a description of the mobile learning experience (Table 1). These three modules were designed to be completed on a computer and at a place and time convenient for the participants. They provided the baseline knowledge and technical information crucial to the completion of the mobile learning experience.

The mobile learning experience was module four, and participants accessed it via their tablet, cell phone or laptop computer on location within their clinical videoconference studio. This allowed participants to interact with the learning content in the authentic workplace setting where they would be using the videoconference equipment. The participants were prompted to perform specific tasks (focusing on technical skills with the remote controls and videoconference systems), answer questions (focusing on etiquette and process knowledge) and provide feedback (in the form of a clinical readiness documents that recorded their preparedness for their first videoconference event). At the conclusion of the mobile learning experience, participants received a feedback form via email based on the questions they answered during the simulation. This feedback both evaluated their performance and provided tips on items they needed to improve or augment. Feedback forms were emailed directly to the participants through the secure link to their Moodle account in order to maintain anonymity.

At the conclusion of the mobile learning experience, participants then returned to the online course to complete modules 5 and 6. Module 5 provided supplemental information to build upon the learnings in the mobile learning experience. Finally, in Module 6 participants were tested on their learning and completed a post-program survey (at the completion of the online course), and reaction survey 2 (after their first clinical videoconference).

The detailed online/mobile module structure, content and delivery modalities can be seen in Table 1.

Table 1

Online/Mobile Module Structure, Content and Delivery Modality

Online/Mobile Module Structure	Module Content	Module Delivery Modality
Activities Prior to Mobile Learning: Online Equipment Course	Module 1: Introduction to the Equipment c) Equipment Terms and Concepts d) Equipment Operation	- Video of live host presenting the videoconference equipment - PDF reference guides and checklists for equipment operation
	Module 2: Introduction to the Remote Control e) Features of the Remote Control f) Functions of the Remote Control	- Screencast of remote control features and functions - PDF reference guides and checklists for remote control operation

	Module 3: Mobile Learning Experience Orientation c) Explanation of Mobile Learning Experience d) Consent for Mobile Learning Experience	- Screencast of mobile learning experience features and functions - Online consent form
Mobile Learning Experience	Module 4: Mobile Learning Experience e) Setting up the Clinical Videoconference Room f) Operating the Videoconference Equipment g) Orienting the Patient to the Clinical Videoconference Appointment h) Facilitating the Appointment	- Avatar host presents all learning tasks and checklist activities - Tasks "pulled" from resource by learner - Checklist "pushed" to resource from learner - Discussion forum access for Community of Practice 1 - Navigation and index features
Activities After Mobile Learning: Online Equipment Course	Module 5:Videoconference Etiquette and Privacy g) Videoconference Etiquette h) Privacy and Videoconferences i) Troubleshooting Tips and Tricks	- Etiquette video of videoconferencing best practices - Photo slide show of privacy best practices - Screencast of common troubleshooting techniques - PDF reference guides
	Module 6: Supplemental Material (Optional Based on Equipment at Member Site) f) Hooking up a Laptop Computer g) Manual Dialing Using the Global Address Book	- Video of host presenting laptop and address book - PDF reference guides for laptop operation and manual dialing
	Module 7: Assessment f) Final Quiz g) Course and Mobile Experience Post-Program Survey h) Reaction Survey 2	- Online quiz and reaction survey - Summary PDF reference guide - Reaction Survey 2 for Community of Practice 2

Mobile Learning Experience 1 and 2. For the purpose of this paper, two versions of the mobile learning experience (in module 4) were produced, and participants were randomly assigned to one of the two versions. Mobile Learning Experience 1 (MLE1) included all of the best practices for delivery identified in the literature review. These included task activities that were "pushed" from the mobile learning experience for participants to complete in the learning environment, and checklist activities that pulled information from the participants from the learning environment into the mobile learning experience. Guidance through the mobile learning experience was provided by an avatar host, who gave participants an orientation to the task and checklist activities as well as instructions on how to navigate through the screens and access the discussion forum and online help. Screenshots of the task, checklist and orientation screens for MLE1 can be seen in the three left columns of Figure 2.

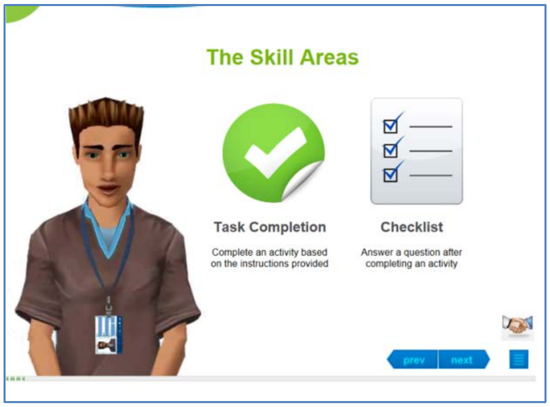
Mobile Learning Experience 2 (MLE2) included all of the identical content, usability (navigation, user interface, resources), structure (inquiry-based activity, embedded in formal online learning course), and communities of practice, but did not include any of the delivery features of MLE1. There was no avatar host, and no identification of task or checklist activities. Participants were not prompted to perform any specific activities, so the mobile learning experience became a didactic screencast presenting information via the participants' mobile devices. Screenshots of the task, checklist and orientation screens for MLE2 can be seen in the three right columns of Figure 2.

It should be noted that participants in MLE2 did not receive the same interactive, complete learning experience as the participants in MLE1 due to the inferior quality of the delivery methods in MLE2. To mitigate this ethical research dilemma, participants in MLE2 were given permanent access to MLE1 upon completion of the post-program survey. This was done via an automatic, conditional release within the Moodle learning management system to ensure the ethical treatment of all participants.

Figure 2

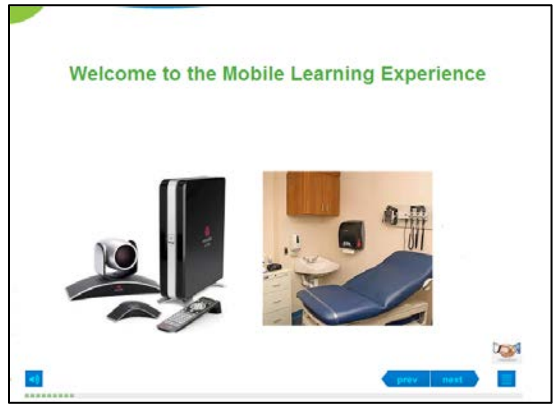
Comparison of Delivery Features of MLE1 and MLE2

Orientation Screen



MLE 1

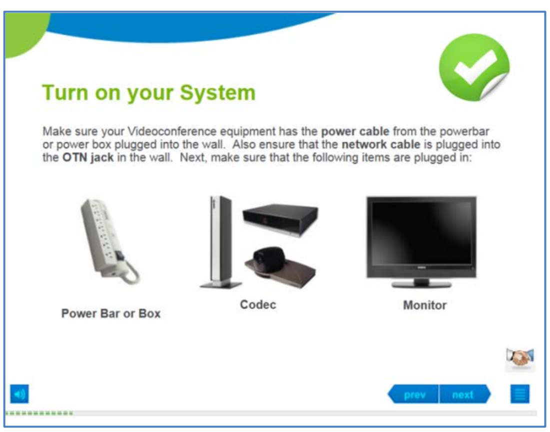
Avatar host provided an introduction to the mobile learning experience, including the task and checklist activities, access to discussion forum and navigation buttons.



MLE2

Participants were presented with an introductory page and audio clip that introduced them to the mobile learning experience and navigation buttons.

Task Screen



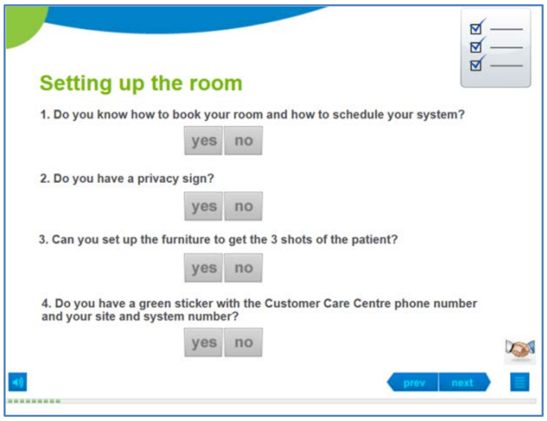
MLE 1

Task screen included task icon (checkmark) and prompted participants to perform a task and then acknowledge its completion with the next button.

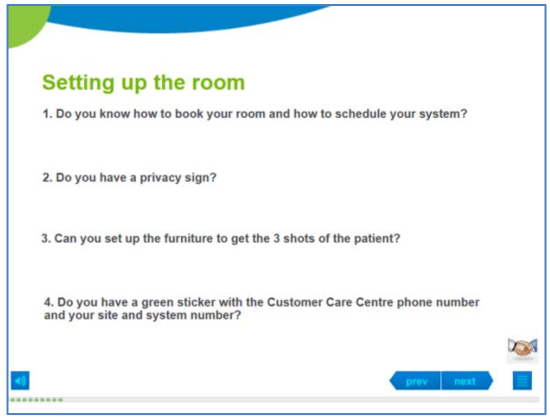
MLE2

The screencast format ran through the same activities as MLE1 but did not prompt participants to perform the activities or for a response.

Checklist Screen



MLE 1



MLE2

Checklist activities included the checklist icon (checkbox) and asked participants for a yes or no answer to a series of questions. Responses were tabulated throughout MLE1 and were emailed as a "to do" list to participants at the end of the simulation.	The screencast format ran through the same questions as MLE1, but did not prompt the participants for an answer. Since there were no responses there was no tabulation or "to do" list in MLE2.

Data Collection

Data collection occurred over a three-month period from December 1, 2013 to March 1, 2014. Quantitative and qualitative sources of data included the following:

Demographic Survey. The demographic survey was completed online prior to the commencement of the online course, and collected basic demographic data, the participants' online experience, their exposure to mobile learning, and their attitudes towards online learning. This gave an idea of the technical experience of the participants and allowed the researcher to identify if this experience had any influence on the learning outcomes achieved by the participants. A copy of the demographic survey can be found in Appendix VI.

Discussion Forum. The discussion forum (also known as CoP1) addressed the identified importance of constructivist learning principles when designing mobile learning content. CoP1 was designed as an open-ended collaboration tool for participants. When participants accessed the forum, the following guiding question was posed: "Please list any questions or comments you may have about this equipment simulation and/or about this mobile learning activity."

Specifically, the forum allowed participants to share information, post challenges and propose solutions to common problems. This provided participants with the opportunity to both build on their prior knowledge as well as provide a valuable resource of qualitative data as to the participants' experiences. The forum was accessed through a "Discussion" icon available on the mobile learning experience interface.

Post-Program Survey. The second survey was a post-program survey that employed a five point Likert scale and was completed online after the completion of each course (Appendix IV). The post-program survey is adapted from the W(e)Learn Post-Module Survey utilized by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010). Questions were divided into five sections to provide a quantitative evaluation of the Content, Delivery (W(e)Learn calls this Media), Structure, Usability and Learning Outcomes of the mobile learning experience. The survey also included six open-ended questions on the participants' learning experience that produced qualitative data for analysis. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html.

Reaction Survey 2. Reaction Survey 2 (also known as CoP2) was a post to the discussion forum and was completed by the participants after their first clinical telemedicine appointment (Appendix VII). This provided valuable insight on how the participants built upon their prior knowledge and applied this new knowledge in the workplace. Reaction Survey 2 also provided qualitative data on the constructivist learning that comes from both the discussion forum and the mobile learning experience itself.

Focus Group Semi-Structured Interviews. Four focus groups with a total of twenty participants (fifteen from MLE1 and five from MLE2) participated in semi-structured interviews within two weeks of completion of the online equipment course. The purpose of the interviews was to gain a greater insight into the personal learning experiences of the participants in each of the simulations. The interviews took approximately 30 minutes, and were guided by a set of interview questions that were open-ended and developed with the influence of questions in the Survey Instrument for the Communities of Inquiry Framework (Garrison, Anderson & Archer, 2000). The interviews were taped and subsequently coded with learners' permission (Crichton & Childs, 2005). The interview questions can be found in Appendix VIII.

Data Analysis

Data from the post-program survey, the two discussion forums and the focus group interviews were triangulated to increase the rigor of this study. Denzin (1978) defines several types of triangulation, one of the most reliable of which is the convergence of multiple sources of data at different times during the research process. The strength of convergent mixed methods research is that it provides the researcher with a greater number of methodological tools at their disposal in order to answer a variety of research questions (Greene, Caracelli & Graham, 1989), and identify emerging questions and themes (Stange, Crabtree & Miller, 2006).

SPSS Data Analysis was used to produce descriptive statistics from the quantitative post-program survey questions. The means and standard deviations of all of the questions for the dimensions of structure and delivery are presented in Appendix X. In addition, individual t-tests were performed to compare the mean scores for all of the questions in the post-program surveys of MLE1 and MLE2. The t-test assesses whether the means of two groups are statistically different from each other (Moore & McCabe, 2003). An independent-measures design was utilized as it is ideal for testing for mean differences between two different treatment conditions (Pallant, 2007). In this case, it was the difference in the dimension of delivery for MLE1 and MLE2. The learning outcomes of MLE1 and MLE2 are also statistically compared and contrasted in Appendix X. Any responses of “not applicable” by participants on the post-program survey were omitted from the data analysis.

In vivo coding along with inductive and deductive reasoning was used to produce a list of codes from the interview data. In vivo coding is an effective method for primary qualitative data analysis as it allows for concepts and feedback to stay as close as possible to participants’ own words and terms (Flick, 2002). The descriptive data from the quantitative results and the list of codes from the qualitative results were both organized into key themes. These key themes were then triangulated to produce both combined and contradictory key themes that can be used for course revisions and publication. A visual diagram of this process can be found in Appendix V. Any other emergent themes within and among the data were also coded and reported. The writing adopted a narrative tone as this captured the experiences of the participants, and direct quotations were included when relevant.

Ethical Considerations

Careful measures were taken to ensure that no participants were harmed as a result of this study. Confidentiality of participants was maintained at all times. The participants were volunteers so they were not, therefore, considered a population that is vulnerable or at risk because of the study. All the transcripts and recordings from the interviews are being kept on the researcher's secured computer under password protection, and answers on the online surveys are kept on a secure server. Learners in OTN online courses who did not volunteer to become participants in this study were flagged in the learning management system and their data was not included in any of the research.

Results

The aim of this study was to explore the learning experiences and outcomes of healthcare professionals pertaining to the mobile learning experiences in the online equipment training courses, particularly with regards to how the mobile learning was structured and delivered. Results are discussed as they pertain to: demographic questionnaire responses, mobile learning structure and how this influenced the learning experiences and outcomes of participants, and mobile learning delivery and how this influenced the learning experiences and outcomes of participants. This will be done by comparing and contrasting the feedback from both mobile learning experience versions 1 and 2 as understood through the feedback surveys, focus group interviews and discussion forum posts.

Demographic Questionnaire

Two hundred and thirteen healthcare professionals took part in this study, consisting of 183 registered nurses, 14 administrative staff, 10 medical students and 6 practicing physicians. Tables 1.1 – 1.6 in Appendix IX provide the detailed demographic results. Demographic results are presented for both MLE1 and MLE2 combined since there were no significant demographic differences between the two groups that would have influenced the study's results. For example, for both groups females made up over 85% of the population, around 50% of participants were between the ages of 31-40, over 84% were nurses, and over 85% indicated that this was their first mobile course.

The majority of the healthcare professionals in the study were between the ages of 31-40, with the average age being 38.5. The vast majority of the participants (85.9%) were registered nurses and 87.8% were female. It was also the first mobile learning course for 86.9% of the participants in the study. Despite this inexperience with mobile learning, participants were familiar with using technology to access information. Over 66% indicated that they used mobile devices sometimes, often or always to access personal or professional information, and 69% said they had taken an online course several times or often in the past.

On a five-point Likert scale (with 1 being none and 5 being always), participants listed audio conferencing (4.01) and videoconferencing (3.31) as their most common types of online experience. As far as mobile experiences the most common were accessing email (4.22), texting (3.97), audio conferencing (3.76), and accessing web pages (3.65). On a five-point Likert scale (with 0 being not applicable and 4 being strongly agree), participants indicated that their past online experiences were extremely positive with a rating of 3.41. Participants were unsure whether mobile learning experiences enhance the online learning environment, only giving that question a 2.67 rating.

Structure

The structure outcomes will be discussed for both Mobile Learning Experience 1 and 2 combined since the structure was the same for both versions. Quantitative descriptive statistics for the structure questions on the post-program mobile learning experience survey can be found in Table 1.1 of Appendix IX. The findings will be presented as themes identified with the codes from the In Vivo coding procedure and subsequently supported by the quantitative data.

Engaging. Participants indicated on the post-program survey that the mobile learning experience kept their interest (3.08), motivated them to learn (3.09), and engaged them in the learning experience (3.24). Engagement was identified as the most valuable aspect of the mobile learning experience by 31 of the participants. "The mobile activity was fun, efficient and kept my interest. It focused me on the activity and had lots of questions and feedback that maintained my interest" (Nurse 3). Another participant agreed: "Short, succinct and to the point. The activity got me involved in the learning process" (Administrator 2). Comments on the post-program survey echoed these findings. "The value of the mobile learning was that it made it fun to learn."

Another participant added: “I wanted to keep going and learn more. What a great way to practice using the video equipment.”

Nurse 5 listed the importance of variety and engagement in the learning process:

> We have a lot of in-service training on technology at our hospital, and it is always delivered live. I find it repetitive and pretty boring. This mobile tour was a great change of pace and let me explore the videoconference system at my own pace and kept me engaged with the questions and tasks I needed to perform.

Application vs. Problem Solving. Participants identified that the mobile learning experience gave them the opportunity to apply the knowledge they had learned (3.23). Forty-seven participants wrote that skill or knowledge application was the most valuable part of the mobile learning experience. “Until I get a piece of technology in my hands to practice I’m not really getting it. I liked the overview of the remote control and then the ability to practice with it during the mobile simulation” (Medical Student 1). Administrator 1 agreed: “Practice makes perfect. Watching the video of how to turn the system on was useful, but being guided on how to do it was even better.”

One item of contention among participants was whether the mobile learning experience gave them the opportunity to problem-solve. This question only had a rating of 2.85 on the post-program survey and this was echoed in the interview comments. “The mobile learning was fantastic from a skill standpoint, but I would have liked to have been given a problem to solve. Not sure I did that here” (Nurse 3). “We love case studies and are used to completing them. This was good but maybe presenting the material in that fashion would be more engaging” (Administrator 2). In the qualitative feedback on the survey, 16 participants wrote that the best way to improve the mobile learning experience would be to include more problem-solving activities.

Logical Progression. Participants were also divided on the logical progression of the mobile learning experience, giving it a rating of 2.73 on the post-program survey. The issue focused on the ordering of the task activities and the checklist questions. Some participants loved the variety of the structure while others found it disrupted the learning process. “The checklist is a valuable tool, but why put it in the middle of the activity? We could perform all the tasks and then do the checklist afterwards” (Administrator 3). Medical Student 1 agreed: “I like working in a linear fashion. I understand the simulation was how to present a patient from start to finish, but including the checklist in the middle seemed to slow down the learning."

Numerous other participants disagreed with these comments, noting that the mobile learning experience challenged them to work in a different and unfamiliar fashion. "It took a while to get used to, but I thought the variety of the questions and tasks was very challenging. It made me work harder and kept me focused" (Nurse 1). Nurse 4 agreed that the disruptive nature of the questions was helpful: "The checklist items forced me stop and question if I am ready to host a patient. They broke up the activity but made it more real for me."

The Successful Hybrid of Mobile and Online Learning. The highest marks on the post-program survey were reserved for the questions on the integration of the mobile learning experience within the online equipment course. Participants strongly agreed that the online learning modules both prepared them for the mobile learning experience (3.23) as well as supported the mobile learning experience after it was completed (3.39). Participants definitely enjoyed the combination of online and mobile learning (3.08). Sixty-eight participants mentioned the structure of imbedding the mobile learning experience within the online course as the most valuable part of the study. "I've done OTN courses where they combine online and live learning. This was similar but better. Breaking up the online course with the mobile activity allowed me to take a break and practice what I learned" (Administrator 1). "This had the benefit of a practical learning object that I could do at my own pace in the telemedicine studio and I knew more when I returned to the online course" (Nurse 5). Practicing Physician 1 noted that the online course presented just the right amount of pre-activity information.

> I must admit that I find a lot of online learning long and boring. This was perfect as it gave us some basic information up front in a few minutes that we could then practice with the mobile learning app. It only took me 20-25 minutes and I felt I was ready to go with the equipment. The stuff after the mobile app was a bit too long but with the context of the practice it made sense.

Differences in Structure Experience Between MLE1 and MLE2. Although MLE1 and MLE2 were identical in how the dimension of structure was designed and delivered, it appears from the quantitative data that the difference in delivery did affect the participants' experiences with regards to structure. In particular, questions 1, 6, and 7 did end up with t-test significance values below 0.05, indicating that there was a significant difference between the means of MLE1 and MLE2 for these three questions. Participants indicated that MLE2 was inferior to MLE1 in the ability of the introductory modules to prepare them for the mobile learning experience, $t(182) = 2.0$, $p = 0.04$, and the ability of the mobile learning experience to both provide opportunities for problem-solving, $t(211) = 5.0$, $p < .001$, and applying the material that was learned, $t(169) = 2.6$, $p < .001$. Results for all of the structure questions are presented in Table 2.

Table 2

Post-Program Survey Structure Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 2 (N=92)

Answer Option	MLE 1[a]		MLE 2[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. The introductory online learning modules prepared me for the mobile learning experience	3.31	0.671	3.11	0.763	0.042
2. The mobile learning experience kept my interest	3.12	0.458	3.03	0.583	0.216
3. The mobile learning experience motivated me to learn	3.08	0.440	3.09	0.410	0.941
4. The mobile learning experience engaged me in the learning experience	3.30	0.459	3.17	0.634	0.087
5. The material follows a logical progression	2.75	0.505	2.70	0.569	0.453
6. The mobile learning experience provides opportunities for problem-solving experiences	3.02	0.516	2.64	0.585	0.000
7. The mobile learning experience provides opportunities to apply material learned	3.31	0.466	3.12	0.590	0.010
8. The online modules supported the mobile learning experience after it was completed	3.44	0.498	3.32	0.467	0.066
9. I enjoyed the combination of online learning with the mobile learning experience	3.08	0.600	3.06	0.570	0.829

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Delivery

The findings for the delivery outcomes will be presented separately for Mobile Learning Experience 1 and 2. Mobile learning experience 2 did not include the avatar host or the feedback checklist but was just presented as a screencast that guided the participants through the activity. The design of the structure, content and usability was the same for both versions 1 and 2. Findings will be subsequently combined and contrasted in the discussion section of this study.

Mobile Learning Experience 1

Capture and Integration. Participants resoundingly agreed (3.38) that the delivery of the mobile learning experience allowed them to capture and integrate information. The checklist was named as the most valuable part of the mobile learning experience by 66 participants on the post-program survey. “I enjoyed the mobile learning activities, but the checklist I received at the end really helped. I have a concrete list of things to do to prepare our room and revise our protocols for our first clinical appointment” (Nurse 3). “I got a to-do list based on the teachings. Great use of technology and feedback” (Administrator 2). Results from reaction survey 2 also supported the value of the checklist, with 22 out of 62 posts mentioning it specifically. “For me the most useful part of the whole experience was the feedback form. It showed the gaps in my knowledge and preparation” (Nurse 38). Added Administrator 25: “My sight sign, protocols and room arrangement were ready to go as identified by the checklist.”

Control. Participants indicated with a mean answer of 3.23 that the delivery of the mobile learning experience gave them control of the learning activity. In addition, while responding to the post-program survey question on how mobile learning should be used in an online learning resource, “control” and/or “greater control” were keywords in the responses of 65 participants. Participants viewed control as critical and agreed that the mobile learning experience delivered it in this study. “Giving me a variety of things to do, jobs to complete and questions to answer was great. It let me take charge of the pace of the simulation” (Medical Student 2). Nurse 4 agreed: “I was a bit nervous in the telemedicine studio at first, but the activities allowed me to gain confidence and control as I went along.” Administrator 17 advocated for even greater control on reaction survey 2: “I thought the activity did a good job of orienting me to the equipment and letting me control my learning. Maybe a case study with more open-ended questions would allow me to explore more?”

Flexible Learning vs. Flexible Tools. The issue of flexibility received mixed reviews from participants. Learners felt that the delivery of the information in the mobile learning experience promoted a flexible learning environment (3.41), but did not feel as strongly about the flexible access to support tools, help and online communication (2.97). “I loved the simulation and the flexibility it provided. I had to stop for a patient appointment and return later and I often flipped back and forth to review something again if needed. Very easy to use and much more convenient than our usual class training” (Administrator 5). Nurse 7 agreed: “I used the mobile activity in both of our clinical video studios. It worked well in both environments and I reviewed the key steps in each.”

Participants questioned the flexibility and ease of access to support tools, help and communication. “I got stuck with the remote control and didn’t find the PDF guide provided in the help link to be much help. I had it already. Talking to someone or access to the videos from the course would be better” (Administrator 1). “I accessed the discussion forum easily and asked a question, but no one responded. I thought it was a live chat but it was just a forum. Got my answer a couple of days later but that was much too late” (Nurse 9). This call for synchronous help, chat or support was echoed in 41 of the post-program surveys. “Real-time help is what’s needed here to make this a complete resource” (Medical Student 4). Added Nurse 31: “I really liked that I could access this resource when I was available, but the access to help was not sufficient and frustrating.”

Lack of Communication and Collaboration. Participants generally felt that the mobile learning experience lacked communication and collaboration. Promoting communication received a mediocre mean score of 2.99, whereas collaboration was much lower at 2.49. The asynchronous nature of the communication/collaboration was not appreciated by participants. “I thought mobile learning was all about collaboration and there was none of it during the simulation itself. I did receive excellent feedback and access to resources in the forum after the course but not during the simulation” (Nurse 4). “Why give access to a discussion forum if it is not going to be real-time?” (Nurse 7). In the post-program survey, 71 participants listed the need for synchronous communication as a means of improving the mobile learning experience. Administrator 19 summarized the resource: “Great mobile activity and very interactive and fun. Adding communication and help would make it complete and help support the learner.”

Avatar as Host. One of the emerging themes from the interviews and post-program survey open-ended questions was the successful integration of the avatar character in the mobile learning experience. Overall, participants felt the avatar was a very effective guide for the activity and made the simulation more interactive. “I was worried that the simulation would just be a list of instructions and questions. The avatar was fun, interactive and walked me through the activities easily” (Administrator 2). “I haven’t taken a mobile learning course before, and the avatar made it work for me. He was in the online course and then when he was in the mobile activity as well it was like the teacher had come along with me. It tied the activity to the course and made the learning more personal and customized” (Medical Student 2). Added Nurse 6: “The simulation wouldn’t have been the same without the avatar.” Numerous participants noted in the post-program survey that the avatar was their favourite part of the mobile learning experience. “The avatar prompted me and guided me through the activity and made it fun” (Nurse 66). “The virtual instructor was fantastic. A fun and effective way to present the material” (Administrator 27).

Mobile Learning Experience 2

Participants in Mobile Learning Experience 2 had predictably different learning experiences than those in Mobile Learning Experience 1. The survey response differences are summarized in Table 3 below followed by the examination of key themes from the qualitative analysis. Note that experiences with regards to communication and collaboration were similar in both versions so they will not be expanded upon in this section.

Table 3

Post-Program Survey Delivery Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 2 (N=92)

Answer Option	MLE 1[a]		MLE 2[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. The resource respects my experience and current knowledge	3.09	0.619	3.06	0.589	0.758
2. The delivery allowed me to control my learning environment	3.23	0.728	2.83	0.784	0.000
3. There is flexible access to support tools, information, help, and online communication	2.97	0.562	2.51	0.620	0.000
4. The delivery of the information promotes a flexible learning environment	3.41	0.511	3.34	0.498	0.275
5. The delivery allowed me to capture and integrate information	3.38	0.767	2.30	0.659	0.000

6. The resource promotes communication among learners	2.99	0.599	2.91	0.765	0.416
7. The resource promotes collaboration among learners	2.49	0.593	2.36	0.622	0.128

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Capture and Integration. The most dramatic difference in the participants' experience between the two versions came with regards to capturing and integrating information, with over a point difference (3.38 to 2.30) in the post-program survey response. The t-test confirmed the significant difference between the experience of the two groups, $t(211) = 1.1$, $p < .001$. This appeared to have a dramatic influence on the learning outcomes of participants as well, with 47/92 learners calling for more interactivity as the best way to improve the mobile learning experience. "I thought mobile learning was about gathering and synthesizing information. I could have watched this movie on any device and it wouldn't make a difference. What was the purpose?" (Administrator 11). Nurse 8 agreed: "I didn't capture anything. It was good to watch the instruction in the studio, but besides that I was just performing a few simple tasks." The level of frustration among participants was perhaps summarized best by Medical Student 5: "This was supposed to be cutting-edge but it was just a screencast. Nothing special here."

Control. Control was another issue of frustration and reduced satisfaction (2.83) among participants of Mobile Learning Experience 2. The t-test confirmed the difference in dissatisfaction of MLE2 from MLE1, $t(197) = 5.6$, $p < .001$. Participants felt they were simply following instructions for the tasks listed in the screencast. "I felt like I was just being told what to do. I got the tasks all done and learned a bit but it was a bit simple in nature" (Nurse 9). Numerous responses in the open-ended questions on the post-program survey noted how learner control should be integrated into MLE2. "The design needs more student involvement" (Administrator 53). Nurse 71 added: "I like to be asked questions and bring my experiences into the classroom, not just be instructed didactically." Nurse 94 agreed: "This resource looked slick and the screencast was professionally produced, but what a bore. I really wanted to learn more than how to turn on the machine and operate the remote control."

Flexible Learning vs. Flexible Tools. Participants in MLE2 felt that the delivery of the material promoted a flexible learning environment, giving a mark similar to those in MLE1 (3.33

to 3.41 respectively). The t-test noted that there was no significant difference between the two groups, $t(198) = 1.1$, $p = .28$. Participants noted the importance of the physical context and its importance on the flexibility of learning. “I enjoyed watching this screencast in the telemedicine room. It let me complete the tasks at my own pace and in the specific place I will use them” (Administrator 9). “Getting off the online course and into the studio was great. Following the tasks made for a great learning experience that let me apply the knowledge in my own time” (Nurse 15).

Participant ratings were almost a half point lower for the question of flexible access to support tools, information, help, and online communication in MLE2 (2.51). This was confirmed as significant by the t-test results, $t(211) = 5.6$, $p < .001$. “I couldn’t access the forum until after the simulation was complete and I didn’t have any feedback on my performance. There was very little help here at all but just a video lecture” (Nurse 11). On the post-program survey, 32/97 participants noted that more access to support and help would be the best way to improve the delivery of the mobile learning experience. Administrator 53 summarized: “More access to help and a feedback mechanism is much needed. I’ve done simulations before and this has helped me learn in the past.”

Need for a Host or Guide. An interesting finding was that participants in MLE2 called for some sort or host or teacher to give them more guidance during the simulation. Twenty-seven participants noted the need for an instructor or video to help guide them in a mobile learning activity. “A teacher would have been a big help. The audio file was good but a video of a real person like in the online portion would help give this more guidance and personality” (Nurse 14). Administrator 8 agreed: “This was dry and lacked interaction. The voice matched the narrator from the online course but a cartoon or video would make this more personal and interesting.” Nurse 15 elaborated: “I’ve seen better screencasts than this in other OTN courses. Where is the cartoon character from the scheduling training? She was a great teacher!”

Learning Outcomes

As mentioned earlier, three levels of learning outcomes were examined in this study: 1) learner satisfaction, 2) development of new knowledge or skill or changes in attitude, 3) changes in learner behavior. Questions 1 and 2 on the post-program survey examined learner satisfaction, and participants indicated that they found both MLE1 (3.10) and MLE2 (3.04) to be interesting and MLE1 (3.27) and MLE2 (3.17) to be valuable. T-test results supported that there was no significant difference between the means of the two groups.

With regards to the development of new knowledge and skills, there was significant discrepancy between MLE1 and MLE2. Participants in MLE1 had higher mean scores for understanding new principles of clinical telemedicine, and acquiring proficiency in new techniques (see Table 4). The discrepancy was even higher when looking at learning applicable skills in a specific context (MLE1 3.21, MLE2 2.77), $t(181) = 7.2$, $p < .001$, and learning information that they could not have accessed through an online course (MLE1 3.39, MLE2 2.88), $t(210) = 5.3$, $p < .001$.

Table 4

Post-Program Survey Outcome Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 2 (N=92)

Answer Option	**MLE 1[a]**		**MLE 2[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
1. The online/mobile course is interesting	3.10	0.592	3.04	0.512	0.567
2. The online/mobile course is valuable	3.27	0.465	3.17	0.409	0.108
3. As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	3.27	0.695	2.78	0.652	0.000
4. As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques	3.15	0.380	2.97	0.479	0.003
5. As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context	3.21	0.412	2.77	0.471	0.000
6. The mobile learning experience allowed me to learn information that I could not have accessed through an online course	3.39	0.725	2.88	0.660	0.000
7. The mobile learning experience made the learning environment more motivating and engaging	3.54	0.500	3.33	0.697	0.009

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Results for changes in learner behavior were purely qualitative and were limited to responses in the post-program survey questions and semi-structured interviews for MLE1. “I am going to continue to work on clinical protocols to promote telemedicine at our site" Nurse 76 wrote in her post-program survey response. Participants in the interviews agreed: "This has shown me another way to provide access to care that is efficient and easy for patients. I'm looking forward to using this more in the future" (Nurse 7). "Our programs are in the early stages, but I can definitely see some ways I can incorporate this technology into my practice" (Physician 1). A need for more quantitative questions regarding changes in learner behavior will need to be incorporated into the post-program survey, and this will be addressed in a future paper on the mobile learning experience conceptual framework.

Discussion

Results indicated that with regards to structure, participants benefitted from the preparatory and concluding activities of the online course prior to and upon completion of the mobile learning experience. Participants also found the structure to be engaging and the opportunity to apply material presented in the specific workplace context motivated participants to learn. The logical progression of the structure was questioned and found to be unsettling to some participants. With regards to the delivery of the mobile learning experience, participants in MLE1 valued the opportunity to capture and integrate information using the checklist as well as the flexible and controllable learning environment provided by the tasks during the simulation. The absence of the checklist control in MLE2 was an extremely frustrating experience for participants. Participants cited a lack of help and support tools and an absence of communication/collaboration as potential design flaws of both MLE1 and MLE2. Finally, the avatar was found to be an excellent facilitator and deliverer of the content as participants found it to be interactive and fun. The results are discussed in detail in the following paragraphs.

Structure

Findings suggested participants highly valued the structure of the hybrid (online/mobile) course, the opportunity to immediately apply learning in the specific context, but found the logical progression of the mobile learning to be unsettling.

Hybrid Learning. Participants indicated that they valued the links between the formal online learning environment and the informal mobile learning experience, particularly how the pre and post-activities online supported and guided the main activities in the mobile learning experience. This supports the model suggested by Bo-Kristensen et al. (2009), where the inquiry-based activity is supported by formal learning in the classroom or online. The findings also support parts of the continuum between formal and informal learning suggested by Taylor, Sharples, Malley, Vavoula and Waycott (2006) and their Task Model for mobile learning. This model is deconstructed by Frohberg, Goth and Schwabe (2009) and is summarized in Table 5 below.

Table 5

TASK Model and Scale of Formal to Informal Learning

Section	Issue	Scale				
Factor		1	2	3	4	5
Section 3: Context (where and when?)	Relevancy of environment and learning issue	Independent context	Formalized context	x	Physical context	Socializing context
Section 4: Tools (wherewith?)	Pedagogic role of tools	Content delivery	Interaction for motivation and control	Reflective interaction	Reflective data collection	Content construction
Section 5: Control (how?)	Tightness of control	Full teacher control	Mainly teacher control	Scaffold	Mainly learner control	Full learner control
Section 6: Communication (with whom?)	Social setting	Isolated learners	Lose couples	Tight couples	Communication within group	Cooperation
Section 7: Subject (who?)	Previous knowledge	Novice	Little previous knowledge	Good previous knowledge	Much previous knowledge	Expert
Section 7: Object(ive) (what?)	Level	Know	Comprehend	Apply	Analyse	Synthesize and evaluate

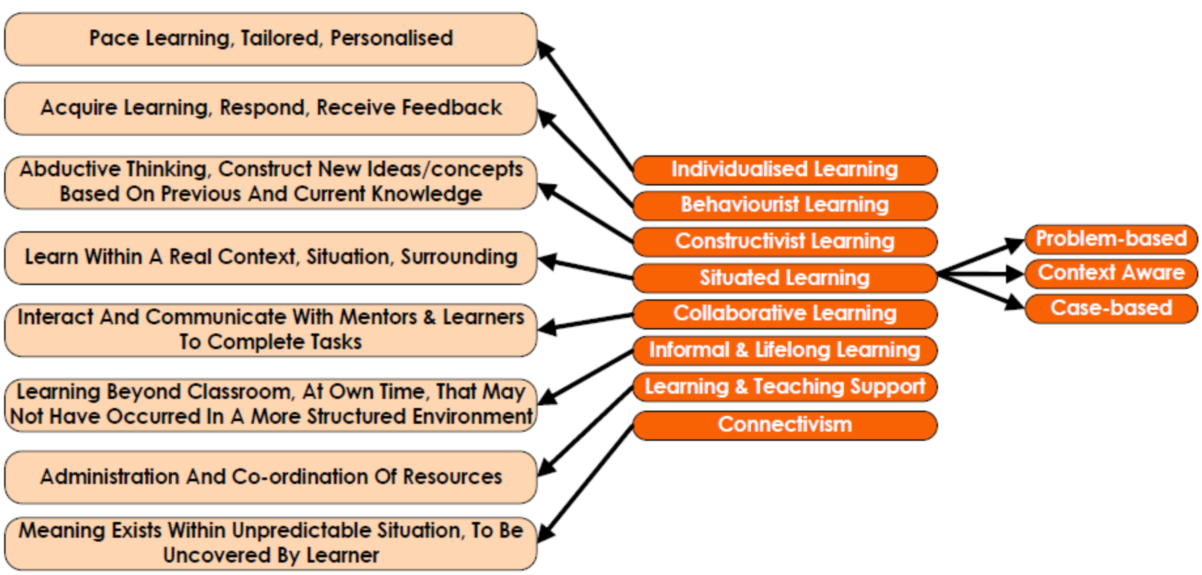
Taken from Frohberg, Goth and Schwabe (2009) p.312

In this study, the mobile learning experience corresponds with Scales 3/4, where the activity is on the informal end of the educational scale continuum and takes place in a specific physical context, involves reflective data collection, is learner controlled, requires good previous knowledge and allows learners to apply and analyze the new knowledge presented. The only difference is that the social setting would fall under scale 1 or isolated learners of the TASK model, since the majority of participants did the simulation alone in their videoconference studio. This contradicts the TASK model recommendation in scale 4 of a social setting that involves communication within a group. Overall, the mobile learning experience was an excellent example of informal learning since it fit the definition of allowing students to make use of their surroundings to gather information as well as the opportunity to reflect and share with other learners (Khaddage & Latteman, 2013). It was discovered, therefore, that the collaboration and communication in the discussion forum during the mobile learning experience was neither synchronous nor successful. However the meaningful sharing of ideas, processes and lessons-learned did occur in the discussion forum after participants had their first clinical event (reaction survey 2). Further investigation into how to incorporate synchronous communication and collaboration in a mobile learning experience would be valuable future research.

Application in Specific Learning Context. Participants overwhelmingly indicated that the contextual, inquiry-based structure of the mobile learning activity made it engaging, interesting and they were able to apply skills in the specific learning context. This aligns with the research of Beckett and Hagar (2002) and Shih, Chuang and Hwang (2010), which call for mobile learning to focus on informal, contextual, inquiry-based activities. The structure of the mobile learning activity also combined almost all of the learning theories proposed by Cheon et al. (2012) and Naismith et al. (2004), as critical components of a successful mobile learning program in order for it to be problem-based, context aware and case-based (Figure 3).

Figure 3

A Combination of Mobile Learning Theories



Taken from Stanton and Ophoff (2013) p. 516

With the exception of collaborative learning and connectivism (which Stanton and Ophoff describe as meaning that exists within unpredictable situations), elements of all of the other learning theories are supported including pace learning, response/feedback, concepts based on previous knowledge, situated learning, informal learning and co-ordination of resources. In addition to the already-noted absence of collaborative learning, connectivism identifies another important gap with the structure of the mobile learning experience in this study. Participants did identify that there was an absence of problem-based learning during the mobile learning experience as the tasks and checklist were primarily skill-based. In that sense, while the learning environment was contextual and inquiry-based it was not unpredictable. A case study or case-based activity would be an interesting addition that could activate problem-solving through abductive reasoning that Burdick and Willis (2011) identify as a dynamic pedagogical approach that can be adopted by mobile learning. Further research is warranted into case-based activities and how they can be incorporated into mobile learning experiences.

Logical Progression. Participants noted that the mobile learning experience lacked a logical progression, and that the task activities were often interrupted by the checklist activities. In effect, this was the balance between the tasks that participants "pulled" from the provided learning activities and the checklist that they "pushed" from their interactions with the specific learning context. These were key design and delivery mechanisms that were incorporated into the structure of the mobile learning experience based on informal learning theory. Unlike the formal online learning component of this course, these feedback and progress indicators were designed to offer guidance, feedback and encouragement, and this has been identified to make mobile learning fun, interactive and engaging for students (Gaved, Kukulska-Hulme, Jones, Scanlon, Dunwell, Lameras, & Akiki, 2013). A lack of logical progression has often been called the "disruptive" effect of informal mobile learning and can be utilized to get students out of their comfort zone and support dynamic learning outcomes (Sharples, 2002).

Influence of Delivery on the Experience of Structure. A fascinating finding that emerged in the quantitative analysis was the influence on delivery on the experiences of participants with regards to structure. Participants in MLE2 indicated that they felt the introductory modules did not prepare them as well for the mobile learning experience as participants in MLE1 (by a mean difference of only 0.20). MLE2 participants also felt that the mobile learning experience provided fewer opportunities to applied material learned than participants in MLE1 (again, only by 0.20). While both statistically small differences, it does demonstrate the importance of the dimension of delivery. Where it became statistically significant, however, was with regards to problem-solving. MLE2 participants noted that the mobile learning experience provided fewer opportunities for problem-solving experiences than participants in MLE1 (by 0.38). Clearly, the lack of task and checklist activities and the design of MLE2 as a webcast provided an inferior structural experience with regards to interaction with and application of the material with regards to solving problems in the context of the clinical videoconference studio. Further study on the influence of delivery on structure is warranted by this fascinating result.

Delivery

Findings for delivery indicated that participants benefited from the flexible learning environment where they could control the pace of learning and capture and integrate information. Participants were frustrated with the lack of tools for effective communication and collaboration, but also indicated how important the avatar host was in guiding them through the mobile learning experience.

Capturing and Integrating Information. Participants indicated that they enjoyed the control that they had over the learning environment as they completed the skill tests provided by the task activities (pulled from the mobile learning environment) as well as completing the feedback checklist (items pushed from their experience in the learning context). These learning outcomes validate the research of Elias (2011) and his “pull” and “push” design which advocates for greater learner control when interacting with a specific learning environment or context. This also coincides with the advice of Park (2011) that mobile learners benefit most when they are in control of the learning environment. In fact, this method of delivery was further validated by the experiences of participants in MLE2, where the feedback checklist and task activities were eliminated from the mobile learning experience. Participants in MLE2 not only gave the experience dramatically lower quantitative ratings on the post-program survey, but demonstrated a high level of frustration and dissatisfaction in their qualitative comments and interview responses. While they found the experience to be flexible because they could perform it in the specific learning context (the videoconference studio), the lack of interaction with the material and didactic nature of the screencast failed to engage participants in the learning process. This supports recent mobile learning research that has found that well-designed feedback, task and progress indicators can offer advice, guidance and encouragement to learners. This makes the learning environment more engaging and interactive (Gaved et al., 2013). Barron (2006) found that informal learning environments that engage participants in hands on activities where they learn by doing as well as activities that allow them to learn by analyzing are ideal when delivering effective context-specific activities.

