Developing expertise of those handling temperature-sensitive pharmaceutical products using e-learning

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This thesis is presented for the degree of Doctor of Philosophy

School of Education
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Declaration

I declare that this thesis is my own account of my research and contains as its main content work that has not previously been submitted for a degree at any tertiary educational institution.

James L. Vesper
Abstract

The use of e-learning as a means of providing academic and professional education and training continues to expand. New technologies allow for innovative instructional approaches, while different instructional approaches catalyze the development of alternative technologies or the repurposing of existing ones. The effort and expense of creating e-learning courses demand that instead of a haphazard design approach or simply duplicating a course using a model that currently exists, developers consider and incorporate a valid theoretical foundation for what they produce.

The purpose of this research was to create an e-learning course—based on theoretical design principles derived from the research literature—that would contribute to the expertise of those handling time- and temperature-sensitive pharmaceutical products (such as vaccines). The e-learning course was based on an existing physical course conducted annually by the World Health Organization in Turkey, but the approach adopted was based on theory and practice more appropriate to online learning. Three learning theories provided the theoretical underpinnings for the study: cognitive apprenticeship, authentic learning, and community of learners.

A design-based research approach was used to conduct the study and create the e-learning solution. Draft design principles were established from the literature and consultations with practitioners, and incorporated and refined throughout the study as the e-learning solution moved from early sketches, a working “alpha” version,” and finally a field test of the working prototype. At each stage, formative evaluations were conducted with the results used to improve the subsequent iterations of the e-learning course.

Interviews and surveys of the learners (participants) and instructors (mentors), learning assignments, diary entries, and researcher observations formed the data that were used and analyzed using semi-quantitative and qualitative techniques. The results were applied to improve subsequent iterations of the course design, including the user
interface, learner tasks and activities, and the interactions between the mentors and participants. Additionally, the results supported the refinement and restructuring of the design principles, which was a major outcome of the research.

The results of this study showed that an e-learning course could be based on an existing physical course, but in doing so, efforts should be made not to simply mirror the new course to the old, but rather to take maximum advantage of the affordances of each mode. Creating an authentic environment with authentic tasks and activities requires close consultation with practitioners in the field and a degree of suspension of disbelief by the learners which is accomplished by effectively communicating the context (or backstory) and the role(s) that they must take in accomplishing the task. While many e-learning design and development efforts emphasize the technologies to be used, the findings here place a higher emphasis on the importance of relationships that participants and mentors establish and develop as they work virtually together to accomplish authentic tasks. The outcomes of the study include an effective e-learning environment ready for implementation under real world conditions and a set of 13 refined design principles.

Implications for practice cohere around the refined design principles that will provide a theoretical and practical foundation for those who develop e-learning solutions in other education and training contexts, and to assist them to incorporate authentic activities in their own e-learning solutions.
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Preface

It was a chance meeting at a conference of pharmaceutical industry trainers where I first met Dr. Ümit Kartoğlu from the World Health Organization (WHO). Also participating in that meeting was Professor Thomas Reeves, Ph.D. whom I had known and worked with for several years previous. It was one of those serendipitous moments when we all recognized each other as kindred spirits in learning and training. I think we each took a personal vow to find ways to collaborate together. Over the next several years, I served as an outside advisor and consultant to WHO. In this role, I participated in several projects, including being a mentor for the “bus trip,” a unique experiential learning program that was the basis for the e-Pharmaceutical Cold Chain Management course described in this thesis.

At one point, when Tom, Ümit, and I were working on a different project, we started talking about developing an e-learning course and it became evident very quickly that the project would be suitable for investigation in a design-based research study. Tom suggested that I explore working with Professor Jan Herrington at Murdoch University because of her interests in design-based research, authentic learning, and e-learning projects, all of which were aligned with the intended WHO e-learning course. Additionally, integral in this was Ümit’s assistance and willingness to allow the WHO e-learning project he was sponsoring to be the subject of my research.