Lack of Tools for Communication and Collaboration. The problem of communication and collaboration was identified by participants in both MLE1 and MLE2. Essentially it became a question of synchronous vs. asynchronous communication. Both the discussion forum during the mobile learning experience and the discussion forum in reaction survey 2 (after their first clinical event) were asynchronous. Participants found the asynchronous forum during the mobile learning experience to be useless as a post in this forum would not be responded to in real-time. The asynchronous forum in reaction survey 2, however, was found to be an extremely useful resource for participants to share experiences, clinical protocols, advice and templates. The asynchronous forum, therefore, functioned well in the formal online learning course but not in the informal, context-based mobile learning experience. This should not be a big surprise since the delivery of the mobile learning experience in this study was based on Park's (2011) Type 2: High Transactional Distance Individualized Mobile Learning, where interactions occur mainly between the learner and the content and not between or among learners. This is designed to make the learning more flexible, portable and influenced by the context. It was selected for this study since participants would be completing the mobile learning experience at different times and at different health care facilities across Ontario. While the majority of mobile learning frameworks such as the one proposed by Pachler (2009) advocate for synchronous communication among learners to promote collaboration, Koole (2009) reminds researchers that mobile learning can be utilized both collectively and individually to consume and create knowledge.

Avatar as a Guiding Host. One of the key and surprising findings in the study was the apparent effectiveness of the avatar as a host to guide the participants through the mobile learning experience activities. Participants of MLE1 repeatedly mentioned how fun, interactive and engaging it was to have the avatar present during the tasks and ask for feedback with the checklist. Participants of MLE2 where there was no avatar even suggested that some sort of host or teacher would be a useful addition to the resource. A likely reason for the avatar's effectiveness was due to the fact that it played a key role in the guided participation structure of the mobile learning experience. Kirschner et al. (2006) found that inquiry based learning is most effective when guidance is provided by a facilitator, and this has been found to be particularly effective for mobile-based learning environments (Evans & Johri, 2008). The avatar took on the mentor role and assigned tasks, set the rules and provided feedback during the activity. This provided the cognitive regulation of skills and tasks that is a key ingredient for an inquiry-based learning environment (Shih et al., 2010).

Avatars have been identified by Peterson (2005) as a manner of enhancing interaction in a virtual space, but research into their use in educational contexts is in its infancy (de Freitas & Oliver, 2006). The potential for future educational use has been outlined in several recent research projects, particularly with regards to experimental learning. "We can use avatars to design learning experiences that are more enjoyable and promote involvement, which may ultimately produce learners who are eager to return and learn more" (Hobart, 2012, p. 112). Inquiry-based learning, when combined with avatar-based virtual environments can increase learner motivation and provide and educationally valuable learning opportunity for students (Falloon, 2010). A majority of the research on avatars has focused on their inclusion in virtual learning environments, so more study on their effectiveness as educational hosts is warranted.

Learning Outcomes

Effectiveness of MLE1 Delivery Methods. Perhaps the most surprising finding was the effectiveness of the delivery methods in MLE1 with regards to practical learning outcomes. Participants in MLE1 experienced a significant difference in learning outcomes as compared to MLE2 with regards to understanding new principles of telemedicine, learning applicable skills in a specific context, and learning information that they couldn't have accessed through an online course. The avatar-hosted, "push" and "pull" methods of delivery allowed learners to interact with and apply the content more effectively than the didactic screencast, despite the fact that they both occurred in the same learning context (the clinical videoconference studio). These findings achieve two key pedagogical potentials that early researchers identified for mobile learning: that successful mobile learning should be a constant process of giving and receiving feedback (Munyinda, 2007), and that mobile learning should provide a unique educational experience that is individualized, personalized and highly interactive (Cobcroft, Towers, Smith & Brund, 2006). Findings for delivery methods with regards to participant satisfaction were inconclusive since satisfaction was essentially the same for MLE1 and MLE2, and no quantitative questions were employed to measure the change in participant behavior. Both learning outcome 1 (satisfaction) and learning outcome 3 (behavior), therefore, require more accurate and reliable evaluation techniques. This revision will be expanded upon in the third paper in this study where the mobile learning experience conceptual framework is evaluated and revised.

Conclusion

Two hundred and thirteen healthcare professionals took part in this mixed methods study that explored how learning outcomes in a mobile learning experience were affected by the structure and delivery of the mobile learning content.

With regards to mobile learning delivery, results revealed the importance of providing learners with a delivery method that promoted flexibility and control when utilizing a mobile learning experience to apply knowledge in a specific learning context. Participants said they felt the delivery of the learning environment engaged them and provided them with both flexibility and control when working through the task and checklist activities that they were able to pull from the resource and then push back from the learning environment. This also allowed them to work at their own pace and provided a variety of types of learning activities that participants felt enabled and engaged them in the learning activity.

The strongest results focused on the capture and integration of new knowledge and the avatar host. The combination of tasks to perform and checklist activities to answer provided the participants with the guided participation and the formative feedback required to develop their technical skills with the videoconference equipment as well as their protocol skills for clinical telemedicine appointments. The avatar host was also found to be an extremely effective facilitator for the mobile learning experience. Despite the individualized nature of the activity, the avatar helped the participants access and connect with the learning content and provided guidance and feedback during the simulation.

The key finding with regards to the structure of mobile learning was the overwhelming success of situating the informal learning of the mobile learning experience within the formal confines of an online course. This allowed the mobile learning experience to provide contextual, hands-on learning for participants that promoted the acquisition of specific workplace skills. The online course was effectively used to prepare learners for the mobile learning experience, and then support them with discussion forums, supplemental material and feedback after the mobile learning was complete. This hybrid model of online/mobile learning increased learner satisfaction, engagement and allowed them to apply skills in a specific, physical learning context. Further examination and study into other applications of this hybrid model is warranted due to the absence of examples in the mobile learning literature, coupled with the positive outcomes from this research.

The integration of the asynchronous discussion forum was not considered a success as participants felt they needed immediate support and interaction in order to promote communication and collaboration. It would be worth further examination into the learning experiences of the participants to examine what type of community of practice would benefit them in a mobile learning experience such as this one.

This study responded to calls from for more research into the delivery of mobile learning in informal contexts, as well as for more studies on how to implement informal mobile learning into formal online learning environments. This study suggests that the structure and delivery of mobile learning experiences should be carefully considered during the instructional design stage in order to provide practical learning experiences, and reliable learning outcomes.

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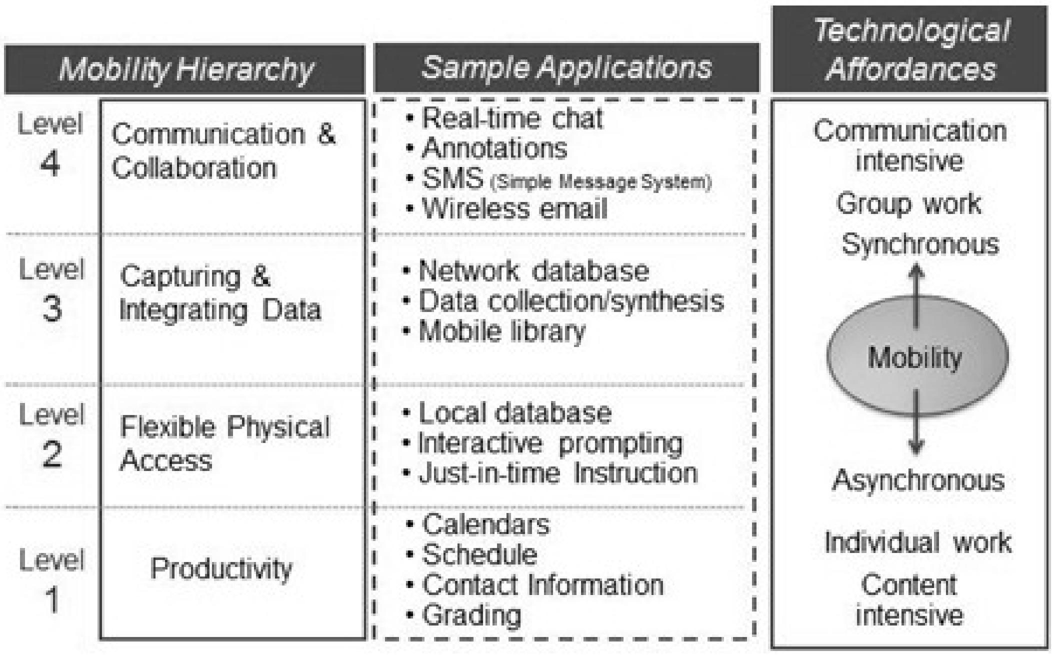
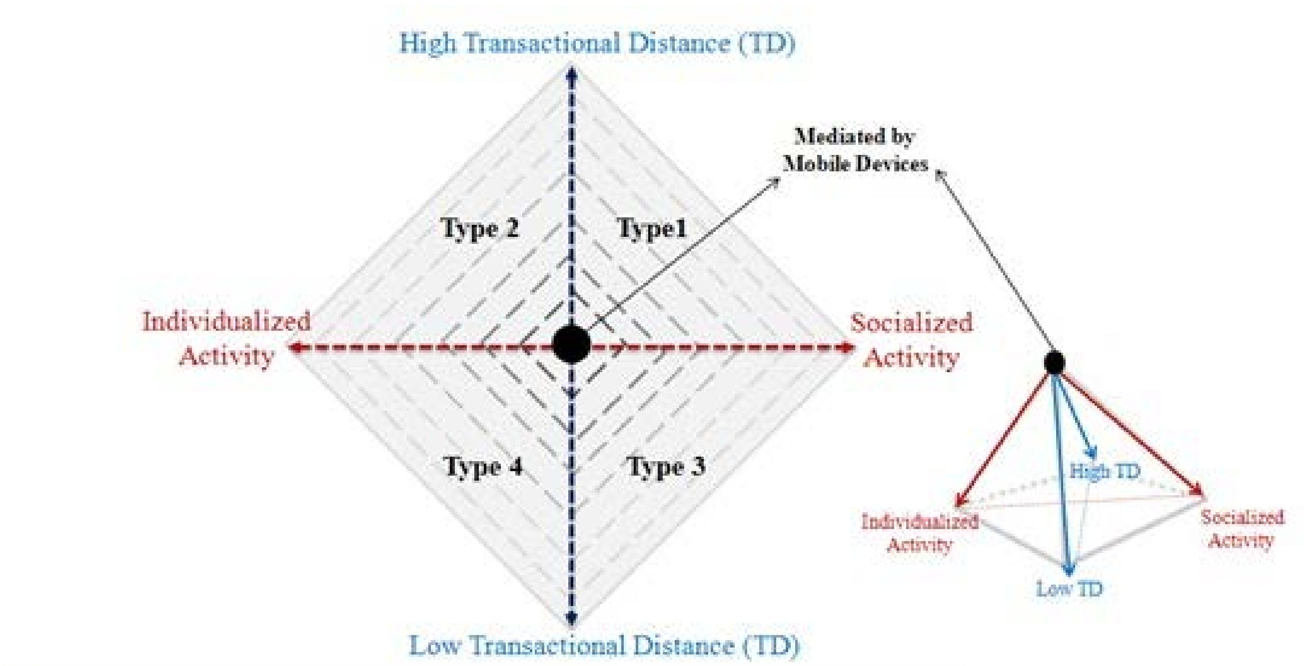
Appendix I: Mobile Hierarchy, Sample Applications and Technical Affordances



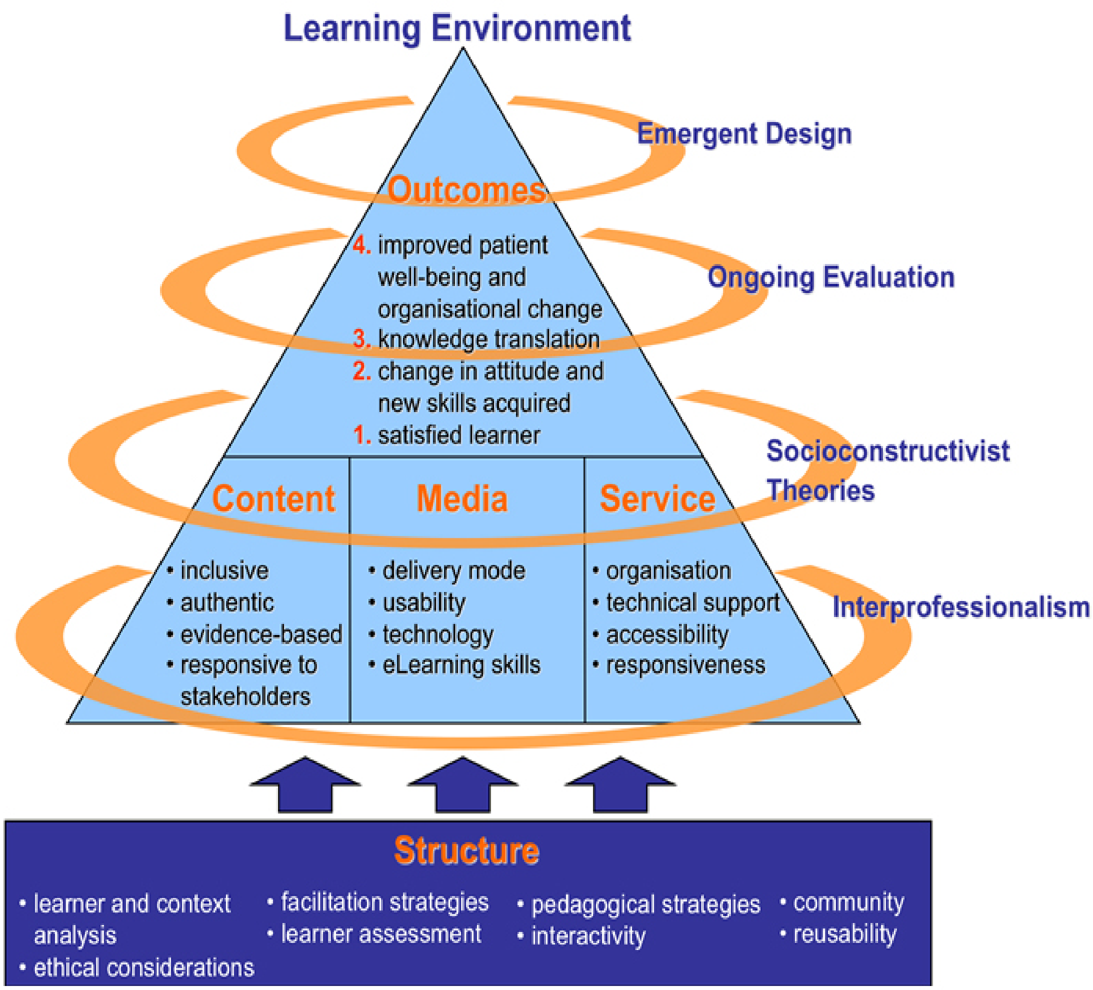
Taken from: (Gay, Rieger & Bennington, 2002)

Appendix II: Four Types of Mobile Learning Based on Transactional Distance Theory



Taken from: (Park, 2011)

Appendix III: The W(e)Learn Framework



(MacDonald et al., 2009)

Appendix IV: Post-Program Mobile Learning Experience Survey

For the following questions, the available response options are: Strongly disagree, Disagree, Agree, Strongly agree, Not applicable

Content

The content is of appropriate depth and breadth
The content is well organized
The content is context-specific
The content effectively presents technical skills that I can apply in my workplace
The content effectively presents clinical skills that I can apply in my workplace
The content effectively guides me through the activities
The content is applicable for my professional life
The content is authentic

Usability

In this program it was easy to "navigate" through the content.
The instruction is divided into clear and logical sections
Uploading and downloading material was fast and efficient
Presentation of material utilizes aesthetically pleasing graphics
Content was displayed in a consistent fashion on my mobile device
Pages loaded quickly
Interactivity was efficient when posting to and accessing the discussion wall
The mobile learning experience was interactive and productive due to its usability

Delivery

The resource respects my experience and current knowledge
The delivery allowed me to control my learning environment
There is flexible access to support tools, information, help, and online communication
The delivery of the information promotes a flexible learning environment
The delivery allowed me to capture and integrate information
The resource promotes communication among learners
The resource promotes collaboration among learners

Structure

The introductory online learning modules prepared me for the mobile learning experience
The mobile learning experience kept my interest
The mobile learning experience motivated me to learn
The mobile learning experience engaged me in the learning experience
The material follows a logical progression
The mobile learning experience provides opportunities for problem-solving experiences
The mobile learning experience provides opportunities to apply material learned

The online modules supported the mobile learning experience after it was completed
I enjoyed the combination of online learning with the mobile learning experience

Outcomes

The online/mobile course is interesting
The online/mobile course is valuable
As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine
As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques
As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context
The mobile learning experience allowed me to learn information that I could not have accessed through an online course
The mobile learning experience made the learning environment more motivating and engaging

Please complete the following statements:

7. The most valuable aspect of the mobile learning experience was….

8. The design or delivery of the mobile learning experience could be improved by…

9. What, if anything, did you learn in the mobile learning experience that you will apply in your professional life?

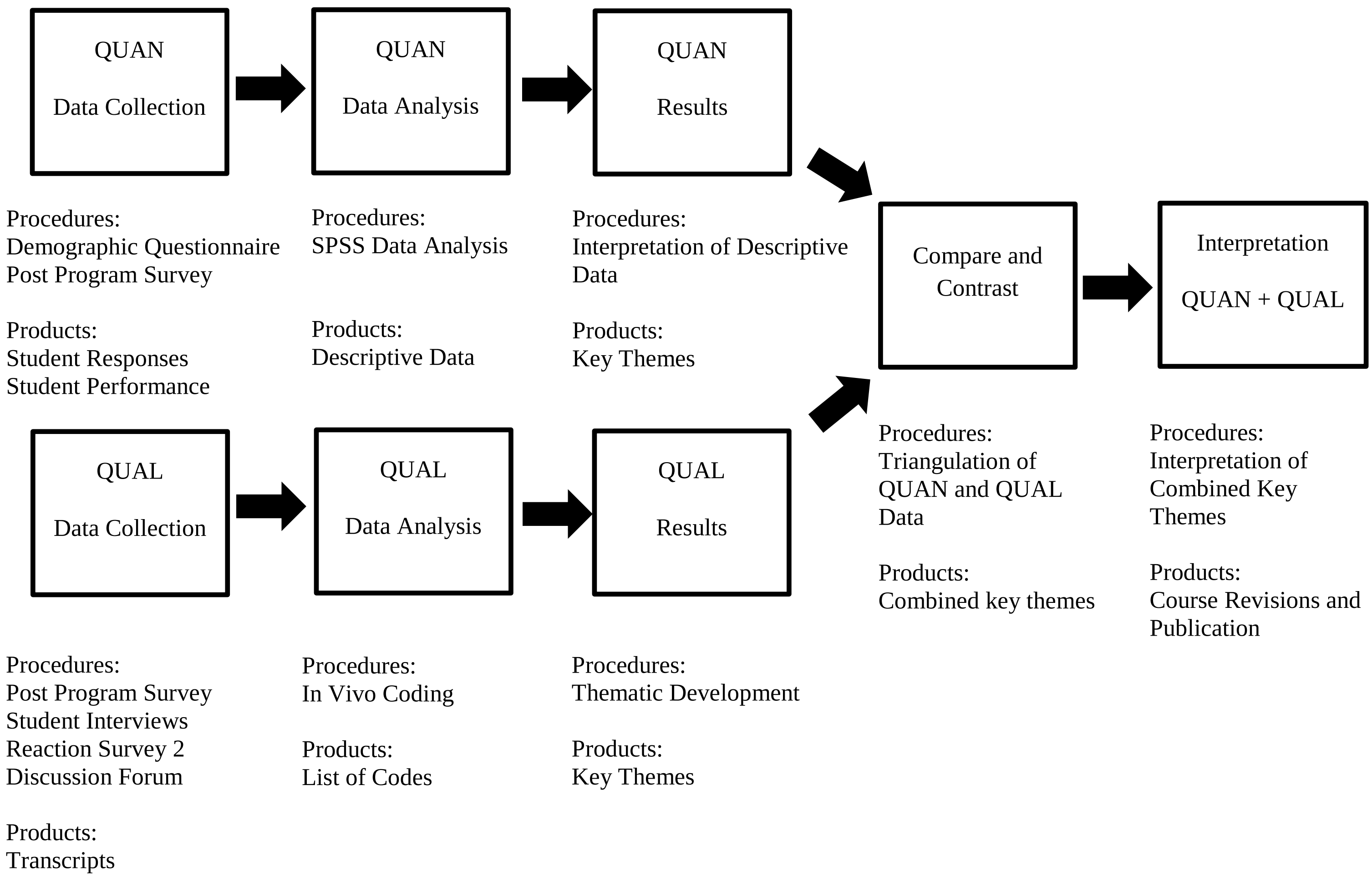
10. What value (if any) did the discussion wall add to the learning resource?

11. How did you access the mobile learning experience?
    a. From my mobile phone
    b. From my tablet
    c. From my personal computer

12. How could or should a mobile learning experience be used in an online learning resource (such as this)?

(Adapted from MacDonald, C. J., Stodel, E. J., Thompson, T-L., & Casimiro, L. (2009)

Appendix V: Convergent Parallel Mixed Methods Design



Adapted from: (Fuji, Paschal, Galt & Abbott, 2010, p. 243)

Appendix VI: Demographic Questionnaire

Please complete the following questions. All responses will be kept confidential.

6. Gender: Female _____ Male_____
7. Please indicate your profession: ___________
8. Please indicate your age:__________

9. How often do you use mobile devices (phones or tablets) to find information for personal interest and/or essential needs? Examples could be Internet browsing, playing online games, shopping, finding medical information, finding help with hobbies etc. Please circle the most correct response.

   1= none
   2= not often
   3=sometimes
   4=often
   5=always

10. a. Is this the first mobile learning experience or course you have taken? (yes / no)

    b. If you answered no, how many mobile learning courses have you taken? ________

5. What types of online experiences have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

participated in threaded discussions	1	2	3	4	5
real-time chat	1	2	3	4	5
listened to podcasts	1	2	3	4	5
co-created wikis	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
simulations	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

7. What types of experiences with mobile devices (phones or tablets) have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

texting	1	2	3	4	5
facebook posts	1	2	3	4	5
accessing email	1	2	3	4	5

accessing web pages	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
sharing audio/video files	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

7. Would you consider your online learning experiences positive?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

10. Rate your exposure to online learning on a scale of 1-4. Please circle the most correct answer.

1= I have never used online learning before
2= Once before
3=Several times before
4=Often

11. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

(Adapted from Archibald, D. 2008)

Appendix VII: Reaction Survey 2: After Your First Telemedicine Appointment

Congratulations on the completion of your first telemedicine appointment. Please answer the following questions relating to how the mobile learning experience prepared you for the telemedicine appointment. If you have any resources/suggestions please post these to the “Resources” section of this forum.

6. Did you find that the mobile learning experience taught you knowledge and skills that you were able to apply in your first telemedicine appointment?

7. What were the most valuable knowledge and/or skills that you learned in the mobile learning experience?

8. Were there any knowledge or skill gaps that you didn’t learn in the mobile learning experience that you required in the telemedicine appointment?

9. Do you find value in posting to this forum?

10. Do you find value in reading the posts of other learners in this forum?

Appendix VIII: Semi-Structured Interview Guide

For learners to read before the interview:

Thank you for agreeing to participate in this interview. The purpose of the interview is to obtain a deeper insight into the data collected from the online survey you completed after completing the online equipment training course. Specifically, these questions will be about the mobile learning experience portion of the course.

We are going to be audio-taped so that I can refer back to this discussion when I write my final report. During this discussion and when I write the report we will be using pseudonyms to protect your identity. No one else but my supervisor and I will listen to the audio recording. Please speak in a loud clear voice so the recorder picks-up what you say.

Sample Questions:

10. Was this an authentic learning resource?
11. Did the content of the mobile learning experience teach you new processes or skills? If so, what are they?
12. Was the mobile learning experience easy do use? What did you think about the navigation and layout?
13. Do you think the mobile learning experience contributed to the online course? If so, how?
14. Did you find the feedback list helpful that you received after the mobile learning experience? How? Explain?
15. Did the discussion forum in the mobile learning experience contribute to your learning? How? Explain?
16. Explain how you would compare this mobile learning experience to the conventional classroom?
17. Will the mobile learning experience help you apply the knowledge created in this course to your work related activities?
18. What, if anything, was missing from this mobile learning experience? Please give examples.

Appendix IX: Demographic Survey Results

Table 1.1
Gender, Age, Profession, Mobile Experience of Participants
(N = 213)

Gender	Count	Total %
Male	26	12.2 %
Female	187	87.8 %

Age	Count	Total %
under 30	54	25.4 %
31-40	101	47.4 %
41-50	46	21.6 %
51-60	12	5.6 %
61-70	0	0 %

Profession	Count	Total%
Nurse	183	85.9 %
Administrator	14	6.6 %
Medical Student	10	4.7 %
Practicing Physician	6	2.8 %

First Mobile Course?	Count	Total%
Yes	185	86.9%
No	28	13.1%

Table 1.2
How Often Participants Use Mobile Devices to Find Information
(N = 213)

Response	Count	Total %
None	27	12.7 %
Not Often	44	20.7 %
Sometimes	73	34.3 %
Often	62	29.1 %
Always	7	3.3 %

Table 1.3
Participants' Exposure to Online Learning
(N = 213)

Response	Count	Total %
Never	21	9.9 %
Once Before	45	21.1 %
Several Times	123	57.7 %

Often 24 11.3 %

Table 1.4

*Participants' Responses to the Types of Online Experiences They Have Had (N=208)**

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Participated in threaded discussions	1	4	2	1.89	0.601
2. Real-time chat	1	4	2	1.95	0.554
3. Listened to podcasts	1	4	2	2.01	0.534
4. Co-created wikis	1	3	1	1.54	0.523
5. Videoconferencing	1	4	3	3.31	0.657
6. Audioconferencing	1	5	4	4.01	0.689
7. Simulations	1	3	2	1.88	0.521

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**five response missing*

Table 1.5

*Participants' Responses to the Types of Mobile Experiences They Have Had (N=208)**

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Texting	1	5	4	3.97	0.622
2. Facebook posts	1	5	3	2.93	0.667
3. Accessing email	1	5	4	4.22	0.545
4. Accessing web pages	1	5	4	3.65	0.688
5. Videoconferencing	1	4	3	2.78	0.654
6. Audioconferencing	1	5	3	3.76	0.697
7. Sharing audio/video files	1	4	2	2.31	0.665

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**five responses missing*

Table 1.6

Participants' Responses to Online and Mobile Experiences (N=213)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Would you consider your online learning experiences to be positive?	0	4	3	3.41	0.572
2. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?	0	4	3	2.67	0.656

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Appendix X: Post-Program Mobile Learning Experience Survey Descriptive Statistics

Table 1.1

Post-Program Survey Structure Responses (N=213)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The introductory online learning modules prepared me for the mobile learning experience	2	4	3	3.23	0.718
2. The mobile learning experience kept my interest	2	4	3	3.08	0.516
3. The mobile learning experience motivated me to learn	2	4	3	3.09	0.426
4. The mobile learning experience engaged me in the learning experience	2	4	3	3.24	0.544
5. The material follows a logical progression	1	4	3	2.73	0.533
6. The mobile learning experience provides opportunities for problem-solving experiences	2	4	3	2.85	0.577
7. The mobile learning experience provides opportunities to apply material learned	2	4	3	3.23	0.531
8. The online modules supported the mobile learning experience after it was completed	2	4	3	3.39	0.488
9. I enjoyed the combination of online learning with the mobile learning experience	2	4	3	3.08	0.586

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.2

Post-Program Survey Delivery Responses Mobile Learning Experience 1 (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The resource respects my experience and current knowledge	2	4	3	3.09	0.619
2. The delivery allowed me to control my learning environment	2	4	3	3.23	0.728
3. There is flexible access to support tools, information, help, and online communication	2	4	3	2.97	0.562
4. The delivery of the information promotes a flexible learning environment	2	4	3	3.41	0.511
5. The delivery allowed me to capture and integrate information	2	4	4	3.38	0.767
6. The resource promotes communication among learners	1	4	3	2.99	0.599
7. The resource promotes collaboration among learners	1	4	2	2.49	0.593

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.3

Post-Program Survey Delivery Responses Mobile Learning Experience 2 (N=92)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The resource respects my experience and current knowledge	2	4	3	3.06	0.589
2. The delivery allowed me to control my learning environment	2	4	3	2.83	0.784
3. There is flexible access to support tools, information, help, and online communication	2	3	3	2.51	0.620
4. The delivery of the information promotes a flexible learning environment	2	4	3	3.33	0.498
5. The delivery allowed me to capture and integrate information	1	3	2	2.30	0.659
6. The resource promotes communication among learners	1	4	3	2.91	0.765
7. The resource promotes collaboration among learners	1	4	2	2.36	0.622

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Chapter 3: Article 2

Developing Interactive Mobile Learning Experiences:

Content, Usability and Community of Practice Considerations

Article for Submission to:

International Journal of Mobile Technologies

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February 20, 2015

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Introduction

The potential for mobile learning to reach people in remote locations (Park, 2011), provide access to context-specific instruction outside the classroom (Klopfer & Squire, 2008), and allow learners to communicate and collaborate during an educational event (Peters, 2007) is found throughout the literature. Mobile learning has been described as "…a personal, unobtrusive, spontaneous, 'anytime, anywhere' way to learn and to access educational tools and material that enlarges access to education for all" (Kukulska-Hulme & Traxler, 2005, p. 1). However there have been numerous technical challenges with regards to delivering universally accessible, high quality mobile learning (Ramos & Trinona, 2010). Traditional instructional design is not applicable for mobile learning as it does not take into account characteristics such as mobility and how smaller screens can be limiting factors with regards to the format and type of content delivered (Chittaro, 2011; Costabile et al., 2008; Naismith, Lonsdale, Vavoula, & Sharples, 2005). "For mobile learning to attain its full potential, it is essential to develop pedagogy and instructional design tailored to the needs of this new learning environment" (Wang, Shen, Novak & Pan, 2009), and address technical challenges for deploying, sharing and managing access to educational materials both on-and off-line (Stead, 2014).

Wang and Shen (2011) have advocated for more research and development in the following areas: designing content based on the learning environment, presenting content that is flexible according to the type of mobile device being used, promoting learners to share information via communities of practice, and designing for learner mobility (through the use of audio, icons, color and symbols). Elias (2011) identifies numerous challenges for designing mobile learning content that maximizes usability including: device variability, slow download speed or limited Internet access, small screen sizes, poor resolution and color, awkward text input, and limited memory. Developing learning strategies for the design of mobile learning content, usability and communication is critical in order to develop innovative and engaging mobile educational tools that foster positive learning performance and outcomes (Chu, Hwang & Tsai, 2010).

The focus of this article is to address three identified research gaps in the mobile learning literature. These include examining best practices for designing inquiry-based contextual instructional content, proposing and testing design considerations to maximize usability for mobile learners, and examining the pedagogical uses and impacts of communities of practice for mobile learning.

For the purpose of this paper, mobile learning is referred to as a mobile learning experience, occurring within the framework of a larger online course. A "mobile learning experience" refers to a learning activity that the participants perform on their mobile device (laptop, tablet or phone), in a specific physical context or location. The content of the mobile learning experience was built upon best practices identified in the mobile learning literature, by providing inquiry-based educational activities within a specific healthcare workplace context. Two instances of communities of practice were presented to participants (one during the mobile learning experience and one afterwards), in order to examine how participants engage, interact and utilize the communities. Additionally, two versions of the mobile learning experience were randomly assigned to participants. Both versions had the identical contextual content and opportunities for communication/collaboration through the communities of practice, but one had its usability designed by best practices identified in the mobile learning literature, while the second did not. This isolation of the dimension of usability provided a more focused examination of the importance of usability to the learning experiences and outcomes of participants. The mobile learning experiences were deployed in the Ontario Telemedicine Network's online videoconference equipment training course which was accessed by physicians, nurses and healthcare professionals at medical organizations across Ontario.

Literature Review

Mobile Learning Content Design

Researchers have identified the need for instructional designers to utilize existing theories of learning in order to determine how to apply mobile technologies to education (Naismith et al., 2005). There are two predominant theories for instructional design discussed in the mobile learning literature. The first involves constructivism and the collaboration and sharing of knowledge via mobile devices, and the second is situated learning where mobile devices are employed in specific contexts. Mobile learning environments have been identified as ideal for adopting the situated learning assumptions of constructivist principles. This is because learners can bring their own experiences and expertise to a specific context and build on and enrich their prior knowledge (Comas-Quinn, Mardomingo & Valentine, 2009; Dede & Sprague, 1999). This promotes interaction, increases learner motivation, allows users greater control over the learning process, and can result in the creation of applicable real-word knowledge (Valdez et al., 2000). Thus situated, constructivist learning can result in interactive learning experiences with practical learning outcomes.

Some researchers, however, have questioned the transferability of skills that students develop by using purely constructivist, participatory simulations, as well as the effectiveness of situated learning environments if the context is not authentic (Naismith et al., 2005). “The most successful learning comes when the learner is in control of the activity, able to test ideas by performing experiments, ask questions, collaborate with other people, seek out new knowledge, and plan new actions” (Naismith et al., p. 15). For the purpose of this study, the category of mobile learning that is being examined will include what Traxler (2007) refers to as situated or contextual learning, where location-specific experiences and activities are used to provide educational experiences that might otherwise be impossible, as well as collaborative or constructivist learning where learners can share and build on their prior knowledge. An ideal mobile learning experience, therefore, is one that is based in real-world, authentic contexts where learners will be in situations and simulations where they would normally apply the skills and knowledge presented. In order to ensure situating learning in authentic contexts, learners should be presented with knowledge and skills that will allow them to determine what works best for them in a specific learning context.

The justification for choosing both situated learning and constructivism for the design of mobile experiences can be found throughout the existing literature. According to Lave (1990), contextual learning focuses on the relationship between the environment and the learner, and learning is heavily influenced by culture and the community of practice within which a learner resides. This situated or contextual learning also influences both the content being delivered and the motivation of the learner. What works in a specific situation dictates the content being delivered which can lead to increased learner motivation by presenting them with applicable knowledge and skills for the specific learning environment. Thus contextual learning strives to engage the learner with a problem, and allow the learner to develop goals to solve the problem through authentic tasks in multiple domains (Barab & Roth, 2006). Social interaction, collaboration and constructing knowledge based on shared and new experiences are also key components of situated learning. Learners can become a part of a community of practice which presents beliefs, knowledge and behaviors that can then be acquired by the learner (Lave & Wenger, 1990). Communities of practice are powerful tools that can be utilized to promote communities of learning, where teaching becomes learner-centered and learners can cooperate, collaborate and build upon prior knowledge together (Sergiovanni, 1994). A more detailed discussion of communities of practice and constructivism is presented later in this paper.

Situated learning is also referred to as situated cognition, which contends that knowledge is embedded in the activity, context and culture in which it was learned (Brown, Collins & Duguid, 1989). Situated cognition allows people to address challenges and problems and engage in a community of practice (Aydede & Robbins, 2009). It is based on the notion that learning is naturally tied to authentic activity, and that it is more difficult to learn from un-natural learning environments (Brown et al., 1989). Situated cognition and situated learning have important implications for the design of classroom instruction and in electronic or technology-based learning (Korthagen, Kessels, Koster, Lagerwerf & Wubbels, 2001). In fact, mobile learning and its ability to place the learner into specific educational contexts has shown to be ideally suited for putting situated cognition and learning into practice (Naismith et al., 2005).

"Context, then, is a central construct of mobile learning. It is continually created by people in interaction with other people, with their surroundings and with everyday tools" (Kukulska-Hulma et al., 2009, p. 21). Franklin (2011), contends that effective mobile learning requires learners to achieve "…intellectual engagement and interaction with the context of the learning outcomes" (p. 264).

Successful contextual mobile learning content must:

(a) Enable learners to reach their potential by giving them access to educational resources and experiences beyond the classroom;

(b) Engage learners in contextual learning experiences where they can take part in problem-solving and critical thinking;

(c) Empower learners to take control of their own educational experiences and development. These "3 E's" (enable, engage, empower) require that mobile learning must: provide individualized content to meet the needs of each participant, allow continuous access to the content so it can be used any time a participant requires it, facilitate communication and collaboration with fellow participants and teachers, and allow for participants to create and share documents, audio files, video clips or other experiments (Franklin, 2011).

Usability of Mobile Learning

Technological usability has been identified as a critical component when designing accessible mobile learning. In fact, if a piece of technology is difficult to use this will become a barrier and it will not be adopted by educators and learners (Fozdar & Kumar, 2007). "It is critical that the overarching problems facing mobile computing be addressed by creating an environment that is flexible, easy to use, and conducive to collaborative communication anytime, anywhere" (Heath et al., 2005, p. 51). Practical usability is just as important as sound theoretical design, as poorly designed interfaces can act as a barrier to teaching and learning (Gu et al., 2011).

Based on the work by Elias (2011) and Wagner (2005), there are eight user interface design principles that are important for practical and useable mobile learning environments. A summary list adapted from their work can be found in Table 1, and each issue will be described in detail as well as how it was addressed for this study.

Table 1

User Interface Design for Inclusive Mobile Learning

Design Principles	Mobile Learning Recommendations
1. Equitable use	- Deliver content in simplest possible format - Use cloud-computing file storage and sharing sites
2. Flexible use	- Package content in small chunks - Offer choices and additional information - Consistent presentation regardless of device
3. Simple and Intuitive	- Simplify interface - Offer text-only options - Utilize visual icons for home pages and tasks - Reduce number of "layers" or clicks for users
4. Perceptible information	- Utilize video, audio and file formats that display consistently across all browsers and screen sizes - Add navigation buttons and table of contents to denote progress-
5. Richness	- Enhance speed with which pages load

	- Reduce size of videos and pictures to increase speed - Videos and audio files play smoothly and seamlessly
6 Ease of interactivity	- Make interactions with content simple - Allow for short responses, ease to upload information - Present content and accept feedback in multiple formats
7. Community of learners and support	- Utilize multiple methods of communication - Easy-to-find links to support services - Group learners according to technological access or preferences
8. Instructional climate	- Make contact and stay involved in learning process - Push regular reminders, activities and questions to students - Pull in learner-generated content and feedback

Adapted from Elias (2011) and Wagner (2005)

The first is equitable use, which refers to delivering content in simple and efficient formats, using use cloud-computing file storage and sharing sites to keep user costs down, and minimizing download times. Wagner (2005) calls this “mobile efficiency” and recommends using text-based web pages, YouTube videos, and screencasts as tools for efficient delivery methods. Open-source Virtual Learning Environments (VLEs) such as Moodle have emerged as cost-effective, efficient means of organizing and delivering online content for uses within the online and mobile learning classrooms (Börner et al., 2010). Moodle was used to house all of the online course content, discussion forums, quizzes, surveys and the link to the mobile learning experience in this study.

The second design principle is flexible use, referring to making a mobile learning environment accessible to learners with different devices and levels of connectivity. Suggestions to increase flexibility include packaging content in small pieces (Gu, Gu & Laffey, 2011), and utilizing software and tools that can identify the device that the learner is using and display the learning content in a consistent fashion based on that device (Dean, 2011). Marcotte (2010) identifies CSS and HTML5 as methods to present consistent content, optimize search engine capabilities, provide access to resources, and allow learners to contribute content to courses. Both CSS and HTML5 were utilized in the design of the mobile learning experience in this study so as to ensure consistent content delivery to participants on a wide range of devices.

A third principle is keeping the mobile environment simple and intuitive. Navigation should be easy, incorporate as few pages as possible, minimize scrolling, and utilize symbols for menus and tabs as much as possible (Hsu & Chen, 2010). This is called a "fixed format of design" by Cassarino (2003), which refers to a consistent user interface throughout an online or mobile experience. The learner should also be oriented to the user interface on the home page at the beginning of the learning activity. The home page is easier to navigate if it contains icons for different tasks or activities, and utilizes breadcrumbs or links from the home page so as to keep the learner acclimated to their position during the learning activity. Poor user interface design has been shown to increase learner confusion and can "…place cognitive demands upon the learner that can reduce interest and divert attention away from the primary learning tasks" (Metros & Hedberg, 2006, p. 108). In this study, an avatar was used to host and orient participants to the mobile learning experience, and simple icons and navigation buttons were utilized to promote an intuitive user interface designed to keep participants focused on the learning activity.

The fourth principle is perceptible information, or the ability of the media content (videos, audio or multimedia files) to be displayed in a consistent fashion regardless of the browser or screen size of the user (Goh & Kinshuk, 2006). Current best practices for content include mpeg-4 for video files, mp3 or aac for audio files, PDF files for written content and png or jpeg for images (Hazael-Massieux, 2013). A second critical factor in perceptible information is that the learner can identify where they are in the learning activity. Easy-to-use navigation buttons and progress bars are a must to keep learners updated on their progress in a mobile learning experience (Stead, 2012). In this study, all current guidelines were utilized for the multimedia files, and easy-to-use navigation buttons, progress bars and table of contents were employed to update participants on their advancement throughout activities and facilitate movement throughout the mobile learning experience.

A fifth important design principle is richness. Wagner (2005) refers to this as the speed with which pages load, animations play, and videos stream. Individual media files must be optimized for the mobile experience and compressed accordingly. Often this may involve detailed testing to determine how small the file can be compressed while still maintaining a high degree of clarity and quality (Hazael-Massieux, 2013). The database used to house and deliver the content must also be configured for optimal performance, and the network utilized to access the content can also affect richness of delivery (Hartmann & Stead, 2011). A great deal of effort was made in this study to compress all media files to their minimum functional size and test the database to ensure connectivity speed was maximized. The networks participants used, however, were dictated by the personal or workplace network that they utilized to access the mobile learning experience as participants were scattered across healthcare organizations in Ontario.

The sixth design principle is ease of interactivity. This refers to the physical and technical effort that it takes for learners to use the phone to interact with and produce course content. Written responses should be short, photos easy to upload, and video and audio clips simple to record and transfer, thus making the learning environment more interactive and productive (Goh & Kinshuk, 2006). The use of checklists with radio buttons, short answer questions, multiple-choice questions, and forum posts have been identified as efficient formats for mobile learning activities. From a programming perspective, HTML5, CSS and Javascript are recommended to provide efficient and interactive functionality (Stead, 2014). Checklists and discussion forums designed and supported with CSS and Javascript were utilized for the interactivity for the mobile learning experience in this study.

A seventh design principle is technical considerations for community of learners and support. Learners should be able to utilize multiple forms of communication (texting, instant messaging, voicemail), and have convenient access to discussion forums and tools. Mobile learning technologies "…provide the ability to engage in learning conversations between students and lecturers, between student peers, students and subject experts, and students and authentic environments within any context" (Cochrane, 2010, p. 2). Blogs and discussion forums are useful social media tools that can allow learners to synchronously or asynchronously reflect upon what they have learned, note what they think is important and assemble a learning archive of their experiences (de Waard, 2014). There are numerous other types of social media platforms for sharing key learnings, but for this study a Moodle discussion forum was employed.

Finally, there is the design principle of the instructional climate, or how the course is delivered. Instructors must consider how to push and pull educational information in order to foster an inclusive and context-specific learning environment (Elias, 2011). The instructor can set up regular updates, tips, reminders and schedules can be "pulled" by the learner in order to highlight key skills and tasks to perform or knowledge for the learner to acquire. In addition, the learner can "push" key learnings from the learning environment by using such strategies as discussion forums, image/audio file sharing, and blog posts. This fosters an inclusive, collaborative atmosphere and provides feedback from the context-specific learning environment (Ramos & Trinoña, 2010). In this study, an avatar host and detailed task list allowed participants to pull content from the mobile learning experience, and an interactive checklist and the discussion forum were utilized by participants to push content from the learning context back to the Moodle online course.

Mobile Learning Communities of Practice

The term "Community of Practice" was first linked to situated learning in 1991 by theorists Jean Lave and Etienne Wenger. There have been many definitions proposed according to the purpose of the community, but Lave and Wenger (1991) began by describing it as "…participation in an activity system about which participants share understandings concerning what they are doing and what that means for their lives and for their communities" (p. 98). According to Lave and Wenger (1991), a community of practice has three required components: a domain (a shared area of interest), a community (the group of people who are sharing and learning from one another), and a practice (sharing of resources and ideas by people of the same profession). The definition of a community of practice was refined in 2002 by Wenger, McDermott and Snyder as: "Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (p. 4). This second definition focuses on the key elements and goals of a workplace community of practice: situated, collaborative and collective learning where solutions are proposed to contextual problems (Lee, Parslow & Julien 2002). It is this definition that will be adopted for the purposes of this study.

Communities of practice have been identified as a useful tool for healthcare professional education on a variety of pedagogical levels. "Wikis, blogs/photoblogs and podcasts (and its video incarnation, the vodcast) carry the potential of complementing, improving and adding new collaborative dimensions to the many Web-based medical/health education, CPD (Continuing Professional Development), and research services currently in existence" (Boulos, Maramba & Wheeler, 2006, p. 2). An online community of practice is often called a virtual community of practice (CoP) and allows participants to share experiences, problems and solutions, tools and methodologies (Gannon-Leary & Fontainha, 2007). Virtual CoPs enhance the learning environment since "…the learning that evolved from these communities is collaborative, in which the collaborative knowledge of the community is greater than any individual knowledge" (Johnson, 2001, p. 54). More importantly for this study, research has found that communities of practice are particularly effective when used in combination with informal situated learning and problem-solving activities (Fox, 2000). This is because experts in the community can share best practices with novice users, thus helping them build upon their prior knowledge and become more proficient in the techniques and skills being presented. "This view reiterates the model of apprenticeship or learning in social or situated contexts, especially in the workplace" (Gannon-Leary & Fontainha, 2007, p. 3).

Wenger, White and Smith (2009) have created a list of common orientations that virtual CoPs can have. Six of their common orientations are summarized in Table 2 below.

Table 2

Virtual Communities of Practice Common Orientations and Descriptions

CoP Orientation	Description
1. Meeting support	A community that emerges from a live or online meeting to share presentations, information or decision making
2. Open-ended conversations	The prototypical discussion forum that is based on ongoing threaded online conversations
3. Project infrastructure	Communities that form around a specific project and share vital information, artifacts and solve problems of workplace practice
4. Content collection and organization	Community that collects and categorizes information to improve ease of access by creating file or data repositories and useful web links
5. Access to expertise	Communities that identify experts and present them to the group for questions or advice
6. Community cultivation	The community cares for a specific topic and contributes content that can be repackaged in a more accessible form by a leadership or governance procedure

Adapted from: Wenger, White and Smith (2009)

Another important consideration within the orientation of each virtual CoP is the level of interaction expected among members of the community. Booth (2011) suggests three possible levels of interaction. The first is one-way dissemination where a central knowledge producer distributes knowledge to consumers who can comment or ask questions. The second is shared development, where communities build knowledge in parallel toward some type of common goal. The third level of interaction is many-to-many interactions, where the users are peers and knowledge flows freely among them. This final level Booth (2011) suggests is the most difficult to grow as it relies on volunteers, can be difficult to motivate participation, and also requires a lot of effort to govern.

Despite the discussion on the orientation and interaction of communities of practice, it's important to note that CoPs have their origin in constructivism. A primary principle of CoPs is to shift control from the instructors to the learners, and allow learners to share goals, solve problems, collaborate and utilize the community as they see fit (Johnson, 2001). Wenger (1998) describes communities of practice as situated learning because they are based on an evolutionary process for learning in groups. So communities of practice are not formed by the instructor, but they develop out of the necessities of the members over time (Liedka, 1999). Therefore learning is promoted through communication between community members, and this can help solve authentic problems and answer open-ended questions (Wick, 2000). In this study, therefore, the two communities of practice will be set up by the instructor, but the purpose, orientation and type of interaction within each CoP will be determined by the participants.

Methodology

Theoretical Background

Mobile learning has elements of both situated learning in a specific context, and constructivist learning where learners bring their own knowledge, perspectives and experiences when interacting with the content. Constructivist learning has an element of contextualized process, as knowledge is constructed based on both personal experiences and hypotheses of the environment in which new knowledge or content is presented (Zemelman, Daniels & Hyde, 1993). Learning is not the passive reception of facts, but an active construction of meaning (Piaget, 1977). In situated learning theory, learning is embedded in activity, context and culture. New knowledge should be presented in authentic contexts, and social interaction and collaboration are integral to the learning process (Lave, 1988; Brown, Collins & Duguid, 1989). Traxler (2007) notes the importance of situated learning for mobile learning design, since location-specific experiences and activities can be used to provide educational experiences that might otherwise be impossible. Situated learning in technology-supported learning environments is also an ideal fit with collaborative or constructivist learning, where learners can share and build on their prior knowledge (Kanuka & Anderson, 1999; Tam, 2000).

The combination of situated and constructivist pedagogical perspectives in mobile learning gives rise to a variety of context-specific research questions, making this study ideal for a pragmatic, mixed methods research approach. This is because pragmatism has been identified as ideal for answering varied and complex research questions that may include a variety of pedagogical perspectives and learning theories. Johnson and Onwuegbuzie (2004) emphasize that the pragmatist philosophy is ideal for educational research as it "…offers a method for selecting methodological mixes that can help researchers better answer many of their research questions" (p. 17). In this study, constructivism and situated learning principles were employed to design the collaborative, practical, context-based content and virtual communities of practice of the mobile learning simulations. Pragmatism was used to evaluate the effectiveness of this design by examining the experiences and learning outcomes of study participants.

Much like pragmatism, many of the strengths and benefits of mixed methods research centre on the enhanced results that the combination of techniques produces. It allows for a better understanding of a research problem by unifying trends within the quantitative data with specific, contextual details from the qualitative data (Hanson, Creswell, Plano Clark & Petska, 2005; Mertens, 2003; Punch, 1998). Researchers also argue that mixed methods can lead to a more comprehensive understanding of the research problem (Bryman, 2006), as well as greater validity and corroboration of results through triangulation (Greene, Caracelli & Graham, 1989). In order to answer the identified research questions and understand the various learning experiences and outcomes, this study used a convergent parallel mixed methods design. This allowed for the quantitative and qualitative results to be compared or related and a more complete interpretation and understanding of the results to be obtained (Creswell & Plano Clark, 2011).

Study Approach

In this convergent parallel mixed methods case study, 215 healthcare professionals participated in the Ontario Telemedicine Network's videoconference equipment online training program between December 1, 2013 and March 1, 2014. The purpose of this online resource was to provide healthcare professionals with the technical skills, process knowledge and etiquette tips to facilitate effective clinical consultations via videoconference.

The convergent parallel mixed methods design can be seen in Appendix III, where the processes of data collection, analysis, results and interpretation are outlined. The purpose of this second section of the mobile learning study was to answer the following research questions:

1. How does the content of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes?
2. How does the usability of a mobile learning experience for healthcare professionals impact its effectiveness as measured by their learning experiences and outcomes?
3. What are the participants' perceptions, interactions and usage of a community of practice during the mobile learning experience?
4. What are the participants' perceptions, interactions and usage of community of practice after the mobile learning experience?

The study was approved by the University of Ottawa's Social Sciences and Humanities Research Ethics Board. Consent letters detailing the requirements of the study were disseminated online and healthcare professionals taking the online equipment course were offered the choice to participate or decline to take part in the study.

Participant Recruitment

Participants in this study were healthcare professionals (registered nurses, nurse practitioners, physicians, administrators) participating in the Ontario Telemedicine Network's Telemedicine Coordinator training program. The mobile learning experience was situated in 12 online Videoconference Equipment Training Courses, where participants were taught how to utilize videoconference equipment to facilitate clinical consultations. There were approximately 50 learners registered in each of the 12 courses. All 600 learners were approached to take part in this study. A total of 215 agreed to participate and subsequently completed both the demographic questionnaire and post-program survey. Twenty participants were interviewed regarding their experience in the online and mobile learning experiences.

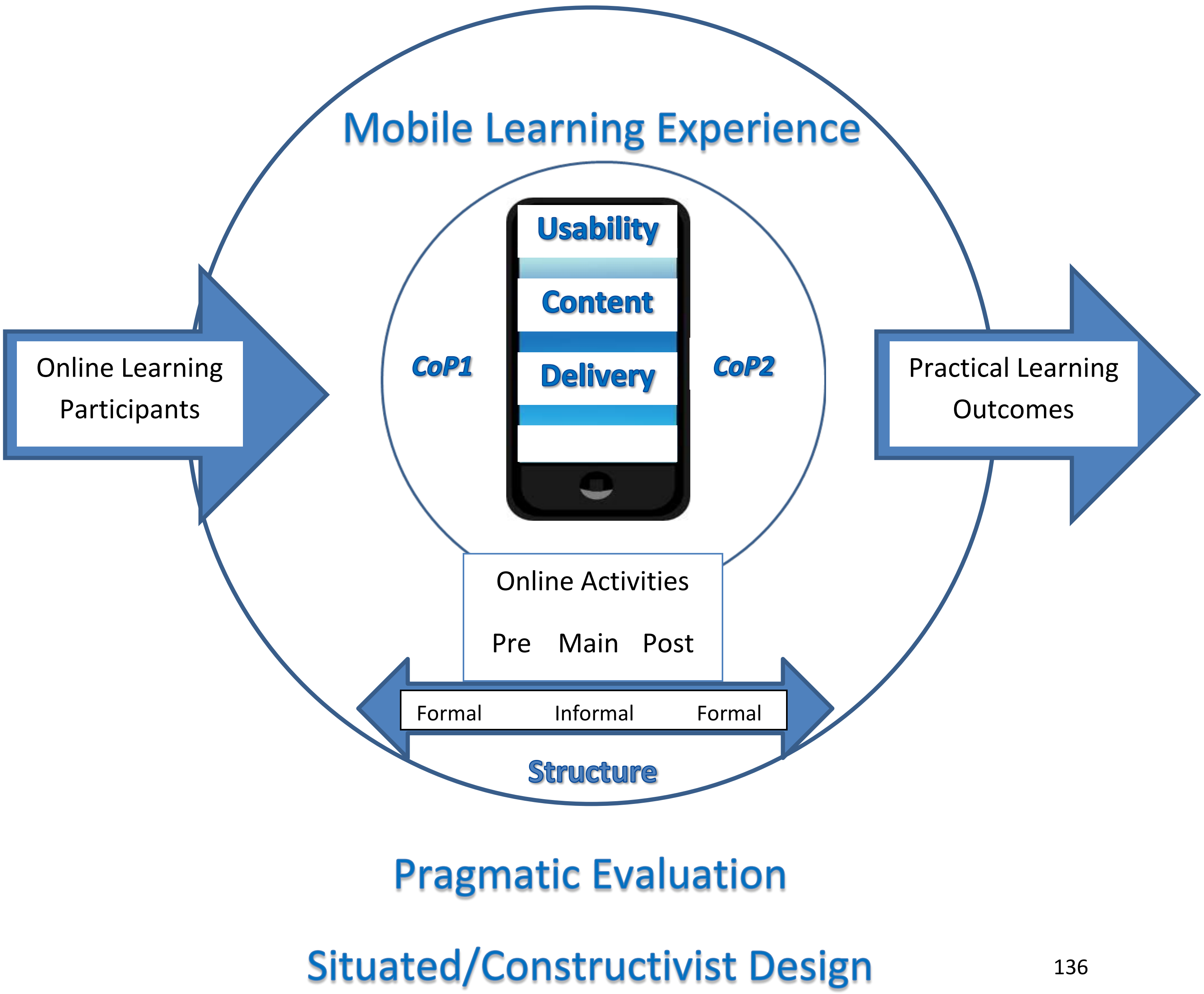
Instruments

Mobile Learning Experience Conceptual Framework. The mobile learning experience was designed and evaluated based on the five dimensions of the mobile learning experience (MLE) conceptual framework. The MLE framework is grounded in the pedagogical perspectives of situated learning and constructivism, as well as best practices identified in a comprehensive review of literature. The MLE framework guided the design and implementation of the mobile learning experience based on the following five dimensions: Content, Delivery, Usability, Structure, and Communities of Practice. The MLE framework can be seen in Figure 1 below.

Figure 1

Mobile Learning Experience Conceptual Framework

Elements adapted from the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009)



Evaluation of the MLE framework was created utilizing a pragmatic methodology and executed with a convergent parallel mixed methods design. With the exception of Communities of Practice, the other four dimensions (delivery is referred to as "media") are key evaluation components of the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009; Casimiro, MacDonald, Thompson & Stodel, 2009), which was designed to act as a quality standard to guide the design, delivery and evaluation of online healthcare education. Due to the similarity in its dimensions to the MLE framework, the evaluation instruments of the W(e)Learn Framework were adapted and utilized as evaluation tools for this paper.

The W(e)Learn Framework can be seen in Appendix I, and the Post-Program Mobile Learning Experience Survey adapted from the W(e)Learn Survey created by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010) can be seen in Appendix II. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html. The survey includes questions to four of dimensions of the MLE conceptual framework: content, usability, delivery and structure. The W(e)Learn Framework also examines three levels of learning outcomes: 1) learner satisfaction, 2) development of new knowledge or skill or changes in attitude, 3) changes in learner behavior. The survey will therefore be used to examine both the learning experiences (based on the four dimensions) and the learning outcomes of participants. Experiences and outcomes for the communities of practice will be based on qualitative data collected in the discussion forum, reaction survey 2 and the semi-structured interviews.

Online Resource. The online course was one hour in length, and engaged learners with a variety of activities including digital video segments, interactive PDFs, written content, and checklists. The first three modules of the course were consistent for all study participants, and included an introduction to the videoconference equipment, remote control, and a description of the mobile learning experience (Table 1). These three modules were designed to be completed on a computer and at a place and time convenient for the participants. They provided the baseline knowledge and technical information crucial to the completion of the mobile learning experience.

The mobile learning experience was module four, and participants accessed it via their tablet, cell phone or laptop computer on location within their clinical videoconference studio.

This allowed participants to interact with the learning content in the authentic workplace setting where they would be using the videoconference equipment. The participants were prompted to perform specific tasks (focusing on technical skills with the remote controls and videoconference systems), answer questions (focusing on etiquette and process knowledge) and provide feedback (in the form of a clinical readiness documents that recorded their preparedness for their first videoconference event). At the conclusion of the mobile learning experience, participants received a feedback form via email based on the questions they answered during the simulation. This feedback both evaluated their performance and provided tips on items they needed to improve or augment. Feedback forms were emailed directly to the participants through the secure link to their Moodle account in order to maintain anonymity.

At the conclusion of the mobile learning experience, participants then returned to the online course to complete modules 5 and 6. Module 5 provided supplemental information to build upon the learnings in the mobile learning experience. Finally, in Module 6 participants were tested on their learning and completed a post-program survey (at the completion of the online course), and reaction survey 2 (after their first clinical videoconference).

The detailed structure of the course and the delivery methods of each section can be seen in Table 3.

Table 3

Structure and Delivery of Online Course and Mobile Learning Experience

Structure	Online Module	Delivery
"Pre" Activities Online Equipment Course	Unit 1: Introduction to the Equipment e) Equipment Terms and Concepts f) Equipment Operation	- Video of host presenting the videoconference equipment - PDF reference guides
	Unit 2: Introduction to the Remote Control g) Features of the Remote Control h) Functions of the Remote Control	- Screencast of remote control features and functions - PDF reference guides
	Unit 3: Mobile Learning Experience Orientation e) Explanation of Mobile Learning Experience	- Screencast of mobile learning experience features and functions

	f) Consent for Mobile Learning Experience	- Online consent form
"Main" Activities Mobile Learning Experience	Unit 4: Mobile Learning Experience i) Setting up the Room j) Operating the Equipment k) Orienting the Patient l) Facilitating the Session	- Avatar host - Tasks "pulled" from resource by learner - Checklist "pushed" from resource by learner - Discussion forum access - Navigation and index features
"Post" Activities Online Equipment Course	Unit 5:Videoconference Etiquette and Privacy j) Videoconference Etiquette k) Privacy and Videoconferences l) Troubleshooting Tips and Tricks	- Etiquette video - Privacy slide show - Troubleshooting Screencast - PDF reference guides
	Unit 6: Supplemental Material (Optional Based on Equipment at Member Site) h) Privacy and Etiquette i) Hooking up a Laptop Computer j) Manual Dialing Using the Global Address Book	- Video of host presenting laptop and address book - PDF reference guides
	Unit 7: Assessment i) Final Quiz j) Course and Mobile Experience Post-Program Survey k) Reaction Survey 2	- Online quiz and reaction survey - Summary PDF reference guide

Mobile Learning Experience 1 and 3. For the purpose of this paper, two versions of the mobile learning experience (in module 4) were produced, and participants were randomly assigned to one of the two versions. Mobile Learning Experience 1 (MLE1) included all of the best practices for usability identified in the literature review. These included icons to identify the task and checklist activities, the progress bar at the bottom of the page to track advancement through the activities, the navigation icons and mute button, simple graphics for the checklist activity, icon link for the discussion forum, and the interactive table of contents. In addition, enhancements using HTML5 and CSS coding were made, meaning that the screen would automatically re-size depending on the participant's device or choice of browser. The number of layers or clicks required by the user were minimized, in addition to reducing the size of all pictures, graphics and audio files to ensure that the richness (page loading speed) was maximized. Screenshots of the task, checklist and orientation screens for MLE1 can be seen in the three left columns of Figure 2.

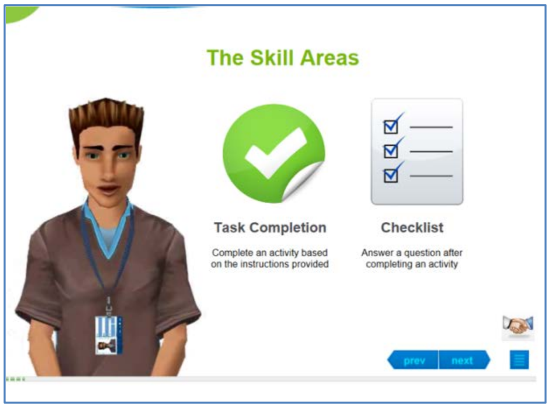
Mobile Learning Experience 3 (MLE3) included all of the identical content, delivery (“push” and “pull” activities, avatar host), structure (inquiry-based activity, embedded in formal online learning course), and communities of practice, but included reduced usability features compared to MLE1. There was no progress bar, icons for task and checklist activities, navigation icons and mute button, simple graphics for the checklist activity, or table of contents. In addition, no HTML or CSS coding was performed, so the mobile learning experience would not intuitively scale to fit a participant’s device or browser. In order to keep the mobile learning experience functional for participants of MLE3, elements of the simple interface (reducing the number of layers or clicks required by the user), the icon link to the discussion forum, the size of the text, and the richness (reducing the size of all pictures, graphics and audio files to ensure efficient page loading) were maintained. In addition, participants were still required to perform MLE3 in the context of their videoconference studio so as to access the information in an authentic workplace context. Screenshots of the task, checklist and orientation screens for MLE3 can be seen in the three right columns of Figure 2.

It should be noted that participants in MLE3 did not receive the same interactive, complete learning experience as the participants in MLE1 due to the inferior quality of the usability features in MLE3. To mitigate this ethical research dilemma, participants in MLE3 were given permanent access to MLE1 upon completion of the post-program survey. This was done via an automatic, conditional release within the Moodle learning management system to ensure the ethical treatment of all participants.

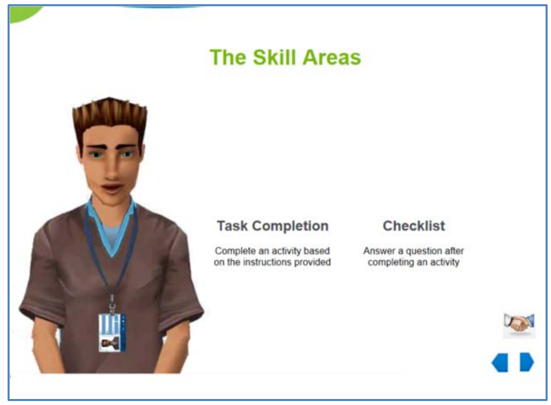
Figure 2

Comparison of Usability Features of MLE1 and MLE3

Orientation Screen



MLE 1



MLE3

Usability included progress bar at bottom of page, large previous and next navigation buttons, interactive table of contents (blue menu), discussion forum access (handshake icon), and an orientation to the task and checklist icons. All graphics and avatar were rendered so as to maximize performance speed.	Usability removed progress bar at bottom of page, interactive table of contents, and task and checklist icons. Navigation buttons replaced with small blue arrows, and discussion forum access remained. All graphics and avatar were rendered so as to maximize performance speed.

Task Screen

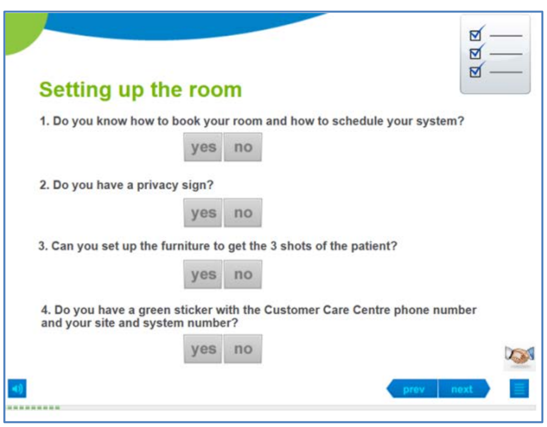
MLE 1

MLE 3

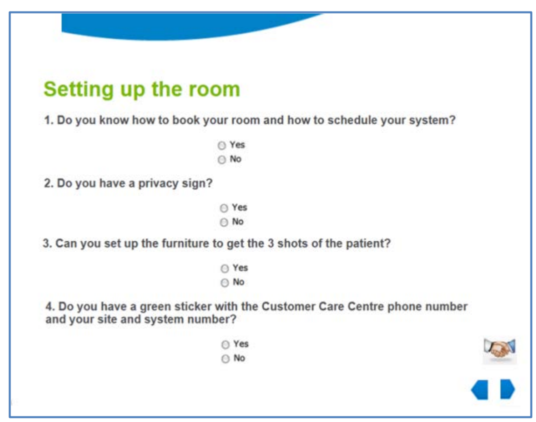
Task icon (checkmark) at the top of the page oriented participants to the activity. Progress bar, navigation icons, table of contents, volume control and discussion forum access were all located at bottom of screen.

No task icon to orient participants to the activity. Only simple navigation (back and forward buttons) and discussion forum access at bottom of screen.

Checklist Activity



MLE 1



MLE3

Checklist icon (checklist) at the top of the page oriented participants to the activity. Large icons that were user-friendly for both mouse and touch (for tablet/smartphone users) allowed participants to easily register responses.

No checklist icon to orient participants to the activity. Small radio buttons for both mouse and touch allowed participants to register responses.

Data Collection

Data collection occurred over a three-month period from December 1, 2013 to March 1, 2014. Quantitative and qualitative sources of data included the following:

Demographic Survey. The demographic survey was completed online prior to the commencement of the online course, and collected basic demographic data, the participants' online experience, their exposure to mobile learning, and their attitudes towards online learning. This gave an idea of the technical experience of the participants and allowed the researcher to identify if this experience had any influence on the learning outcomes achieved by the participants. A copy of the demographic survey can be found in Appendix IV.

Discussion Forum. The discussion forum (also known as CoP1) addressed the identified importance of constructivist learning principles when designing mobile learning content. CoP1 was provided as an open-ended collaboration tool for participants, although the ultimate purpose of the forum would be determined by the needs of the community that utilized it. When participants accessed the forum, the following guiding question was posed: "Please list any questions or comments you may have about this equipment simulation and/or about this mobile learning activity." Specifically, the forum was intended for participants to share information, post challenges and propose solutions to common problems. The forum also provided a valuable source of qualitative data as to the participants' experiences with both the technical learning content (facilitating a clinical videoconference) and the mobile learning experience. The forum was accessed through a "Discussion" icon available on the mobile learning experience interface.

Post-Program Survey. The second survey was a post-program survey that employed a five point Likert scale and was completed online after the completion of each course (Appendix II). The post-program survey is adapted from the W(e)Learn Post-Module Survey utilized by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010). Questions were divided into five sections to provide a quantitative evaluation of the Content, Delivery (W(e)Learn calls this Media), Structure, Usability and Learning Outcomes of the mobile learning experience. The survey also included six open-ended questions on the participants' learning experience that produced qualitative data for analysis. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html.

Reaction Survey 2. Reaction Survey 2 (also known as CoP2) was a post to the discussion forum and was completed by the participants after their first clinical telemedicine appointment (Appendix V). This provided valuable insight on how the participants utilized the learnings in the mobile learning experience to build upon their prior knowledge and apply these new skills in the workplace. Questions in Reaction Survey 2 also retrieved qualitative data on the participants' learning experiences by inquiring about the strengths, weaknesses, opportunities and challenges of the mobile learning experience. Participants were also invited to share tips, resources and experiences in a resource section of the discussion forum.

Focus Group Semi-Structured Interviews. Four focus groups with a total of twenty participants (fifteen from MLE1 and five from MLE3) participated in semi-structured interviews within two weeks of completion of the online equipment course. The purpose of the interviews was to gain a greater insight into the personal learning experiences of the participants in each of the simulations. The interviews took approximately 30 minutes, and were guided by a set of interview questions that were open-ended and developed with the influence of questions in the Survey Instrument for the Communities of Inquiry Framework (Garrison, Anderson & Archer, 2000). The interviews were taped and subsequently coded with learners' permission (Crichton & Childs, 2005). The interview questions can be found in Appendix VI.

Data Analysis

Data from the post-program survey, the two discussion forums (CoP1 and CoP2) and the focus group interviews were triangulated to increase the rigor of this study. Denzin (1978) defines several types of triangulation, one of the most reliable of which is the convergence of multiple sources of data at different times during the research process. The strength of convergent mixed methods research is that it provides the researcher with a greater number of methodological tools at their disposal in order to answer a variety of research questions (Greene, Caracelli & Graham, 1989) and identify emerging questions and themes (Stange, Crabtree & Miller, 2006).

SPSS Data Analysis was used to produce descriptive statistics from the quantitative post-program survey questions. The means and standard deviations of all of the questions for the dimensions of structure and delivery are presented in Appendix VII. In addition, an individual t-test was performed to compare the mean scores for all of the questions in the post-program survey for both MLE1 and MLE3. The t-test assesses whether the means of two groups are statistically different from each other (Moore & McCabe, 2003). An independent-measures design was utilized as it is ideal for testing for mean differences between two different treatment conditions (Pallant, 2007). In this case, it was the difference in the dimension of usability for MLE1 and MLE3. The learning outcomes of MLE1 and MLE3 are also statistically compared and contrasted in Table 6. Any responses of "not applicable" by participants on the post-program survey were omitted from the data analysis.

In vivo coding along with inductive and deductive reasoning was used to produce a list of codes from the interview data. In vivo coding is an effective method for primary qualitative data analysis as it allows for concepts and feedback to stay as close as possible to participants' own words and terms (Flick, 2002). The descriptive data from the quantitative results and the list of codes from the qualitative results were both organized into key themes. These key themes were then triangulated to produce both combined and contradictory key themes that can be used for course revisions and publication. A visual diagram of this process can be found in Appendix III. Any other emergent themes within and among the data were also coded and reported. The writing adopted a narrative tone as this captured the experiences of the participants, and direct quotations were included when relevant.

Ethical Considerations

Careful measures were taken to ensure that no participants were harmed as a result of this study. Confidentiality of participants was maintained at all times. The participants were volunteers so they were not, therefore, considered a population that is vulnerable or at risk because of the study. All the transcripts and recordings from the interviews are being kept on the researcher's secured computer under password protection, and answers on the online surveys are kept on a secure server. Learners in OTN online courses who did not volunteer to become participants in this study were flagged in the learning management system and their data was not included in any of the research.

Results

The aim of this study was to explore the learning experiences and outcomes of healthcare professionals pertaining to the mobile learning experiences in the online equipment training courses, particularly with regards to the mobile learning content, usability and development of the communities of practice. Results are discussed as they pertain to: demographic questionnaire responses, mobile learning content, mobile learning usability, and communities of practice and how these influenced participants' learning experiences and outcomes. This will be done by comparing and contrasting the feedback from both mobile learning experience versions 1 and 3 as understood through the post-program survey, focus group interviews and discussion forum posts.

Demographic Questionnaire

Two hundred and fifteen healthcare professionals took part in this study, consisting of 177 registered nurses, 19 administrative staff, 15 medical students and 4 practicing physicians. Tables 1.1 – 16 in Appendix VIII provide the detailed demographic results. Demographic results are presented for both MLE1 and MLE3 combined since there were no significant demographic differences between the two groups that would have influenced the study's results. For example, for both groups females made up over 82% of the population, around 48% of participants were between the ages of 31-40, over 85% were nurses, and over 87% indicated that this was their first mobile course.

The average age of healthcare professionals was 37.8, with the majority being between the ages of 31-50. The vast majority of the participants (82.3%) were registered nurses and 84.7% were female. It was also the first mobile learning course for 88.8% of the participants. Participants were familiar with using technology to access information despite the inexperience with mobile learning. Almost 71% indicated that they used mobile devices sometimes, often or always to access personal or professional information, and 73.9% said they had taken an online course several times or often in the past.

With regards to their online experience, on a five-point Likert scale (with 1 being none and 5 being always), participants listed audio conferencing (3.95) and videoconferencing (3.08) as most common. As far as mobile experiences, the most common were accessing email (4.19), texting (3.92), audio conferencing (3.82), and accessing web pages (3.76). On a five-point Likert scale (with 0 being not applicable and 4 being strongly agree), participants indicated their past online experiences were very positive with a rating of 3.32. Participants were unsure whether mobile learning experiences enhance the online learning environment, only giving that question a 2.53 rating.

Content

The content outcomes will be discussed for both Mobile Learning Experience 1 and 3 together since the content was identical in both experiences. One of the interesting results was that content questions in the post-program survey and during interviews were not significantly different, and this will be examined further in the discussion section. Quantitative descriptive statistics for the structure questions on the post-program mobile learning experience survey can be found in Table 1.1 of Appendix VII. The findings will be presented as themes identified with the codes from the In Vivo coding procedure and subsequently supported by the quantitative data.

Context-Specific and Comprehensive. Participants indicated that on the post-program survey that the content was of appropriate depth and breadth (with a mean score of 3.11), and strongly felt that the content was context-specific (3.30). Forty-four participants indicated that the most valuable part of the mobile learning experience was that the content was presented in a specific workplace context (the videoconference studio) where they could learn and practice their new clinical telemedicine skills. Responses were also enthusiastic in the semi-structured interviews: “Getting into the videoconference room helped me learn better. The online modules were a good introduction but I learn by doing so it was valuable” (Medical Student 2). “If the entire course could just be the mobile learning in the studio that would be enough for me. It had lots of great tips and was easy to learn when the (videoconference) system was right there” (Nurse 8). Nurse 10 (from MLE3) agreed: “The mobile activity was hard to navigate but the material was excellent. The tasks let me explore the videoconference studio and see how to present my patients effectively.”

When asked if the content of the mobile learning experience taught them new processes or skills, all twenty interview participants (from both MLE1 and MLE3) indicated that they had a variety of positive learning outcomes. Processes learned included clinical protocols, patient presentation and privacy requirements. “We are used to following protocols and having this one outlined so well will make it easy to adopt” (Nurse 6). “I liked the content on patient presentation and making them feel comfortable with the equipment. That is important for us to learn” (Administrator 2). Participants also listed skills such as turning on the equipment, preparing the room and operating the remote control as other successful outcomes. “The video system has a lot of functions and buttons and this exercise really clarified them for me" (Nurse 4). "Practicing with the remote and getting a feel for moving the camera was fantastic. Hard at first but I stopped the simulation and could continue to practice" (Nurse 3). Administrator 4 (from MLE3) added: "Getting a chance to practice with the remote and system in this simulation is so important in me developing my skills for this service delivery."

Applicable and Authentic Activities. Participants found that the content was both authentic (3.07) and applicable for their professional lives (3.03). This applied both to the tasks that they were prompted to perform as well as the checklist that was required for them to complete throughout the mobile learning experience. "The tasks were focused on specific things that we needed to learn. They apply directly to a patient appointment and how to use the system in that situation. Very valuable" (Administrator 6). "Setting up the shots and moving the camera were things we will need to do every day with this system" (Nurse 14). Added Nurse 13: "Don't forget setting up the microphone and privacy protocols. Both are critical for us to use for every patient appointment." Administrator 1 also found the checklist to be an authentic and valuable tool. "The checklist was great in that it verified what we were learning and identified gaps and items we need to work on. Our clinical protocol was missing privacy considerations and the checklist reminded me to fix this." Physician 1 agreed: "The checklist identified what we need to do to prepare our room and clinic for a telemedicine appointment. There were more details than I realized." Medical Student 3 (from MLE3) said: "Checklists for protocols and new services are an ideal format for enabling adoption." Finally, Nurse 4 summarized the checklist as being as useful as a shopping list: "When I go shopping I've got my list and I get it done. I've got my list of things to finish and when I'm done our service will be ready for our first clinical appointment. This was exciting and practical work."

Technical vs. Clinical Skills. Participants were divided when it came to what type of skill the content developed. They indicated that technical skills were presented effectively (3.12), whereas clinical skills were not as effectively conveyed (2.86). In reaction survey 2 which was completed after their first telemedicine appointment, 45/62 respondents indicated that they had learned some sort of technical skill with regards to the videoconference equipment, with 27 of those centering on the remote control. "I learned how to operate the remote, maintain my telepresence and utilize the peripheral camera" (Nurse 44). "The mystery of the remote control was unraveled," joked Medical Student 7. In the interviews, participants elaborated on the importance of the technical skill development. "This simulation went beyond how to push a few buttons and showed us all of the technical steps in sequence of how to prepare the room, patient and system for an appointment. We also learned privacy and how to troubleshoot. It was a complete experience" (Nurse 3).

The issue of clinical skills that were developed divided participants. "The clinical protocol identification and the presentation of the patient were the most valuable parts of this," wrote Nurse 57 in the post-program survey. Administrator 22 agreed: "The clinical preparation and presentation of the patient were important items for me." In the interviews, the concept of the mobile learning experience teaching skills became contentious. "I'm not sure why we are talking about clinical skills. This taught technological skills with the system and a few logistical skills for presenting patients, but clinical skills, no" (Medical Student 3). Nurse 9 agreed: "This simulation was a great example of teaching technical skills. Not sure it fits into clinical processes or skill development."

Organization and Guidance. Participants seemed to give average to above-average scores on the post-program survey when answering whether the content was well-organized (2.91) or effectively guided them through the activities (2.93). However the standard deviation scores (0.450 and 0.733 respectively) reveal the true story. Participants were satisfied with the organization but some felt the guidance or navigation to be lacking. This sentiment was revealed in the semi-structured interviews. "I thought the content was organized effectively and I liked how it tracked the steps to perform before, during and after the appointment. Very realistic" (Nurse 13). Administrator 6 also appreciated the chronological organization of the content: "Doing this in sequence was a practical way to prepare me for my first clinical. More than just information but a useful simulation." In fact, 21 out of 62 respondents on reaction survey 2 listed how the step-by-step organization of the content benefitted them in their first clinical appointment.

With respect to guidance through the activities, the disagreement appeared to come with regards to the checklist questions. "I thought the checklist was great. It asked me questions at key times, gave some variety and produced a fantastic resource at the end" Administrator 6. The practical value of the checklist was not in question but its deployment in the content was a problem for several participants. "The checklist is such a valuable tool, but why put it throughout the resource. I had to keep stopping what I was doing and answer the questions" (Nurse 15). Medical Student 2 agreed: "Not sure why we had to keep answering the questions. Present the patient from start to finish and then ask me questions. Valuable but annoying at times for certain."

Differences in Content Experience Between MLE1 and MLE3. Although MLE1 and MLE3 were identical in how the dimension of content was designed and delivered, there were a couple of items on the post-program survey that indicate that usability did affect the participants' experiences with regards to content. Questions 2, 5 and 6 all ended up with t-test significance values below 0.05, indicating that there was a significant difference between the means of MLE1 and MLE3 for these four questions. First, participants indicated that MLE3 was inferior to MLE1 with respect to the content being well-organized, $t(213) = 5.4$, $p < .001$, and with regards to the content effectively guiding the participants through the activities, $t(204) = 7.9$, $p < .001$. Question 5 is an interesting case, as it indicates that with regards to clinical skills being presented participants preferred MLE3 over MLE1 (by a mean score of 2.96 – 2.78), $t(145) = -2.2$, $p = 0.03$. Results for all of the content questions are presented in Table 4.

Table 4

Post-Program Survey Content Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 3 (N=94)

Answer Option	MLE 1[a]		MLE 3[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. The content is of appropriate depth and breadth	3.02	0.465	3.03	0.426	0.100
2. The content is well-organized	3.05	0.312	2.73	0.532	0.000
3. The content is context-specific	3.29	0.523	3.31	0.464	0.776
4. The content effectively presents technical skills that I can apply in my workplace	3.14	0.521	3.10	0.530	0.468
5. The content effectively presents clinical skills that I can apply in my workplace	2.78	0.475	2.96	0.648	0.030
6. The content effectively guides me through the activities	3.24	0.659	2.54	0.634	0.000

7. The content is applicable for my professional life	3.16	0.538	3.14	0.337	0.171
8. The content is authentic	3.06	0.372	3.07	0.446	0.771

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Usability

The findings for the usability outcomes will be presented separately for Mobile learning experience 1 (MLE1) and 3 (MLE3). MLE3 included reduced usability elements identified as important for situated learning. Content was served as a screencast, with no icons to identify activities, no adaptability according to the participant's device, and no table of contents or progress bar. The design of the structure, content and delivery was the same for both MLE1 and MLE3. Findings will be subsequently combined and contrasted in the discussion section of this study.

Mobile Learning Experience 1

Navigation. Participants found the navigation of mobile learning experience 1 to be simple to use, interactive and easy to control, giving it a rating of 3.02 on the post-program survey. Responses in the semi-structured interviews indicated that participants found the navigation buttons, progress bar and table of contents to be effective tools for moving through MLE1. "The mobile module was really easy to navigate. The previous and next buttons were responsive and I liked to see my progress across the bottom of the screen to let me know how much I had finished" (Administrator 2). Physician 1 agreed: "The best part was the table of contents. I missed it at first but it let me skip forwards and backwards and even checked off what I'd finished. I was able to return later and finish up what I had begun." Nurse 7 really liked the navigation: "This was great. I loved how easy it was to navigate on my iPad. No typing or scrolling and I just had to touch the icons to move throughout the module." Participants also noted that it was easy to interact with and navigate through the task and checklist activities. "I was able to click through the tasks easily and the checklist was just radio buttons. It was so easy and fast to use!" (Nurse 4). "On my iPad all of the navigation bars and radio buttons were touch-friendly so I could just use my finger. This was simple to work with" (Administrator 1).

There was some variance among responses, as indicated by the high standard deviation of 0.612 among participant responses with regards to navigation. The issue seemed to revolve around the discussion forum. The forum link was on the page, but participants were directed out of the mobile learning experience and back to the online course in Moodle if they wanted to post or view the forum. “The forum access threw me off. I had to leave the mobile learning and then when I wanted to go back I had trouble finding the page. This is a big flaw in this simulation” (Administrator 3). Nurse 9 agreed: “As long as I stayed in the mobile course I was fine but as soon as I clicked on the forum I lost my place.”

Graphics and Presentation. Participants gave the highest scores on the post-program survey to the graphical display (3.34) and consistent presentation of material (3.20) regardless of the device or browser that was being used. There were no open-ended questions on the surveys that specifically referenced the graphics or presentation, but they were common themes when discussing usability in the semi-structured interviews. “I thought the presentation of the mobile learning was professional and appealing. The buttons were big, the character (avatar) and images were crisp and the blue/green colors were easy on the eyes” (Nurse 7). “The look and feel was clean and precise. The simple, big buttons made it easy to navigate and I liked that all of them were in blue” (Administrator 1).

Participants that used a variety of devices also reported that the user interface was consistent and user-friendly. “I accessed the simulation on my iPad and it looked fantastic. I was able to turn the iPad and it adjusted properly” (Medical Student 1). “The mobile learning was probably designed for a small device but the graphics and navigation sized perfectly on my laptop. Great presentation!” (Nurse 8). Administrator 3 accessed the mobile learning experience on her iPhone and also reported a positive experience. “On a couple of the pages the text was a bit small, but everything else looked clear and was easy to see, follow and access. I was surprised it worked as well as it did on my phone.” The only problem reported by participants was with the discussion forum, and could have contributed to the high standard deviation for content display (0.714). “I couldn’t see the discussion forum very well on my iPad. The Moodle graphics were just too small” (Medical Student 1). “The forum was a bust on my tablet as the icons were missing from it when I accessed it from the mobile learning” (Nurse 7).

Page Loading and Downloading. One of the big usability issues even in MLE1 was the issue of page loading speeds and the speed of downloading materials (with mean scores on the lower end at 2.67 and 2.76 respectively). It was an issue for a majority of participants, with just under half (59/121) noting on the post-program survey that page loading speed needed to be improved. “The mobile learning was a bit painful to maneuver at times. I would click on some pages and it would take a bit to load, especially if the cartoon (avatar) was on the page” (Nurse 2). Administrator 1 agreed: “The simulation was excellent but the speed was so slow that it took away from the activity. Nobody likes to wait for pages to load nowadays.”

Several participants also noted that downloading links and content within the mobile learning experience was also slow. “I clicked on a PDF link and it worked fine, but another page with graphics and audio on it was very slow to load” (Nurse 5). Administrator 3 had a similar issue: “The links to the screencasts for the remote controls were very slow to appear but I saw the written (PDF) guides right away.” One participant may have found the solution to the page and downloading problem. “I know you are all complaining about the speed, but I used my laptop that was hard-wired into the hospital network and the simulation was extremely fast. At our facility the wireless is painfully slow so I avoid it at all costs” (Nurse 4).

Discussion Access and Interactivity. Participants noted in the post-program survey that interactivity was not efficient when posting to and accessing the discussion forum, giving it a mean score of 2.66. This was the lowest quantitative score on this survey, and the frustration of participants was echoed in the interview responses. “The discussion forum in the mobile learning was a waste of time. It disrupted the flow of the simulation since it got me lost, and I had to log back into Moodle to access it. Very poor design” (Nurse 7). Medical student 2 added: “I think the forum should have been part of the actual mobile learning, maybe like a blog or Twitter feed? Having it outside disrupted the experience for sure.” The discussion forum will be discussed in more detail in the community of practice results section of this study.

Mobile Learning Experience 3

Participants in MLE3 had significantly different learning experiences than those in MLE1. The survey response differences are summarized in Table 5 below followed by the examination of key themes from the qualitative analysis. Note that experiences with regards to page loading speed and downloading were similar in both versions so they will not be expanded upon in this section.

Table 5

Post-Program Survey Usability Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 3 (N=94)

Answer Option	MLE 1[a]		MLE3[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. In this program it was easy to "navigate" through the content.	3.02	0.612	2.71	0.478	0.000
2. The instruction is divided into clear and logical sections	2.80	0.572	2.63	0.508	0.019
3. Uploading and downloading material was fast and efficient	2.76	0.503	2.78	0.444	0.838
4. Presentation of material utilizes aesthetically pleasing graphics	3.34	0.493	2.93	0.264	0.000
5. Content was displayed in a consistent fashion on my mobile device	3.20	0.714	2.47	0.634	0.000
6. Pages loaded quickly	2.67	0.472	2.34	0.632	0.000
7. Interactivity was efficient when posting to and accessing the discussion wall	2.66	0.601	2.60	0.592	0.426
8. The mobile learning experience was interactive and productive due to its usability	2.88	0.451	2.46	0.522	0.000

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Poor Presentation. The most dramatic quantitative drop in the post-program survey occurred with regards to the pages being presented in a consistent fashion regardless of the device used, with a drop in mean score from 3.20 in MLE1 to 2.47 in MLE3, $t(213) = 7.4$, $p < .001$. This discrepancy was echoed in the feedback and frustration of participants in their interview responses. “The presentation of this simulation on my tablet is unprofessional at best. It cuts off the top of the page and I can’t see the navigation buttons unless I scroll down. To come from the online portion of the course to this is disappointing” (Nurse 14). Administrator 6 was even more frustrated: “This was a waste of my time and I didn’t bother completing it once the checklist was cut off. I couldn’t answer any questions so I quit.” These sentiments were reiterated in the post-program survey, with 31/94 calling for improvements in the presentation. “The cutoff screens looked terrible. Definitely needs technical work” (Nurse 48). “A poor example of programming and not a usable resource” (Administrator 17).

Navigation Frustration. Navigation was also a significant issue with MLE3, receiving a mean score of 2.71, down from 3.02 in MLE1, $t(213) = 4.2$, $p < .001$. The mobile learning experience was still viewable in that it was a screencast and participants could click the screen if they wanted to pause or play the material. The lack of the table of contents and navigation buttons (they were only forward and back arrows), however, were a source of confusion for participants. “This simulation looked great but I couldn’t move through the content or review anything. I wanted to go back and I couldn’t” (Nurse 13). “I didn’t know where I was, how much time was left or how to skip forwards or backwards. I’m not sure if it’s possible to put in forward and back buttons but they really would have helped” (Administrator 5). The post-program survey once again reinforced these comments, with 33/94 participants citing navigation as an issue for improvement. “If I can’t control the movement and progress I won’t do it” (Medical Student 5). “Why would I complete something if I don’t know how long it’s going to take” (Administrator 19). Practicing Physician 4 summarized participant frustration with navigation: “I felt trapped having to watch the whole simulation. I got through it but not sure what I learned.”