While I had helped design and produce several large e-learning projects in the past, this project was more of a challenge, in part because the team was in multiple locations, with team members speaking different languages. Our team was made up of true professionals with whom I had the opportunity to work and learn: Gokhan Gurses, a gifted artist/illustrator with a sharp mind and sense of humor; Umit Kivanc, a leading documentary filmmaker from Istanbul; and Gencer Yurttas, a talented photographer and production assistant. Gokhan Akaalp was the lead IT/programming/application expert behind the screens. And then there was our “scout” or tour guide for the physical bus
trips, Hakan Gönendik who was always prepared for any that could arise. Tom Reeves served as the learning consultant to the team, challenging our assumptions and sharing ideas and different approaches.

As we developed the e-learning course, there were subject matter experts from different disciples who helped in many different ways, including Kevin O’Donnell, Andrew Garnett, Bill Aggen, Shelley Morse, and Ron Gregory.

The participants from the different bus trips and those who participated in the field testing of the prototype were very generous in their ideas and comments used to improve the course. Thanks to them for their time and willingness to do this.

**Personal reflection – what I learned**

The design of this e-learning course and the evaluations of three iterations that are described in this thesis, resulted in five realizations that I found particularly valuable. First, I gained a richer understanding of underlying theories, particularly authentic learning, cognitive apprenticeship, and constructivist learning. Intuitively, my leanings have been towards “learning by doing,” but now having a stronger theoretical foundation since appreciation of the educational context makes for even richer, more interesting learning solutions. I have used these theories in a very practical way that has, I believe, improved the learning solutions that I have developed. Additionally, understanding the theories and why they contribute to better learning outcomes have allowed me to make stronger, fact-based arguments when called on to defend an approach that differs from the classical “sage on the stage.”

Second, I gained the ability to evaluate and critique learning solutions and interventions. One of the most fascinating articles that I read during the literature review was entitled “Skiing as a model of instruction” (Burton, Brown, & Fischer, 1984), a work that gave me in insight into cognitive apprenticeship, but also provided a lens with which to look at instructors and mentors in a different light.
Third, I recognized the importance of relationships over technology. This was one of my most surprising insights during the research. I have always been attracted to the technologies involved in learning—bulky videotape players, interactive video discs, computer-based learning, and now iPads and augmented reality—but with a new understanding of the community of learners and participants collaborating on authentic tasks, I realize that the emphasis has been misplaced. Technology is not the goal in itself but the means to creating, developing, and sustaining relationships between people in which people learn.

Fourth, I experienced and learned from the challenges of working at a distance. Being part of the team design and developing the e-learning solution, conducting the research, and writing this thesis have principally been done at a distance from the other team members and thesis supervisors. Email, web-cloud file sharing systems, and communication tools like Skype and Facetime permit this collaboration, but it is still a challenge that demands a high amount of motivation and persistence on everyone’s part.

Fifth, and finally, I was reminded of the value of a strong team with members from different backgrounds and various points of view. Contributing to the success of this e-learning project was a team that was not only talented, but one that was willing to consider alternatives while focused on achieving a successful outcome.
As the ten chapters in this thesis are having their final review, I have the opportunity to look back at the past several years and think of those who have supported me in a variety of ways.

My first thanks go to Professor Jan Herrington, my principal supervisor, and Professor Thomas Reeves, my local (US-based) supervisor, for being so generous in sharing their knowledge, skills, and ideas. Their high expectations, encouragement, and humor induced me to work even harder.

There are many other professional friends and colleagues, some of whom also have gone through the doctoral process and, often unwittingly, encouraged me to keep moving ahead: Amy Davis, Larry Lynam, Steve Jacobs, Barry Garfinkle, Tim Gillum, Jenna Conroy, Cathy Sands, Tina Tocco, and Wendy Kouba.

There are a number of other friends who have given me advice and encouragement: The Wednesday Night Supper Club members—Tim Scheie, Craig Sellers, Stephen Kennedy, David Higgs, Mark Witteveen, Maura Keefe, Frank Nowak, Paul Muto, Bob Weeden, Jorge Cazzorla, Alan Curle, and Andrew London; also John DeGrandis, Jim Kiselic, Joe DeConstanza, BJ Douglass, Bruce Gorman, Laura Mayer, and Pat Youngdahl.