Usability and Productivity. A significant correlation between usability and productivity was confirmed by participants in this study. When rating whether the mobile learning experience was interactive and productive due to its usability, participants gave MLE1 a solid rating of 2.88, whereas MLE3 received a 2.46, $t(213) = 6.4$, $p < .001$. When asked on the post-program survey what could be improved in the mobile learning resource, 87/94 participants in MLE3 mentioned some form of usability concern, many referencing how this negatively affected the learning environment. “It was so hard to use that I don’t think I got anything out of it” (Medical Student 12). “I would have learned and applied more if I had more power than just watching a movie” (Nurse 42). These written responses were reinforced by the semi-structured interviews, where Nurse 33 linked usability to interactivity: “I like to click and move through an online simulation and really get involved. It’s how I learn and that was missing here.” Administrator 22 made the connection between usability and productivity: “I wanted to get my hands dirty and use this simulation to practice, but it was so hard to use I doubt I’m ready to present a patient on video.”

Communities of Practice

There were two attempts made at building communities of practice in this study. The first (CoP1) was the discussion forum that participants could access during the mobile learning simulation to access help and post comments. It was designed as an open-ended conversation where all participants could interact and share knowledge. The second (CoP2) was survey response 2 that participants would access once they had completed their first clinical event. This had a content collection orientation where participants could share experiences, expertise and resources. Results were obtained from posts in both CoPs, and from the semi-structured interviews.

CoP1: Mobile Learning Experience Discussion Forum

Lack of Value. The discussion forum during the mobile learning experience received a large number of comments from participants questioning its value. Out of 121 posts, 34 questioned the purpose of the discussion forum. “Why would I post here? I’m not sure I understand the reason for having this forum” (Nurse 31). Administrator 44 agreed: “I clicked on this forum looking for help, but I’m just seeing comments from participants and no real value here.” Numerous participants (43) did post comments on the effectiveness of the mobile learning experience or asked questions about their videoconference system (27). Overall, however, Medical Student 7 summed it up best: “This forum is great for posting experiences which is great for the instructor but not for us. If we ask a question it’s unclear when or if it will be answered. This needs better organization.” Nurse 7 echoed these comments in her interview response: “The forum during the course lacked direction and purpose. All it did was take me away from the cool mobile learning app. Once I clicked on it once I didn’t bother to go back.”

Synchronicity. A large number of participants (32) in their forum posts questioned the purpose of an asynchronous discussion forum in the middle of an interactive mobile learning activity. In her interview response, Nurse 8 noted: “The mobile learning was interactive, fast-paced and fun. To leave that and then go to a run of the mill discussion forum was a wasted of time. I would have liked a chat box or real-time blog a lot better.” Administrator 3 agreed: “Some sort of instantaneous help chat or comment field would have been really cool. If we could chat with other students while they were doing the course that could have made it more fun.” Some of the facetiousness in the discussion forum posts displayed the lack of satisfaction among participants. “Hello, can anyone help me? I need help with this remote” (Medical Student 12). “Is anybody out there?” (Nurse 77). “I’m wondering why I’m posting here since the instructor isn’t online and will probably be reading these next week” (Nurse 83).

Navigation and Access. Perhaps the biggest frustration among participants was the difficulty in accessing the discussion forum. “I had a lot of trouble finding this blog and now I don’t know how to get back” (Nurse 91). “We shouldn’t have to leave the mobile learning for this. Could you have a Twitter feed or Facebook link in the activity?” (Administrator 23). Medical Student 9 agreed: “Having a scrolling tab with the most recent posts form across the province like on Twitter would be very cool. You’d get the feeling that others were taking the course with you.” Nurse 14 summed up the sentiment of the participants in her interview response:

> I think one of the problems I’ve seen in online classes is that we have to post to forums all of the time. Not everyone learns that way and unless the teacher is online at the time and sends a response right back it is pretty useless. Sharing of information and expertise, yes. Just using a forum for the purpose of blogging really doesn’t have a useful purpose in online courses and maybe even less so here.

CoP2: Reaction Survey 2

Added Value. Unlike CoP1, many participants (41/62) lauded the value of CoP2, particularly with respect to the shared resources and information. “The value in the posts of this forum is very high. I’ve already downloaded a clinical protocol and a template for a patient brochure. This will help a young program like ours.” (Nurse 72). Administrator 17 also identified the collaboration in the forum as valuable: “I was able to meet a nurse that is also developing a telemedicine program at her site. We are going to see if we can link consultants at her site with patients at our org and work together on the protocols.” Nurse 39 concurred: “This is fantastic! To see ideas from another mental health coordinator is so valuable and we’re hoping to connect via video soon.” A number of participants also noted the value of this forum in their interview responses. Nurse 11 noted the problem-solving capability of forum collaboration: “I was able to post a question about locating a patient site in the forum and I got back several examples from nurses in eastern Ontario.” Administrator 5 agreed: “This forum is allowing us the opportunity to identify our problems and find practical solutions from our colleagues. This is the value in productive discussions.”

Asynchronous Productivity. One of the common themes in the forum posts was how the asynchronous nature of CoP2 was ideal for communication and collaboration “I learned a lot from examining the posts of previous bloggers. So many great ideas and resources in one place!” (Nurse 57). “I love discussion forums like this because they let me examine the perspectives of others and give me time to formulate thoughtful responses. I can also return anytime I like if I think of more to add.” (Nurse 43). “Whenever I visit a blog like this I get new ideas and tips from my colleagues. This one has a great community feel about it.” (Nurse 36). CoP2 productivity was also listed as a strength by interview participants: “I wasn’t too sure about forums after the one during the simulation but this one was great. Lots of resources, questions and responses all stored for me to view. Great to see people working together to solve issues” (Nurse 7). Administrator 4 agreed: “Love the interaction in the second forum. I posted a question and there were several responses when I remembered to check a few days later. Nice to get such great feedback from across the province.”

Best Practices. Participants frequently (22/62) mentioned in their posts how valuable CoP2 was as a repository for content collection, particularly with respect to assembling and sharing best practices. “Practical, practical, practical is all I can say” (Nurse 22). “This forum is full of best practices and troubleshooting techniques. Medicine is all about clinical bps (best practices) and this is an invaluable way to share them across the system. If this content was synthesized into FAQs that would be even better.” (Medical Student 14). Nurse 31 reiterated the call for a more organized presentation: “You have to dig a bit, but there’s a lot of great info here. Maybe if there were topics by area of practice it will help sort the data.” In his interview response, Administrator 4 noted the content collection: “So much valuable content was available in the forum. The first time I went there I only saw a few posts, but after a few weeks it really grew and the PDFs, examples and resources were tremendous.” Nurse 7 agreed: “I’ve bookmarked the forum and I hope it will continue to grow as a library or sharing site so we can have access in the future.”

Learning Outcomes

As mentioned earlier, three levels of learning outcomes were examined in this study: 1) learner satisfaction, 2) development of new knowledge or skill or changes in attitude, 3) changes in learner behavior. Questions 1 and 2 on the post-program survey examined learner satisfaction, and participants indicated that they found both MLE1 (3.00) and MLE3 (3.06) to be interesting and MLE1 (3.27) and MLE3 (3.02) to be valuable. T-test results supported that there was no significant difference between the means of the two groups with regards to interest, but there was a difference with regards to value, $t(213) = 3.8$, $p < .001$.

With regards to the development of new knowledge and skills, there were discrepancies between MLE1 and MLE3. Participants in MLE1 had higher mean scores for understanding new principles of clinical telemedicine (3.27 to 2.82), but lower scores for acquiring proficiency in new techniques (3.15 to 3.38). The scores were virtually identical when looking at learning applicable skills in a specific context (MLE1 3.21, MLE3 3.20), $t(140) = -1.2$, $p = .205$, and learning information that they could not have accessed through an online course (MLE1 3.39, MLE3 3.27), $t(206) = 1.2$, $p = .234$. Participant motivation and engagement was significantly lower in MLE3 (3.18) compared with MLE1 (3.54), $t(170) = 4.4$, $p < .001$. See Table 6 below for the responses.

Table 6

Post-Program Survey Outcome Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 3 (N=94)

Answer Option	MLE1[a]		MLE3[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. The online/mobile course is interesting	3.00	0.592	3.06	0.601	0.438
2. The online/mobile course is valuable	3.27	0.465	3.02	0.508	0.000
3. As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	3.27	0.695	2.82	0.445	0.000
4. As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques	3.15	0.380	3.38	0.510	0.000
5. As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context	3.21	0.412	3.20	0.632	0.205
6. The mobile learning experience allowed me to learn information that I could not have accessed through an online course	3.39	0.725	3.27	0.679	0.234
7. The mobile learning experience made the learning environment more motivating and engaging	3.54	0.500	3.18	0.655	0.000

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Results for changes in learner behavior were purely qualitative and were taken from the post-program survey questions and semi-structured interviews, and were positive for both MLE1 and MLE3. “I am going to continue to work on clinical protocols to promote telemedicine at our site” Nurse 76 wrote in her post-program survey response for MLE1. Participants in the interviews agreed: “This has shown me another way to provide access to care that is efficient and easy for patients. I’m looking forward to using this more in the future” (Nurse 7). “Our programs are in the early stages, but I can definitely see some ways I can incorporate this technology into my practice” (Physician 1). A need for more quantitative questions regarding changes in learner behavior will need to be incorporated into the post-program survey, and this will be addressed in a future paper on the mobile learning experience conceptual framework. MLE3 also received positive responses from participants, as Nurse 43 wrote in the post-program survey: “This simulation has changed the way I view our video studio. I’m going to be a lot more confident presenting patients and growing programs going forward.” In the MLE3 interview group, Nurse 11 valued the mobile learning: “Loved the simulation. The avatar was a great teacher and I’ve got my checklist on how I can improve our service.” Administrator 6 agreed: “I am going to work more efficiently now that I have participated in this mobile activity.”

Discussion

Results indicated that with regards to the content, findings were largely consistent regardless of which mobile learning experience was utilized. Participants benefitted from the comprehensive and context-specific design, and found the task and checklist activities to be applicable and authentic. Participants also noted that the sequential organization of the activities fit their learning style, but some questioned the guidance through the mobile learning experience. With regards to the usability of the mobile learning experience, participants in MLE1 found the navigation, guidance and consistent presentation to all enhance the learning environment and made it fun and interactive. The absence of the navigation buttons, progress bar and table of contents in MLE3 predictably left participants frustrated with the presentation, navigation and ultimately pedagogical productivity of the mobile learning experience. Participants in both MLE1 and MLE3 found the page loading speed, download speed and discussion forum access to all detract from the interactivity of the learning environment. Finally, participants found CoP1 to lack communicative value, recommended it should be delivered in a synchronous fashion, and was difficult to access, all limiting its effectiveness as a teaching resource. CoP2, on the other hand, was found to be a valuable tool to build upon learnings because it was an excellent source of resources and information, was a suitable asynchronous tool for problem-solving, and also a rich library for presenting and sharing best practices. The results are discussed in detail in the following paragraphs.

Content

Findings suggested participants benefitted from the context-specific design, practiced and developed knowledge by taking part in the task and checklist activities, and found the organization of the resource to be excellent but the guidance to be disjointed and unsettling.

Consistency of Results. Perhaps the most surprising finding was that participants noted no major difference between the content regardless of whether they were in MLE1 or MLE3. Variability in the quantitative post-program survey results was within plus or minus 3/10 of a point for all eight of the questions and comparisons between the standard deviations also provided negligible differences. This could be because of several factors:

1. The content was identical in every way in both versions. It was contextual, based on workplace processes, allowed participants the freedom to access at their own pace, and consisted of a variety of applicable tasks and useful checklist activities.

2. Content questions on the post-program survey were not constructed properly and did not "load" onto the theme of content. This gap or error will be further explored in another paper on this study.

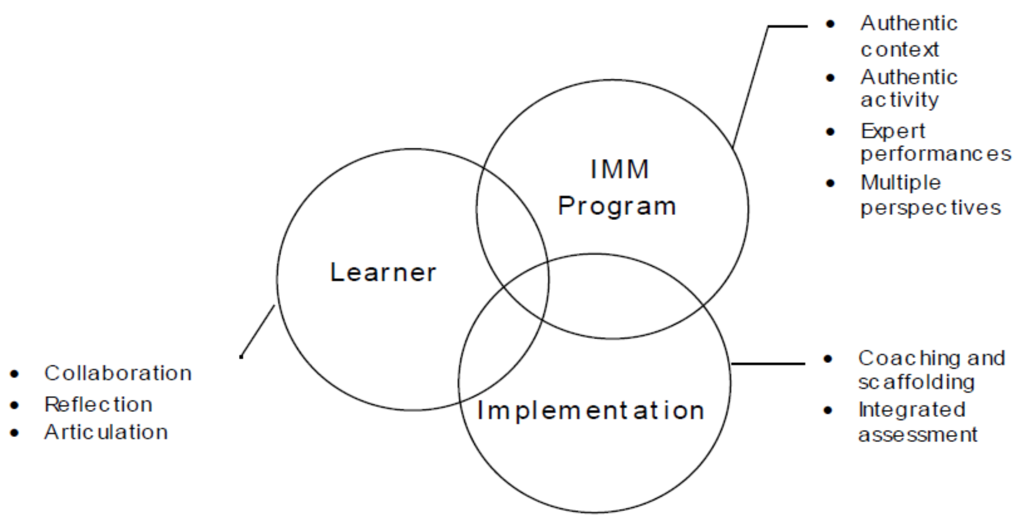
3. Questions in the semi-structured interviews addressed each factor (content, usability, communities of practice) separately and this did not adequately account or allow for the overlapping of participants' experiences or learning outcomes.

Applicability of Context. The core function of the mobile learning experience in this study was to place participants in the clinical videoconference studio at their organization in order to practice basic skills they learned online and develop new skills and knowledge based on contextual interactions with videoconference equipment and clinical protocols. The content, therefore, was developed with elements of the situated learning assumptions of constructivist principles suggested by Comas-Quinn, Mardomingo and Valentine (2009). Participants repeatedly indicated the value of the situated context of the learning content, which supports the constructivist concept that learning is based on constructing meaning from experience, self-direction and situated cognition (Merriam & Caffarella, 1999). Situated cognition learning theory aligns nicely with this study, since it places such strong emphasis on the physical context of learning, and assumes that knowledge is inseparable from the contexts and activities within which it develops (Putnam & Borko, 2000). An argument could be made that this was not situated cognition in its truest form because there was an absence of social interaction and the content was strictly regimented with specific tasks to perform and checklists to complete. Situated cognition research cautions that when using a skill-based approach the instructor should not reduce skills and learning to a narrow context, but to allow for the learners to create meaning for themselves and determine what they need to know how to use the information (Sandlin, 2000). Social interaction and using the group as a resource is also a common recommendation of situated cognition (Putnam & Borko, 2000) that was lacking during the mobile learning experience, but was a valuable part of the learning environment after the mobile activity in the interactions within CoP2. Therefore this study exposed the value of contextual learning, but was not a demonstration of a truly open-ended mobile learning activity. It does propose that situated learning activities can be prescribed and specific and still result in participants creating meaning for themselves and exhibiting positive learning outcomes.

Task and Checklist Activities. Participants indicated that the tasks and checklist activities gave them control in the learning environment, allowed them to practice and experiment with technical skills, and plan future actions. All of these activities are critical elements of what Naismith et al. (2005) prescribe for authentic situated learning. The researchers also suggest that designing participatory simulations without control and experimentation, while engaging for learners, may not lead to the transferability of skills that students develop. Participants did overwhelmingly indicate in the surveys and interviews that they learned practical, applicable technical and procedural skills that they will use in their daily practice of clinical videoconferencing. The content in the mobile learning experience was centred in an authentic context (the videoconference studio), participants engaged in authentic activities (tasks and checklist), had skills modelled for them (by the avatar), and engaged with the content through a variety of perspectives (tasks for setting up equipment, answering checklist questions and identifying protocols). These four elements fit nicely into an early model of situated learning in interactive multimedia and virtual environments proposed by Herrington, Oliver and Herrington (2007). The researchers refer to three areas of influence in the learning environment: the learner, the implementation and the interactive multimedia program (or content). Their work was based on situated learning research by Lave and Wenger (1991) which referred to agent, activity and world and the research by Brofenbrenner (1979) which referred to person, process and context for the three areas of influence. In this study, the three areas of influence were: learner, content, delivery. See Figure 3 below.

Figure 3

Constitutive Elements of Situated Learning in Interactive Multimedia



Taken from Herrington and Oliver (1995) p. 256

Although their model was created for virtual multimedia worlds, the four elements under the IMM program (content) align perfectly with the task and checklist activities in this study and this provides a basis for the development of a conceptual framework for mobile learning experience content and delivery which will be discussed in a later paper on this study.

Organization vs. Guidance. Participants valued the organization of the mobile learning experience as it sequentially walked them through all of the preparation, execution and follow-up of a clinical consultation via videoconference. This supports an identified gap in the research that "…in order to combine and sequence learning objects to achieve expected learning outcomes, object design must be commensurate with actual learning processes, an approach that is lacking in current models" (Farmer & Hughes, 2005, p.73). Sequencing of content in increasing complexity and diversity is also a key factor in Collins, Brown and Newman's (1989) situated learning research known as "cognitive apprenticeship." The cognitive apprenticeship should allow learners to practice skills and concepts in a learning environment that mirrors real-life processes in complexity, sequence and authenticity (Driscoll, 2004). The fact that the mobile learning experience mirrored a clinical consultation so precisely in the sequencing of its technical content was one of the major factors in the successful learning experiences and outcomes of participants.

Participant feedback for guidance throughout the mobile learning experience was inconsistent. Some participants questioned the embedding of the checklist activities within the sequence of the simulation. The intent was to garner participant feedback and identify gaps in learner knowledge at key moments in the simulation. Participants could then look at their list of gaps in the checklist feedback at the end of the mobile learning experience and this would stimulate reflection and problem-solving activities. In this sense, the checklist gave participants the opportunity to interact with the learning content in a different, more reflective fashion from the task activities. This is supported in the literature, as situated learning is sometimes compared to anchored instruction, which refers to anchoring learning material in an authentic context and allowing learners to examine and interact with the content from multiple perspectives (Barab, Hay & Duffy, 2000). The anchored instruction allows for exploration by learners but is not as open-ended or as socially constructed as problem-based learning (Barab, Hay, Barnette & Squire, 2001). This is ideal for a mobile learning experience such as the one in this study. Contextual exploration and interaction is critical, but problem-solving is limited to the activity at hand and social interaction is limited until after the activity is complete. Guidance in this activity, therefore, while unsettling to some participants was an important part of content development as it challenged participants to interact with the learning material in a new way.

Usability

Findings for usability demonstrated that there were several successes of MLE1 that participants found to enhance the learning environment, particularly with the navigation, graphics and consistent presentation. In MLE3, these three factors were found to be of such a detriment to the learning experience that participants were either completely frustrated upon completion of the mobile learning experience or chose not to finish it at all. The usability of MLE3 also was found to severely decrease learning productivity and outcomes among participants. Page loading speed, downloading speed and discussion forum access were found to be challenges in usability in both MLE1 and MLE3.

Navigation. In order to discuss navigation, a deeper definition of the importance of usability and mobile learning success is required. As Stead (2014) contends, it is virtually impossible to separate the technology from the learning when utilizing mobile devices for learning environments. “This is true from an academic perspective, as well as a technical perspective: the effectiveness of the full learning experience is a complex blend of the learner’s own skills, the affordances of the device, the appropriateness of the content, the context of the learning, the fluidity of the software, and the performance of the mobile app itself” (p.2). Navigation is an integral part of the performance of the mobile app as it provides the learner with control, allows them to review material, bookmark progress and interact effectively with the learning content. Participants noted how simple the navigation and interaction with the material was, especially with regards to the checklist and task activities. This aligns with the recommendations of Elias (2011) regarding low physical and technical effort, where learners should only have to type short responses, or click on a navigation button to easily move through material. This reduces the barrier of technology and allows learners to access and interactive with learning content more freely.

Participants in this study utilized their own devices (laptops, tablets, smartphones, etc.) for the mobile learning experience and mentioned that the navigation buttons, progress bar and table of contents were effective tools for moving through the content. Engaging learners by allowing them to utilize their own devices (referred to as "bring your own device" or BYOD), is an excellent way to reduce costs for an educational initiative (Raths, 2012), and can lead to greater comfort and ease of use for the learner since they are utilizing a device that they prefer and are already familiar with (Smart & Gourneau, 2012). Combining this with navigation that is simple, consistent on every page and that promotes "findability" of content results in greater interactivity and familiarity between the learner and the mobile learning content, and promotes positive learning outcomes (Ralston, 2014).

Graphics and Presentation. The graphics and presentation of MLE1 got some of the best responses from participants with regards to the layout of the user interface and the adaptability of the resource on different devices and browsers. Villar (2013) lists this as "responsive design" and it entails designing a mobile user interface that has a flexible, grid-based layout, flexible images and media, and media queries. Basically, this allows a website or learning object to respond to the devices that accesses it in order to deliver the layout and content in a viewable output (Marcotte, 2010). The mobile learning experience was built as a mobile web application that would run on a participant's mobile device browser and then automatically adjust using CSS media queries. This made the application behave like a native app, or in other words retain all of the natural navigation and page layout that was on the participant's mobile device. This has major advantages such as simplified deployment, immediate availability and familiarity for the participant, all of which make the mobile learning experience more accessible and navigable for participants (Stead, 2014). Graphics were also designed on a white background with branded, standardized blue and green navigation and a minimum of text and business on each page. This made the mobile learning experience intuitive and perceptible for participants which promoted easy access to learning content (Elias, 2010).

Page Loading and Downloading. This was referred to as "richness" by Wagner (2005) and is the speed with which pages and media load and this can be affected by the speed of the database, size of the multimedia and speed of the network. Poor richness was identified as a frustrating problem for some participants in both MLE1 and MLE3. In this study, a great deal of testing (as recommended by Hazael-Massieux, 2013) was employed to compress and minimize the size of multimedia (graphics, avatar, images) on each page. The OTN database was also configured for maximum integration and speed with the Moodle and mobile learning experience database. The uncontrollable factor, however, was the speed of the networks that participants utilized to access the mobile learning experience. It is a known challenge for mobile learning identified throughout the literature (Traxler, 2007), that poor bandwidth and subsequent inferior connection and download speeds can be a significant barrier to mobile learning effectiveness and adoption. Participants that utilized laptops that were hard-wired into their network reported no problems. Unfortunately, bandwidth and network speed is a known issue at a majority of hospitals and healthcare organizations in Ontario. This was a known issue in the design of this study, but the decision to design the mobile learning experience as a mobile web application (where users would access content via the Internet) was chosen rather than a direct download as it would be the easiest access for participants and use up the least amount of data on their personal devices. With improving bandwidth in healthcare organizations and access to 3G and 4G networks, this issue should be mitigated in the future. A better mechanism for testing bandwidth could also be built into the online preparation module for the mobile learning experience.

Usability and Productivity. Experiences of participants in this study highlighted the critical importance of ease of usability in mobile learning. In fact, the dramatic difference between the learning experiences of the two groups is a key finding of this study. Participants in MLE1 were appreciative of the superior navigation, graphics and presentation and found the mobile learning experience to be engaging, interactive and authentic as a result. Participants in MLE3 were frustrated by the same usability factors since they were absent from their version of the mobile learning experience, and identified that the usability was either a hindrance or an outright barrier of productivity. This has been supported by findings in a number of studies that poor usability and graphical user interface can distract the learner from the learning task by placing unnecessary cognitive demands on them (Metros & Hedberg, 2006), and this can lead to a lack of cognitive ownership of material (Traxler, 2007), and decreased learner engagement (Cassarino, 2003). These points have all been supported by the learning experiences and outcomes observed by participants of MLE1 and MLE3 in this study.

Communities of Practice

Findings for the communities of practice were extremely useful in informing best practices for implementing CoPs in concert with a mobile learning experience. CoP1 (the discussion forum during the mobile learning experience) was found by participants to be distracting and lack value, unhelpful and did not promote collaboration due to its asynchronous format, and was difficult to access. CoP2 (reaction survey 2 in Moodle accessed after their first clinical consultation) was found by participants to be of excellent value for sharing resources and expertise, to promote reflection and collaboration due to its asynchronous design, and promote best practices by becoming a repository for resources.

CoPs During Mobile Learning. Participants overwhelmingly felt that CoP1 during the mobile learning experience was of little value, hampered navigation, and was difficult to access as the link to the forum took them out of the mobile learning experience and back to the Moodle interface. CoP1 was made asynchronous and deployed within Moodle for two main reasons: it was simple and cost-efficient to deploy and did not require any technical or pedagogical support. In addition, there was a desire to allow for the purpose and use of CoP1 to emerge as it was accessed by the participants. This followed the constructivist recommendations of early researchers such as Liedka (1999), who advocated that communities of practice are not formed but evolve out of the needs of their members. The teacher is a coach or facilitator who can help set up the community (Johnson, 2001), but does not prescribe how it is to be utilized.

Due to the dissatisfaction of participants, it became evident that the asynchronous CoP1 located outside of the mobile learning experience was of little value and did not evolve into a tool that participants could use to communicate or collaborate. Several useful recommendations resulted from feedback in the interviews and surveys. Participants noted that they wanted to connect with colleagues and help in a synchronous fashion from within the mobile user interface. A desire for a Twitter feed or scrolling feed was suggested by numerous participants. This is an important finding of this study and it does support research in the literature. Wenger, White and Smith (2009) did recommend that open-ended conversations with large groups like CoP1 do lend themselves well to synchronous communications because they can promote sharing, instant collaboration and support. McElvaney and Berge (2010) note that virtually all mobile devices now have mobile-friendly versions of social media tools that can easily be incorporated into learning activities. Mobile learning technologies provide the ability to add the social dimension by the capturing of collective intelligence and facilitate active participation of users within any context (Carsten et al., 2008; Shiriram & Warner, 2010). There are a number of social media tools that can be utilized for synchronous communication within a mobile learning activity, and de Waard (2014) has recommended several best practices as outlined in Table 7 below.

Table 7

Mobile Social Media Tools

Social Media Tool	Why Use It and Implementation	Example
Idea and content sharing through microblogging	Twitter allows the global learner group to share short messages with one another, linking it to more content.	Twitter -Twitterchats can be organized by people or organizations and focus on specific topics.
Social networking	Building a network of people can add to the knowledge creation of the learner.	Facebook or LinkedIn -LinkedIn has a feature enabling a user to send Q&As to their professional network. This is a meaningful way to stay in touch.
Social bookmarking	Social bookmarking allows the learner group to find bookmarked items related to the topic at hand gathered in one place.	Diigo (which also has networking and sharing options)
Multimedia sharing	Sharing visuals, audio and/or movies gives others an in-depth view on what is happening.	Video (e.g., YouTube, Vimeo). Audio (e.g., Skype) Pictures (e.g., Flickr, Picasa)
Shared workspaces	These allow synchronous or asynchronous collaboration on content, strategies and planning, storage of knowledge, and overview updating.	Asana can be used for keeping a project with different members and tasks organized (available for iPhone). Google docs is a mobile version.
Blogs	Blogs can be used by learners to reflect on what they learned and what they think is of importance; and to keep a learning archive or personal learning environment.	WordPress Blogger Posterous

Adapted from de Waard (2014), p. 118

For future iterations of this mobile learning experience, a direct link to a tool such as Asana or Google docs would be particularly useful for keeping the project organized and offer access to help and support for participants.

CoPs After Mobile Learning. Participants found that CoP2 after the mobile learning experience was an extremely effective use of a discussion forum and creation of a community of practice. Once again, the asynchronous format was selected because it was simple to implement in the Moodle LMS, required a minimum amount of supervision by the instructor, and would allow for participants to develop and use the CoP as they saw fit. But in this case, CoP2 was useful for sharing resources, information, solving problems, collaborating on common issues, and as a best practice resource library. CoP2, therefore, evolved into a community with an orientation that aligns with the research of Wenger, White and Smith (2009). It appears it developed into a CoP with a content collection and organization orientation, where the community created file and data repositories with useful web links, templates, case studies and program examples. It would also appear CoP2 emerged as a community with a hybrid of two levels of interaction proposed by Booth (2011). There was definitely shared development, where participants in the community built toward the common goal of a useful repository of clinical resources, but there was also an element of Booth's many-to-many interactions, where the users were peers and knowledge transferred freely between them. Participants shared stories, suggestions and lessons learned as well as documents and resources.

The learning experiences of participants in CoP2 also support the research of Cochrane (2014), which found that mobile learning communities of practice can lead to "…development of mutually collaborative partnerships that have seen rewards in increased student engagement, deeper pedagogical reflection and practice-based research outputs" (p. 78). Thus CoP2 evolved into a rich community that not only promoted communication among its members, but collaboration as well. According to these findings, therefore, asynchronous discussion forums can be effectively utilized in concert with mobile learning for collecting feedback, promoting collaboration, solving problems, and sharing expertise and resources related to real-world workplace activities.

Learning Outcomes

Influence of Usability on Learning Outcomes. A significant finding was that the inferior usability of MLE3 did not have a more pronounced effect on some of the learning outcomes of participants. In fact, MLE3 participants rated it just as high or higher than MLE1 with regards to being interesting, understanding new principles of clinical telemedicine, applying skills in a specific context, and acquiring proficiency in new techniques. It was only the outcomes of value, motivation and engagement that were significantly negative with regards to MLE3. This brings up two interesting points: what usability features were included in MLE3 that may have led to the positive ratings, and how strong is the link between value, motivation, engagement and usability?

The features that were eliminated from MLE3 focused on three user interface design principles recommended by Elias (2011) and Wagner (2005), namely: flexible use (inconsistent presentation on devices), simple and intuitive (removal of icons for home pages), and perceptible information (removal of navigation buttons and table of contents). All of the other five principles remained intact. Several interface design elements identified as keys to successful mobile learning were retained: richness (page loading speed), community of learners, and instructional climate (inclusion of push and pull activities). It is likely that while the experience of MLE3 participants was not as "usable" as those in MLE1, elements that were eliminated obviously did not have an enduring effect on participant motivation, engagement and sense of value. Further research is warranted into the eight individual design elements and their corresponding effects on learning outcomes. This could help instructional designers identify and prioritize the design elements that have the greatest benefit for mobile learning instruction.

The issue of how learner value, motivation and engagement are affected by the usability of mobile devices is a pedagogical question that is in its infancy. Overall, there is a lack of work regarding mobile learning usability (Ting, 2007), a lack of research on the effectiveness and efficiency of mobile learning usability (Lobo, Kaskaloglu, Kim & Herbert, 2011), and a need for more complete usability testing in mobile learning both before and after an application is launched (Fisher & Wright, 2010). What this study has shown, however, is that even with relatively minor encumbrances there appears to be a direct link between technical usability and learner motivation and engagement. This is a key finding that will require further study, and suggestions of how to incorporate questions regarding learning outcomes and mobile learning will be made in the third paper on this study.

Conclusion

Two hundred and fifteen healthcare professionals took part in this mixed methods study that explored how learning outcomes in a mobile learning experience were affected by content, usability and communities of practice. Results proved the effectiveness of mobile learning experiences to present context-specific content via a situated learning pedagogical perspective. Participants were in control of the videoconference studio learning context, engaged in authentic task and checklist activities that mirrored a clinical consultation, had best practices presented and modeled within the activity, and were able to interact with the material from a variety of perspectives. This increased positive learning experiences and outcomes including application of learned skills, integration of new knowledge and identification of workplace best practices. Content design was based on best practices for contextual learning from throughout the existing literature, and closely aligns with the interactive multimedia recommendations of Herrington, Oliver and Herrington (2007), and the enable, engage, empower principles of mobile learning from Franklin (2011).

Despite the inferior design of MLE3, participants did not associate the lack of usability with an inferior learning experience with the mobile learning experience content. As noted in the discussion section, this could be due to the superior contextual design of the content, or the inferior wording of qualitative and quantitative questions in the post-program survey and semi-structured interviews. In any event, further study is warranted to determine the potential negative impact of poor usability with interaction with mobile learning content.

Usability was demonstrated to have a profound effect on the learning experiences, outcomes and productivity of participants in a mobile learning experience. Participants in MLE3 found the poor usability to undermine their success and motivation to complete the mobile learning activities. While slow page loading and downloading were factors that inhibited the learning environment for some users due to poor bandwidth and network speed at the health care organizations of some participants, numerous best practices for the design of mobile learning experience usability were confirmed. A mobile web application responsive design (Villar, 2013) was used to provide access to the mobile learning experience. This was found along with media queries to customize the adaptability of the mobile learning environment to the browser and device that each participant was using. The employment of simple, intuitive graphics, navigation buttons, progress bars and a table of contents also facilitated the ease of interactivity of the mobile learning experience and allowed participants to achieve cognitive ownership of the learning environment and practice clinical presentation skills in an authentic learning environment.

Several important recommendations for the implementation of communities of practice were confirmed in this study. Participants noted that the asynchronous discussion forum that was presented during the mobile learning experience did little to enhance the communication or collaboration among learners and in fact detracted from the navigation and intuitive user interface. A synchronous discussion forum that aligns with the social networking or shared workspaces designs suggested by de Waard (2014) would be ideal for providing collaborative tools and instructor support for contextual mobile learning experiences like the one in this study. Asynchronous discussion forums designed for content collection as suggested by Wenger, White and Smith (2009) and deployed like CoP2 in this study are confirmed to be excellent resources for post-mobile learning collaboration, problem-solving and resource sharing.

This study addresses several gaps in mobile learning research, most notably those identified by Frohberg et al. (2009). They found that in a review of 102 mobile learning projects published between 2002 and 2007, that only five percent addressed social learning, less than four percent developed higher level thinking, and only ten percent facilitated user-generated content or feedback. The outcomes of this study provide suggestions of how mobile learning content, usability and communities of practice can be effectively utilized to address these identified discrepancies in the research literature.

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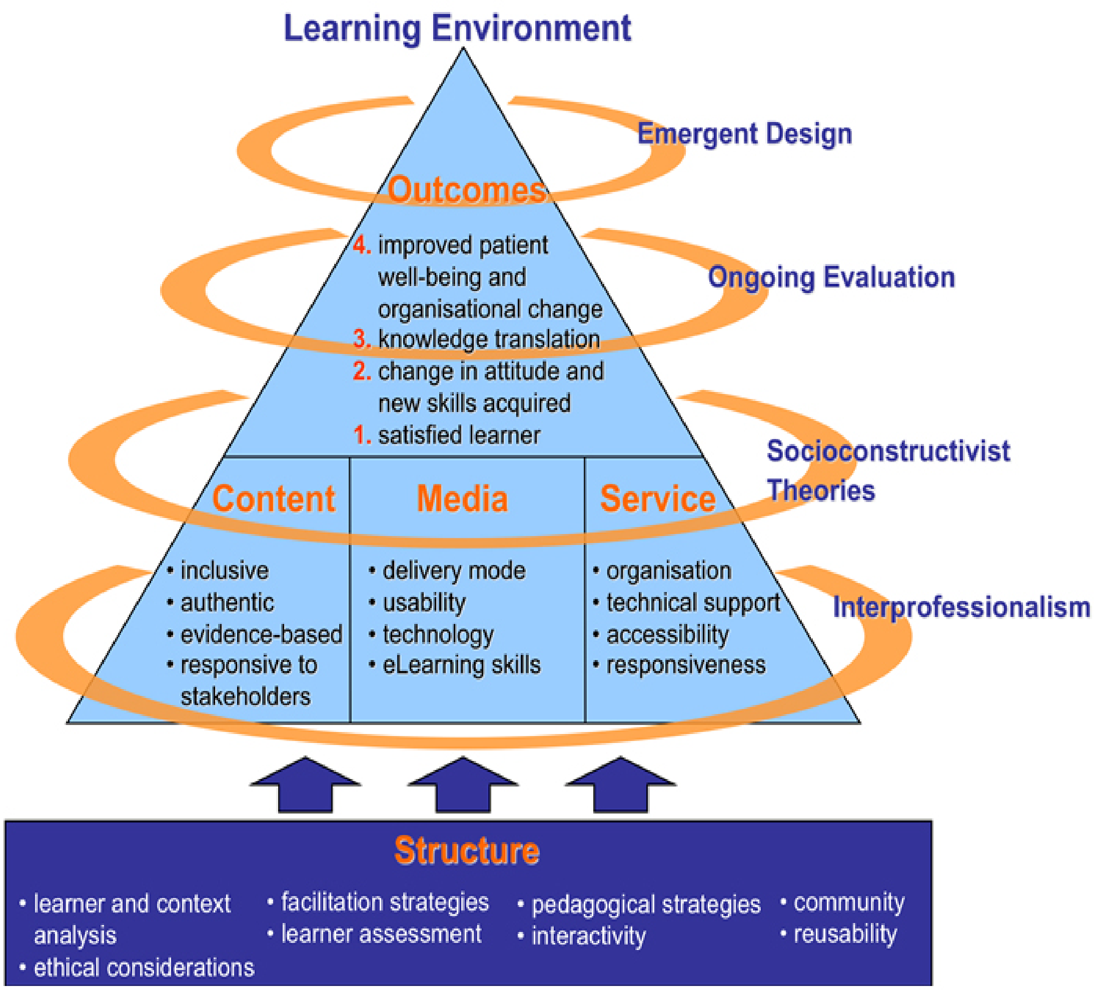
Appendix I: The W(e)Learn Framework



(MacDonald et al., 2009)

Appendix II: Post-Program Mobile Learning Experience Survey

For the following questions, the available response options are: Strongly disagree, Disagree, Agree, Strongly agree, Not applicable

Content

The content is of appropriate depth and breadth
The content is well organized
The content is context-specific
The content effectively presents technical skills that I can apply in my workplace
The content effectively presents clinical skills that I can apply in my workplace
The content effectively guides me through the activities
The content is applicable for my professional life
The content is authentic

Usability

In this program it was easy to "navigate" through the content.
The instruction is divided into clear and logical sections
Uploading and downloading material was fast and efficient
Presentation of material utilizes aesthetically pleasing graphics
Content was displayed in a consistent fashion on my mobile device
Pages loaded quickly
Interactivity was efficient when posting to and accessing the discussion wall
The mobile learning experience was interactive and productive due to its usability

Delivery

The resource respects my experience and current knowledge
The delivery allowed me to control my learning environment
There is flexible access to support tools, information, help, and online communication
The delivery of the information promotes a flexible learning environment
The delivery allowed me to capture and integrate information
The resource promotes communication among learners
The resource promotes collaboration among learners

Structure

The introductory online learning modules prepared me for the mobile learning experience
The mobile learning experience kept my interest
The mobile learning experience motivated me to learn
The mobile learning experience engaged me in the learning experience
The material follows a logical progression
The mobile learning experience provides opportunities for problem-solving experiences
The mobile learning experience provides opportunities to apply material learned

The online modules supported the mobile learning experience after it was completed
I enjoyed the combination of online learning with the mobile learning experience

Outcomes

The online/mobile course is interesting
The online/mobile course is valuable
As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine
As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques
As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context
The mobile learning experience allowed me to learn information that I could not have accessed through an online course
The mobile learning experience made the learning environment more motivating and engaging

Please complete the following statements:

13. The most valuable aspect of the mobile learning experience was….

14. The design or delivery of the mobile learning experience could be improved by…

15. What, if anything, did you learn in the mobile learning experience that you will apply in your professional life?

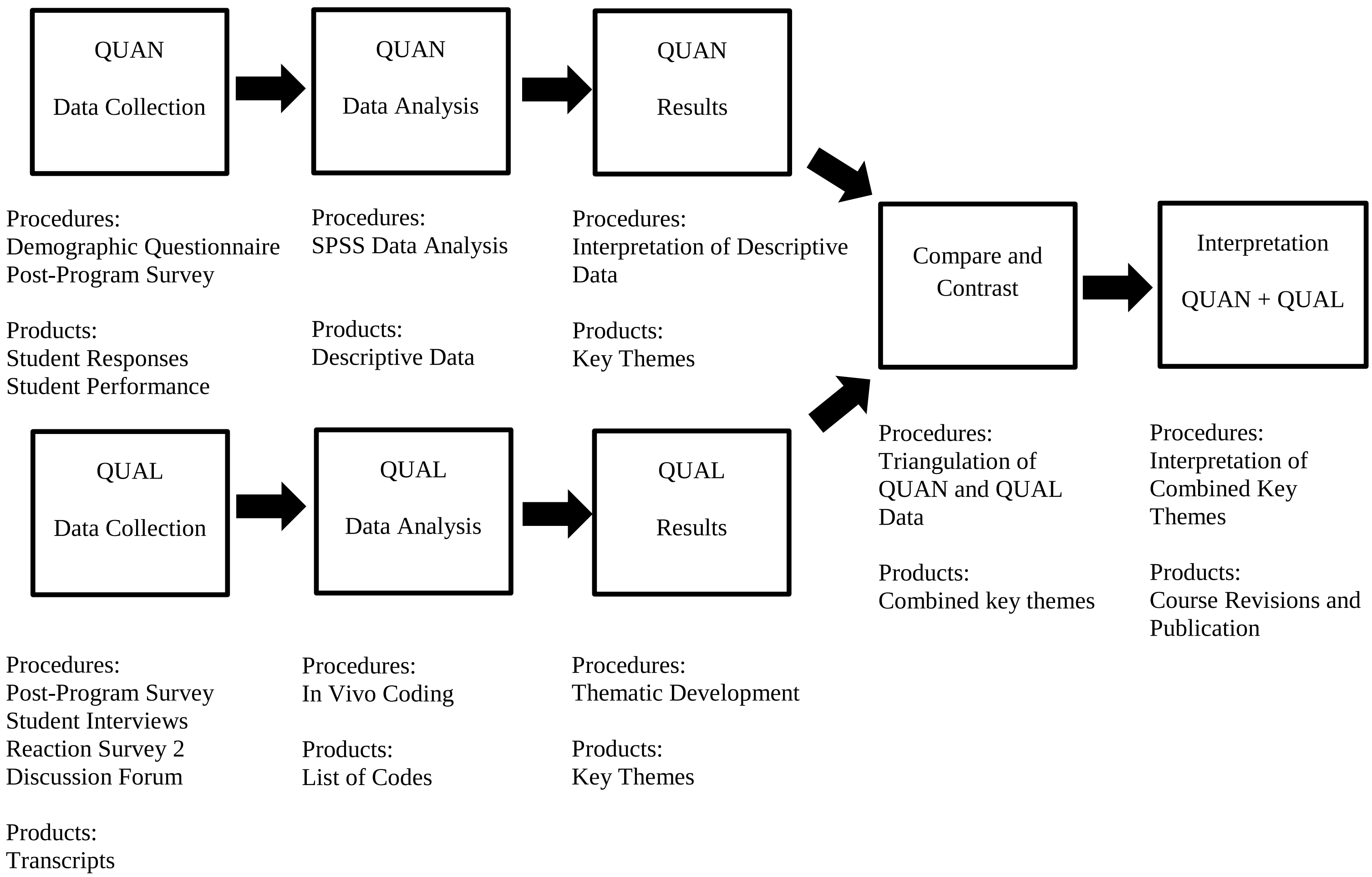
16. What value (if any) did the discussion wall add to the learning resource?

17. How did you access the mobile learning experience?
    a. From my mobile phone
    b. From my tablet
    c. From my personal computer

18. How could or should a mobile learning experience be used in an online learning resource (such as this)?

(Adapted from MacDonald, C. J., Stodel, E. J., Thompson, T-L., & Casimiro, L. (2009)

Appendix III: Convergent Parallel Mixed Methods Design



Adapted from: (Fuji, Paschal, Galt & Abbott, 2010, p. 243)

Appendix IV: Demographic Questionnaire

Please complete the following questions. All responses will be kept confidential.

11. Gender: Female _____ Male_____
12. Please indicate your profession: __________
13. Please indicate your age:_________

14. How often do you use mobile devices (phones or tablets) to find information for personal interest and/or essential needs? Examples could be Internet browsing, playing online games, shopping, finding medical information, finding help with hobbies etc. Please circle the most correct response.

    1= none
    2= not often
    3=sometimes
    4=often
    5=always

15. a. Is this the first mobile learning experience or course you have taken? (yes / no)

    b. If you answered no, how many mobile learning courses have you taken? _______

5. What types of online experiences have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

participated in threaded discussions	1	2	3	4	5
real-time chat	1	2	3	4	5
listened to podcasts	1	2	3	4	5
co-created wikis	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
simulations	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

8. What types of experiences with mobile devices (phones or tablets) have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

texting	1	2	3	4	5
facebook posts	1	2	3	4	5
accessing email	1	2	3	4	5

accessing web pages	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
sharing audio/video files	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

7. Would you consider your online learning experiences positive?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

12. Rate your exposure to online learning on a scale of 1-4. Please circle the most correct answer.

1= I have never used online learning before
2= Once before
3=Several times before
4=Often

13. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

(Adapted from Archibald, D. 2008)

Appendix V: Reaction Survey 2: After Your First Telemedicine Appointment

Congratulations on the completion of your first telemedicine appointment. Please answer the following questions relating to how the mobile learning experience prepared you for the telemedicine appointment. If you have any resources/suggestions please post these to the "Resources" section of this forum.