My brother, David Vesper, has been commenting on the process and encouraging me with his unique, dry sense of humor. And nephew Noah has been watching the past four years from his vantage point of being in—and now graduating—high school.

One disappointment is that my father isn’t able to see this finished thesis, as he died on Christmas Day, 2013, five months before it was completed. He and my mother who
pre-deceased him were always encouraging my brother and me to learn and be the best we could be. I hope I’ve done them proud.

And, there’s one more person who was important in this: Graham Brown, my partner. He gave me the freedom and ongoing encouragement to be involved in this project and supported me with tremendous patience as I read, wrote, and traveled Gray: a very special thank you to you.
### Abbreviations and acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ADDIE</td>
<td>Analysis, design, develop, implement, evaluate</td>
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<td>CMC</td>
<td>Computer mediated communication</td>
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<tr>
<td>DBR</td>
<td>Design-based research</td>
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<td>e-PCCM</td>
<td>e-learning version of Pharmaceutical Cold Chain Management</td>
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<td>FMEA</td>
<td>Failure mode effects analysis</td>
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<td>FTA</td>
<td>Fault tree analysis</td>
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<td>GDP</td>
<td>Good distribution practice requirements</td>
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<td>GLO</td>
<td>Global Learning Opportunities</td>
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<td>GMP</td>
<td>Good manufacturing practice requirements</td>
</tr>
<tr>
<td>GSP</td>
<td>Good storage practice requirements</td>
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<tr>
<td>HACCP</td>
<td>Hazard analysis and critical control points</td>
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<td>ICT</td>
<td>Information and communication technology</td>
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<td>MOOC</td>
<td>Massive online open course</td>
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<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<tr>
<td>OOS</td>
<td>Out-of-specification (test result)</td>
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<tr>
<td>PCCMoW</td>
<td>Pharmaceutical Cold Chain Management on Wheels (“the bus course”)</td>
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<td>PRA</td>
<td>Preliminary risk assessment</td>
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<tr>
<td>RA/RM</td>
<td>Risk assessment and risk management</td>
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<tr>
<td>SEARO</td>
<td>Southeast Asia Regional Office (of WHO)</td>
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<td>SME</td>
<td>Subject matter expert</td>
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<tr>
<td>SMS</td>
<td>Simple messaging system (text messages)</td>
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<td>TTSPP</td>
<td>Time- and temperature-sensitive pharmaceutical products</td>
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<td>USP</td>
<td>United States Pharmacopeia</td>
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<tr>
<td>VVM</td>
<td>Vaccine vial monitors</td>
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<td>WHO</td>
<td>World Health Organization</td>
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CHAPTER 1

Introduction and background to the study

Whether it is called e-learning, online learning, or web-based learning (Moore, Dickson-Deane, & Galyen, 2011), the use of computer applications to support distance learning is having a major impact on how education and training is delivered now more than ever. Although the use of computers and other technologies to support learning at a distance has a history going back nearly fifty years within the higher education sector (Kearsley, 2005), these developments have not captured the attention of the world until very recently when large-scale enterprises such as Coursera, edX, and Udacity began offering courses taught by prominent scholars from prestigious universities (e.g., Harvard, M.I.T, and Stanford) through massive open online courses or MOOCs (Karsenti, 2013). As further evidence of the expanding attention to online education in academe, the M.I.T. Review proclaimed that the MOOC was the most important educational technology of the last 200 years (Regalado, 2012), and shortly thereafter the New York Times described 2012 as “The Year of the MOOC” (Pappano, 2012).

Online education is also increasingly prevalent in the K-12 education sector as evidenced by growth of virtual schooling around the world (Barbour & Reeves, 2009). In the USA, many individual states have set up their own virtual schools while at the same time for-profit enterprises such as K-12.com seek national and even international clients (Barbour, 2013).

In professional environments as well, e-learning has become more commonplace. A recent survey conducted by the American Society for Training and Development (Miller, 2012) reported that 39-50 percent of corporate learning content was delivered using technology-based tools which included e-learning courses and web-based seminars. Various forms of e-learning are increasingly utilized for military training
E-learning offers a number of benefits. Clark and Mayer (2008) described benefits in the areas of feedback, dynamic adjustment of instruction based on learner responses, and games and simulations. Concannon, Flynn, and Campbell (2005) outlined the opportunity to students of easy access to resources and study materials. McKimm, Jollie and Cantillon (2003) highlighted benefits of e-learning to the learner and environment, including 24/7 and global availability, consistent delivery of content, reduced (or no) travel costs, reduced environmental impact, and an approach that supports independent and active learning.

Notwithstanding these advantages and benefits, e-learning is often poorly designed (Allen, 2007), and even when it is well-designed, e-learning may not match the needs of every learner. Online learners frequently feel isolated (Lehman, 2010) or engage in procrastination and other dysfunctional behaviors that limit learning and foster attrition (Michinov, Brunot, Le Bohec, Juhel, & Delaval, 2011). Many learners find that the group work and collaboration required in online learning environments is very difficult, and “divide and conquer” cooperation is often adopted by online learners rather than true collaboration (Oh, 2011). Park and Wentling (2007) found that anxiety about using computers can reduce the transfer of learning to the job.

As with so many educational technology innovations in the past, much of the research on online learning has been focused on the question of whether online learning is as effective as traditional classroom instruction (Clark, 2012). Meta-analyses of these types of comparative media studies (online versus classroom) consistently show a lack of significant differences in outcomes (Hattie, 2009; Means, Toyama, Murphy, Bakia, & Jones, 2010; Tallent-Runnels, Thomas, Lan, Ahern, Shaw, & Liu, 2006).

Clark (2012) concluded that it is the instructional methods (e.g., direct instruction model versus an authentic learning model) that directly affect learning rather than the media or technology (e.g., classroom versus online) that are used. Clark recommended
focusing research on variables other than learning such as costs and efficiency. However, if it is methods that really make the difference in learning outcomes, a question arises concerning whether a learning model, for example experiential learning (Kolb, 1984) that is widely recognized as effective in traditional classrooms could be instantiated in electronic media and with what effects. This study examines how an experiential learning environment instantiated in the “real world” (Vesper, Karçãoğlu, Bishara, & Reeves, 2010) can be replicated in the online world with equal or enhanced outcomes.

The research need and background

With the increasing development of biotech medicines and the growing introduction of new vaccines, there is a greater concern in how time- and temperature-sensitive pharmaceutical products (TTSPP) are stored, transported, and distributed to the end users (Milstien, Karçãoğlu, & Zaffran, 2006). Today’s cold chain accommodates TTSPPs with different characteristics; all being sensitive to high temperatures, and some being highly sensitive to freezing. High temperature impact on these products is cumulative, and may damage the product when it reaches unacceptable levels. Freezing of freeze-sensitive TTSPPs result in damaging the physical structure of the product, and rendering it inactive (Kurzątkowski, Karçãoğlu, Staniszewska, Górska, Krause, & Wysocki, 2013). There are individual and public health risks involved with the exposure of TTSPPs to unacceptable temperatures. For example, a person’s diabetes may not be controlled if they use insulin that has been frozen; or a national immunization campaign may at the very least waste time and money or, in the worst case, result in illness and even death if frozen vaccines are used (Edstam, Dulmaa, Tsendjav, Dambasuren, & Densmaa, 2004; Ewbank & Gribble, 1993).

There can also be high financial costs if pharmaceutical products are exposed to temperatures beyond their specifications. For example, a shipping company recently had to pay a US $10 million claim when insulin (a temperature-sensitive protein) was exposed to freezing temperatures (Loh, 2009).

Beyond the requirements that most countries have that cover the manufacturing and testing of all pharmaceutical products known as Good Manufacturing Practices (GMPs)
are additional legal requirements for the distribution and handling of TTSPPs known as Good Distribution Practices (GDPs) (USP, 2013a, 2013b; WHO, 2010, 2011). These requirements mandate that personnel who handle and distribute pharmaceutical products have the education, training, and experience enabling them to effectively perform their jobs (Vesper, 2001).