11. Did you find that the mobile learning experience taught you knowledge and skills that you were able to apply in your first telemedicine appointment?

12. What were the most valuable knowledge and/or skills that you learned in the mobile learning experience?

13. Were there any knowledge or skill gaps that you didn't learn in the mobile learning experience that you required in the telemedicine appointment?

14. Do you find value in posting to this forum?

15. Do you find value in reading the posts of other learners in this forum?

Appendix VI: Semi-Structured Interview Guide

For learners to read before the interview:

Thank you for agreeing to participate in this interview. The purpose of the interview is to obtain a deeper insight into the data collected from the online survey you completed after completing the online equipment training course. Specifically, these questions will be about the mobile learning experience portion of the course.

We are going to be audio-taped so that I can refer back to this discussion when I write my final report. During this discussion and when I write the report we will be using pseudonyms to protect your identity. No one else but my supervisor and I will listen to the audio recording. Please speak in a loud clear voice so the recorder picks-up what you say.

Sample Questions:

19. Was this an authentic learning resource?

20. Did the content of the mobile learning experience teach you new processes or skills? If so, what are they?

21. Was the mobile learning experience easy do use? What did you think about the navigation and layout?

22. Do you think the mobile learning experience contributed to the online course? If so, how?

23. Did you find the feedback list helpful that you received after the mobile learning experience? How? Explain?

24. Did the discussion forum in the mobile learning experience contribute to your learning? How? Explain?

25. Explain how you would compare this mobile learning experience to the conventional classroom?

26. Will the mobile learning experience help you apply the knowledge created in this course to your work related activities?

27. What, if anything, was missing from this mobile learning experience? Please give examples.

Appendix VII: Post-Program Mobile Learning Experience Survey Descriptive Statistics

Table 1.1

*Post-Program Survey Content Responses (N=214)**

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The content is of appropriate depth and breadth	2	4	3	3.11	0.460
2. The content is well-organized	2	4	3	2.91	0.450
3. The content is context-specific	2	4	3	3.30	0.497
4. The content effectively presents technical skills that I can apply in my workplace	2	4	3	3.12	0.448
5. The content effectively presents clinical skills that I can apply in my workplace	1	4	3	2.86	0.561
6. The content effectively guides me through the activities	1	4	3	2.93	0.733
7. The content is applicable for my professional life	2	4	3	3.03	0.482
8. The content is authentic	2	4	3	3.07	0.405

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree
**one response missing*

Table 1.2

Post-Program Survey Usability Responses Mobile Learning Experience 1 (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. In this program it was easy to "navigate" through the content.	2	4	3	3.02	0.612
2. The instruction is divided into clear and logical sections	2	4	3	2.80	0.572
3. Uploading and downloading material was fast and efficient	2	4	3	2.76	0.503
4. Presentation of material utilizes aesthetically pleasing graphics	2	4	3	3.34	0.493
5. Content was displayed in a consistent fashion on my mobile device	2	4	4	3.20	0.714
6. Pages loaded quickly	1	4	3	2.67	0.472
7. Interactivity was efficient when posting to and accessing the discussion wall	1	4	2	2.66	0.601
8. The mobile learning experience was interactive and productive due to its usability	2	4	3	2.88	0.451

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.3

Post-Program Survey Usability Responses Mobile Learning Experience 3 (N=94)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. In this program it was easy to "navigate" through the content.	1	4	2	2.71	0.478
2. The instruction is divided into clear and logical sections	1	4	3	2.63	0.508
3. Uploading and downloading material was fast and efficient	1	4	3	2.78	0.444
4. Presentation of material utilizes aesthetically pleasing graphics	2	4	3	2.93	0.264
5. Content was displayed in a consistent fashion on my mobile device	1	4	2	2.47	0.634
6. Pages loaded quickly	1	4	3	2.34	0.632
7. Interactivity was efficient when posting to and accessing the discussion wall	1	4	2	2.60	0.592
8. The mobile learning experience was interactive and productive due to its usability	1	4	3	2.46	0.522

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Appendix VIII: Demographic Survey Results

Table 1.1
Gender, Age, Profession, Mobile Experience of Participants (N = 215)

Gender	Count	Total %
Male	33	15.3 %
Female	182	84.7 %

Age	Count	Total %
under 30	49	22.8 %
31-40	94	43.7 %
41-50	63	29.3 %
51-60	9	4.2 %
61-70	0	0 %

Profession	Count	Total%
Nurse	177	82.3 %
Administrator	19	8.8 %
Medical Student	15	7.0 %
Practicing Physician	4	1.9 %

First Mobile Course?	Count	Total%
Yes	191	88.8%
No	24	11.2%

Table 1.2
How Often Participants Use Mobile Devices to Find Information (N = 215)

Response	Count	Total %
None	22	10.2 %
Not Often	41	19.1 %
Sometimes	85	39.5 %
Often	59	27.4 %
Always	8	3.8 %

Table 1.3
Participants' Exposure to Online Learning (N = 215)

Response	Count	Total %
Never	16	7.4 %
Once Before	40	18.6 %
Several Times	128	59.5 %

Often 31 14.4 %

Table 1.4

Participants' Responses to the Types of Online Experiences They Have Had (N=211)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Participated in threaded discussions	1	4	2	1.93	0.589
2. Real-time chat	1	4	2	1.78	0.543
3. Listened to podcasts	1	4	2	2.23	0.547
4. Co-created wikis	1	4	1	1.33	0.522
5. Videoconferencing	1	4	3	3.08	0.603
6. Audioconferencing	1	5	4	3.95	0.576
7. Simulations	1	4	2	1.68	0.531

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**four responses missing*

Table 1.5

Participants' Responses to the Types of Mobile Experiences They Have Had (N=211)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Texting	1	5	4	3.92	0.601
2. Facebook posts	1	5	3	2.85	0.688
3. Accessing email	1	5	4	4.19	0.522
4. Accessing web pages	1	5	4	3.76	0.623
5. Videoconferencing	1	5	3	2.55	0.621
6. Audioconferencing	1	5	3	3.82	0.634
7. Sharing audio/video files	1	4	2	2.12	0.642

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**four responses missing*

Table 1.6

Participants' Responses to Online and Mobile Experiences (N=215)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. Would you consider your online learning experiences to be positive?	0	4	3	3.32	0.556
2. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?	0	4	3	2.53	0.647

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Chapter 4: Article 3

Toward a Conceptual Framework to Guide the Design, Delivery and Evaluation of Quality Mobile Learning Experiences

Article for Submission to:

International Journal of Mobile and Blended Learning

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February 20, 2015

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Introduction

There is tremendous potential for mobile devices to provide flexible access to learning opportunities beyond the traditional classroom or online learning course. Mobile learning can transform the way people learn and build knowledge in different settings, particularly with new advancements in apps and cloud technologies (Khaddage & Knezek, 2013). Numerous benefits have been noted for mobile learning throughout the literature, with Gomez, Zervas, Sampson and Fabregat (2013), providing an excellent summary:

> Mobile devices can (a) engage students in experiential and situated learning without place, time and device restrictions, (b) enable students to continue learning activities, initiated inside the traditional classroom, outside the classroom through their constant and contextual interaction and communication with their classmates and/or their tutors, (c) support on-demand access to educational resources regardless of students' commitments, (d) allow for new skills or knowledge to be immediately applied and (e) extend traditional teacher-led classroom scenario with informal learning activities performed outside the classroom (p. 48).

Despite this pedagogical potential, more research related to mobile learning design and evaluation is required, particularly with regards to developing conceptual frameworks for how to provide pedagogic application for mobile learning object deployment (Muyinda, Lubega, Lynch & van der Weide, 2011). There is a particular requirement for more research in the theory of instructional design of mobile learning environments (Cochrane, 2010; Elias, 2011). This includes a methodology for incorporating mobile environments in regular online curricula (Pfeiffer, Gemballa, Jarordzka, Scheiter & Gerjets, 2009), a need for the development of theoretical frameworks to guide evaluation of mobile learning effectiveness (Park, 2011), the development of pedagogical environments for mobile learning (Keegan, 2005), and how to utilize emerging mobile technologies in concert with classroom instruction (Aubusson, Schuck & Burden, 2009). There has also been a call for more research on how mobile learning technologies can be deployed and conceptual frameworks developed to bridge formal and informal learning (Lai, Khaddage & Knezek, 2013).

The focus of this article is to address the gap in the literature suggesting the need to design, implement and evaluate a conceptual framework for creating contextual, interactive mobile learning. The first step is to synthesize information from the existing literature and design a curriculum framework for contextual mobile learning. Second, this article details how the mobile learning curriculum framework was implemented and tested in order to establish best practices associated with designing and delivering mobile learning to achieve desired learning outcomes. These best practices include methods for designing instructional material, delivering content, facilitating usability, incorporating communities of practice, and combining mobile learning and online learning. Finally, the conceptual framework and its evaluation tools are revised based on the identified best practices as well as feedback from study participants in order to provide a practical, evidence-based tool for informing the effective design of mobile learning.

For the purpose of this paper, mobile learning is referred to as a mobile learning experience, occurring within the framework of a larger online course. A “mobile learning experience” refers to a learning activity that the participants perform on their mobile device (laptop, tablet or phone), in a specific physical context or location. The mobile learning experiences were deployed in the Ontario Telemedicine Network’s online videoconference equipment training course which was accessed by physicians, nurses and healthcare professionals at medical organizations across Ontario. Participants in the online course received an introduction to the content and the mobile learning experience, then took their mobile device and participated in the mobile learning experience in their videoconference studio, then returned to the online course for supplementary material and testing. Feedback from participants was collected during and after the mobile learning experience via a variety of evaluation tools and methods in order to obtain an accurate picture of their learning experiences and outcomes.

Literature Review

Existing Mobile Learning Conceptual Frameworks

There are several conceptual frameworks that have been developed for mobile learning. Some focus on the implementation of technology and ease of navigation, such as the framework proposed by Botha, Cornje and Ford (2007). Another framework categorizes mobile learning into five broad categories based on learning contexts: free, formalized, digital, physical, and informal (Frohberg, 2006). The majority of proposed mobile learning frameworks such as the

Framework for the Rational Analysis of Mobile Education (FRAME) put a premium on social interaction between students while engaging in mobile learning activities (Koole, 2009). The framework suggested by Park (2011) takes social engagement a step further and incorporates it with transactional distance theory, thereby making distance a key consideration for pedagogical design. Yet another predominant focus among frameworks is the context within which the mobile learning is occurring (Naismith, Lonsdale, Vavoula & Sharples, 2004). Despite recent research, much work is needed in order to understand how to synthesize all of the above mentioned elements (learning content, social interaction, usability, delivery, and learning environment) into a framework that advocates for both the effective design and evaluation of mobile learning. This is critical because there is great potential for mobile learning to be used to create the pedagogical environment where cognitive activities can be engaged in order to produce desired learning outcomes (Laurillard, 2007).

Best Practices for the Design of Five Mobile Learning Dimensions: Delivery, Structure, Content, Usability and Communities of Practice

A literature review and detailed evaluation of the five mobile learning dimensions have been undertaken in two previous articles in this study. A concise literature review of each of the five dimensions is warranted here as they are the building blocks of the mobile learning experience conceptual framework.

Delivery. Mobile learning delivery is ideal for situated learning as the device can be embedded in a contextual learning activity (Park, 2011), and can be accessed both collectively and individually by students in order to both consume and create knowledge (Koole, 2009). Park (2011) classifies the informal mobile learning utilized in this study as one of his four educational applications of mobile technologies: Type 2: High Transactional Distance Individualized Mobile Learning

Park (2011) describes mobile learning activities as type 2 when

> 1) the individual learners have more psychological and communication space with the instructor or instructional support; 2) the individual learners receive tightly structured and well organized content and resources (e.g., recorded lectures, readings) through

> mobile devices; 3) the individual learners receive the content and control their learning process in order to master it; and 4) the interactions mainly occur between the individual learner and the content (p. 25).

Park also identifies this type of learning as having greater flexibility, portability and primarily influenced by “the context regarding when and where to learn” (p. 26).

In this type of content-driven, context-specific mobile learning experience, therefore, content delivery becomes paramount when considering how to instruct the learner when interacting with the environment. Elias (2011) describes this balance in the design of the instructional climate as how the learner “pulls” content from the learning activity and “pushes” learning out from the instructional environment. Regular updates, tips, reminders and schedules can be “pulled” automatically by learners, and learners can “push” content from the learning environment by using such strategies as discussion forums, image/audio file sharing, and blog posts (Elias, 2011). How the content is delivered or pushed and pulled, therefore, was a primary consideration of the design of the conceptual framework in this study.

Structure. Mobile learning has the opportunity and obligation to strengthen the linkages between formal and informal learning environments (Bo-Kristensen, Ankerstjerne, Neutzsky-Wulff & Schelde, 2009). This is important for mobile learning pedagogical design because much of the real-world, contextual knowledge that individuals learn about their jobs, social groups or learning environments are acquired informally in the field through conversation, observation and trial-and-error (Comas-Quinn, Mardomingo & Valentine, 2009). Evans and Johri (2008) recommend what they call “guided participation” for inquiry-based mobile learning environments. This involves such principles as setting rules, providing spontaneous and formative feedback, team-based learning, mentorship roles as well as informal interactions. The environment is open for exploration but has a designed pedagogical framework with planning, monitoring and evaluation during learning. “A support tool incorporating goal-lists, hints, prompts, cues and templates is needed to support the cognitive regulation skills of students during a fluid dynamic task” (Shih, Chuang & Hwang, 2010, p. 51).

Bo-Kristensen et al. (2009) advise forming links between formal and informal learning environments by creating three types of activities: pre-activities, main activities and post-activities. Pre-activities take place in the classroom or online prior to the mobile learning, and can orient participants to the activity, formulate questions, and construct basic skills and foundational knowledge (Shih et al., 2010). The main activity takes place in the mobile learning environment and involves and inquiry-based activity such as guided questions, collection of data, and collaboration with colleagues (Hsu & Chen, 2010). The post activities such as reports, presentations, tests or projects occur back in the classroom or online and result in cognitive “ownership” of the new information by the participants (Richards & Rodgers, 2001). Overall, this three step approach sets the groundwork and then cements the learning for the inquiry-based activity, and ensures that the structure of mobile learning follows the pedagogical principle of guided participation.

Content. Two of the predominant theories discussed in the mobile learning literature are constructivism and the collaboration and sharing of knowledge via mobile devices, and situated learning where mobile devices are employed in specific contexts. Mobile learning environments are ideal for adopting the situated learning assumptions of constructivist principles, where learners can bring their own experiences and expertise to a specific context and build on and enrich their prior knowledge (Comas-Quinn et al., 2009; Dede & Sprague, 1999). “The most successful learning comes when the learner is in control of the activity, able to test ideas by performing experiments, ask questions, collaborate with other people, seek out new knowledge, and plan new actions” (Naismith et al., 2005, p. 15). For the purpose of this paper, the category of mobile learning that is being examined will include what Traxler (2007) refers to as situated or contextual learning, where content is presented via location-specific experiences and activities. This contextual content provides educational experiences that might otherwise be impossible, as well as collaborative or constructivist learning, where learners can share and build on their prior knowledge.

The justification for choosing both situated learning and constructivism for the content design of mobile experiences can be found throughout the existing literature. According to Lave (1990), contextual learning focuses on the relationship between the environment and the student, and learning is heavily influenced by culture and the community of practice within which a learner resides. Thus contextual learning content strives to engage the learner with a problem, and allow the learner to develop goals to solve the problem through authentic tasks in multiple domains (Barab & Roth, 2006). Both situated learning theory and constructivist theories of learning, therefore, are ideal for developing mobile learning experiences, since they suggest that learning is unintentional and situated within authentic contexts, activities and cultures (Lave, 1990).

Usability. Based on the work by Elias (2011) and Wagner (2005), there are eight user interface design principles that are important for practical and useable mobile learning environments. They are:

1. Present content in simple, efficient formats
2. Package content in small bundles that are easy and quick to access
3. Navigation must be intuitive, and minimize page numbers and scrolling
4. Display content consistently regardless of device or browser
5. Customize content in order to maximize download and page loading speeds
6. Keep interactivity (such as responses and uploads) short and fast to perform
7. Provide learners with multiple forms of communication (text, audio, forums)
8. Content should be both pushed and pulled to increase interactivity

These design elements are all important to ensure that the learning environment is flexible, interactive and productive. “It is critical that the overarching problems facing mobile computing be addressed by creating an environment that is flexible, easy to use, and conducive to collaborative communication anytime, anywhere” (Heath et al., 2005, p. 51).

Communities of Practice (CoPs). A community of practice is defined as: “Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” (Wenger, McDermott & Snyder, 2002, p. 4). A workplace community of practice involves situated, collaborative and collective learning where solutions are proposed to contextual problems (Lee, Parslow & Julien 2002). Communities of practice (CoPs) have been identified as a useful tool for healthcare professional education on a variety of pedagogical levels. “Wikis, blogs/photoblogs and podcasts have the potential of complementing, improving and adding new collaborative dimensions to the many Web-based medical/health education, CPD (Continuing Professional Development), and research services currently in existence” (Boulos, Maramba & Wheeler, 2006, p. 2). An online community of practice is often called a virtual community of practice (Gannon-Leary & Fontainha, 2007), and can enhance the learning environment since "…the learning that evolves from these communities is collaborative, in which the collaborative knowledge of the community is greater than any individual knowledge" (Johnson, 2001, p. 54).

Wenger, White and Smith (2009) have created a list of common orientations that virtual CoPs can develop. These include meeting support, open-ended conversations, project infrastructure, content collection and organization, access to expertise and community cultivation. Three of the most common and easily implemented for mobile learning are:

- Open-ended conversations: A discussion forum that is based on ongoing threaded online conversations.
- Project infrastructure: Communities that form around a specific project that can solve problems of workplace practice.
- Content collection and organization: Community that collects and categorizes information to improve ease of access by creating file or data repositories.

In addition, the level of interaction within a virtual CoP can vary. Booth (2011) suggests three possible levels of interaction. The first is one-way dissemination where a central knowledge producer distributes knowledge to consumers who can comment or ask questions. The second is shared development, where communities build knowledge in parallel toward some type of common goal. The third level of interaction is many-to-many interactions, where the users are peers and knowledge flows freely among them. This final level Booth (2011) suggests is the most difficult to grow as it relies on volunteers, can be difficult to motivate participation, and also requires a lot of effort to govern. Both orientation and level of interaction can be implemented and encouraged by the facilitator, but are ultimately determined by the interactions of participants in the virtual CoP.

Comparing the Dimensions of E-Learning and Mobile Learning

There have been numerous conceptual frameworks implemented for online learning or e-learning, however the mobile learning literature is divided on the extent of influence that e-learning research should have on mobile learning design and delivery. Early researchers contended that mobile learning is a subset of e-learning (Brown, 2005), or that mobile learning in its simplest form is e-learning using a mobile device with a wireless connection (Hoppe, Joiner, Millard & Sharples, 2003). Other early researchers, however, recognized the unique omnipresent capabilities of mobile learning due to its flexible, mobile and collaborative natural characteristics and how these could lead to spontaneous learning moments (Harris, 2001). This sentiment is echoed in the majority of the current literature, which views mobile learning as not simply “e-learning lite,” but as a flexible method of pedagogical delivery that has many unique characteristics of its own that warrant customized frameworks and delivery methods (Brown & Haag, 2011).

These characteristics must be taken into account when designing mobile learning, and include flexibility, mobility, and context, since it removes the restrictions of time, space and place (Kumar, 2013). The research of Traxler (2007) attempts to distinguish between e-learning (which is described as structured, formal, media-rich, interactive, intelligent, usable), and mobile learning (which is described as personal, spontaneous, informal, situated, context-aware, bite-sized, portable). It is these differences that can inform the successful instructional design of mobile learning, since it has such potential for disrupting the formal nature of the live or online classroom, and leading to contextual, informal learning opportunities (Sharples, 2005).

Despite the obvious advantages and adaptability of pedagogical tools that mobile learning offers, some current researchers contend that elements of mobile learning can be informed by earlier e-learning research and developments, specifically when it comes to the development of conceptual frameworks (Muyinda et al., 2011). This is because mobile learning is based upon similar design elements as e-learning (such as user interface, pedagogical design, and evaluation), but has its own rules, structure and design best practices for each of these elements (Kumar, 2013). When constructing a conceptual framework for mobile learning, therefore, it is important to understand what these common design elements are in order to identify how mobile learning is not simply a subset of e-learning, but has its own unique rules and opportunities for effective instructional design and delivery.

One of the most flexible and prominent frameworks for online or e-learning (The Global E-learning Framework) was proposed by Khan (2009), as his definition of e-learning is based on an open and distributed learning perspective:

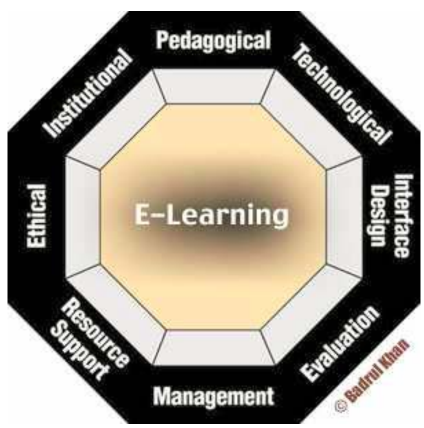
> E-Learning can be viewed as an innovative approach for delivering well-designed, learner-centered, interactive, and facilitated learning environment to

> anyone, anyplace, anytime, by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open and distributed learning environment (p. 42).

The above definition directly aligns with current definitions of mobile learning as learning which is flexible, contextual, and takes place anytime and in anyplace using a mobile device (Traxler, 2007). This is because Khan (2009) bases his classification of e-learning on an open and distributed learning environment, which is defined as both learning in your own time, pace and place (Calder & McCollum, 1998), but also allowing learners greater control in the educational process by having a say in how, where and when learning takes place (Ellington, 1997). The Khan framework, therefore, shares many characteristics with current mobile learning theory and can be seen in Figure 1 below, and is an excellent framework for the comparison and contrast of mobile and e-learning design elements (or what Khan refers to as the eight dimensions of e-learning design).

Figure 1

The Global E-Learning Framework



Taken from Khan (2009) p. 46

Khan's institutional dimension refers to administrative affairs and student services related to e-learning, and therefore for the purposes of this study, it was not examined as part of the mobile learning experience. The ethical dimension was addressed in the online portion of the course and therefore was not examined as part of the mobile learning experience. Participants completed online consent forms for both the Ontario Telemedicine Network's privacy office as well as the consent form for this research. Privacy and security modules were also included in the online course after the mobile learning experience. The other six dimensions (pedagogical, technological, interface design, evaluation, management and resource support) are all key components of efficient mobile learning design and delivery and were utilized to inform the dimensions of the proposed conceptual framework for mobile learning experiences.

As noted in the introduction, recommended items for a mobile learning framework include how to design and evaluate: educational content, social interaction (communities of practice), usability, delivery, and structure of the learning environment. In order to understand the unique features and requirements for mobile learning design, six of the dimensions of the Global E-Learning Framework designed by Khan (2009) are aligned with the five mobile learning experience dimensions (content, delivery, structure, usability and communities of practice) identified in the literature review above. The alignment, requirements and supporting research for each dimension can be seen in Table 1. It can be seen that while the five mobile learning experience dimensions may share the same core title as the e-learning dimensions, they are far more than a subset of one another, but possess unique characteristics that require specialized instructional and technological design, implementation and evaluation. In particular, the mobile learning experience dimensions focus on the collaborative, situated, informal and flexible capabilities that mobile devices provide. These unique characteristics will be incorporated into the Mobile Learning Conceptual Framework proposed later in this paper.

Table 1

Global E-Learning and Mobile Learning Experience Common Dimensions

Global E-Learning Dimension	Key Components	Mobile Learning Experience Dimension	Description and Supporting Research
Pedagogical	Content Analysis Design Approach Instructional Strategies Blended Strategies	Content and Delivery	Situated, Contextual Content (Comas-Quinn et al., 2009) Enable Instruction (Franklin, 2011) Engage Activities (Franklin, 2011) Empower Problem-Solving (Valdez et al., 2000)
Technological	Infrastructure Planning Software Support	Delivery	Individual/Collaborative (Koole, 2009). Push/Pull Activities

			(Elias, 2011) Guided Participation (Evans & Johri, 2008)
Management	Managing Content Development eLearning Environment	Structure	Mobile Informal (Khaddage & Lattemann, 2013) Online Formal Eraut (2000) Pre/Main/Post Activities (Bo-Kristensen et al., (2009) Inquiry-Based (Shih, Chuang & Hwang, 2010) CoP Problem-Solving (Booth, 2011)
Interface Design	Navigation Accessibility Page/Site Design	Usability and Structure	Flexible Navigation (Hsu & Chen, 2010) Intuitive and Interactive (Börner et al., 2010) Page/Site Design (Hazael-Massieux, 2013) Consistency (Marcotte, 2010) Perceptible Information (Goh & Kinshuk, 2006)
Resource Support	Online Support Resources	Usability	Resource Access (Cochrane, 2010) CoP Content Collection (Wenger, White & Smith, 2009)
Evaluation	Content Development eLearning Environment Learner Assessment	Evaluation	Evaluate Learning Outcomes (MacDonald et al., 2009) Evaluate Framework/Questions (MacDonald et al., 2009)
Institutional	Administrative Affairs Student Services	Not Applicable	Not Applicable
Ethical	Cultural Diversity Etiquette Legal Issues	Not Applicable	Not Applicable

Adapted from Khan (2009) p. 47

Methodology

Theoretical Background

Mobile learning has elements of both situated learning in a specific context, and constructivist learning where learners bring their own knowledge, perspectives and experiences when interacting with the content. Constructivist learning has an element of contextualized process, as knowledge is constructed based on both personal experiences and hypotheses of the environment in which new knowledge or content is presented (Zemelman, Daniels & Hyde, 1993). Learning is not the passive reception of facts, but an active construction of meaning (Piaget, 1977). In situated learning theory, learning is embedded in activity, context and culture, knowledge should be presented in authentic contexts, and social interaction and collaboration are integral to the learning process (Lave, 1988; Brown, Collins & Duguid, 1989). Traxler (2007) notes the importance of situated learning for mobile learning design, since location-specific experiences and activities can be used to provide educational experiences that might otherwise be impossible. Situated learning is also an ideal fit with collaborative or constructivist learning, where learners can share and build on their prior knowledge.

The combination of situated and constructivist pedagogical perspectives in mobile learning gives rise to a variety of context-specific research questions. This made this study ideal for a pragmatic, mixed methods research approach, in particular because pragmatism has been identified as ideal for answering varied and complex research questions that may include a variety of pedagogical perspectives and learning theories. Johnson and Onwuegbuzie (2004) emphasize that the pragmatist philosophy is ideal for educational research as it "…offers a method for selecting methodological mixes that can help researchers better answer many of their research questions" (p. 17). In this study, constructivism and situated learning principles were employed to design the collaborative, practical, context-based content and virtual communities of practice of the mobile learning simulations while pragmatism was used to evaluate and the effectiveness of this design by examining the experiences and learning outcomes of study participants.

Much like pragmatism, many of the strengths and benefits of mixed methods research centre on the enhanced results that the combination of techniques produces. It allows for a better understanding of a research problem by unifying trends within the quantitative data with specific, contextual details from the qualitative data (Hanson, Creswell, Plano Clark & Petska, 2005; Mertens, 2003; Punch, 1998). Researchers also argue that mixed methods can lead to a more comprehensive understanding of the research problem (Bryman, 2006), as well as greater validity and corroboration of results through triangulation (Greene, Caracelli & Graham, 1989).

In order to answer the identified research questions and understand the various learning outcomes, this study used a convergent parallel mixed methods design. This allowed for the quantitative and qualitative results to be compared or related and a more complete interpretation and understanding of the results to be obtained (Creswell & Plano Clark, 2011).

Study Approach

In this convergent parallel mixed methods case study, 121 healthcare professionals participated in the Ontario Telemedicine Network's videoconference equipment online training program between December1, 2013 and March 1, 2014. The purpose of this online resource was to provide healthcare professionals with the technical skills, process knowledge and etiquette tips to facilitate effective clinical consultations via videoconference.

The convergent parallel mixed methods design can be seen in Appendix III, where the processes of data collection, analysis, results and interpretation are outlined. The purpose of this third section of the mobile learning study was to examine the following research questions:

1. How does the use of a curriculum framework to design mobile learning experiences impact the learning experiences and outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?
2. How important are content design, content delivery, usability, communities of practice and structure to participants? How can feedback from the experiences and learning outcomes of participants be used to evaluate and revise the mobile learning experience conceptual framework?

The study was approved by the University of Ottawa's Social Sciences and Humanities Research Ethics Board. Consent letters detailing the requirements of the study were disseminated online and healthcare professionals taking the online equipment course were offered the choice to participate or decline to take part in the study.

Participant Recruitment

Participants in this study were healthcare professionals (registered nurses, nurse practitioners, physicians, administrators) participating in the Ontario Telemedicine Network's Telemedicine Coordinator training program. The mobile learning experience was situated in 12 online Videoconference Equipment Training Courses, where participants were taught how to utilize videoconference equipment to facilitate clinical consultations. There were approximately 50 learners registered in each of the 12 courses. All 600 learners were approached to take part in this study. A total of 121 agreed to participate and subsequently completed both the demographic questionnaire and post-program survey. Fifteen participants were interviewed regarding their experience in the online and mobile learning experiences.

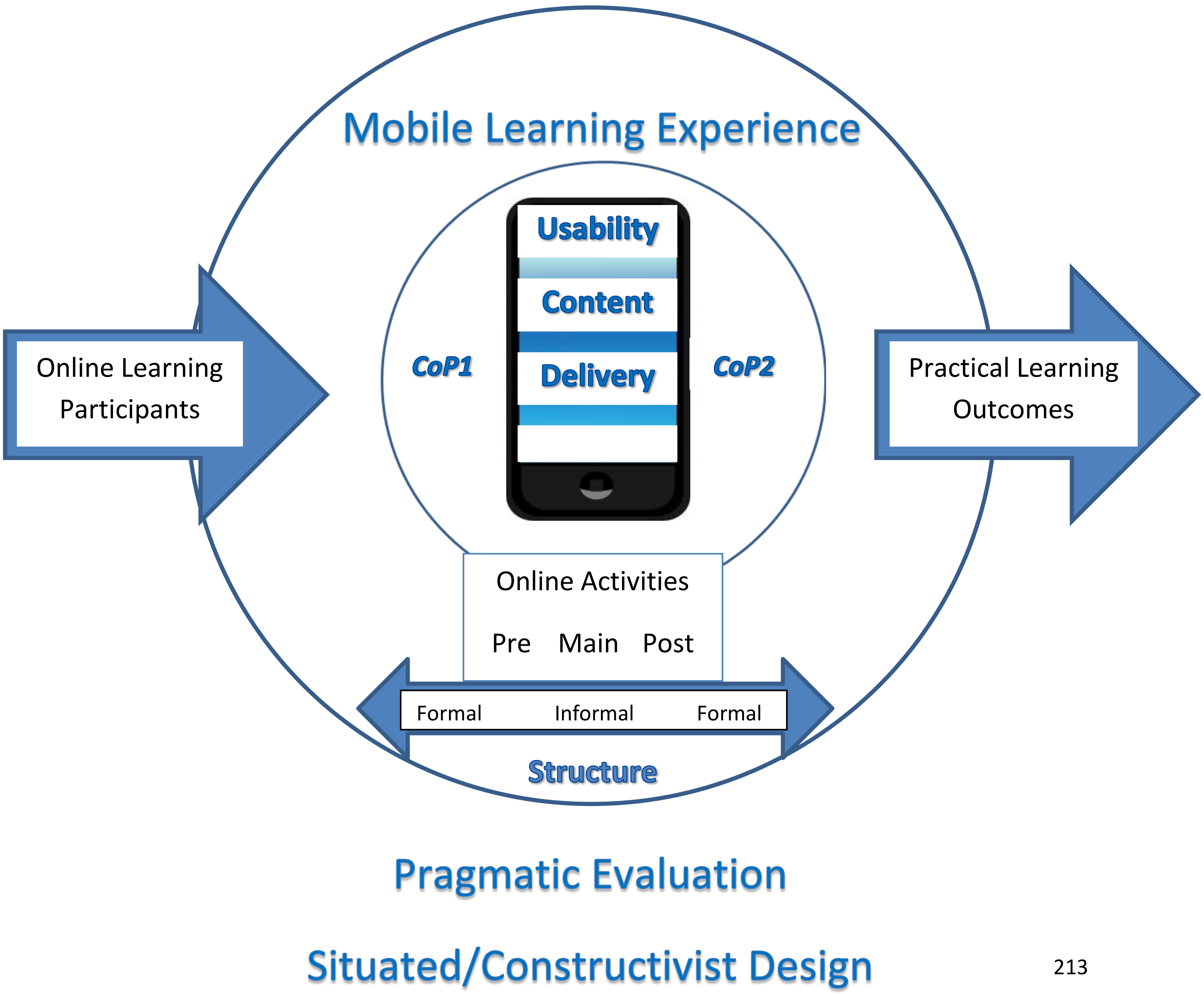
Instruments

Mobile Learning Experience Conceptual Framework. The Mobile Learning Experience Conceptual Framework draws upon the best practices of all the existing mobile learning dimensions identified in the literature review. The framework goes beyond pulling the best practices of all existing frameworks by also adding two variables not yet seen in any of the currently available frameworks: incorporating informal mobile learning experiences within online learning environments, and utilizing mixed methods research to evaluate the practical learning experiences and outcomes of learners. This study focuses on the creation of a framework because a framework is a system of rules, ideas or beliefs that is used to plan or decide something, or “a plane of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena” (Jarabeen, 2009, p. 51). Frameworks also exhibit a capacity for modification as well as place an emphasis on understanding instead of prediction, both of which can lead to a thorough comprehension of the topic being researched (Jarabeen, 2009). To this end, the success of the framework design was tested upon completion of the data analysis and potential suggestions to refine or revise the framework will be made in this paper. The Mobile Learning Experience (MLE) Conceptual Framework demonstrates how this research was situated within the literature. The framework guided the design, implementation and evaluation of the mobile learning experiences and is based on the following five dimensions: Content, Delivery, Usability, Structure, Communities of Practice, and how these elements contribute to learning outcomes. The MLE Conceptual Framework can be seen in Figure 2 on the next page.

Figure 2

Mobile Learning Experience Conceptual Framework

Elements adapted from the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009)



Evaluation of the MLE conceptual framework was created utilizing a pragmatic methodology and executed with a convergent parallel mixed methods design. With the exception of Communities of Practice, the other four dimensions (delivery is referred to as "media") are key evaluation components of the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009; Casimiro, MacDonald, Thompson & Stodel, 2009), which was designed to act as a quality standard to guide the design, delivery and evaluation of online healthcare education. W(e)Learn supports collaborative online and blended learning and was "…developed according to the principle that carefully designed educational programs with the appropriate blend of factors can help achieve desired outcomes" (Pullen, 2012, p. 241). W(e)Learn has been utilized in over twelve studies to date, and was a logical choice as a starting point for evaluation as it has been implemented and proven in the healthcare setting. The framework includes four levels of learning outcomes that were derived from the framework of Barr, Koppel, Reeves, Hammick and Freeth (2005), which itself was based upon the seminal training outcomes research of Kirkpatrick (1967) which is used throughout North America as a standard of workplace education and evaluation. The four levels of learning outcomes of the W(e)Learn Framework are: 1) learner satisfaction, 2) development of new knowledge or skill or changes in attitude, 3) changes in learner behavior, 4) organizational change and improved patient outcomes. For the purpose of this study the focus will be on learning outcomes 1-3 as organizational change and patient outcomes are both beyond the allotted timeframe for this research.

The W(e)Learn Framework can be seen in Appendix I, and the Post-Program Mobile Learning Experience Survey adapted from the W(e)Learn Survey created by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010) can be seen in Appendix II. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html.

In this paper, the experiences and learning outcomes of study participants will be utilized to evaluate the design of the mobile learning experience conceptual framework, along with an extensive quantitative examination (via descriptive statistics and Factor Analysis examinations) of the questions and dimensions in the Post-Program Mobile Learning Experience Survey in the findings sections. Suggestions for revisions to the mobile learning experience conceptual framework will be made in the discussion section.

Online Resource. The online course was one hour in length, and engaged learners with a variety of activities including digital video segments, interactive PDFs, written content, and checklists. The first three modules of the course were consistent for all study participants, and included an introduction to the videoconference equipment, remote control, and a description of the mobile learning experience (Table 2). These three modules were designed to be completed on a computer and at a place and time convenient for the participants. They provided the baseline knowledge and technical information crucial to the completion of the mobile learning experience.

The mobile learning experience was module four, and participants accessed it via their tablet, cell phone or laptop computer on location within their clinical videoconference studio. This allowed participants to interact with the learning content in the authentic workplace setting where they would be using the videoconference equipment. The participants were prompted to perform specific tasks (focusing on technical skills with the remote controls and videoconference systems), answer questions (focusing on etiquette and process knowledge) and provide feedback (in the form of a clinical readiness documents that recorded their preparedness for their first videoconference event). At the conclusion of the mobile learning experience, participants received a feedback form via email based on the questions they answered during the simulation. This feedback both evaluated their performance and provided tips on items they needed to improve or augment. Feedback forms were emailed directly to the participants through the secure link to their Moodle account in order to maintain anonymity.

At the conclusion of the mobile learning experience, participants then returned to the online course to complete modules 5 and 6. Module 5 provided supplemental information to build upon the learnings in the mobile learning experience. Finally, in Module 6 participants were tested on their learning and completed a post-program survey (at the completion of the online course), and reaction survey 2 (after their first clinical videoconference).

The detailed online/mobile module structure, content and delivery modalities can be seen in Table 2.

Table 2

Structure and Delivery of Online Course and Mobile Learning Experience

Structure	Online Module	Delivery
“Pre” Activities Online Equipment Course	Unit 1: Introduction to the Equipment g) Equipment Terms and Concepts h) Equipment Operation	- Video of host presenting the videoconference equipment - PDF reference guides
	Unit 2: Introduction to the Remote Control i) Features of the Remote Control j) Functions of the Remote Control	- Screencast of remote control features and functions - PDF reference guides
	Unit 3: Mobile Learning Experience Orientation g) Explanation of Mobile Learning Experience h) Consent for Mobile Learning Experience	- Screencast of mobile learning experience features and functions - Online consent form
“Main” Activities Mobile Learning Experience	Unit 4: Mobile Learning Experience m) Setting up the Room n) Operating the Equipment o) Orienting the Patient p) Facilitating the Session	- Avatar host - Tasks “pulled” from resource by learner - Checklist “pushed” to resource from learner - Discussion forum access for CoP1 - Navigation and index features
“Post” Activities Online Equipment Course	Unit 5:Videoconference Etiquette and Privacy m) Videoconference Etiquette n) Privacy and Videoconferences o) Troubleshooting Tips and Tricks	- Etiquette video - Privacy slide show - Troubleshooting Screencast - PDF reference guides
	Unit 6: Supplemental Material (Optional Based on Equipment at Member Site) k) Hooking up a Laptop Computer l) Manual Dialing Using the Global Address Book	- Video of host presenting laptop and address book - PDF reference guides
	Unit 7: Assessment l) Final Quiz m) Course and Mobile Experience Post-Program Survey n) Reaction Survey 2	- Online quiz and reaction survey - Summary PDF reference guide - Reaction Survey 2 for CoP2

Mobile Learning Experience. The dimensions of the MLE conceptual framework will now be discussed based on how they were implemented in the design of the mobile learning experience.

Content. Content was delivered in a situated fashion, where mobile devices were utilized in a context-specific environment: the clinical videoconference studios of healthcare professionals across Ontario. Participants brought their prior knowledge (experiences as clinical practitioners as well as the introductory material from the online course) to the situated learning environment where they were enabled to interact with equipment, tools, protocols and processes in a specific real-world context. Participants were engaged with tasks and questions in order to solve problems and plan future actions for their clinical videoconference programs. Finally, participants were empowered by being able to control and interact with the content in a variety of fashions: short-answer questions, checklists, guided activities, discussion forums and resource guides.

Delivery. For delivery, the learning continuum fell between content intensive and communication intensive as proposed by Gay et al. (2002). The content was served on a mobile device (phone, tablet or laptop) in order to provide flexible physical access via interactive prompting and just-in-time instruction, and also allowed the participants to capture and integrate data that they learned in the specific context and activity. According to Park's (2011) High Transactional Distance Individualized mLearning Model, the individual participants received the content and controlled their learning process in order to master it and the interactions mainly occurred between the individual learner and the content. Specific tasks to complete and skills to master were "pulled" by the participants via the mobile device. These included instructions on preparing the patient, preparing the room and videoconference equipment, presenting the patient, facilitating the consultation, and organizing follow-up activities. Questions during the learning activity allowed information to be "pushed" from the participants and compiled into detailed summaries of the mobile learning experience. These questions focused on items required for the clinical consultation, the preparedness of the clinical space, and the successful operation of the videoconference equipment. The mobile learning experience compiled a summary of these questions so that the participants could identify gaps in their knowledge, technical skills and processes, and identify future areas of learning or development.

Usability. Technical usability was a key component of the conceptual framework. Participants provided answers to questions via short texts or check boxes in order to ensure mobile efficiency. Content was packaged into a short module of 25 minutes or less, with avatars and audio files providing the instruction in order to minimize bandwidth use and download times. Navigation was designed to minimize scrolling, and symbols were used for all menus and tabs. By utilizing HTML5 and CSS interactivity, the mobile learning experience detected the type of device the participant was using (iPhone, Blackberry, Android, Tablet, Laptop) in order to ensure display consistency. Pages were designed to load and play quickly by simplifying page layout and testing all multimedia files to ensure that they played seamlessly while maintaining a small file size. Progress bars, navigation icons, an avatar host and a table of contents were also employed to facilitate navigation and standardize the user interface.

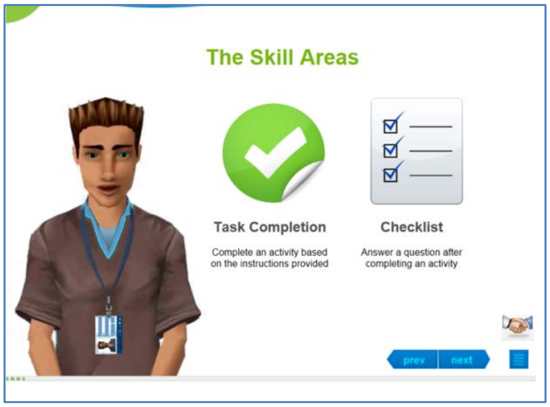
Structure. With regards to structure, the informal learning tasks with the mobile devices were embedded within the formal learning environment of an online course. First, participants completed the “Pre” activities online, where they were given an introduction to the key technical and clinical points of presenting a patient via videoconference, as well as orientation as to how to use the mobile devices for the learning activity. The “Main” activity involved the mobile learning in a context-specific environment, where participants utilized inquiry-based learning in order to acquire specific skills, responded to questions and identified future tasks for completion. The “Main” activity was used to scaffold the learning from the “Pre” activities and allowed the participants to take control of the learning activities in an authentic context. Finally, the participants returned to the online environment for the “Post” activities. In the “Post” activities the participants augmented their knowledge by being presented with other cases studies and detailed information, accessed supplementary and optional material specific to their clinical area of practice, and completed final quizzes and reaction surveys. Thus the mobile learning experience comprised the meat of the online learning experience, with the introductory “Pre” activities setting the stage for the authentic, context-based “Main” activity, followed by the cementing of the new knowledge in the “Post” activities.

Communities of Practice. For communities of practice, participants were asked to “post” their key learnings, suggestions and challenges in a discussion forum that could be accessed by all participants while taking part in the mobile learning experience. The first forum or CoP1 was design as an open-ended conversation where participants could share common problems and observations based on the mobile learning experience activities. The second forum or CoP2 asked participants to post to the discussion forum after their first clinical telemedicine appointment, and comment on what knowledge and skills they found useful or lacking in the mobile learning experience. Participants received a message via email at the end of the course reminding them to post to the discussion forum and that they had continual access to the forum even after course completion. CoP2 adopted a content collection orientation where participants could problem-solve and share resources and expertise. A visual representation of the orientation, task and checklist screens in MLE1 can be seen in Figure 3.