**Preventing damage to time and temperature sensitive medicines**

To meet the challenge of ensuring that pharmaceuticals are not subject to temperature and handling abuse, a *cold chain* is designed and implemented as an integrated system of equipment (e.g., shipping containers, refrigerators, trucks), procedures, records, and activities used to handle, store, transport, distribute, and monitor time-temperature sensitive products (Afsar & Kartoğlu, 2006; Taylor, 2001). The allusion to a chain is very apt: as with a physical chain, a cold chain is only as strong as its weakest link.

People are a critical element of a cold chain. For example, logistics specialists must specify shipping containers and temperature control systems so products stay at the right temperature, air cargo personnel must not leave containers on a hot tarmac, medical center managers need to identify the potential risks to their storage facilities should the power fail and there is no automatic back-up generator, pharmacists need to communicate to their customers how to take special care with temperature-sensitive products, and those involved in transportation and distribution must correctly execute procedures and take appropriate actions in the event of a problem. Beyond the people directly involved in the cold chain are those who design shipping containers and develop monitoring devices to track the temperatures that the pharmaceuticals are exposed to. Every person involved in the transportation and storage of pharmaceutical products requires the appropriate knowledge and skills so they can perform their jobs and efficiently solve problems.

Training, performance support, and job aids are among the strategies that have been applied to ameliorate problems with the cold chain for temperature sensitive pharmaceuticals. Training is used widely, but the quality and effectiveness of cold chain training varies widely. Tools intended to support performance such as written
procedures and job aids have limited effectiveness because users often do not understand the underlying goals and the basic scientific and regulatory rationales for requirements.

**The problem that the research addresses**

Because of its international scope and work in the area of vaccines, the World Health Organization’s Global Learning Opportunities for Vaccine Quality (WHO GLO) (previously called Global Training Network) recognized the need to develop the knowledge and skills of those involved in the pharmaceutical cold chain. Specifically, WHO GLO strives to meet the challenge of providing engaging learning events for public health officials, manufacturers, healthcare providers, regulators, and other partners in the supply chain of temperature-sensitive products so they can critically evaluate a pharmaceutical cold chain system to assure the quality, purity, safety, and efficacy of the pharmaceutical product to the patients.

In the context of handling TTSP, those involved need to know more than just the rules and requirements of national authorities. Rather, people must be able to apply those requirements and solve sometimes very complicated, conflict-filled problems in a way that is consistent with cold chain requirements best-of-industry practices. They need to have the cognitive skills to flexibly and critically evaluate various options, including identifying potential risks and ways to control and mitigate them. This type of higher-level thinking is illustrated in the upper-levels of Bloom’s Taxonomy (Bloom & Krathwohl, 1956) and its more recent interpretations (Anderson & Krathwohl, 2001).

**An e-learning solution**

To meet this need of developing the knowledge and skills of those involved in handling TTSP, the WHO GLO developed a unique training course, *Pharmaceutical Cold Chain Management on Wheels* (PCCMoW or sometimes referred to as the bus course), that regularly takes 15 carefully selected participants on a six-day bus trip in Turkey where they can make direct observations of the storage, warehousing, distribution and health care facilities, while travelling with mentors down the length of the cold chain (Vesper, et al., 2010). Throughout the course, guided observation exercises take place at the visited facilities. Participants are provided with notes and tools to support their
critical observations as they interact with operational staff and management at various facilities. Presentations and group discussions take place on the bus, in cafes and restaurants, and in open spaces before and after the visits to the facilities. Turkey was selected as the course venue, in part, because of the cultural practice of hospitality, the availability of a complete cold chain operation within a relatively small geographic region, and the availability of a local tour coordinator who could help with the logistics and extensive planning required (WHO, 2005, 2008; WHO Global Training Network on Vaccine Quality, 2009).

Approximately 90 people have participated in the PCCMoW course at the time of this thesis—a very small number compared to the tens of thousands of people world-wide who could benefit from gaining expertise in this field. This sentiment was stated at a WHO conference in Antalya, Turkey, in February 2009 when, after viewing a video about the bus course (WHO, 2008), a WHO official said, “That looks very nice, but I have tens-of-thousands of people who need this training. What can you do to help me?” (Vesper, personal recollection).

The idea for an e-learning version of the bus course grew out of conversations between Dr. Umit Kartoglu, the creator and sponsor of the bus course, and Dr. Thomas C. Reeves, an educational consultant to WHO (and co-supervisor of this research). In a videotaped conversation in February 2013, they reflected on the possibilities of widely distributing the learning experience by using computer technology. Dr. Kartoglu described the initial discussions when Dr. Reeves visited WHO headquarters in Geneva and watched a video of the course:

We start to discussing whys and hows…. [Dr Reeves] was explaining why he believed that this would make a very good e-learning course. After these discussions, I was so much convinced that this should be the first example for global learning opportunities … because we could bring all the authenticity to [it] as Tom was explaining.

Dr. Reeves remembered that moment when he saw the video and what the course included:

Right away, I thought, we could do an experiential learning in an online environment … In this type of course, using the videos, using the real world of experiences, people will vicariously travel. [They] travel down a cold chain through their computer screen. That they can be just as engaged as if they were
on the bus. The whole thing culminates in a real world authentic task. They are helping a real client, with a real task. To me, this just was a natural.

With this need and the confidence that an e-learning course could be a solution, the challenge, then, was to find the best way to fit a bus into computer screen (Kartoğlu, 2013). Were there ways to engage the participants, getting them to work with each other, asking questions of the experienced mentors, and get involved in addressing a real-world challenge—and do these activities virtually, with course participants and mentors spread out around the globe? Could an e-learning course provide a learning environment as rich as the sites visited in Turkey?

The ‘virtual’ challenge

Answering the challenge required more than a team of subject matter experts, visual designers, and programmers. How the course was to be designed, produced, and implemented required a foundation of accepted adult learning theories or perspectives. To that end, three particular theories and approaches were selected to inform the approach. Table 1.1 identifies the three theories together with the reasoning behind their selection.

<table>
<thead>
<tr>
<th>Learning theory</th>
<th>Rationale for inclusion</th>
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<tr>
<td>Cognitive apprenticeship</td>
<td>A pragmatic theory of how knowledge, skills, and expertise are acquired by the learner, who is involved in activities relevant to the trade or profession. The learner is guided by a mentor who has a higher level of expertise and is able to guide the interactions of participants and the structuring of activities.</td>
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<tr>
<td>Authentic learning</td>
<td>A pragmatic approach that incorporates the environment, tasks, and assessments that are appropriate to the knowledge and skill domain to be acquired by the learner. This type of hands-on approach will be used in designing cases, activities, and projects for the learners.</td>
</tr>
<tr>
<td>Community of learners</td>
<td>A theory of how learners form formal and informal groups that foster learning. This will be used as teams are set up, coached, and monitored throughout the e-learning course in order to provide a safe and effective learning situation.</td>
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Anticipated benefits and value of this project

While the intensive experience of the Pharmaceutical Cold Chain Management on Wheels (PCCMoW) is very effective for a small group, providing a technology-based learning opportunity for larger numbers of people would strengthen the effectiveness of the cold chain and contribute to positive public health outcomes. This project
anticipated providing educational benefits to the users of the learning solution, and, if successful in the long-term, would result in health benefits for those who would use TTSP. The benefits for learners would include:

- being actively engaged in the learning process with mentors and other participants,
- acquiring insights into how experts make judgments and decisions,
- experiencing a very different approach to learning (i.e., authentic tasks and communities of practice) and identifying opportunities where they could apply these models in their own practices, and
- building relationships with other participants and mentors that would contribute to a vibrant and productive ongoing community of practice.

**Research questions**

In the process of creating an e-learning solution that was designed to meet the needs described earlier in this chapter, there were several opportunities that presented themselves for further inquiry. Specifically, the following research question was explored and answered during this research project:

- In what ways can a technology-based e-learning solution be used to facilitate the development of expertise of those involved in the distribution and handling of time- and temperature-sensitive pharmaceutical products?