Figure 3

Design Features of the Mobile Learning Experience

Orientation Screen

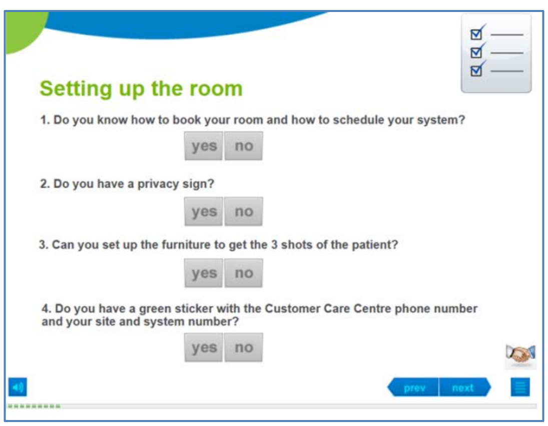


Usability included progress bar at bottom of page, large previous and next navigation buttons, interactive table of contents (blue menu), discussion forum access (handshake icon), and an orientation to the task and checklist icons. All graphics and avatar were rendered so as to maximize performance speed.

Task Screen

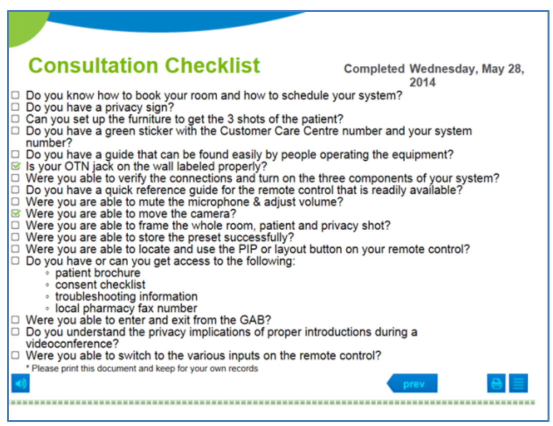
Task icon (checkmark) at the top of the page oriented participants to the activity. Progress bar, navigation icons, table of contents, volume control and discussion forum access were all located at bottom of screen.

Checklist Activity



Checklist icon (checklist) at the top of the page oriented participants to the activity. Large icons that were user-friendly for both mouse and touch (for tablet/smartphone users) allowed participants to easily register responses.

Checklist Output



Checklist output was accessed on the final page of the mobile learning experience and was automatically emailed to participants. Checklist identified strengths and gaps in the clinical videoconference preparation of participants, giving them a practical "to-do" list after the MLE concluded.

Data Collection

Data collection occurred over a three month period from December 1, 2013 to March 1, 2014. Quantitative and qualitative sources of data included the following:

Demographic Survey. The demographic survey was completed online prior to the commencement of the online course, and collected basic demographic data, the participants' online experience, their exposure to mobile learning, and their attitudes towards online learning. This gave an idea of the technical experience of the participants and allowed the researcher to identify if this experience had any influence on the learning outcomes achieved by the participants. A copy of the demographic survey can be found in Appendix IV.

Discussion Forum. The discussion forum (also known as CoP1) addressed the identified importance of constructivist learning principles when designing mobile learning content. CoP1 was provided as an open-ended collaboration tool for participants, although the ultimate purpose of the forum would be determined by the needs of the community that utilized it. When participants accessed the forum, the following guiding question was posed: "Please list any questions or comments you may have about this equipment simulation and/or about this mobile learning activity." Specifically, the forum was intended for participants to share information, post challenges and propose solutions to common problems. The forum also provided a valuable source of qualitative data as to the participants' experiences with both the technical learning content (facilitating a clinical videoconference) and the mobile learning experience. The forum was accessed through a "Discussion" icon available on the mobile learning experience interface.

Post-Program Survey. The second survey was a post-program survey that employed a five point Likert scale and was completed online after the completion of each course (Appendix II). The post-program survey is adapted from the W(e)Learn Post-Module Survey utilized by MacDonald, Archibald, Trumpower, Casimiro, Cragg and Jelley (2010). Questions were divided into five sections to provide a quantitative evaluation of the Content, Delivery (W(e)Learn calls this Media), Structure, Usability and Learning Outcomes of the mobile learning experience. The survey also included six open-ended questions on the participants' learning experience that produced qualitative data for analysis. An online copy of the original W(e)Learn survey can be found here: http://ennovativesolution.com/WeLearn/IPE-Instruments.html.

Reaction Survey 2. Reaction Survey 2 (also known as CoP2) was a post to the discussion forum and was completed by the participants after their first clinical telemedicine appointment (Appendix V). This provided valuable insight on how the participants utilized the learnings in the mobile learning experience to build upon their prior knowledge and apply these new skills in the workplace. Questions in Reaction Survey 2 also retrieved qualitative data on the participants' learning experiences by inquiring about the strengths, weaknesses, opportunities and challenges of the mobile learning experience. Participants were also invited to share tips, resources and experiences in a resource section of the discussion forum.

Focus Group Semi-Structured Interviews. Four focus groups with a total of fifteen participants from MLE1 were interviewed within two weeks of completion of the online equipment course. The purpose of the interviews was to gain a greater insight into the personal learning experiences of the participants in each of the simulations. The interviews took approximately 30 minutes, and were guided by a set of interview questions that were open-ended and developed with the influence of questions in the Survey Instrument for the Communities of Inquiry Framework (Garrison, Anderson & Archer, 2000). The interviews were taped and subsequently coded with learners' permission (Crichton & Childs, 2005). The interview questions can be found in Appendix VI.

Data Analysis

Data from the post-program survey, the two discussion forums (CoP1 and CoP2) and the focus group interviews were triangulated to increase the rigor of this study. Convergence of multiple sources of data at different times during the research process is one of the most reliable forms of triangulation. Denzin (1978) defines several types of triangulation, one of the most reliable of which is the convergence of multiple sources of data at different times during the research process. The strength of convergent mixed methods research is that it provides the researcher with a greater number of methodological tools at their disposal in order to answer a variety of research questions (Greene, Caracelli & Graham, 1989) and identify emerging questions and themes (Stange, Crabtree & Miller, 2006). Any responses of “not applicable” by participants on the post-program survey were omitted from the data analysis.

Descriptive data from the quantitative reaction survey questions was produced by using SPSS Data Analysis. In vivo coding along with inductive and deductive reasoning was used to produce a list of codes from the interview data. In vivo coding is an effective method for primary qualitative data analysis as it allows for concepts and feedback to stay as close as possible to participants’ own words and terms (Flick, 2002). The descriptive data from the quantitative results and the list of codes from the qualitative results from the learning outcomes were both organized into key themes. These key themes were then triangulated to produce both combined and contradictory key themes that can be used for course revisions and publication. A visual diagram of this process can be found in Appendix III. Any other emergent themes within and among the data were also coded and reported. The writing adopted a narrative tone as this captured the experiences of the participants, and direct quotations were included when relevant.

Quantitative data from the evaluation surveys from the mobile simulation courses was analyzed using Principal Component Analysis (PCA). This entailed taking a measure of sampling accuracy, performing a factor extraction, drawing a scree plot and utilizing a rotated component matrix. PCA, therefore, was utilized as a method to determine how accurately the evaluation survey questions related to the five elements of content, delivery, usability, communities of practice and structure in the mobile learning conceptual framework. PCA assessed how reliable and relevant the survey questions were, and dictated what changes were required to increase the validity of the questions and framework.

Ethical Considerations

Careful measures were taken to ensure that no participants were harmed as a result of this study. Confidentiality of participants was maintained at all times. The participants were volunteers so they were not, therefore, considered a population that is vulnerable or at risk because of the study. All the transcripts and recordings from the interviews are being kept on the researcher’s secured computer under password protection, and answers on the online surveys are kept on a secure server. Learners in OTN online courses who did not volunteer to become participants in this study were flagged in the learning management system and their data was not included in any of the research.

Results

There were three purposes for this paper. The first was to examine the impact of the Mobile Learning Experience Conceptual Framework based on the learning experiences and outcomes of participants based on the qualitative and quantitative data analysis. The learning outcomes of interest are numbers 1-3 (learner satisfaction, new knowledge or skills developed, learner behavior) according to the W(e)Learn Framework. Results are discussed as they pertain to: demographic questionnaire responses, a summary of the results of the participant responses regarding the five dimensions of the mobile learning experience framework, and how the learning outcomes of participants were influenced by the mobile learning experience. To fulfill the second purpose of the paper, the MLE conceptual framework will be evaluated by comparing and contrasting the feedback from the mobile learning experience as understood through the post-program survey, focus group interviews and discussion forum posts.

The third purpose of the paper is to revise the evaluation tools for the MLE conceptual framework. To do this, the results from the questions on the post-program survey will also undergo a factor analysis to determine the accuracy of the questions and whether they truly relate to the dimensions (content, delivery, structure and usability) to which they were assigned. Based on the Factor Analysis the dimensions or their associated questions may require reorganization or revision.

Demographic Questionnaire

One hundred and twenty-one healthcare professionals took part in this study, consisting of 99 registered nurses, 12 administrative staff, 8 medical students and 2 practicing physicians. Tables 1.1 – 16 in Appendix VII provide the detailed demographic results.

The average age of healthcare professionals in the study was 38.3, with most being between the ages of 31-50. The vast majority of the participants (81.8%) were registered nurses and 87.6% were female. It was also the first mobile learning course for 86.8% of the participants in the study. Participants were familiar with using technology to access information despite the inexperience with mobile learning. Over 70% indicated that they used mobile devices sometimes, often or always to access personal or professional information, and 76.1% said they had taken an online course several times or often in the past.

With regards to their online experience, on a five-point Likert scale (with 1 being none and 5 being always), participants listed audio conferencing (3.84) and videoconferencing (3.22) as most common. As far as mobile experiences, the most common were accessing email (4.22), texting (4.11), audio conferencing (3.96), and accessing web pages (3.87). On a five-point Likert scale (with 0 being not applicable and 4 being strongly agree), participants indicated that their past online experiences were very positive with a rating of 3.42. Participants were unsure whether mobile learning experiences enhance the online learning environment, giving that question a 2.62 rating.

Dimension Results

Results for the five dimensions (content, delivery, structure, usability, communities of practice) have been presented and discussed in detail in two previous papers by this researcher. Below is a summary of the major themes of participant learning experiences identified by the mixed methods analysis for each of the five dimensions, as well as a description of each theme and sources of supporting evidence (Table 3). The sources of supporting evidence were coded in the following manner: post-program survey quantitative responses (1), post-program survey open-ended question responses (2), CoP1 or discussion forum posts (3), CoP2 or survey 2 responses (4), semi-structured interview responses (5).

Table 3

Mobile Learning Experience (MLE) Dimensions: Themes, Descriptions and Evidence

Dimension	Theme	Description	QUAN Evidence	QUAL Evidence
Content	Comprehensive	MLE provided content that effectively covered the material in depth and breadth	1	2,5
	Context-Specific	MLE content was valuable and effective as it was presented in specific workplace context	1,2	2,3,4,5
	Process and Skills	MLE presented and instructed new process and skills for clinical videoconferencing	None	2,4,5
	Applicable and Authentic	MLE content presented activities that were authentic for the workplace and applicable for participants' daily work	1,1,2	2,4,5
	Technical Skills	MLE taught technical skills that could be applied to workplace activities	1,2	2,4,5
	Clinical Skills	MLE did not teach clinical skills that could be applied to workplace activities	1	2,5
	Organization vs. Guidance	MLE provided superior organization of content but some participants felt the guidance through the checklist to be lacking	1,1	2,3,4,5
Structure	Engaging	MLE kept participants' interest, motivated them to learn and engaged them in the learning experience	1,1,1	2,4,5
	Application	MLE allowed participants the opportunity to apply learned knowledge	1,2	2,4,5
	Problem Solving	MLE lacked problem-solving activities or opportunities	1	2,5
	Logical Progression	Participants divided over whether structure provided a logical progression for MLE activities	1,2	2,4,5
	Hybrid Learning	Participants strongly agreed that online learning prepared for and supported the MLE	1,1	2,3,4,5
Delivery	Capture and Integration	MLE delivery allowed participants to capture information from the learning environment and integrate into best practices	1,2	2,4,5
	Control	Participants felt delivery of MLE gave them control of the learning activity	1	2,3,4,5
	Flexible Learning	MLE delivery promoted a flexible learning environment	1	2,4,5
	Flexible Tools	MLE delivery did not provide flexible, easy access to support tools, help or communication	1	2,3,4,5
	Communication and Collaboration	MLE delivery provided limited access to communication or collaboration during the activities	1,1	2,4,5
	Avatar Host	MLE successfully integrated the avatar host, which guided participants through the activities	None	2,4,5

Usability	Navigation	Navigation was simple to use, interactive and easy to control	1	2,5
	Graphics and Presentation	Graphical display was simple, intuitive and appealing and presentation was consistent across devices	1,2	2,5
	Page Loading and Downloading	Page loading speeds and downloading speeds varied for participants and some were frustrated with network access at their site	1,1,2	2,5
	Discussion Access	Discussion forum access was difficult and navigation/interactivity poor due to its location in Moodle (outside the MLE)	1	2,3,5
	Interactive and Productive	MLE was productive due to its interactivity and ease of use	1	2,5
Communities of Practice	CoP1 Value	Discussion forum lacked purpose and value for participants	1,2	2,3,5
	CoP1 Synchronicity	Participants questioned the asynchronous nature of the discussion forum and advocated for a synchronous format	3	2,3
	CoP1 Navigation and Access	Participants did not find the navigation within or access to the discussion forum to be intuitive due to its location in Moodle	None	3,5
	CoP2 Added Value	Participants lauded the value of reaction survey 2 for its information and resource sharing	2	4,5
	CoP2 Asynchronous Productivity	Asynchronous nature of reaction survey 2 was ideal for collaboration on common problems and solutions	None	4,5
	CoP2 Best Practices	Content collection and assembly of best practices created a useful resource library in reaction survey 2	4	4,5

Evidence: 1 = Post-Program Survey QUAN; 2 = Post-Program Survey QUAL; 3 = CoP1; 4 = CoP2; 5 = Interview

Learning Outcomes

The results for the learning outcomes of participants of the mobile learning experience will be presented and discussed according to levels 1-3 (satisfaction, new knowledge developed and behavior) of the W(e)Learn Framework (MacDonald et al., 2009).

Participant Satisfaction. Participants indicated on the post-program survey (a five-point Likert scale with 0 being not applicable, 1 being strongly disagree and 4 being strongly agree) that the mobile learning experience was both interesting (3.00) and valuable (3.27). Participant satisfaction was also high in the discussion forum during the mobile learning experience. “This simulation is fantastic! It’s been fast, fun and I’ve learned a lot about the remote control and system in a short time" (Nurse 82). "I feel lucky to be a part of this cutting-edge research and resource-sharing activity. This is cool stuff" (Administrator 17). Nurse 53 echoed this sentiment in her reaction survey 2 post: "I think this new technology is very effective for teaching technical skills. It made the experience fun." Nurse 28 agreed: "To learn in such a specific setting is rewarding for me and I understand the concepts so much better now."

Responses in the semi-structured interviews were also extremely positive, with all fifteen participants agreeing that utilizing the mobile learning experience was rewarding. "I think we've all taken a lot of online courses before so they're not that new anymore. This is something different and I liked the diversity of the hands-on experience" (Nurse 3). "I liked the experience and would recommend it to colleagues that want something short and informative. A good use of my time" (Medical Student 2).

New Knowledge and Skills. Participants indicated on the post-program survey that they most definitely learned new knowledge and skills while participating in the mobile learning experience. They indicated that they understood new principles of clinical videoconferencing (3.27), acquired proficiency in new techniques (3.15), and learned applicable skills in a specific context (3.21). In fact, new techniques and applicable skills had two of the lowest (0.380 and 0.412 respectively) standard deviations of all of the post-program scores, indicating a similar positive experience for the majority of participants. Accordingly, responses for the semi-structured interviews were similarly positive. "It was extremely useful to perform the activities in our telemedicine (videoconference) studio as I learned what I needed to know where I needed to know it" (Nurse 5). "Looking at a video online is good for an introduction, but getting my hands dirty and learning how to use the remote control and system in our room was valuable. My skills are better developed this way" (Administrator 3). Responses on reaction survey 2 were equally positive. "This is my second week on the job and the skills I've learned here are fabulous. I've learned a lot in a very short time with this simulation" (Nurse 28). "I now understand the process of a clinical videoconference. Not sure I could have picked up these skills as quickly with only an online course" (Administrator 14).

Behavior Change. Learning a new behavior is often the most difficult to evaluate, but there were positive indications that participants adopted new behaviors as a result of the teachings in the mobile learning experience. In the post-program survey, participants indicated that the mobile learning experience allowed them to learn information that they couldn't have accessed through and online course (3.39), and that it also made the learning environment more motivating and engaging (3.54). These were important because they aligned with the qualitative feedback of participants. In reaction survey 2, Administrator 21 commented on the link between the mobile learning experience and her behavior change. "The mobile learning helped me change the way I deliver care via telemedicine (videoconference). To be able to teach the processes in the right context makes adopting these new protocols easy." Nurse 31 agreed: "I can see now how to adopt these skills pretty easily because of the simulation." The issue of motivation and engagement was also linked to a change in behaviors by the responses in the interviews. "The mobile learning put the clinical consultation into the right context for me. It motivated me to learn and how to incorporate telemedicine into our daily workflows" (Nurse 6). The change in workflows and behavior was reinforced by Medical Student 1: "I think to be able to see this stuff in action and participate in the studio brought this to life for me and made me think of how we can use this service in our existing practices." Administrator 1 summarized: "It's easier to change processes and workflows when you see how something works. This experience showed me how telemedicine works and could work for us."

Factor Analysis and the Mobile Learning Experience Conceptual Framework

Overview of Factor Analysis. Factor analysis was chosen as a method of testing the accuracy of the mobile learning experience conceptual framework post-program survey in order to determine if the questions truly do relate to the five dimensions of delivery, usability, structure, content and outcomes. A type of factor analysis known as Principal Component Analysis (PCA) was chosen as the statistical technique for this study. PCA is known as a method of data reduction that can describe the variability among observed variables with regards to a lower number of unobserved variables that are called factors (Tabachnick & Fidell, 2001). PCA is used to find optimal ways of combining variables into a small number of subsets or factors, or which questions "load" onto which of the dimensions (in this case factors) in the mobile learning experience conceptual framework. Factors are independent and normalized random variables from which the variability of the dataset can be reproduced, and PCA ranks the factors according to their contribution to the global variance (Ringer, 2008).

According to Comrey and Lee (1992), 1000 cases is an excellent number for PCA or factor analysis, with only 100 cases considered poor. This is because PCA is based on a correlation matrix of all of the variables in the data set, and usually correlations require a larger sample size before they stabilize. For the purpose of this study, only 121 samples were collected so there is an understanding that the power may suffer as a result. This study can, however, be viewed as an exploratory study that could yield a suggestion for further research and revisions regarding the mobile learning conceptual framework's post-program survey and evaluation methods.

Data Cleansing. An important method used to clean data that is important for multivariate datasets is to examine how closely the variables are correlated. If the variables are too closely correlated (multicollinearity), then the power of an experiment is compromised since the effects of a factor are spread over multiple variables rather than one (Tabachnick & Fiddell, 2007). There is also a concern regarding singularity, where two or more variables perfectly predict a third variable. Inclusion of this third variable would then reduce power and not add any further information.

An examination of the correlation matrix displays how there is a method to eliminate multicollinearity and singularity in this dataset. All of the significance values are well below 0.05, and there are no variables with correlation coefficients greater than 0.9. Therefore no variables will be eliminated from the study in order to eliminate the problem of singularity. As a dataset, the determinant is 0.000293 which is greater than the necessary value of 0.00001, therefore mulitcollinearity is not a concern for these data (Brown, 2009).

Measure of Sampling Accuracy. Table 4 includes two important parts of the output for this study: the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

Table 4

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.789
Bartlett's Test of Sphericity	Chi-Square	3719.687
	df	741
	Sig.	.000

The KMO measure of sampling adequacy varies between 0 and 1, with a value close to 1 indicating that the patterns of correlations are compact and therefore principal components analysis will yield reliable and distinct factors. Hutcheson and Sofroniou (1999) consider a value between 0.7 and 0.8 to be good and a value over 0.8 to be great for PCA or factor analysis. The study's value of .789 is therefore adequate. Bartlett's Test of Sphericity also has a significance value much less than .005, demonstrating that PCA or factor analysis is appropriate since there are distinct relationships among the variables.

Factor Extraction. Table 6 illustrates the total variance explained by the components or factors identified in the study. There were 39 components studied since there were 39 variables. The eigenvalues associated with each factor represent the variance explained by that particular factor or component. For the purpose of this study, only factors with eigenvalues greater than 1 (10 from a possible 39) were extracted (see Table 5). Looking at the rotation sums of squared loadings, it is evident that there are 7 factors that had eigenvalues greater than 1 and are included in this analysis.

Table 5

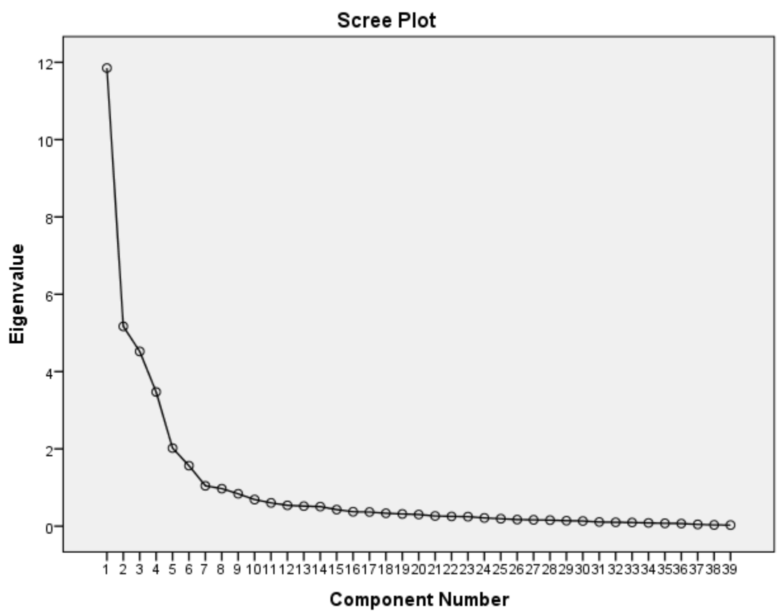
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	11.851	30.388	30.388	11.851	30.388	30.388	9.483
2	5.168	13.251	43.639	5.168	13.251	43.639	9.238
3	4.521	11.592	55.231	4.521	11.592	55.231	5.227
4	3.473	8.906	64.137	3.473	8.906	64.137	3.081
5	2.020	5.180	69.317	2.020	5.180	69.317	4.190
6	1.566	4.015	73.332	1.566	4.015	73.332	4.323
7	1.044	2.677	76.009	1.044	2.677	76.009	3.796
8	0.971	2.490	78.499				
9	0.839	2.150	80.649				
10	0.690	1.768	82.417				

Scree Plot. The scree plot can be seen in Figure 4 and it is evident that there is a point of inflexion in the curve around component 6-7, thereby justifying the choice to limit the results to an examination of the top six or seven factors.

Figure 4

Scree Plot



Rotated Component Matrix. The rotated component matrix can be found in Table 1 in Appendix IX. Rotation can assist in the interpretability of factors as it maximizes the loading of individual variables on one factor while minimizing the loading on other factors (Hutcheson & Sofroniou, 1999). A promax oblique rotation was selected for this study because the correlations among variables almost all exceeded .32, and this means that there is at least a 10% overlap in variance among factors and this warrants oblique rotation (Tabachnick & Fiddell, 2007). The factors have some overlap and are not completely independent from one another. The normal criterion for retaining individual variables on a factor is when the value in the component matrix exceeds 0.6 and the sample size is greater than 250 (Field, 2005). Unfortunately, the sample size in this case is only 121, but for the purpose of this study all variables with values in the component matrix greater than 0.6 will be retained, with the understanding that this is an exploratory study acknowledging and accepting this loss of power.

According to this criterion, the retained factors, their associated questions and factor loadings are listed in Table 6. It is clear that the questions that load onto each of the mobile learning experience conceptual framework dimensions will have to be revised and reorganized due to the results below.

Table 6

Factors and Associated Post-Program Survey Questions

Factor	Associated Questions	Factor Loading
1	D4 The delivery of the information promotes a flexible learning environment	.927
	C3 The content is context-specific	.916
	S4 The mobile learning experience engaged me in the learning experience	.864
	U4 Presentation of material utilizes aesthetically pleasing graphics	.831
	S8 The online modules supported the mobile learning experience after it was completed	.771
	D2 The delivery allowed me to control my learning environment	.729
	C6 The content effectively guides me through the activities	.638
2	D6 The resource promotes communication among learners	.900
	S9 I enjoyed the combination of online learning with the mobile learning experience	.815
	O1 The online/mobile course is interesting	.753
	S6 The mobile learning experience provides opportunities for problem-solving experiences	.720
	D5 The delivery allowed me to capture and integrate information	.717
	D3 There is flexible access to support tools, information, help, and online communication	.713
	U1 In this program it was easy to "navigate" through the content	.668
	U8 The mobile learning experience was interactive and productive due to its usability	.612
3	S7 The mobile learning experience provides opportunities to apply material learned	.875
	O2 The online/mobile course is valuable	.827
	O5 As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context	.822
4	C4 The content effectively presents technical skills that I can apply in my workplace	.965
	S3 The mobile learning experience motivated me to learn	.718
5	C8 The content is authentic	.935
	C7 The content is applicable for my professional life	.803
6	C1 The content is of appropriate depth and breadth	1.009
	O4 As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques	.701
7	C5 The content effectively presents clinical skills that I can apply in my workplace	.885
	U7 Interactivity was efficient when posting to and accessing the discussion wall	.601

Unassociated Post-Program Survey Questions. A total of 13 questions from the post-program survey questions failed to have a component matrix greater than 0.6 and therefore did not load onto one of the seven factors. Since the post-program survey was adapted from the W(e)Learn framework (which was designed to evaluate online learning), it is likely that these 13 questions were either poorly-worded or not applicable for the study of a mobile learning environment. There is data that can be presented and examined to explore this statement.

In two previous papers on this study, three versions of the mobile learning experience (MLE1, MLE2 and MLE3) were created and randomly assigned to study participants. MLE1 was the ideal version of the mobile learning experience including best practices for the design and implementation of content, delivery, structure, usability and communities of practice. MLE2 included best practices for all elements except for delivery, and MLE included best practices for all elements except for usability. T-tests were utilized against all of the post-program survey questions to determine if there were significant differences in the learning experiences of participants between MLE1 and the other two mobile learning experiences. In order to examine the 13 questions that did not load onto any of the seven factors, they are presented along with their t-test results in Table 7 (comparing MLE 1 and MLE3) and Table 8 (comparing MLE1 and MLE3). Further examination of these results will continue in the discussion section of this paper.

Table 7

Post-Program Survey Content, Usability and Outcome Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 3 (N=94)

Answer Option	**MLE 1[a]**		**MLE 3[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
C2. The content is well-organized	3.05	0.312	2.73	0.532	0.000
U2. The instruction is divided into clear and logical sections	2.80	0.572	2.63	0.508	0.019
U3. Uploading and downloading material was fast and efficient	2.76	0.503	2.78	0.444	0.838
U5. Content was displayed in a consistent fashion on my mobile device	3.20	0.714	2.47	0.634	0.000
U6. Pages loaded quickly	2.67	0.472	2.34	0.632	0.000

O7. The mobile learning experience made the learning environment more motivating and engaging	3.54	0.500	3.18	0.655	0.000

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 8.

Post-Program Survey Structure, Delivery and Outcome Responses Mobile Learning Experience 1 (N=121) and Mobile Learning Experience 2 (N=92)

Answer Option	**MLE 1[a]**		**MLE 2[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
S1. The introductory online learning modules prepared me for the mobile learning experience	3.31	0.671	3.11	0.763	0.042
S2. The mobile learning experience kept my interest	3.12	0.458	3.03	0.583	0.216
S5. The material follows a logical progression	2.75	0.505	2.70	0.569	0.453
D1. The resource respects my experience and current knowledge	3.09	0.619	3.06	0.589	0.758
D7. The resource promotes collaboration among learners	2.49	0.593	2.36	0.622	0.128
O3. As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	3.27	0.695	2.78	0.652	0.000
O6. The mobile learning experience allowed me to learn information that I could not have accessed through an online course	3.39	0.725	2.88	0.660	0.000
O7. The mobile learning experience made the learning environment more motivating and engaging	3.54	0.500	3.33	0.697	0.009

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Discussion

This mixed methods study explored the influence of content design, delivery, structure, usability and communities of practice on the learning experiences and outcomes of healthcare professionals as they learned how to utilize telemedicine equipment and develop clinical processes via a hybrid online course and mobile learning experience. It also provided the opportunity to test the design and evaluation of the Mobile Learning Experience Conceptual Framework. Results for the five dimensions of the framework (content, delivery, structure, usability, communities of practice) have been discussed in length in two previous papers on this study, so a brief summary of these discussions will be presented here. An analysis of the learning outcomes of participants will also be explored, along with any proposed revisions to the design of the Mobile Learning Experience Conceptual Framework. The second part of the discussion will focus on the factor analysis that was performed on the post-program survey and how results influence the revision of the survey and the evaluation tools of the MLE conceptual framework.

Dimensions of the MLE Conceptual Framework

Content. Findings suggested participants were motivated to learn by the context-specific design, practiced and developed knowledge by taking part in the task and checklist activities, and found the organization of the resource to facilitate information delivery but the guidance to be disjointed and unsettling. Participants valued the situated context of the learning content, which supports the constructivist concept that learning is based on constructing meaning from experience, self-direction and situated cognition (Merriam & Caffarella, 1999). Situated cognition learning theory aligns with these findings, since it places such strong emphasis on the physical context of learning, and assumes that knowledge is inseparable from the contexts and activities within which it develops (Putnam & Borko, 2000). While the social interaction that is an important part of situated cognition was absent during the mobile learning experience, the study demonstrated that situated learning activities can be prescribed and specific and still result in effective interactivity between a learner and pedagogical content.

Participants found that the tasks and checklist activities gave them control in the learning environment, allowed them to practice and experiment with technical skills, and plan future actions. All of these activities are critical elements of what Naismith et al. (2005) call authentic situated learning. The content in the mobile learning experience was centred in an authentic context (the videoconference studio), participants engaged in authentic activities (tasks and checklist), had skills modelled for them (by the avatar), and engaged with the content through a variety of perspectives (tasks for setting up equipment, answering checklist questions and identifying protocols). These four elements validate an early model of situated learning in interactive multimedia and virtual environments proposed by Herrington and Oliver (1995).

Participants valued the organization of the mobile learning experience as it sequentially guided them through all of the preparation, execution and follow-up of a clinical consultation via videoconference. This fulfills an identified gap in the research that "…in order to combine and sequence learning objects to achieve expected learning outcomes, object design must be commensurate with actual learning processes, an approach that is lacking in current models" (Farmer & Hughes, 2005, p.73). The fact that the mobile learning experience mirrored a clinical consultation in the sequencing of its technical content was one of the major factors in the successful learning experiences and outcomes of participants.

Feedback for guidance throughout the mobile learning experience varied as some participants questioned the embedding of the checklist activities within the sequence of the simulation. The intent was to garner participant feedback and identify gaps in learner knowledge at key moments in the simulation. This is supported in the literature, as situated learning is sometimes compared to anchored instruction, which refers to anchoring learning material in an authentic context but at the same time allowing learners to examine and interact with the content from multiple perspectives (Barab, Hay & Duffy, 2000). Guidance in this activity, while unsettling to some participants, was an important part of content development as it challenged participants to interact with the learning material in a new way.

Delivery. Findings for delivery indicated that participants benefited from the flexible learning environment because they could control the pace of learning and capture and integrate information. Participants were frustrated with the lack of tools to facilitate effective communication and collaboration, but indicated how important the avatar host was in guiding them through the mobile learning experience. Participants said that they enjoyed the control that they had over the learning environment as they completed the skill tests provided by the task activities (pushed from the mobile learning environment) as well as completing the feedback checklist (items pulled from their experience in the learning context). These learning outcomes validate the research of Elias (2011) and his "pull" and "push" design which advocates for greater learner control when interacting with a specific learning environment or context.

Brown and Haag (2011) point to just-in-time learning, collaboration, feedback, location-specific content, simulations, user-generated content, and decision support as some of the specialized areas of learning for which mobile learning is ideally suited.

The problem of communication and collaboration was identified by participants, and it focused on a question of synchronous vs. asynchronous communication. The discussion forum during the mobile learning experience and the discussion forum in reaction survey 2 (after their first clinical event) were asynchronous. Participants found the asynchronous forum during the mobile learning experience to be useless as a post there would not be responded to in real-time. The asynchronous forum in reaction survey 2, however, was found to be an extremely useful resource for participants to share experiences, clinical protocols, advice and templates. This should not be a big surprise since the delivery of the mobile learning experience in this study was based on Park's (2011) Type 2: High Transactional Distance Individualized Mobile Learning, where interactions occur mainly between the learner and the content and not between learners.

An important finding in this study was the apparent effectiveness of the avatar as a host to guide the participants through the mobile learning experience activities. Participants repeatedly mentioned how fun, interactive and engaging it was to have the avatar present the tasks and ask for feedback with the checklist. "We can use avatars to design learning experiences that are more enjoyable and promote involvement, which may ultimately produce learners who are eager to return and learn more" (Hobart, 2012, p. 112). Inquiry-based learning, when combined with avatar-based virtual environments can increase learner motivation and provide and educationally valuable learning opportunity for students (Falloon, 2010).

Structure. Findings suggested participants highly valued the structure of the hybrid (online/mobile) course as it prepared and supported the mobile learning experience, the opportunity to immediately apply learning in the specific context in order to apply learned skills, but found the logical progression of the mobile learning to be unsettling and interrupt the learning experience.

To begin, participants indicated that they valued the links between the formal online learning environment and the informal mobile learning experience, particularly how the pre and post-activities online prepared and supported the main activities in the mobile learning experience. This supports the model suggested by Bo-Kristensen et al. (2009), where the inquiry-based activity is supported by formal learning in the classroom or online. Overall, the mobile learning experience was an excellent example of informal learning since it fit the definition of allowing students to make use of their surroundings to gather information as well as the opportunity to reflect and share with other learners (Khaddage & Latteman, 2013). The collaboration and communication in the discussion forum during the mobile learning experience was neither synchronous nor successful, but the meaningful sharing of ideas, processes and lessons-learned did occur in the discussion forum after participants had their first clinical event (reaction survey 2).

Participants said that the contextual, inquiry-based structure of the mobile learning activity made it engaging, interesting and they were able to apply skills in the specific learning context. This supports and furthers the research of Beckett and Hagar (2002), and Shih et al. (2010) which identify mobile learning as being ideally suited for informal, contextual, inquiry-based activities. A case study or case-based activity would be an interesting addition that could activate problem-solving through abductive reasoning that Burdick and Willis (2011) identify as a dynamic pedagogical approach that can be adopted by mobile learning. Further research is warranted into case-based activities and how they can be incorporated into mobile learning experiences.

Participants found that the mobile learning experience lacked a logical progression, and that the task activities were often interrupted by the checklist activities. In effect, this was the balance between the tasks that were “pulled” by participants from the provided learning activities and the checklist that was “pushed” from participants’ interactions with the specific learning context. These were key design and delivery mechanisms that were incorporated into the structure of the mobile learning experience based on informal learning theory. Unlike the formal online learning component of this course, these feedback and progress indicators were designed to offer guidance, feedback and encouragement, and this has been identified to make mobile learning fun, interactive and engaging for students (Gaved, Kukulska-Hulme, Jones, Scanlon, Dunwell, Lameras, & Akiki, 2013).

Usability. Findings for usability demonstrated that there were several successes of the mobile learning experience that participants found to enhance the flexibility and interactivity of the learning environment, particularly with regards to navigation, graphics and consistent presentation. Page loading speed, downloading speed and discussion forum access were found to be challenges in usability.

As Stead (2014) identified, it is virtually impossible to separate the technology from the learning when utilizing mobile devices for learning environments. Participants noted the simplicity of navigation and interaction with the material, especially with regards to the checklist and task activities. This aligns with the recommendations of Elias (2011) regarding low physical and technical effort, where learners should only have to type short responses, click on a navigation button or use their fingers on a touch-sensitive device in order to easily move through material. Participants in this study utilized their own devices (laptops, tablets, smartphones, etc.) for the mobile learning experience and mentioned that the navigation buttons, progress bar and table of contents simplified access and use to move through the content. Engaging learners by allowing them to utilize their own devices (referred to as “bring your own device” or BYOD), is an excellent way to reduce costs for an educational initiative (Raths, 2012), and can lead to greater comfort and ease of use for the learner since they are utilizing a device that they prefer and are already familiar with (Smart & Gourneau, 2012). Combining this with navigation that is simple, consistent on every page and that promotes “findability” of content results in greater interactivity and familiarity between the learner and the mobile learning content and results in positive learning outcomes (Ralston, 2014).

The graphics and presentation of the mobile learning experience were lauded by participants with regards to the layout of the user interface and the adaptability of the resource on different devices and browsers. Villar (2013) lists this as “responsive design” and it entails designing a mobile user interface that has a flexible, grid-based layout, flexible images and media, and media queries (or allowing content to adapt to conditions like screen resolution, browser and device). The mobile learning experience was built as a mobile web application that would run on a participant’s mobile device browser and then automatically adjust using CSS media queries. This has major advantages such as simplified deployment, immediate availability and familiarity for the participant, all of which make the mobile learning experience more accessible and navigable for participants (Stead, 2014).

Page loading and downloading or “richness” (Wagner, 2005) was identified as a problem for some participants. In this study, a great deal of testing (as recommended by Hazael-Massieux, 2013) was employed to compress and minimize the size of multimedia (graphics, avatar, images) on each page. The uncontrollable factor was the speed of the networks that participants utilized to access the mobile learning experience. It is a known challenge for mobile learning identified throughout the literature (Traxler, 2007), that poor bandwidth and subsequent inferior connection and download speeds can be a significant barrier to mobile learning effectiveness and adoption. With improving bandwidth in healthcare organizations and access to 3G and 4G networks, this issue should be mitigated in the future. A better mechanism for testing bandwidth could also be built into the online preparation module for the mobile learning experience.

Communities of Practice. CoP1 (the discussion forum during the mobile learning experience) was found by participants to be distracting and lack value, was unhelpful and did not promote collaboration due to its asynchronous format. It was also found to be difficult to access. Participants overwhelmingly felt that CoP1 during the mobile learning experience was of little value, hampered navigation, and was difficult to access as the link to the forum took them out of the mobile learning experience and back to the Moodle interface. This is an important finding of this study as it supports research in the literature. Wenger, White and Smith (2009) recommend that open-ended conversations with large groups like CoP1 lend themselves well to synchronous communications because they can promote sharing, instant collaboration and support. There are a number of social media tools that can be utilized for synchronous communication within a mobile learning activity, and de Waard (2014) has recommended several best practices including social networking, bookmarking and multimedia sharing that could be utilized in future versions of this mobile learning experience.

CoP2 (reaction survey 2 in Moodle accessed after their first clinical consultation) was found by participants to be of excellent value for sharing resources and expertise, to promote reflection and collaboration due to its asynchronous design, and promote best practices by becoming a repository for resources. Participants found that CoP2 after the mobile learning experience was an extremely effective use of a discussion forum and creation of a community of practice. Learning outcomes from this study support the research of (Cochrane, 2014), which found that mobile learning communities of practice can lead to "…development of mutually collaborative partnerships that have seen rewards in increased student engagement, deeper pedagogical reflection and practice-based research outputs" (p. 78). As demonstrated by this study, asynchronous discussion forums, therefore, can be quickly designed and facilitated for collecting feedback, promoting collaboration, problem-solving, and sharing expertise and resources related to real-world workplace activities.

Learning Outcomes. Participants indicated a high level of satisfaction with the mobile learning resource because they felt it was innovative, provided access to applicable skills in an authentic context, and that it was concise and easy to use. This was significant not only because it was a positive finding, but because the learning outcome of participant satisfaction was measured by this study. There has been little research on mobile learning environments that measure or evaluate learner satisfaction (Seong, 2006). One of the newest studies that did include participant satisfaction in its design was undertaken by Chu, Hwang, Tsai and Tseng (2010). It proposes a scale of nine questions based on the participants' satisfaction with the learning approach of the mobile learning activity. The nine questions are included in Table 9 and include measures of satisfaction, acquisition of skills/knowledge and behavioral change. These questions could be used to revise the learning outcome questions on the post-program survey which will be discussed in the next section of this discussion.

Table 9

Satisfaction with the Learning Approach (for Mobile Learning Activities)

No.	Question	Learning Outcome
1	The mission of this learning activity makes me better understand how to identify and classify the features of the target learning objects.	Skills/Knowledge
2	I have endeavored to observe the differences between the target learning objects in this learning activity.	Skills/Knowledge
3	The mission of this learning activity was not easy to complete, but it was easy to understand the way of learning.	Satisfaction
4	Learning with the PDA system is more challenging and interesting than learning with the traditional approach.	Satisfaction
5	I had new findings or knowledge about the target learning objects owing to the use of this PDA system to learn in the authentic environment.	Skills/Knowledge
6	I have tried new ways or thinking styles to learn owing to the use of this mobile learning system.	Behavior
7	The guidance provided by this PDA system is helpful to me in learning how to identify the features of the target learning objects	Skills/Knowledge
8	The guidance provided by this PDA system is helpful to me in observing the differences within the target learning objects.	Satisfaction
9	When using this PDA system, I learned how to observe the target learning objects from new perspectives.	Behavior

Participants felt that the mobile learning experience was extremely useful in teaching new skills or knowledge because of its hands-on activities, the control it provided the learner, the processes it presented with the checklists, and the sequential structure of the learning content. This is because mobile learning is an excellent platform for utilizing active and interactive learning techniques (Wang, Shen, Novak & Pan, 2009), which have demonstrated to help learners acquire knowledge, practice critical thinking, develop problem-solving skills as well as independent thinking (Ratto, Shapiro, Truong & Griswold, 2003). Again, the ability of this study to identify the skills and knowledge acquired by participants is a gap identified in the literature (Seong, 2006).

Finally, participants indicated that they did undertake new behaviors as a result of participating in the mobile learning experience. They listed new methods of health care delivery, creating new clinical protocols, motivation to adopt clinical videoconferencing, and incorporating new clinical workflows as specific examples of applied learned behaviors. This is because mobile learning affords the opportunity for the individual to interact with contextual and social factors that promote learning behaviors (Chu et al., 2010). The authors contend that this is supported when positive relationships occur between the learner and themselves (motivation), the learners and others (peers and colleagues) and the learners and the environment (or learning delivery and content). Participant motivation, social interaction (in CoP2) and interaction with the delivery and content have all been cited as positive learning outcomes throughout this study, and have therefore had an influence on the learned behaviors of participants.