Three secondary questions helped address the overall problem area identified in the primary question:

- What are the factors that enable a technology-based e-learning solution and the affordances the technology provides, to “mirror” an existing, experiential learning event and potentially improve on that event?
- In what ways can a community of learners be established and enhanced when the participants are in different physical locations and of different cultures?
• How did e-learning course participants respond to cognitive apprenticeship and authentic learning tasks which were intended to develop their expertise?

Organization of the thesis

This section describes the organization of the thesis and the layout of the chapters. Because of the design-based research (DBR) approach, the substantive description of the study begins with the methodology rather than the literature review. This is because an important element of the DBR approach includes the development of design principles to guide the development of the learning solution (or intervention). Draft design principles are derived from the literature review, so a clear explanation of the process is required from the start.

Thus, in Chapter 2, the Research Approach (or methodology), examines the design-based research model on which this study was structured. Here, design-based research is described—what it is and why it was appropriate for use in this study. Design-based research uses iterations of formative evaluation to refine the innovative intervention (i.e., the e-learning solution) and to identify reusable design principles that might be applied to similar problems. These are discussed and supported with key references. This chapter delineates the conduct of the study, and how the data were collected and analyzed.

Chapter 3, the Literature Review, examines the concept of expertise—what it is and how one acquires it, along with an in-depth review of three relevant pedagogical theories that guided the development of the e-learning solution: cognitive apprenticeship, community of learners, and authentic learning.

Chapter 4 identifies the Draft Design Principles derived from the literature review. Fourteen draft design principles based on the theories of cognitive apprenticeship, community of learners, and authentic learning are identified. How these draft design principles were incorporated into the e-learning project is also be examined.

Chapter 5 describes The Solution in the form of a virtual bus tour. The chapter provides detail of the design and development of several iterations of the e-learning solution,
based on the initial design principles, and subsequently improved using data supplied by three formative evaluations.

Chapter 6, *Formative Evaluation 1: Expert Review*, presents the first iteration of the virtual bas tour and the formative evaluation that was performed by three experts: two instructional designers and one graphics/visual designer. The method and tools used in this formative evaluation are discussed as well as the outcome of the reviews.

Chapter 7, *Formative Evaluation 2: Mentor Evaluation*, describes the findings of a walk-through of the e-learning course by those who would be mentors (i.e., facilitators) in a field trial of the prototype e-learning solution course. In this round of formative evaluation, a formal risk assessment was created and used to identify what could go wrong, the potential impact and likelihood that it would happen, and ways to control and/or mitigate that risk.

Chapter 8, *Formative Evaluation 3: Field Trial*, presents the findings of the implementation of the prototype e-learning solution with a group of participants, selected in part because they had been on a previous Pharmaceutical Cold Chain Management on Wheels (also known as “the bus course”). During the 12-week field trial, data were collected and analyzed from surveys, diary entries, and teleconference calls. From this analysis, a number of recommendations for improvement were made that were incorporated into the next implementation of the e-learning course.

In Chapter 9, *Reflection and Revised Design Principles*, discusses what was learned in the three iterations of design, development and formative evaluation and broadens its application to other potential e-learning projects.

Chapter 10, the *Conclusion*, summarizes the research study, addresses and discusses the primary research question, lists the final set of 13 design principles, identifies the limitations of the study and implications for practice, and describes opportunities for further research.
As the study proceeded, several chapters, or parts of them, were presented at conferences or published in proceedings to obtain feedback and peer review. A list of publications is provided in Appendix 1.
CHAPTER 2

Research approach

Introduction
Research can be accomplished using a variety of methods both systemic and analytic (Salomon, 1991). Patient and perceptive observers can discover a phenomenon like a quasar never before identified, or a bird previously thought to be extinct. From astronomers to zoologists, scientists design experiments to reveal new knowledge or compare the effectiveness of one treatment to another. Similarly, literature reviews provide in-depth analyses of published research around a specific topic, while case studies enable “analyses of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods” (Thomas, 2011, p. 23).

In educational research, there is another approach—design-based research—that has gained wide acceptance over the last decade (Anderson & Shattuck, 2012), and is the method that is used in this study. The characteristics, advantages, and rationale of why design-based research (DBR) was selected to guide the inquiry are discussed in this chapter, together with a description of the research methodology as conducted in the study. Because the literature review is integral to the design-based research method, it follows—rather than precedes—this chapter.