Revisions to the Design of the Mobile Learning Experience Framework

As a result of the examination of participant experiences and synthesis with existing literature for the five dimensions of the framework (content, delivery, structure, usability, communities of practice) and the learning outcomes of participants, a few changes to the MLE conceptual framework design are proposed:

a. Differentiate between the method of delivery for the communities of practice
    i. CoP1 or the discussion forum during the mobile learning experience should adopt a synchronous format where participants could interact in real-time with each other, technical support, and the instructor

   ii. CoP2 will remain in an asynchronous format but promote collaboration for the assembly of a resource library of resources, user guides and protocols

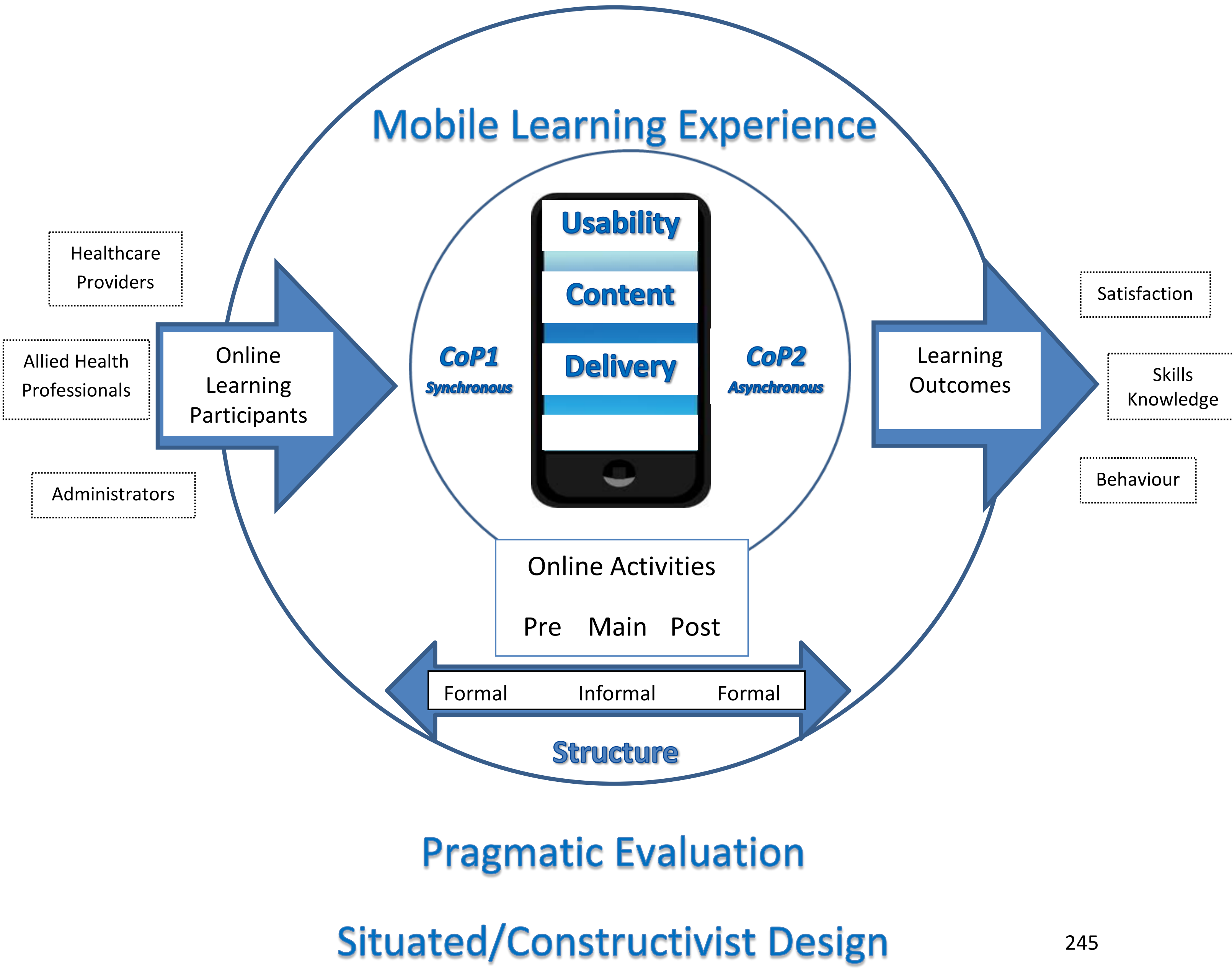
b. Identify the three levels of learning outcomes identified by the W(e)Learn Framework (MacDonald et al., 2009) in the framework: satisfaction, acquisition of knowledge/skills and learner behavior
c. Incorporate a robust bandwidth and firewall screening device for participants to check the capabilities of their “bring your own device” or BYOD prior to commencement of the mobile learning experience, thus minimizing the effects of poor page loading or downloading speeds
d. Incorporate an avatar or video host as a best practice for designing guided participation activities during a mobile learning experience

Revisions to the MLE conceptual framework design can be seen in Figure 5 below.

Figure 5

Revised Mobile Learning Experience Conceptual Framework

Elements adapted from the W(e)Learn Framework (MacDonald, Stodel, Thompson & Casimiro, 2009)



Evaluation of the MLE Conceptual Framework Post-Program Survey

As evidenced in Table 6 (Factors and Associated Post-Program Survey Questions) this study produced some contradictory and important findings with regards to the validity of the questions in the post-program survey. The post-module survey questions do not appear to relate well to the five dimensions of the MLE Conceptual Framework. In fact, the first two factors had questions from four different dimensions, demonstrating that the questions may have been poorly worded, vague or redundant. The factor analysis has also eliminated 13 of the survey questions either due to within question variability or the fact that they did not load or correlate with any of the seven identified factors. In short, these questions are not designed properly for mobile learning and are generating unreliable responses.

It would appear that these findings demonstrate a point of discussion in the literature review, namely that mobile learning is not simply a subset of online learning, but a unique pedagogical tool with its own set of design requirements and recommendations. The post-program survey tool was adapted from the W(e)Learn Framework proposed by MacDonald, Stodel, Thompson and Casimiro (2009). While the W(e)Learn framework was designed to act as a quality standard to guide the design, delivery and evaluation of online healthcare education, it was created as a tool for e-learning and not mobile learning. As mentioned in the discussion of Khan's (2009) Global E-Learning Framework, the dimensions of mobile learning (content, delivery, usability, structure, communities of practice) align with the dimensions of e-learning in category only. The description, design and implementation of each dimension must take into account the unique features of mobile learning devices, contexts and users in order to provide appropriate guidelines for instructional designers. Therefore the post-program survey questions need to be revised.

It is important to note the exhaustive nature of the literature review on best practices for mobile learning design in chapters 2-4 of this dissertation, as well as the strength of the participant evaluation in the Communities of Practice, focus group interviews and post-program survey results of MLE1 (based on the best practices for mobile learning design identified in the literature). In short, MLE1 was viewed as a superior instructional and educational tool by study participants. Due to this sound literature review and strong experimental evaluation, the mobile learning experience conceptual framework and post-program survey will retain the five original dimensions of content, delivery, usability, structure and outcomes. In addition, a sixth unique dimension for communities of practice will be added. The revision of the questions in the five original dimensions will be based on the Principle Component Analysis results, and best practices identified in the literature review will guide the creation of the questions regarding communities of practice. The revision process is summarized in the following paragraphs.

By examining the themes of the factors in Table 6 the decision to retain the five original dimensions appears justified. Factor 1 has questions associated with delivery, Factor 2 deals with usability, Factor 3 with outcomes and Factors 4 and 5 with content. It is evident that the structure questions were poorly designed and do not associate with the informal, inquiry-based structural design identified in the literature review. S4 asks about engagement, S6 with problem-solving, S7 with application, and S3 with motivation. Also, the communities of practice require their own associated questions. Table 10 provides the revised dimensions and questions which were developed by combining the literature review themes from Table 3 with the supporting factor analysis from this study from Table 5. The 13 questions that were not retained due to the factor analysis are also examined presented in Tables 7 and 8. The questions that have insignificant t-test values will be discarded entirely, whereas those with significant values will be either rewritten or reassigned to a different dimension.

To begin, content was one of the dimensions that had the most questions eliminated by the factor analysis, only retaining two in Factor 5 in Table 6 (C8 - the content is authentic and C7 - the content is applicable for my professional life). These two questions were retained as well as the addition of 3 questions based on Franklin’s (2011) recommendation of mobile learning content that should enable instruction, engage via activities, and empower via problem-solving. A question was also added to ensure that the content is context-specific (see Table 10 below).

Delivery retained two questions from the first survey in Factor 1 of the factor analysis (D2 - the delivery allowed me to control my learning environment, and D4 - delivery of information promotes a flexible learning environment). A content question (C6 - the content effectively guides me through the activities) is an example of an online learning question that needs to be changed when applied to mobile learning, as it was the delivery of the avatar and user-interface that guided participants through the activities. The factor analysis identified this inaccuracy in the original survey and so the question has been added to the delivery section.

In addition, two questions have been added to take into account the “push” and “pull” activities identified as critical in the literature review and praised by participants as excellent methods of delivering mobile learning content. These were: D3 - the delivery allowed me to integrate information from the instructions and apply it in the learning context, and D4 - the delivery allowed me to capture and store information from my experiences in the learning context. The literature review in the first paper in this study identified that avatars can make mobile learning more enjoyable and engaging for learners, so a question has been added to evaluate this claim (D6 - the avatar/host made the learning environment more enjoyable and helped involve me in the learning activities). Finally, two questions that were eliminated via the factor analysis (D1 – the resource respects my experience and current knowledge, and D7 – the resource promotes collaboration among learners) were also found to be insignificant via the t-test analysis presented in Table 8. These questions were both removed from the survey.

Usability had two questions retained in Factor 2 of the factor analysis (U1 - in this program it was easy to "navigate" through the content, and U8 - the mobile learning experience was interactive and productive due to its usability). U8 was split into two questions in order to deal with interactivity and productivity individually in the revised survey. Also, four questions were added based on the literature review in the second paper in this study and feedback from study participants on items that were important to them. These included download speed, discussion forum access, intuitive user interface, and consistent presentation of material. The revised questions are: U2 - there is flexible access to online communication, U3 - the graphics and icons identified the activities and tasks that I was to perform, and U6 - interactivity was efficient when accessing resources and support. It should be noted that original questions U5 (content was displayed in a consistent fashion on my mobile device) and U6 (pages loaded quickly) were eliminated via the factor analysis, but were found to be significant in the t-test analysis presented in Table 7. These questions were therefore retained and reworded to U4 - activity content was displayed in a consistent fashion on my mobile device, and U5 - activity pages loaded quickly on my mobile device.

Structure had only three questions retained by the factor analysis, and they were spread among factors 1, 2, and 3. The questions were poorly-worded and actually loaded onto the factors that had themes of delivery, usability and outcomes. This was because questions from the survey had been designed for online learning and not a hybrid of online and mobile learning. For example, S5 – the material follows a logical progression was not only eliminated by the factor analysis but was also found to be insignificant via the t-test. Mobile learning progression is controlled by the user and does not need to be as logical as a linear online course. On the other hand, S1 – the introductory online learning modules prepared me for the mobile learning experience, while eliminated by factor analysis was found to be significant via the t-test. It has been reworded to: S2 - the online modules provided me with information and skills that I could apply in the mobile learning experience. The questions, therefore, have been completely revised to take into account the structural themes of mobile learning: hybrid learning, online support, informal mobile, and inquiry-based learning. See Table 10 for a list of the structure questions.

Only two outcome questions were retained in the factor analysis in Factor 3: O2 the online/mobile course is valuable, and O5 as a result of my participation in the mobile learning experience I have learned applicable skills in a specific context. However, three outcome questions eliminated via the factor analysis were found to be significant via t-test. They were: O3 – as a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine, O6 - the mobile learning experience allowed me to learn information that I could not have accessed through an online course, and O7 – the mobile learning experience made the learning environment more motivating and engaging. It is likely that the wording of these questions was imprecise, so they were retained and split into multiple questions on learner engagement, motivation, and mobile learning outcomes. The new outcome questions were revised according to the 3 levels identified by the W(e)Learn Framework (satisfaction, acquisition of knowledge, and changed learner behavior), and combined with the mobile learning satisfaction survey developed by Chu, Hwang, Tsai and Tseng (2010) as seen in Table 9. A complete list of the revised outcome questions are found in Table 10.

Finally, a new section to evaluate communities of practice was added to the post-program survey. Since the orientation of communities of practice is ultimately determined by the participants, questions were created to identify both the effectiveness and purpose of each community. Survey questions evaluate the effectiveness of the communities of practice both during (synchronous access) and after (asynchronous access) the mobile learning experience. Questions were also developed to assess the communication, collaboration, resource sharing and identification of best practices by the communities of practice. All questions can be seen in Table 10 below.

Table 10

Revised MLE Conceptual Framework Post-Program Survey Questions

Factor	Associated Questions	Factor Themes (From Literature Review and Supporting Evidence)
Content	C1 The content is context-specific C2 The content is authentic C3 The content presents applicable skills for my workplace environment C4 The content enables me to learn new skills in an applicable context C5 The content engages me in the learning experience C6 The content empowers me to interact with the learning environment via problem-solving activities	- Context-specific - Authentic - Organization - Technical skills - Enable instruction - Engage activities - Empower problem-solving
Delivery	D1 The delivery of the information allowed me to control my learning environment D2 The delivery promoted a flexible learning environment D3 The delivery allowed me to integrate information from the instructions and apply it in the learning context D4 The delivery allowed me to capture and store information from my experiences in the learning context D5 The avatar/host effectively guided me through participating in the learning environment D6 The avatar/host made the learning environment more enjoyable and helped involve me in the learning activities	- Control - Flexible learning - Flexible access - Pull information - Push feedback - Guided participation - Promote involvement
Structure	S1 The mobile learning experience allows me to progress at my own pace S2 The online modules provided me with information and skills that I could apply in the mobile learning experience S3 After the mobile learning experience the online modules provided supporting material S4 The informal mobile learning experience motivated me to learn S5 The combination of online and mobile learning allowed me to learn information that I could not have accessed through an online course S6 The mobile learning experience provides opportunities to explore material learned in the online portion of the course	- Hybrid learning - Online preparation - Online support - Informal mobile - Inquiry-based
Usability	U1 In the mobile learning experience it was easy to "navigate" through the content. U2 There is flexible access to support tools, information, help, and online communication U3 The graphics and icons identified the activities and tasks that I was to perform	- Simple navigation - Graphical user-interface - Consistent presentation - Loading speeds

	U4 Activity content was displayed in a consistent fashion on my mobile device U5 Activity pages loaded quickly on my mobile device U6 Interactivity was efficient when accessing resources and support U7 The mobile learning experience was interactive due to its usability U8 The mobile learning experience was productive due to its usability	- Productive - Access to resources - Intuitive and interactive
CoPs	CP1 The discussion forum during the mobile learning experience was easy to access and utilize CP2 The discussion forum provided real-time access to resources and support CP3 The discussion forum allowed me to communicate effectively with colleagues CP4 The feedback forum provided a useful environment for resource sharing CP5 The feedback forum allowed for collaboration with colleagues CP6 The feedback forum allowed for problem-solving and identification of best practices	- Synchronous support - Asynchronous resources - Purpose and value - Flexible access - Communication - Collaboration - Best practices
Outcomes	O1 This online/mobile course is interesting and valuable O2 The mobile learning experience motivated me to explore the learning material O3 As a result of my participation in the mobile learning experience I have acquired new knowledge O4 As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context O5 As a result of my participation in the mobile learning experience I will employ new techniques or skills in my workplace O6 As a result of my participation in the mobile learning experience I will adopt new practices in my workplace	- Satisfaction - Knowledge and skill development - Changed learner behavior

It should be noted that due to the small sample size (121) the power of this experiment with regards to factor analysis was compromised and therefore the results do not have the desired reliability. This study, however, did demonstrate that the MLE conceptual framework was effectively designed from the initial literature review, but that the post-program survey evaluation tool required a rather drastic revision to its questions in order to adapt them for the evaluation of mobile learning. Findings did inform the reconstruction of the survey and now it aligns more closely with the existing research. Some suggestions for future study include:

- Obtaining a larger sample size (greater than 250) and designing a new study based on the revised MLE conceptual framework

- Obtaining a larger sample size (greater than 250) and utilizing the revised evaluation tool suggested here and then performing a factor analysis on the results in order to validate the revisions from this study

Conclusion

One hundred and twenty-one healthcare professionals took part in this mixed methods study that explored how the use of a curriculum framework to design mobile learning experiences impacted the learning outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes.

Results indicated that the design of the framework to include context-specific content, guided participation delivery, flexible and intuitive usability, formal online and informal mobile structure and access to communities of practice all resulted in practical, applicable learning outcomes and a high degree of satisfaction among participants. Participants said that they were able to apply and integrate skills presented in the authentic context of the clinical videoconference studio, and adopt new clinical protocols and best practices as a result of the feedback from the checklist activity. Participants also implemented new workplace behaviors by following clinical videoconference best practices, and integrating new programs into their existing healthcare practices as a result of the education received through the mobile learning experience. Best practices for the implementation of these dimensions of the MLE conceptual framework were identified by the existing literature and subsequently supported and/or modified by results from this research.

This study did uncover several important design modifications for the mobile learning experience conceptual framework. The communities of practice were split in their delivery modality, with recommendations for synchronous communities of practice during mobile learning so as to promote communication among colleagues and allow them to share questions, support and resources (Wenger, White & Smith, 2009). New social media tools such as social bookmarking, shared workspaces or blogs are affordable, flexible options for inclusion in mobile learning experiences (de Waard, 2014). The communities of practice after a mobile learning experience should be asynchronous in design, and promote ongoing collaboration, problem-solving and content collection (Cochrane, 2014). This will enable learners to have continuing access to a stable of evolving best practices and lessons-learned from the flexible, informal mobile learning experience.

With regards to learning outcomes, the inclusion of specific outcomes of learner satisfaction, acquisition of knowledge/skills and change in learner behavior were also added to the MLE conceptual framework. This will allow for a more accurate tracking and evaluation of the success of the framework in future iterations of its research. The importance of a host (either video or avatar) in order to guide the participation of learners was also a critical finding, as the avatar in this study was identified to increase engagement, interactivity and motivation.

The quantitative instrument (the post-program survey) underwent a factor analysis and rather drastic revision as a result of this research. Questions for the five dimensions were better aligned utilizing themes from the existing literature as well as data from the factor analysis and supporting evidence from the mixed methods inclusion of qualitative data analysis in this study. The result is a robust and more reliable tool that will benefit from future testing and research.

In the end, the mobile learning experience framework is a design and evaluation tool that is in its infancy but does identify numerous evolving and emerging best practices for creating practical, applicable mobile learning experiences. Further research should be undertaken to examine the robustness of the revised quantitative evaluation tool as well as to identify specific influence on learning outcomes by each of the five dimensions of the mobile learning experience framework.

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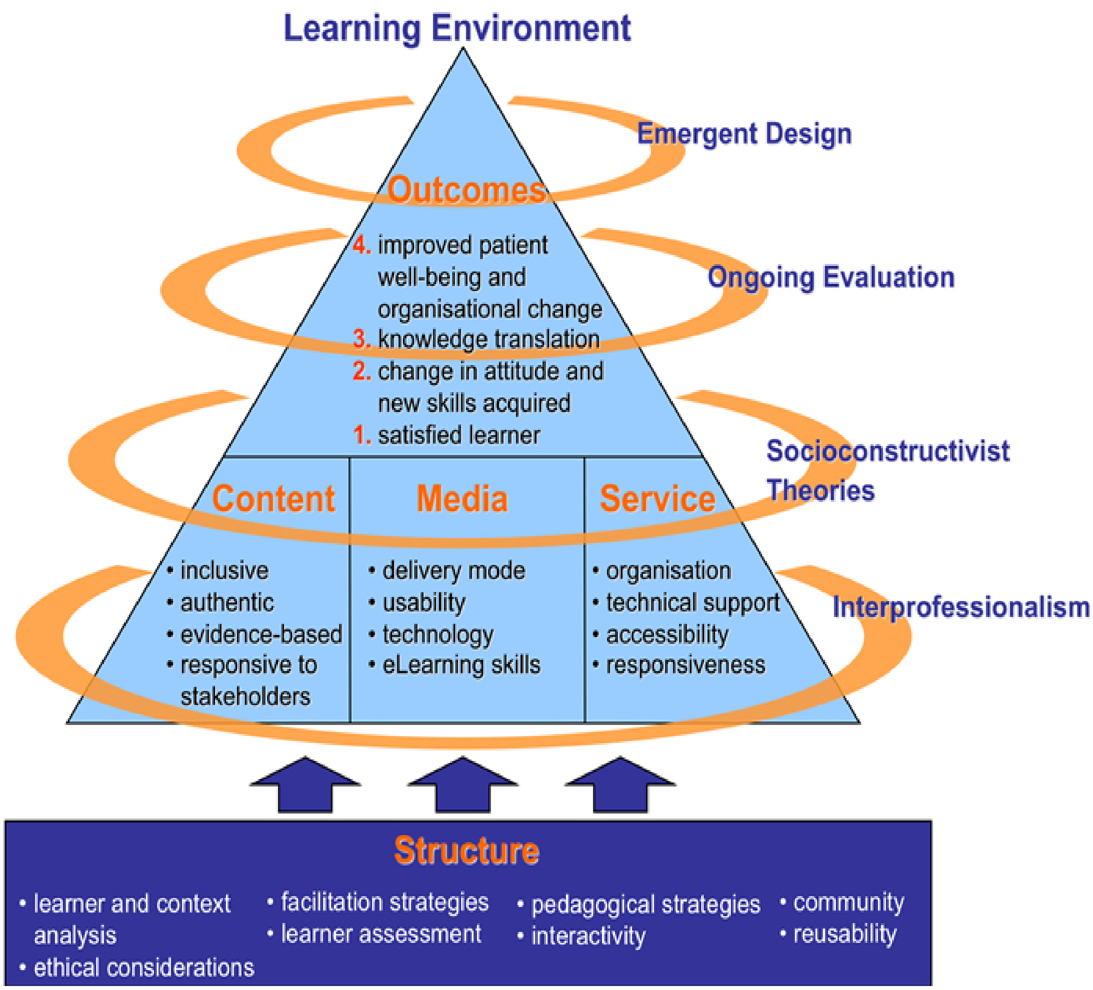
Appendix I: The W(e)Learn Framework



(MacDonald et al., 2009)

Appendix II: Post-Program Mobile Learning Experience Survey

For the following questions, the available response options are: Strongly disagree, Disagree, Agree, Strongly agree, Not applicable

Content

The content is of appropriate depth and breadth
The content is well organized
The content is context-specific
The content effectively presents technical skills that I can apply in my workplace
The content effectively presents clinical skills that I can apply in my workplace
The content effectively guides me through the activities
The content is applicable for my professional life
The content is authentic

Usability

In this program it was easy to "navigate" through the content.
The instruction is divided into clear and logical sections
Uploading and downloading material was fast and efficient
Presentation of material utilizes aesthetically pleasing graphics
Content was displayed in a consistent fashion on my mobile device
Pages loaded quickly
Interactivity was efficient when posting to and accessing the discussion wall
The mobile learning experience was interactive and productive due to its usability

Delivery

The resource respects my experience and current knowledge
The delivery allowed me to control my learning environment
There is flexible access to support tools, information, help, and online communication
The delivery of the information promotes a flexible learning environment
The delivery allowed me to capture and integrate information
The resource promotes communication among learners
The resource promotes collaboration among learners

Structure

The introductory online learning modules prepared me for the mobile learning experience
The mobile learning experience kept my interest
The mobile learning experience motivated me to learn
The mobile learning experience engaged me in the learning experience
The material follows a logical progression
The mobile learning experience provides opportunities for problem-solving experiences
The mobile learning experience provides opportunities to apply material learned

The online modules supported the mobile learning experience after it was completed
I enjoyed the combination of online learning with the mobile learning experience

Outcomes

The online/mobile course is interesting
The online/mobile course is valuable
As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine
As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques
As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context
The mobile learning experience allowed me to learn information that I could not have accessed through an online course
The mobile learning experience made the learning environment more motivating and engaging

Please complete the following statements:

19. The most valuable aspect of the mobile learning experience was….

20. The design or delivery of the mobile learning experience could be improved by…

21. What, if anything, did you learn in the mobile learning experience that you will apply in your professional life?

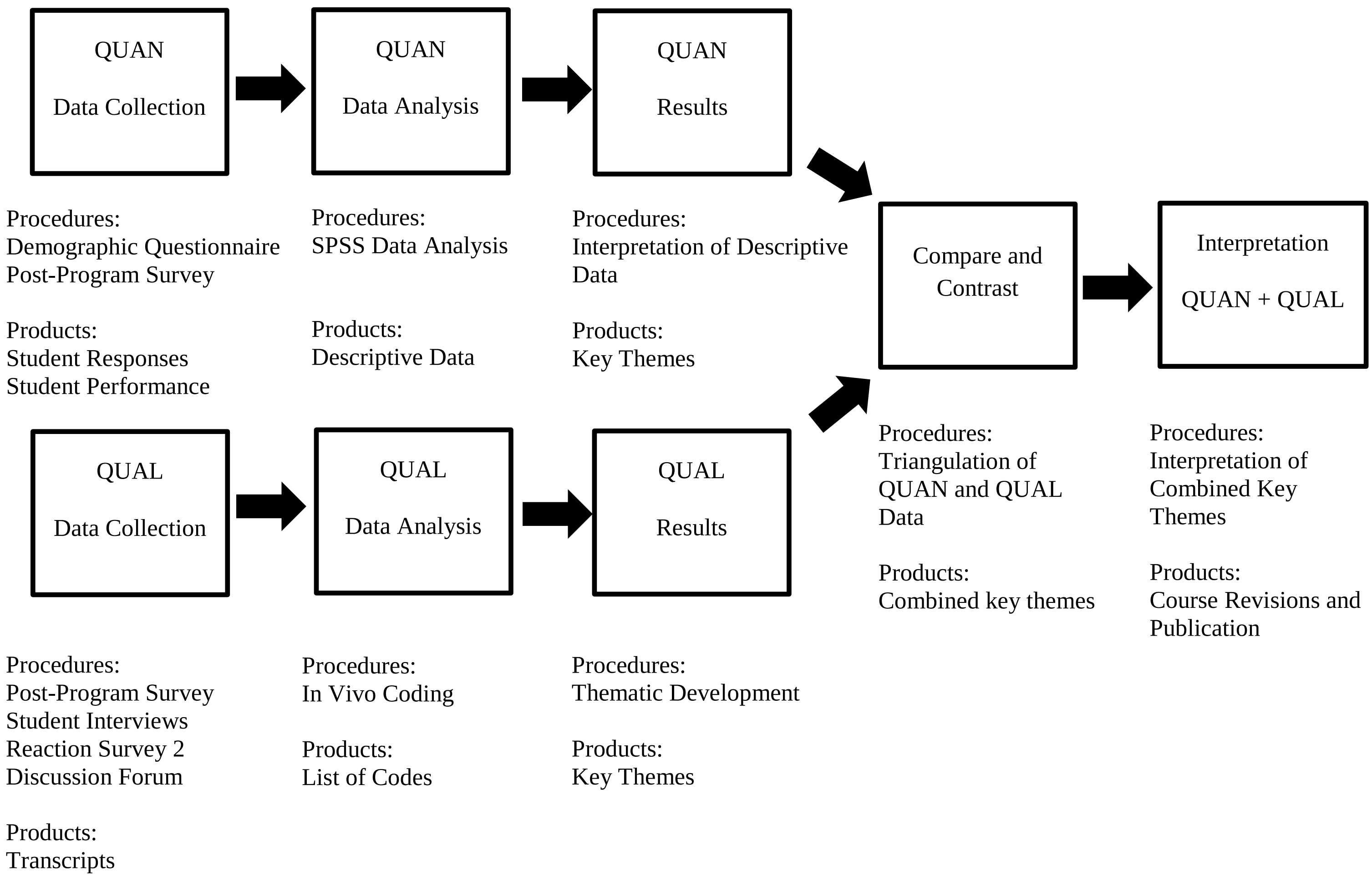
22. What value (if any) did the discussion wall add to the learning resource?

23. How did you access the mobile learning experience?
    a. From my mobile phone
    b. From my tablet
    c. From my personal computer

24. How could or should a mobile learning experience be used in an online learning resource (such as this)?

(Adapted from MacDonald, C. J., Stodel, E. J., Thompson, T-L., & Casimiro, L. (2009)

Appendix III: Convergent Parallel Mixed Methods Design



Adapted from: (Fuji, Paschal, Galt & Abbott, 2010, p. 243)

Appendix IV: Demographic Questionnaire

Please complete the following questions. All responses will be kept confidential.

16. Gender: Female _____ Male_____
17. Please indicate your profession: ___________
18. Please indicate your age:__________

19. How often do you use mobile devices (phones or tablets) to find information for personal interest and/or essential needs? Examples could be Internet browsing, playing online games, shopping, finding medical information, finding help with hobbies etc. Please circle the most correct response.

    1= none
    2= not often
    3=sometimes
    4=often
    5=always

20. a. Is this the first mobile learning experience or course you have taken? (yes / no)

    b. If you answered no, how many mobile learning courses have you taken? ________

5. What types of online experiences have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

participated in threaded discussions	1	2	3	4	5
real-time chat	1	2	3	4	5
listened to podcasts	1	2	3	4	5
co-created wikis	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
simulations	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

9. What types of experiences with mobile devices (phones or tablets) have you had? Rate your experiences on a scale of 1-5 (1= none, 2= not often, 3=sometimes, 4=often, 5=always). Please circle the most correct answer.

texting	1	2	3	4	5
facebook posts	1	2	3	4	5
accessing email	1	2	3	4	5

accessing web pages	1	2	3	4	5
videoconferencing	1	2	3	4	5
audioconferencing	1	2	3	4	5
sharing audio/video files	1	2	3	4	5
other	1	2	3	4	5

Please explain ____

7. Would you consider your online learning experiences positive?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

14. Rate your exposure to online learning on a scale of 1-4. Please circle the most correct answer.

1= I have never used online learning before
2= Once before
3=Several times before
4=Often

15. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?

0 = not applicable

1 = strongly disagree

2 = disagree

3 = agree

4 = strongly agree

(Adapted from Archibald, D. 2008)

Appendix V: Reaction Survey 2: After Your First Telemedicine Appointment

Congratulations on the completion of your first telemedicine appointment. Please answer the following questions relating to how the mobile learning experience prepared you for the telemedicine appointment. If you have any resources/suggestions please post these to the “Resources” section of this forum.

16. Did you find that the mobile learning experience taught you knowledge and skills that you were able to apply in your first telemedicine appointment?

17. What were the most valuable knowledge and/or skills that you learned in the mobile learning experience?

18. Were there any knowledge or skill gaps that you didn’t learn in the mobile learning experience that you required in the telemedicine appointment?

19. Do you find value in posting to this forum?

20. Do you find value in reading the posts of other learners in this forum?

Appendix VI: Semi-Structured Interview Guide

For learners to read before the interview:

Thank you for agreeing to participate in this interview. The purpose of the interview is to obtain a deeper insight into the data collected from the online survey you completed after completing the online equipment training course. Specifically, these questions will be about the mobile learning experience portion of the course.

We are going to be audio-taped so that I can refer back to this discussion when I write my final report. During this discussion and when I write the report we will be using pseudonyms to protect your identity. No one else but my supervisor and I will listen to the audio recording. Please speak in a loud clear voice so the recorder picks-up what you say.

Sample Questions:

28. Was this an authentic learning resource?

29. Did the content of the mobile learning experience teach you new processes or skills? If so, what are they?

30. Was the mobile learning experience easy do use? What did you think about the navigation and layout?

31. Do you think the mobile learning experience contributed to the online course? If so, how?

32. Did you find the feedback list helpful that you received after the mobile learning experience? How? Explain?

33. Did the discussion forum in the mobile learning experience contribute to your learning? How? Explain?

34. Explain how you would compare this mobile learning experience to the conventional classroom?

35. Will the mobile learning experience help you apply the knowledge created in this course to your work related activities?

36. What, if anything, was missing from this mobile learning experience? Please give examples.

Appendix VII: Demographic Survey Results

Table 1.1
Gender, Age, Profession, Mobile Experience of Participants
(N = 121)

Gender	Count	Total %
Male	15	12.4 %
Female	106	87.6 %

Age	Count	Total %
under 30	31	25.6 %
31-40	51	42.1 %
41-50	34	28.1 %
51-60	5	4.2 %
61-70	0	0 %

Profession	Count	Total%
Nurse	99	81.8 %
Administrator	12	9.9 %
Medical Student	8	6.6 %
Practicing Physician	2	1.7 %

First Mobile Course?	Count	Total%
Yes	105	86.8%
No	16	13.2%

Table 1.2
How Often Participants Use Mobile Devices to Find Information
(N = 121)

Response	Count	Total %
None	11	9.1 %
Not Often	25	20.7 %
Sometimes	49	40.5 %
Often	33	27.2 %
Always	3	2.5 %

Table 1.3
Participants' Exposure to Online Learning
(N = 121)

Response	Count	Total %
Never	7	5.7 %
Once Before	22	18.2 %
Several Times	74	61.2 %

Often 18 14.9 %

Table 1.4

Participants' Responses to the Types of Online Experiences They Have Had (N=118)

Answer Option	**Min[a]**	**Max**	**Mode**	**Mean**	**SD**
1. Participated in threaded discussions	1	4	2	2.01	0.579
2. Real-time chat	1	4	2	1.85	0.501
3. Listened to podcasts	1	4	2	2.32	0.565
4. Co-created wikis	1	4	1	1.27	0.499
5. Videoconferencing	1	4	3	3.22	0.588
6. Audioconferencing	1	5	3	3.84	0.571
7. Simulations	1	4	2	1.72	0.503

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**three responses missing*

Table 1.5

Participants' Responses to the Types of Mobile Experiences They Have Had (N=118)

Answer Option	**Min[a]**	**Max**	**Mode**	**Mean**	**SD**
1. Texting	1	5	4	4.11	0.576
2. Facebook posts	1	5	3	2.92	0.675
3. Accessing email	1	5	4	4.22	0.501
4. Accessing web pages	1	5	4	3.87	0.607
5. Videoconferencing	1	5	3	2.54	0.611
6. Audioconferencing	1	5	3	3.96	0.598
7. Sharing audio/video files	1	4	2	2.05	0.651

[a]Response options: 1 = none; 2 = not often; 3 = sometimes, 4 = often, 5 = always
**three responses missing*

Table 1.6

Participants' Responses to Online and Mobile Experiences (N=121)

Answer Option	**Min[a]**	**Max**	**Mode**	**Mean**	**SD**
1. Would you consider your online learning experiences to be positive?	0	4	3	3.42	0.535
2. Please indicate your agreement with the following statement: Mobile learning experiences enhance the online learning experience?	0	4	3	2.62	0.623

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Appendix VIII: Post-Program Mobile Learning Experience Survey Descriptive Statistics

Table 2.1

Post-Program Survey Content Responses (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The content is of appropriate depth and breadth	2	4	3	3.02	0.423
2. The content is well-organized	2	4	3	3.05	0.312
3. The content is context-specific	2	4	3	3.29	0.523
4. The content effectively presents technical skills that I can apply in my workplace	2	4	3	3.14	0.521
5. The content effectively presents clinical skills that I can apply in my workplace	1	4	3	2.78	0.475
6. The content effectively guides me through the activities	1	4	3	3.24	0.659
7. The content is applicable for my professional life	2	4	3	2.96	0.538
8. The content is authentic	2	4	3	3.06	0.372

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 2.2

Post-Program Survey Usability Responses (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. In this program it was easy to "navigate" through the content.	2	4	3	3.02	0.612
2. The instruction is divided into clear and logical sections	2	4	3	2.80	0.572
3. Uploading and downloading material was fast and efficient	2	4	3	2.76	0.503
4. Presentation of material utilizes aesthetically pleasing graphics	2	4	3	3.34	0.493
5. Content was displayed in a consistent fashion on my mobile device	2	4	4	3.20	0.714
6. Pages loaded quickly	1	4	3	2.67	0.472
7. Interactivity was efficient when posting to and accessing the discussion wall	1	4	2	2.66	0.601
8. The mobile learning experience was interactive and productive due to its usability	2	4	3	2.88	0.451

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 2.3

Post-Program Survey Structure Responses (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The introductory online learning modules prepared me for the mobile learning experience	2	4	3	3.31	0.671
2. The mobile learning experience kept my interest	2	4	3	3.12	0.458
3. The mobile learning experience motivated me to learn	2	4	3	3.08	0.439
4. The mobile learning experience engaged me in the learning experience	2	4	3	3.30	0.459
5. The material follows a logical progression	1	4	3	2.75	0.505
6. The mobile learning experience provides opportunities for problem-solving experiences	2	4	3	3.02	0.516
7. The mobile learning experience provides opportunities to apply material learned	2	4	3	3.31	0.466
8. The online modules supported the mobile learning experience after it was completed	2	4	3	3.44	0.498
9. I enjoyed the combination of online learning with the mobile learning experience	2	4	3	3.08	0.600

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 2.4

Post-Program Survey Delivery Responses (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD
1. The resource respects my experience and current knowledge	2	4	3	3.09	0.619
2. The delivery allowed me to control my learning environment	2	4	3	3.23	0.728
3. There is flexible access to support tools, information, help, and online communication	2	4	3	2.97	0.562
4. The delivery of the information promotes a flexible learning environment	2	4	3	3.41	0.511
5. The delivery allowed me to capture and integrate information	2	4	4	3.38	0.767
6. The resource promotes communication among learners	1	4	3	2.99	0.599
7. The resource promotes collaboration among learners	1	4	2	2.49	0.593

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 2.5

Post-Program Survey Outcomes Responses (N=121)

Answer Option	Min[a]	Max	Mode	Mean	SD

1. The online/mobile course is interesting	2	4	3	3.00	0.592
2. The online/mobile course is valuable	2	4	3	3.27	0.465
3. As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	2	4	3	3.27	0.695
4. As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques	2	4	3	3.15	0.380
5. As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context	2	4	3	3.21	0.412
6. The mobile learning experience allowed me to learn information that I could not have accessed through an online course	2	4	4	3.39	0.725
7. The mobile learning experience made the learning environment more motivating and engaging	2	4	4	3.54	0.500

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Appendix IX: Rotated Component Matrix

Table 1

Pattern Matrix

	Component						
	1	2	3	4	5	6	7
D4 The delivery of the information promotes a flexible learning environment	.927						
C3 The content is context-specific	.916						
S4 The mobile learning experience engaged me in the learning experience	.864						
U4 Presentation of material utilizes aesthetically pleasing graphics	.831						
S8 The online modules supported the mobile learning experience after it was completed	.771						
D2 The delivery allowed me to control my learning environment	.729						
C6 The content effectively guides me through the activities	.638						
D7 The resource promotes collaboration among learners	-.548	.436					
O3 As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	.544		-.485				
U2 The instruction is divided into clear and logical sections	.493						
S5 The material follows a logical progression	.490						
O7 The mobile learning experience made the learning environment more motivating and engaging	.485		.440				
O6 The mobile learning experience allowed me to learn information that I could not have accessed through an online course	.416		.410				
D6 The resource promotes communication among learners		.900					
S2 The mobile learning experience kept my interest		-.819			.491		
S9 I enjoyed the combination of online learning with the mobile learning experience		.815					
O1 The online/mobile course is interesting		.753					
S6 The mobile learning experience provides opportunities for problem-solving experiences		.720					
D5 The delivery allowed me to capture and integrate information		.717					
D3 There is flexible access to support tools, information, help, and online communication		.713					
U1 In this program it was easy to "navigate" through the content		.668		.501			
D1 The resource respects my experience and current knowledge		-.633			.501		
U8 The mobile learning experience was interactive and productive due to its usability		.612					

S1 The introductory online learning modules prepared me for the mobile learning experience		-.593				.554	
S7 The mobile learning experience provides opportunities to apply material learned			.875				
O2 The online/mobile course is valuable			.827				
O5 As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context			.822				
U3 Uploading and downloading material was fast and efficient			.415				
C4 The content effectively presents technical skills that I can apply in my workplace				.965			
S3 The mobile learning experience motivated me to learn				.718			
U6 Pages loaded quickly				-.431			
C8 The content is authentic				.421	.935		
C7 The content is applicable for my professional life					.803		
U5 Content was displayed in a consistent fashion on my mobile device	.470				-.552		
C1 The content is of appropriate depth and breadth						1.009	
O4 As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques						.701	
C2 The content is well organized							
C5 The content effectively presents clinical skills that I can apply in my workplace							.885
U7 Interactivity was efficient when posting to and accessing the discussion wall							.601

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.[a]
a. Rotation converged in 11 iterations.

CHAPTER 5: Conclusion

This dissertation studied the learning outcomes and experiences of physicians, nurses and healthcare professionals who participated in the Ontario Telemedicine Network's hybrid online/mobile learning training courses. The findings for the study were presented in three individual chapters. This final integration chapter will review the findings from Chapters 2-4 and also offer insights and discussion about the findings as a collective, singular study. The chapter will also present practical implications for mobile learning development, suggestions for future research, as well as the strengths and limitations of this research study.

Integration of Results

The purpose of this study was to gain an understanding of the effectiveness of utilizing a conceptual framework informed by best practices from the mobile learning literature to design and evaluate a mobile learning experience incorporated within an online course. The effectiveness was measured by the learning outcomes and experiences of the participants in the study. The major question guiding this research was:

How does the use of a curriculum framework to design mobile learning experiences impact the learning experiences and outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?

The sub-questions developed from the literature review were:

1. How does the content of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?
2. How does the delivery of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?
3. How does the usability of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?

4. How does the structure of a mobile learning experience for healthcare professionals impact the effectiveness as measured by the participants' learning experiences and outcomes?
5. What are the participants' perceptions of community of practice during the mobile learning experience?
6. What are the participants' perceptions of community of practice after the mobile learning experience?
7. How does the use of a curriculum framework to design mobile learning experiences impacts the learning experiences and outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes?
8. How important are content design, content delivery, usability, communities of practice and structure to participants? How can feedback from the experiences and learning outcomes of participants be used to evaluate and revise the mobile learning experience conceptual framework?

This study adopted a combination of a pragmatic methodology with mixed methods data collection in order to provide an effective means of combining qualitative and quantitative data sources (Morgan, 2008), specifically through the implementation of a convergent parallel mixed methods design (Creswell & Plano-Clark, 2011). This provided a credible and reliable understanding of the learning experiences and outcomes of study participants. Table 1 depicts the relationship between the research questions and the results reported in chapters 2-4. Table 1 is followed by a more detailed discussion of research question 7 with regards to the importance of each dimension of the framework to participants and whether the dimensions can be used to develop a conceptual framework for designing mobile learning activities.

Table 1

Research Questions and Key Findings from Chapters 2-4

Research Question	Integration of Results
How does the use of a curriculum framework to design mobile learning experiences impact the learning experiences and outcomes of healthcare professionals with regards to developing	*Learning Outcome 1: Satisfaction* - Participants were extremely satisfied with the MLE and said it was interesting, valuable and fun due to its contextual situation and interactive format. *Learning Outcome 2: New Skills*

workplace skills and understanding clinical processes?	- Participants said the MLE taught them new techniques, applicable skills in a specific context and that they understood new principles of clinical videoconferencing. *Learning Outcome 3: Behavior Change* - Participants indicated the MLE motivated and engaged them to adopt new clinical processes, design new telemedicine workflows and create protocols to foster clinical videoconferencing appointments.
How does the content of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?	*Applicable and Authentic* MLE content presented activities that were authentic for the workplace (equipment and patient preparation) and applicable for participants' daily work. *Comprehensive and Context-Specific* MLE content was valuable and effective because it was presented in a specific workplace context (clinical videoconference studio), and effectively covered the material in depth and breadth. *Processes and Technical Skills* Content in the MLE effectively conveyed protocols for patient presentation, and taught technical skills for operating the equipment and utilizing the remote control. Clinical skills were not presented. *Organization vs. Guidance* Content was effectively organized in a chronological manner and was authentic for patient appointments, but guidance (due to the checklist activities) was found to be disjointed and to interrupt the learning experience.
How does the delivery of a mobile learning experience for healthcare professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?	*Capture and Integration* MLE delivery (the checklists) allowed participants to capture information from the learning environment and later apply or integrate it into best practices. *Avatar Guidance* MLE avatar host provided guidance and support (via orientation to resource, introduction to activities and concepts) for participants. *Flexible Learning* Delivery promoted a flexible environment where participants could access the information from a variety of perspectives (checklist, activities, help guides). *Control* Participants felt delivery gave them control by allowing them to perform activities at their own pace and provide feedback through the checklists. *Flexible Tools and Communication/Collaboration* MLE did not provide easy access to the support tools such as the discussion forum and this hampered communication and collaboration among participants.
How does the usability of a mobile learning experience for healthcare	*Navigation* Participants found navigation in the MLE to be simple to use and

professionals impact its effectiveness as measured by the participants' learning experiences and outcomes?	interactive due to the graphic previous and next buttons, progress bar and table of contents. *Graphics and Presentation* Simple graphics and photos to display content along with customized icons for checklist and tasks kept participants oriented and made the presentation clean and simple. *Interactive Lead to Productive* Participants listed the interactivity of the MLE due to navigation and graphics to increase productivity (successful completion of activities and assembly of the feedback checklist). *Page Loading/Downloading and Discussion Forum* Weaknesses of the MLE includes poor loading speeds due to poor bandwidth and Internet connections, as well as poor navigation to the discussion forum as it was in Moodle and not embedded in the MLE.
How does the structure embedding an informal mobile learning experience within the formal learning environment of an online course for healthcare professionals impact the effectiveness as measured by the participants' learning experiences and outcomes?	*Hybrid Learning* Participants felt the online learning prepared them (via introduction to remote control, equipment and MLE navigation) for the MLE and then supported the experience with follow-up activities (supplementary equipment information, troubleshooting, final quiz and survey). *Application* MLE allowed participants the opportunity to apply (via equipment, remote control and room setup) information they had been presented in the online course *Engaging* MLE engaged participants, kept their interest and motivated them to learn by presenting the inquiry-based activity (prepping for a clinical videoconference appointment) in the authentic learning environment. *Problem-Solving* Participants noted that the MLE guided them through the activities but lacked a case study or problem-solving activity.
What are the participants' perceptions of community of practice during the mobile learning experience?	*Discussion Forum (CoP1) Lack of Value* Participants said CoP1 lacked value due to its asynchronous nature which did not promote interaction between participants or provide access to support. *Advocacy for Synchronous Format* Participants advocated for CoP1 to adopt a synchronous format such as a live feed or scrolling menu in order to access instructor support or share ideas/problems with colleagues. *Navigation and Access* CoP1 should be embedded right into the MLE itself and not require an external link in order to promote collaboration and facilitate access.
What are the participants' perceptions of	*Reaction Survey 2 (CoP2) Added Value*

community of practice after the mobile learning experience?	Participants lauded the value of CoP2 for its resource sharing (protocols, troubleshooting tips, templates) and interactivity as a library or repository for content. *Asynchronous Productivity* CoP2 was productive due to its asynchronous nature where participants could receive multiple answers to questions, have continuing access to review topics/concepts, and share resources. *Best Practices* CoP2 had great value for participants as they could share best practices and lessons-learned with colleagues with similar clinical programs.

Comparison of MLE2 and MLE3

In chapter 2, a comparison of the learning experiences and outcomes of MLE1 and MLE2 was presented, and in chapter 3, a comparison of learning experiences and outcomes of MLE1 and MLE3 was presented. It is important to also explore a comparison of the learning experiences and outcomes between participants of MLE2 (where best practices for delivery were omitted) and MLE3 (where best practices for usability were omitted). This will be done here by comparing the quantitative results from the post-program surveys for content, usability, delivery, structure and outcomes. The complete set of descriptive statistics and t-test results for all five dimensions can be found in Appendix I.

With regards to content, delivery and usability had varying degrees of influence on the learning experiences of participants. The inferior usability of MLE3 led to lower mean scores than MLE2 for the organization of the content, and the content effectively guiding participants through the activities. The lack of navigation buttons and progress bars are likely the cause of these inferior scores. The inferior delivery of MLE2 led to lower mean scores for the content being of appropriate depth and breadth, presenting clinical skills that participants could apply in the workplace, and the content being applicable for participants. As far as content was concerned, therefore, usability affected the perceptions of navigation, whereas delivery affected the practical applicability and value of the content for participants. This is an interesting distinction between the pedagogical effects of these two dimensions.

The dimension of structure was more directly affected by poor delivery than by poor usability. There were three items that had significant differences between MLE2 and MLE3: participants felt that in MLE2 the introductory online learning modules did not prepare them for the mobile learning experience, the mobile learning did not keep their interest, and the mobile learning didn't motivate them to learn. While all of the mean differences were 0.25 or less, this does follow the theme that delivery seems to adversely affect the feeling of value and interest in participants towards the mobile learning experience.

With regards to outcomes, the theme of poor delivery being more impactful on negative learning experiences continued. There were three questions where MLE2 received statistically significant lower mean scores than MLE3. They are: as a result of my participation in the mobile learning experience I have acquired proficiency in new techniques (MLE2 = 2.97, MLE3 = 3.38), $t(184) = -5.7$, $p < .001$; as a result of my participation in the mobile learning experience I have learned applicable skills in a specific context (MLE2 = 2.77, MLE3 = 3.31), $t(161) = -6.4$, $p < .001$; and the mobile learning experience allowed me to learn information that I could not have accessed through an online course (MLE2 = 2.88, MLE3 = 3.28), $t(184) = -4.0$, $p < .001$. Again, these are important distinctions between the effects of delivery and usability on learning outcomes. Participants were less likely to say that they had learned techniques, skills or information that was unique or valuable when the delivery of the mobile learning experience was compromised as opposed to when the usability was inferior. This is a critical finding that will be noted later in this paper.

Finally, as far as the dimensions of delivery and usability, there were few surprises. As expected, the post-program responses for usability were all lower for MLE3 (where usability was inferior) except for one: uploading and downloading material (MLE2 = 2.29, MLE3 = 2.78), $t(155) = -5.7$, $p < .001$. This was likely due to the fact that there were no "push" and "pull" activities in MLE2 so very little downloading or uploading was occurring. Also as expected the delivery responses were all lower for MLE2 (where delivery was inferior) except for two: delivery of the information promoting a flexible learning environment (MLE2 = 3.04, MLE3 = 2.5), $t(184) = 4.3$, $p < .001$, and the resource promoting communication among learners (MLE2 = 2.91, MLE3 = 2.32), $t(184) = 6.3$, $p < .001$. These results again were barriers that could be explained by the poor navigation of MLE3, as the lack of navigation buttons and table of contents made moving through the mobile learning experience and accessing the discussion forum both challenging tasks.

In summary, a fascinating theme has emerged with the examination of the learning experiences and outcomes of MLE2 and MLE3: participants found that poor delivery had a more dramatic impact than poor usability with regards to perceived value, motivation and the ability to practice skills or apply knowledge in the learning context. This is significant since context, value and applying skills are all critical elements of the situated learning theory of Naismith, Lonsdale, Vavoula & Sharples (2005) that was used to frame the design of the mobile learning content in this study. This certainly does not diminish the effects of poor usability, as it was a powerful barrier towards the development of the community of practice during the mobile learning experience as well as guidance and organization as participants moved through the activities. The dramatic impact of delivery, however, is an important finding for this study and warrants further research with the new mobile learning experience conceptual framework evaluation tools that were redesigned in the last chapter of this dissertation.

Results and Designing a Conceptual Framework for Mobile Learning Experiences

The type of mobile learning being explored in this study was called a mobile learning experience (MLE) as it was an informal mobile learning activity embedded within a formal online learning course. The original design of the MLE conceptual framework was informed entirely by a literature review and synthesis. The study allowed for a critique of this process and identified what worked and what did not when the MLE was applied to a real-world online course for healthcare professionals, resulting in some modifications to the framework. The post-program evaluation survey, which was examined using factor analysis, underwent a more dramatic revision that is outlined in chapter 4 of this dissertation. What follows is a description of the results (with specific examples from this research) that supported, refuted, and produced new information for the mobile learning literature.

Findings Supporting the Literature

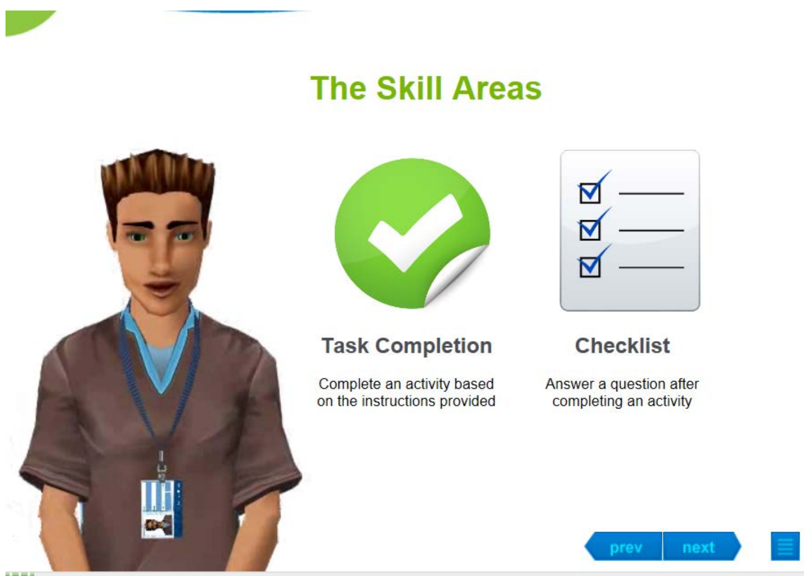
Content. Several major themes in the existing literature regarding the design of mobile learning content were supported by study findings. To begin, Traxler's (2007) situated learning theory for utilizing location-specific unique educational experiences was a key contributor to the content development for the MLE. All of the content (such as task activities for the feedback checklist) was based within the context of the clinical videoconference studio. Participants repeatedly indicated on the post-program survey, CoP2 and in the semi-structured interviews that the contextual content was critical to their applicable and authentic learning outcomes. Secondly, the “3 E’s” (Enable with access to experiences, Engage with contextual learning, Empower with control of the activity) recommended by Franklin (2011) were also content design elements that participants cited as extremely beneficial. Participants were given access to tasks and checklist questions with regards to clinical videoconferencing, engaged with the learning content in their videoconference studio, and were given control of the activities with a simple and intuitive user interface. Control and empowerment to interact with the content on their own terms and at their own pace were benefits that participants listed as creating a flexible, interactive learning environment.

Usability. Recent research has switched from focusing on the technological potential of mobile devices and has addressed the usability requirements for successful mobile learning (Lobo, Kaskaloglu, Kim & Hebert, 2011). The multitude of excellent guidelines for designing interactive mobile learning such as Cassarino (2003), Elias (2011) and Wagner (2005) all provide recommendations for the technological implementation of mobile learning. Perhaps the most important were related to the consistency of presentation of material, either through perceptible information where multimedia formats are implemented that display on all browsers and screen sizes (Goh & Kinshuk, 2006), and flexible use, where the learning content detects the participant’s type of mobile device and adjusts the user interface so it displays consistently (Gu, Gu & Laffey, 2011). Consistent presentation was critical in providing equitable access to the material for all users of a mobile learning activity, and those who did not receive it (in MLE3) were frustrated and angry with the experience. They found it severely inhibited the learning potential due to the inconsistent access to content. In fact, several participants quit the activity and this demonstrated that flexible use is a critical design element when considering mobile learning deployment.

A simple, intuitive interface that utilizes visual icons for home pages and tasks, and minimizes the number of layers in order to simplify navigation (Hsu & Chen, 2010) was a third design element mentioned by participants as crucial for building interaction and engagement between the learner and the content. The final piece of effective mobile programming is ease of interactivity, where interactions with the material are short, simple and involve a click or touch of the screen, as well as an opportunity to interact with the content in multiple formats such as activities, checklists, videos and audio cues using HTML 5 or CSS (Stead, 2014). The ease of interactivity was identified by participants as giving them control of the learning environment and thereby empowering them to make decisions and solve problems. Figure 1 displays an introductory page from the mobile learning experience and displays how all of the three above principles of programming were integrated into its design.

Figure 1

Mobile Learning Experience Introductory Page



The Introductory page in Figure 1 displays how the simple, intuitive format with the easy-to-use previous and next buttons, table of contents, progress bar, and avatar host were utilized in the mobile interface design. These elements (along with consistent presentation to guide participants through the task and checklist activities) provided greater control and interactivity with the mobile learning content.

Delivery. Delivery was also identified by participants as being a critical design element for enhancing the interactivity and productivity of the mobile learning experience. Capturing (by following the task activities) and integrating information (by answering the checklist questions) aligned with the “pull” and “push” activities advocated by Elias (2011) to increase participant control and engagement. The task (learning by doing) and checklist (learning by analyzing) activities also are ideal for optimizing informal, context-specific learning as found by Barron (2006). The frustrating and dissatisfied experiences of participants in MLE2, where task and checklist activities were absent, also supported the interactivity and engagement promoted by the “push” and “pull” activities.

Control and flexibility of the learning environment were also cited as positive outcomes by participants with regards to the delivery of the mobile learning experience. The task and checklist activities were delivered in a fashion that allowed participants to control the interaction with the content from multiple perspectives, either by performing tasks at their own pace or answering checklist questions based on their contextual experiences. This supports best practices for enabling learner control and engagement as prescribed by situated learning theory (Barab, Hay & Duffy, 2000).

Structure. Structure was perhaps the defining element of the mobile learning experience, as it was a hybrid format with both formal and informal learning components. The MLE was designed to be an informal, inquiry-based learning activity that would serve as the main hands-on component of the course. The MLE was supported by pre (introductory) and post (summary) learning that was presented utilizing the formal structure of the online equipment course. Participants gave extremely positive quantitative and qualitative responses indicating that this was a successful hybrid of the contextual mobile learning and didactic online learning. The structure was designed utilizing the recommendations of Bo-Kristensen, Ankerstjerne, Neutzsky-Wulff and Schelde (2009) regarding pre, main and post activities. In particular, participants indicated that the online pre (video orientation to equipment, remote control, mobile learning) and post (supplementary equipment information, privacy, quiz, survey) activities engaged them with the learning material and provided them with the background knowledge required to take part in the mobile learning experience. The MLE then provided them with the opportunity to apply the learned material in a real-world, contextual environment and therefore scaffold and cement the learning of new skills, clinical protocols and processes (Frohberg, Goth & Schwabe, 2009). This finding provides new opportunities for further research on combining online and mobile learning.

Communities of Practice. Findings did support the recommendations in the literature regarding communities of practice both during (in this study CoP1 or the discussion forum) and after (CoP2 or reaction survey 2) the mobile learning experience. Participants' frustration with the asynchronous design of CoP1 validated the research of Wenger, White and Smith (2009) that advocates for open-ended, synchronous collaboration and knowledge sharing during mobile learning. The best practices for utilizing social media tools (such as social networking, bookmarking and shared workspaces) identified by de Waard (2014) were also incorporated into the discussion in chapter 3. Overall, participants felt that for the CoP to be of value during a dynamic, contextual mobile learning experience that it required a synchronous design in order to promote effective communication and collaboration among colleagues.

Unlike the discussion forum, CoP2 (or reaction survey 2) was considered a useful tool by participants in this study. The asynchronous design of CoP2 (which was accessed after the mobile learning experience was completed) was found to be an effective forum for content collection, shared development, problem-solving and sharing expertise. Participants shared experiences, clinical protocols, procedural templates and lessons-learned and CoP2 became a resource repository for best practices for clinical videoconferencing, thereby validating the suggestions of Wenger et al. (2009) for asynchronous forum design.

Overall, three key themes governing participant engagement with the mobile learning experience arose from the design, testing and evaluation of all five of the dimensions of the MLE conceptual framework: control, flexibility and interactivity. If participants felt they had control of the MLE, it was flexible to use and provided interactivity, then it was viewed as productive and led to positive learning outcomes of participant satisfaction, development of new skills and adoption of new behaviors. These findings align with the principles of self-directed, lifelong learning proposed by Candy (1991) which include personal autonomy, independent pursuit of learning without formal support and learner-control of instruction. In fact, control, flexibility and interactivity also reflect much of the initial work on andragogy (or adult learning) by Knowles (1989) and his Principles of Adult Learning:

1. Adults are internally motivated and self-directed (they like control and self-direction)

2. Adults bring life experiences and knowledge to learning experiences (they like to use experiences in problem-solving, reasoning and reflection)

3. Adults are goal oriented (require meaningful, realistic inquiry-based learning)

4. Adults are relevancy oriented (need choices and applicable experiences)

5. Adults are practical (like real-world contexts and active participation)

6. Adult learners like to be respected (they like to provide feedback and have their expertise acknowledged)

All of Knowles' principles listed above (based on informal adult learning) are addressed in some way in the learning outcomes and experiences of participants in this research. This validates the beneficial elements of informal, adult education that mobile learning experiences can deliver.

Findings Refuting the Literature

Content. There appears to be some conflict between the organization and sequencing of the mobile learning experience content during the mobile learning experience. While participants identified that the sequencing and alignment of the mobile learning experience with real-world applications and processes was excellent, some did not like the inclusion of the checklist questions in the middle of the task activities. The checklist questions were designed to both garner feedback from the participants at key points during the sequence, as well as allow them to interact with the learning content from another perspective. This supports the guidance for anchored instruction within authentic contexts proposed by Barab, Hay and Duffy (2000), as well as the "push" and "pull" activities of Bo-Kristensen et al (2009). Virtually all of the participants listed the benefits of the checklist activities, so their indication that the checklist questions "interrupted" the flow of the MLE is a significant finding. It may be that the content needs to embed questions into the task activities or include all of the checklist questions at the end of the simulation in order for them to be seamlessly integrated. Or it may be that the disruption of the checklist questions makes the participants focus on them more acutely, thereby providing more accurate, in the moment responses. While this may interrupt the logical sequence of the learning activity, it promotes reflection and thoughtful feedback. Further research into this problem is warranted.

Structure. A second finding that seems to contradict the literature was the fact that participants found the mobile learning experience to be engaging, interactive and flexible, yet it lacked many of the open-ended characteristics of problem-based learning. In fact, some mobile learning research such as that proposed by Stanton and Ophoff (2013) calls for problem-based learning to be a fundamental factor when designing mobile learning, since it can lead to abductive reasoning and a more dynamic learning environment (Burdick & Willis, 2011). Interestingly enough, some participants suggested that a problem-based approach might make the learning environment more interactive and flexible. The mobile learning experience in this study was designed as a generic case study of presenting a patient via videoconference since it was accessed by healthcare professionals from a variety of disciplines and facilities across Ontario. A specific case-specific, problem-based approach could be adopted in future versions of this MLE, where content would be customized to specific disciplines such as mental health, primary care and oncology (all common uses for clinical videoconferencing). Participants could be challenged to prepare a patient consultation with less guided instruction from the avatar host. For the moment, however, the current MLE remains slightly at odds with the current literature, as it does present a context-based, informal learning activity that has tightly controlled content. Despite this somewhat didactic structure, it still produces practical, applicable outcomes and allows participants to have flexibility and control in the learning environment.

Communities of Practice. A majority of learning theories on mobile learning include some form of communication or collaboration among learners as a key component of their design and delivery (Sharples, Arnedillo-Sanchez, Milrad & Vavoula, 2009). Yet in this study, participants not only questioned the asynchronous, poor usability of the discussion forum (CoP1) during the mobile learning experience, they also questioned why they should post to it at all. This appears to fly in the face of such research projects as the TASK Model proposed by Taylor, Sharples, Malley, Vavoula and Waycott (2006), which advises that a contextual, reflective, learner-controlled mobile learning activity should involve communication and cooperation within the participating group. Several participants noted that a synchronous forum might be useful during the mobile learning experience, but most did not find CoP1 to have any usefulness whatsoever. This could be attributed to the asynchronous nature of CoP1, and it also should be noted that CoP2 (reaction survey 2) after the mobile learning experience was viewed as being a fantastic resource for communication and collaboration from study participants. So the issue here may be the placement of the CoP during the learning continuum. Perhaps a CoP for communication and collaboration is not necessary during the mobile learning experience itself? Perhaps it is more suitable afterwards in the formal online learning environment? Or perhaps a synchronous structure should be included in future versions of CoP1. Further study is warranted on the issue of CoP inclusion and design for mobile learning experiences, particularly with regards to structure, orientation and collaborative learning outcomes.

New Information for the Mobile Learning Literature

Usability. "Richness" or the page with which pages and media load (Wagner, 2005) was identified as an issue for some participants during the mobile learning experience. A great deal of testing and customizing was performed to ensure that the database was configured for maximum downloading and uploading speeds, and that multimedia elements (avatar, videos, audio clips, photos) were the smallest possible size. It was also decided to produce the mobile learning experience as a mobile web application (accessed via an Internet connection) instead of a direct download as this would minimize the use of data on the participants' mobile devices. As the complexity and detail of mobile learning experiences grows, more research is required in how to maximize richness. Giving participants the choice between a downloadable MLE or a mobile web application MLE would be a good start. In addition, having a mechanism for checking bandwidth speed that would estimate download times and make recommendations based on the participant's mobile device and connection strength would also be a useful tool for maximizing richness. More research is required into the effective design and implementation of these tools in mobile learning experiences.

Delivery. As noted in chapter 2, the effectiveness of the avatar host at guiding the participants through the activities in the mobile learning experience was one of the key findings in this study. Participants found the avatar to make the learning environment more fun, personalized and interactive. Research into the use of avatars in educational contexts is still in its infancy (de Freitas & Oliver, 2006). While avatars have recently been used to design learning activities that promote participant involvement, more research into how this may influence participant engagement is warranted (Hobart, 2012). The participants' impressions of the avatar were so positive that it is possible that this interaction may have contributed to the participants' lack of interest in the discussion forum during the mobile learning experience. In effect, the avatar was guiding them and providing access to rudimentary documents and support materials, thereby eliminating some of the need for social interaction and collaboration. The avatar may also have compensated for the lack of problem-solving activities as it presented the tasks and checklist questions in a case-based format. More research would be required to determine if these hypotheses are true, but the inclusion of the avatar host in the mobile learning experience definitely contributed to learner satisfaction and engagement in this study.

Communities of Practice. The lack of success of the discussion forum (CoP1) during the mobile learning experience leads to some interesting implications for future mobile learning research, particularly with regards to methods of delivery. If a synchronous discussion forum is preferred in order to access support and promote communication, there have been several recommendations for best practices for real-time delivery as identified by de Waard (2014). Platforms such as Twitter, Facebook, Diigo, YouTube and Asana have been recommended, but virtually no research into their pedagogical design and implementation into mobile learning environments has been performed. Considering the importance placed on communication and collaboration in the research literature, this is a key design element that requires further study.

Implications

This dissertation highlights numerous implications for the creation of a conceptual framework that can be used to guide the design and evaluation of mobile learning experiences for healthcare professional education. They are discussed below with regards to the three learning outcomes identified in this research: participant satisfaction, development of new skills and behavioral change. Practical and technical guidelines for mobile learning experience design were also important implications from this research and will also be discussed in this section.

Implications for MLE Design for Healthcare Professionals Learning Satisfaction

This research has shown how mobile learning experiences can be an enabling, engaging and satisfying medium for delivering training and education to healthcare professionals. Numerous research studies have demonstrated the importance that participant satisfaction in online learning has on engagement, motivation and positive learning outcomes such as the development of new skills, knowledge and behaviors (Eom & Arbaugh, 2011). Research has also demonstrated that healthcare professionals (and nurses in particular) report high levels of satisfaction when online learning is designed using both adult and constructivist learning theory (Gerkin, Taylor & Weatherby, 2009). These theories lead to instructional design principles that create an interactive online learning environment through online discussion, reflection, timely feedback, collaboration and the application of real-world knowledge (Ali, Carlton & Ryan, 2004). Table 2 outlines how these key elements influencing participant satisfaction were successfully incorporated in the dimensions of the mobile learning experience conceptual framework.

Table 2

Instructional Design Principles Influencing Satisfaction and the MLE Conceptual Framework

Instructional Design Principle (Satisfaction)	MLE Conceptual Framework Dimension
Online Discussion	CoP1: Discussion Forum (synchronous in future versions of MLE)
Reflection	Delivery: Integration of “Push” activity of checklist questions
Timely Feedback	Delivery: Checklist summary form emailed to participants upon completion of MLE Usability: Access to PDF guides and screencasts if participants require more information
Collaboration	CoP2: Reaction Survey 2 (allows for assembly of best practices and sharing of resources after MLE)
Application of Real-World Knowledge	Content: Task activities provide guided instruction as participants undertake workplace activities (presentation of a patient via clinical videoconferencing)

Implications for MLE Design for Healthcare Professionals Skill Development

Participants in this study indicated that the mobile learning experience was extremely successful in allowing them to develop new knowledge and skills with regards to clinical videoconferencing. Research in mobile learning has demonstrated that participants develop new skills when the learning environment is autonomous, learner-centered and contextual (Cobcroft, Towers, Smith & Bruns, 2006). The support of a learning community and the opportunity to practice new concepts are also important (Sharples, Taylor & Vavoula, 2007). Table 3 outlines how these key elements of mobile learning that influence skill development were incorporated in the dimensions of the MLE conceptual framework

Table 3

Instructional Design Principles Influencing Skill Development and the MLE Conceptual Framework

Instructional Design Principle (Skill Development)	MLE Conceptual Framework Dimension
Learner Autonomy	Usability: MLE presented with intuitive interface, interactive graphics, consistent presentation on participants' devices Delivery: Avatar host guides participants through learning activities Content: Designed for application in the participants clinical videoconferencing studio
Learner-Centred	Structure: Informal, inquiry-based mobile learning experience in workplace context
Contextual	Content: Designed for application in the clinical videoconference studio Delivery: "Main" activity includes tasks and checklist questions based on the environment of the clinical videoconference studio
Supported by a Learning Community	CoP2: Reaction Survey 2 (allows for assembly of best practices and sharing of resources after MLE)
Opportunity to Practice New Concepts	Structure: "Pre" activities presented new knowledge and prepared participants for mobile activity, "Main" activity provided guided participation in the specific learning environment

Implications for MLE Design for Healthcare Professionals Behavior Change

Participants indicated that the mobile learning experience prompted them to develop new behaviors in their workplace, particularly with the adoption of new clinical protocols, processes and creation of new clinical videoconference programs. Research in mobile learning has demonstrated that participants adopt new behaviors when case-based storytelling aligns with real-world experiences (Bubenzer, 2011), when participants capture and integrate information from the field, receive social support, and blend "heads down" or guided use of the mobile device with experiences in a specific context (Cahill et al., 2011). Table 4 outlines how the key elements of mobile learning influencing behavior change were incorporated in the dimensions of the MLE conceptual framework

Table 4

Instructional Design Principles Influencing Behavior Change and the MLE Conceptual Framework

Instructional Design Principle (Behavior Change)	MLE Conceptual Framework Dimension
Case-Based Storytelling Aligns with Real-World Experiences	Content: MLE content presented activities that were authentic for the workplace (equipment and patient preparation) and chronological based on presentation of a patient
Capture and Integrate Information from the Field	Delivery: Integration of "Push" activity of checklist questions Delivery: Checklist summary form emailed to participants upon completion of MLE
Social Support	CoP2: Reaction Survey 2 (allows for assembly of best practices and sharing of resources after MLE)
Blend Guidance with Experiences in a Specific Context	Structure: Inquiry-based, guided participation provided in an informal format within the specific learning context

Practical/Technical Guidelines and Implications

Beyond the theoretical and research implications from this study, numerous best practices for the technical and practical design of mobile learning experiences were implemented, tested and evaluated. Each of the five dimensions of the MLE conceptual framework and their identified best practices will be discussed in this section.

Content. Instructional designers of mobile learning experiences should focus on developing authentic content that:

- Is designed using case-based scenarios that can be tailored for specific disciplines
- Provides opportunities for problem-solving activities and collaboration to establish best-practices
- Is situated in a specific workplace context (office, studio, warehouse) where participants can interact with the everyday tools of their jobs

- Is organized in a fashion that mirrors the sequence and processes of authentic workplace activities via a chronological approach
- Focuses on the instruction of workplace processes and technical or clinical skills by assigning tasks, providing tips or soliciting participant feedback

Delivery. Mobile learning experiences should be delivered utilizing the following identified best practices:

- Allow participants to capture information (via quizzes, checklists or blogs) that can later be assembled and integrated into best practices (via quiz results, checklist forms, discussion forums)
- Utilize a host to provide guidance and support to participants (this could be an avatar, cartoon or live video host) via introductions, orientation to the resource and on-demand support tools (such as videos, PDF guides or screencasts)
- Provide access to the learning material utilizing a variety of pedagogical tools (task activities, checklists, screencasts, simulations, role playing)
- Allow participants to control the pace, navigation and provide feedback via an intuitive interface and simple-to-use navigation buttons
- Provide participants the means to communicate and collaborate (via communities of practice)

Structure. The structure of the mobile learning experience should be informal in nature and allow participants to achieve autonomy and control over learning activities via:

- Embedding the informal mobile learning experience as the “main,” situated activity within a formal online learning environment via a downloadable or web-based application format
- Providing introductory information in the formal online environment (via “pre” activities such as videos, screencasts and slideshows) before the mobile learning experience in order to orient the participants to the topic, learning objectives and mobile learning activity

- Providing summary information in the formal online environment (via "post" activities such as feedback tools, quizzes and surveys) after the mobile learning experience so participants can integrate, share and collaborate on lessons learned

Usability. Technical usability (or lack thereof) can be a barrier towards learning, and should be designed in the mobile learning experience according to the following specifications:

- Provide intuitive navigation via clickable/touchable icons, progress bars, tables of contents, popup video players and embedded discussion forums/tools
- Utilize simple, customized graphics to identify the task or activity the participants are completing, ensuring large text fonts and accompanying audio or video files
- Test all multimedia tools (graphics, photos, videos, screencasts, PDFs, audio files) to ensure they are the smallest file size possible
- Provide a bandwidth testing application that can advise participants on the best devices and browsers to utilize to access the material
- Provide instructions and access to both a downloadable and web-based application version of the mobile learning experience
- Utilize HTML5, CSS and bootstrap software to ensure that all content displays efficiently regardless of the device or browser that participants are utilizing

Communities of Practice. The importance of efficient access to support, communication and collaboration both during and after the mobile learning experience has been highlighted in this research. Identified best practices include:

- Communities of practice during the mobile learning experience should be synchronous and accessible in real-time via platforms such as Twitter, Facebook, YouTube, Diigo, Asana or WordPress
- Communities of practice during the mobile learning experience can be utilized for such supportive activities as sharing of short messages, knowledge creation, bookmark key learning items, share video/audio files, develop strategies and planning, and blog on a learning experience

- Communities of practice after a mobile learning experience can be housed in a traditional learning management system (Moodle, Blackboard, Desire2Learn) and should provide continual access to participants for future reference
- Communities of practice after a mobile learning experience and can be designed for the following orientations: project infrastructure/development, content collection and organization, access to subject matter experts, and community cultivation

Limitations

This dissertation is subject to a few limitations. They are discussed in this section based on limitations in the research design and the biases of the researcher.

Research Design Limitations

The first limitation involves the convergent parallel mixed methods design employed in this research. While excellent for increasing both validity and reliability due to the triangulation of multiple forms of data, it can be very difficult for a beginning researcher to master both the qualitative and quantitative data collection and analysis techniques (Creswell, 2011). Acquiring these skills meant completing two courses in both qualitative and quantitative research in the Ph.D. program at the University of Ottawa. In addition, the qualitative analysis of over three hundred post-program surveys and twenty-five interview transcripts was extremely time-consuming and laborious.

A second limitation involved the demographics of the study participants. Over 86% of participants were registered nurses, thereby limiting the variety of the healthcare professionals that participated in this research and skewing the data to the particular perspective of the nurse profession. The specific nature of the participant population, however, is warranted in this case. Over 75% of all telemedicine (clinical videoconferencing) coordinators that access the Ontario Telemedicine Network's services are in fact nurses. Therefore the population for this study is representative of the profession that accesses and utilizes clinical videoconferencing on a daily basis within Ontario's healthcare system.

A third limitation is that the study relied on a relatively small number of interview participants (15 from MLE1, 5 from MLE2, 5 from MLE3). To mitigate this limited sample size, the large numbers of responses (213) to the open-ended questions in the post-program survey were also included in the qualitative data. This allowed the codes identified in the interview data to be compared, contrasted and triangulated with the codes in the survey data. Results from the quantitative data were also combined with the qualitative data to result in a more reliable final interpretation of the findings. The primary researcher's coding and analysis was also checked and verified by an independent researcher to increase the validity of the findings.

Sample size was also an issue in this study, particularly with regards to the factor analysis, as 100 is considered poor as correlations do not usually stabilize until a much larger number (over 300) is obtained (Comrey & Lee, 1992). The results from the factor analysis, however, when combined with the literature review and supporting evidence from the study did provide a solid foundation for the revisions to the post-program survey questions.

Another limitation was the number of participants who accessed and posted in both the discussion forum (CoP1) and reaction survey 2 (CoP2). Only 104 participants posted in CoP1 (for a total of 121 posts) and only 62 participants completed CoP2 (for a total of 84 posts). Considering that there were 307 total participants in the study, and that all of them completed at least some portion of the post-program survey these numbers are relatively low. This was due to two main factors:

1. Participants did not see the value in posting to the asynchronous CoP1 during the mobile learning experience and/or had trouble accessing it
2. CoP2 was to be completed after participants completed their first clinical videoconference, and the four month window of this study simply did not give participants enough time to do this

A final limitation of this research was the inability to test the re-designed mobile learning experience conceptual framework within the timelines of this study. The W(e)Learn framework (MacDonald, Stodel, Thompson & Casimiro, 2009) provided an excellent base for the design of the evaluation component for the conceptual framework, but as evidenced from the factor analysis in chapter 4 there were several revisions required to make the post-program survey more reliable for evaluating the MLE learning outcomes. More research into the effectiveness of the revised conceptual framework is warranted.

Biases of the Researcher

In a study such as this where one researcher designs the experiment, performs the literature review, designs the resource, interviews the participants and analyzes the data, researcher bias is an inherent part of the process. I have attempted to mitigate any personal bias by taking numerous precautionary steps as outlined below.

To begin, as the researcher and interviewer, it is possible that I have anticipated some participant responses and results based on my familiarity with the mobile learning literature. This can be common in qualitative research (Yin, 2009). I mitigated this limitation by both inviting study participants to review their interview transcripts as well as having a second independent researcher review my qualitative coding and theme development. In addition, the qualitative results and analysis were cross-referenced with the quantitative data during the “compare and contrast” portion of the convergent parallel mixed methods design in order to produce combined key themes. The convergent parallel mixed methods design can be seen in Appendix II.

My dual role as both research designer and interviewer could also have contributed to bias during the data collection and analysis processes. To mitigate this, I made it very clear to interview participants of my dual role, and that participation in the interview process was entirely voluntary. These are both recommendations to eliminate bias and maintain confidentiality in qualitative research (Baez, 2002). In addition, assignment to any of the three versions of the mobile learning experience was completely automated and random within the Moodle learning management system. I also included all contradictory data and reported it in the results and discussion sections of chapters 2-4.

Personal Reflection

I feel that through this doctoral research experience that I have grown as both an instructional designer and researcher. The design process of the mobile learning experience involved not only detailed research into the literature on mobile learning, but also the development of HTML5 programming knowledge with regards to mobile web application implementation. This was a time-consuming but fascinating process. As there was no budget for the design of the mobile learning experience, it was developed in large part by myself in concert with support from two other PhD students at the University of Ottawa. They provided guidance and support on the HTML5 coding but not on the content of the resource itself. I had already had extensive experience designing online learning resources so the Moodle programming was relatively straight forward. Nevertheless the technical challenges were both rewarding and time-consuming during the life of the entire project.

With regards to the research, I feel (and hope) that I have grown since the completion of my Master's thesis. I realize the importance of a thorough literature review and how this can help inform and guide effective research design. I also recognize the importance of rigorous methods, particularly when it comes to coding of the qualitative data and triangulation of both forms of data in the mixed methods process. The benefit of following an established research methodology such as the convergent parallel mixed methods design also became evident. The organization of the design as seen in Appendix II enabled me to stay on track as well as understand when and how to combine and contrast the qualitative and quantitative results. In future research, I hope to focus on these processes in order to uphold validity and support trustworthiness.

I also realized during this research that the completion of a PhD program is not a solo process once the class component is completed. I was able to collaborate and receive support from a wide variety of people, from the invaluable feedback from my thesis supervisor and committee, the programming support from my two fellow PhD students, the coding review by an assistant professor, and the moral support from students in my program. I have often heard that a PhD program can be a lonely process, but the comradery, collaboration and support from colleagues has been overwhelmingly positive and appreciated during my journey.

Conclusion

This study examined how the use of a curriculum framework to design mobile learning experiences impacted the learning outcomes of healthcare professionals with regards to developing workplace skills and understanding clinical processes. Healthcare professionals voluntarily participated in the study in which they shared their experiences, observations and feedback. Findings helped inform the revision of the conceptual framework and evaluation tools in order to design more effective, interactive and productive mobile learning experiences.

This research found that mobile learning experiences can provide satisfying learning experiences for healthcare professionals that can help them develop technical and clinical skills as well as adopt new workplace behaviors. Participating healthcare professionals indicated a high degree of satisfaction with regards to the hybrid online/mobile learning course and also felt that the community of practice (CoP2) resulting from the study would be a valuable resource to further collaboration and cooperation among healthcare professionals in Ontario.

This dissertation revealed many positive pedagogical benefits of mobile learning including autonomy, flexibility, collaboration and contextual application. Further research is needed into the re-designed mobile learning experience conceptual framework, its evaluation tools, and how to implement synchronous collaboration in mobile learning experiences.

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Appendix I: Post-Program Mobile Learning Experience Survey Descriptive Statistics

Table 1.1

Post-Program Survey Content Responses Mobile Learning Experience 2 (N=92) and Mobile Learning Experience 3 (N=94)

Answer Option	MLE 2[a]		MLE 3[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. The content is of appropriate depth and breadth	3.05	0.477	3.23	0.426	0.007
2. The content is well-organized	3.04	0.293	2.73	0.532	0.000
3. The content is context-specific	3.29	0.545	3.31	0.464	0.840
4. The content effectively presents technical skills that I can apply in my workplace	3.18	0.490	3.10	0.330	0.147
5. The content effectively presents clinical skills that I can apply in my workplace	2.77	0.477	2.96	0.648	0.026
6. The content effectively guides me through the activities	2.90	0.647	2.54	0.634	0.000
7. The content is applicable for my professional life	2.97	0.523	3.14	0.377	0.011
8. The content is authentic	3.07	0.357	3.07	0.446	0.876

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.2

Post-Program Survey Usability Responses Mobile Learning Experience 2 (N=92) and Mobile Learning Experience 3 (N=94)

Answer Option	MLE 2[a]		MLE 3[a]		T-test
	Mean	SD	Mean	SD	Sig. (2-tailed)
1. In this program it was easy to "navigate" through the content.	2.90	0.664	2.17	0.478	0.027
2. The instruction is divided into clear and logical sections	2.77	0.648	2.63	0.508	0.094
3. Uploading and downloading material was fast and efficient	2.29	0.633	2.78	0.444	0.000
4. Presentation of material utilizes aesthetically pleasing graphics	3.32	0.467	2.93	0.264	0.000
5. Content was displayed in a consistent fashion on my mobile device	3.15	0.573	2.47	0.634	0.000
6. Pages loaded quickly	2.80	0.399	2.34	0.632	0.000
7. Interactivity was efficient when posting to and accessing the discussion wall	2.74	0.560	2.60	0.592	0.000

8. The mobile learning experience was interactive and productive due to its usability	2.97	0.346	2.46	0.522	0.000

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.3

Post-Program Survey Structure Responses Mobile Learning Experience 2 (N=92) and Mobile Learning Experience 3 (N=94)

Answer Option	**MLE 2[a]**		**MLE 3[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
1. The introductory online learning modules prepared me for the mobile learning experience	3.11	0.763	3.34	0.476	0.014
2. The mobile learning experience kept my interest	3.03	0.583	3.23	0.450	0.009
3. The mobile learning experience motivated me to learn	3.09	0.410	3.24	0.456	0.014
4. The mobile learning experience engaged me in the learning experience	3.16	0.634	3.03	0.663	0.170
5. The material follows a logical progression	2.70	0.569	2.74	0.507	0.536
6. The mobile learning experience provides opportunities for problem-solving experiences	2.64	0.585	2.77	0.582	0.133
7. The mobile learning experience provides opportunities to apply material learned	3.12	0.590	3.26	0.485	0.089
8. The online modules supported the mobile learning experience after it was completed	3.32	0.467	3.24	0.475	0.392
9. I enjoyed the combination of online learning with the mobile learning experience	3.07	0.570	2.99	0.726	0.430

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Table 1.4

Post-Program Survey Delivery Responses Mobile Learning Experience 2 (N=92) and Mobile Learning Experience 3 (N=94)

Answer Option	**MLE 2[a]**		**MLE 3[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
1. The resource respects my experience and current knowledge	3.07	0.589	3.12	0.383	0.457
2. The delivery allowed me to control my learning environment	3.04	0.783	2.85	0.687	0.076

3. There is flexible access to support tools, information, help, and online communication	2.51	0.620	2.72	0.694	0.029
4. The delivery of the information promotes a flexible learning environment	3.34	0.498	3.02	0.508	0.000
5. The delivery allowed me to capture and integrate information	2.30	0.659	2.69	0.464	0.000
6. The resource promotes communication among learners	2.91	0.765	2.32	0.473	0.000
7. The resource promotes collaboration among learners	2.36	0.622	2.38	0.791	0.816

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

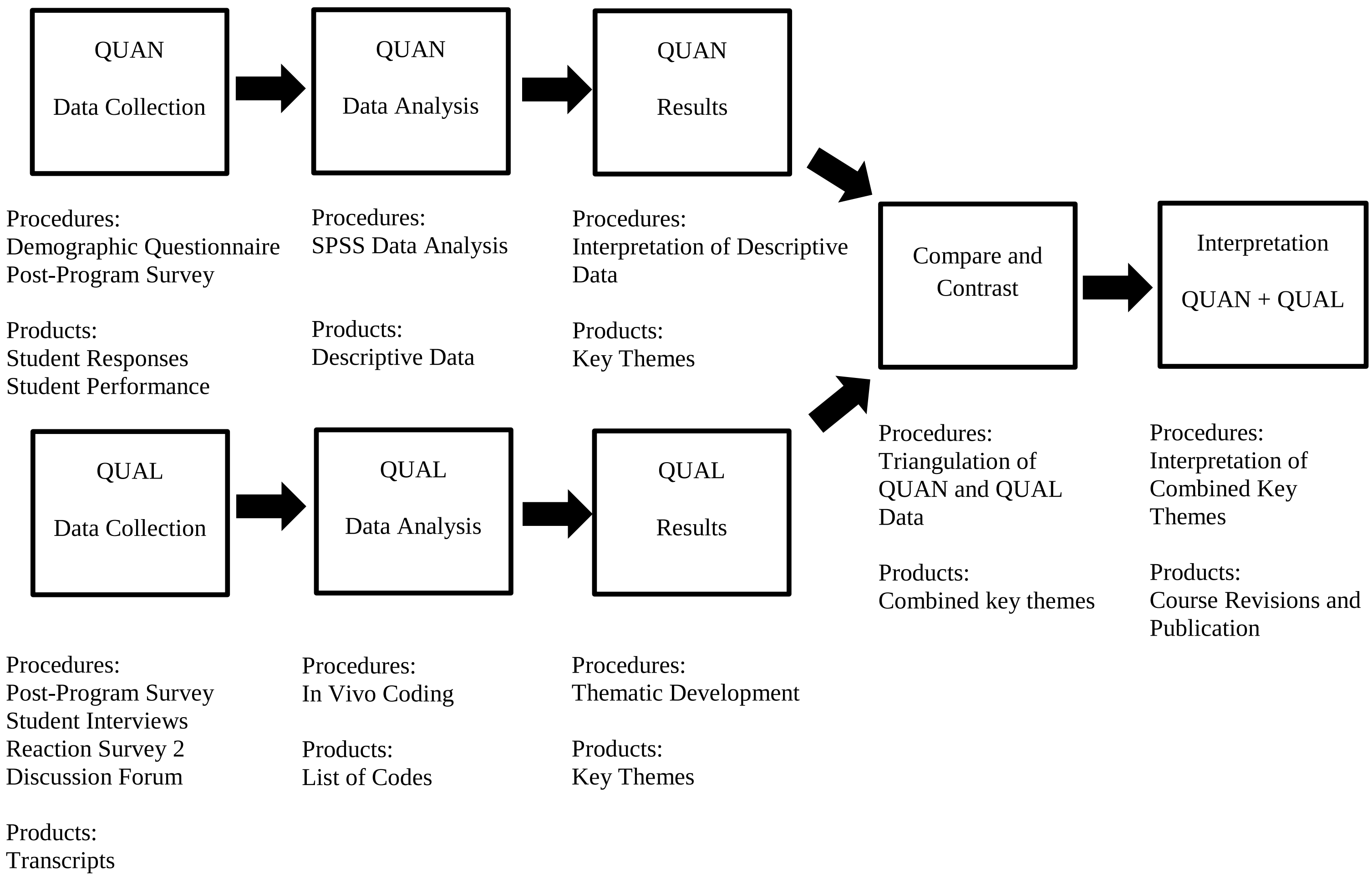
Table 1.5

Post-Program Survey Outcomes Responses Mobile Learning Experience 2 (N=92) and Mobile Learning Experience 3 (N=94)

Answer Option	**MLE 2[a]**		**MLE 3[a]**		**T-test**
	Mean	**SD**	**Mean**	**SD**	**Sig. (2-tailed)**
1. The online/mobile course is interesting	3.04	0.512	3.06	0.601	0.804
2. The online/mobile course is valuable	3.17	0.409	3.02	0.508	0.055
3. As a result of my participation in the mobile learning experience I understand new principles of clinical telemedicine	2.78	0.562	2.82	0.445	0.631
4. As a result of my participation in the mobile learning experience I have acquired proficiency in new techniques	2.97	0.479	3.38	0.510	0.000
5. As a result of my participation in the mobile learning experience I have learned applicable skills in a specific context	2.77	0.471	3.31	0.632	0.000
6. The mobile learning experience allowed me to learn information that I could not have accessed through an online course	2.88	0.660	3.28	0.678	0.000
7. The mobile learning experience made the learning environment more motivating and engaging	3.33	0.697	3.18	0.655	0.145

[a]Response options: 0 = not applicable; 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree

Appendix II: Convergent Parallel Mixed Methods Design



Adapted from: (Fuji, Paschal, Galt & Abbott, 2010, p. 243)