One approach to research: Case control studies
In order to move a drug (medicinal) product from laboratory discovery to patient use, case control studies are used. Such an approach has the candidate drug moving through very specific stages of testing as researchers collect data on its safety and effectiveness, while at the same time, trying to minimize risk to those taking part in the trials.
For example, during pharmaceutical development, Phase I testing is conducted with a small number of patients (n=20 to 100) under very highly controlled conditions to determine safety and metabolism mechanisms. Prior to Phase I studies there are a number of in-vitro (non-animal) and in-vivo (animal) studies that help researchers to understand how the drug candidate works and enable them to predict risks to humans. If the Phase I studies are successful, Phase II studies are performed with more patients (n=100 to 500) who have the disease or condition to be treated. If safety and effectiveness are demonstrated, a Phase III study is performed using 1000-5000 patients, or even more. For example, a recent rotavirus vaccine study had 70,000 study subjects (WHO, 2007). Usually, such studies are designed to compare the test drug (an “intervention”) with a placebo (a sugar tablet or an injection of sterile saline), or with an existing treatment for the disease or condition (the “comparator drug”). To reduce bias in the studies, study subjects are randomly assigned to be administered the test drug, or the placebo or alternative treatment. Additionally, the tests are blinded so the study subjects do not know if they are receiving the test drug or the comparator. Often these studies are double-blinded so neither the study subjects nor the health-care providers know if the test article given to patients is the test drug or the comparator (PhRMA, 2007).

Randomized controlled experimental studies have been considered by many to be the “gold standard” in medical research (Grady, 2008) so why not use them in studying educational interventions and solutions as some have suggested?

Use of case controlled studies in educational research

A strong advocate for the use of rigorous experimental studies in education (similar to controlled clinical trials) is Slavin (2002). Although he acknowledges the difficulties and challenges in these experiments—such as finding study subjects (i.e., teachers, classrooms, schools), the costs of conducting such large-scale studies, and inducing participation—Slavin (2008) insists that these well-designed experimental studies are needed when making decisions about educational programs and policies. He states:

The evidence to date suggests that quasi-experimental studies in which experimental and control groups are well matched, and in which covariates that
correlate strongly with pretests (e.g., achievement pretests) are used to adjust outcomes, produce good, if not perfect, estimates of program outcomes, as long as there are no possibilities of selection bias at the individual student level. (Slavin, 2008, p. 5)

**Questioning the appropriateness of case-controlled studies in educational research**

While few would disagree with Slavin (2008) on some of his points, such as the urgent need for quality research (Sloane, 2008), there continues to be debate on Slavin’s insistence of randomized experimental trials (Reeves, 2006a). For example, while Slavin puts an emphasis on the clinical testing model, he equates it inappropriately to the entire drug discovery and development process. Contrary to Slavin’s assumptions, in discovery and early development, the emphasis is on understanding the safety of the drug and the principles and mechanism (the why and the how, respectively) of the treatment, not on how well it works compared to a placebo or an alternative method (Sloane, 2008).

Researchers conducting case-controlled experiments are looking to discover or confirm causal relationships (Slavin, 2002), or to test theories (Walker, 2006), whereas those wanting to solve problems and contribute to theory development (McKenney & Reeves, 2012) can use a different way: design-based research. This is an applied research approach, putting the researcher in a role analogous to an engineer (Barab & Squire, 2004). As a founder of the study of aeronautics put it, “Scientists discover the world that exists; engineers create the world that never was” (von Karman, 1994).

There are other criticisms of clinical-trial like experiments—some of which Slavin himself makes: the costs involved, the time required, having adequate controls/comparators, and the number of participants needed. In educational research, there are additional limitations, such as not being able to disguise the treatment from the comparator—teachers and learners may be able to see what is being “tested.” This can also lead to the Hawthorne effect where any change can result in a difference (Olson, 2004). Olson also points out that new ideas that might show benefits during a study may have different results when “implemented under constraints of a fixed set of goals and common criteria for achievement” (p. 24).
Finally, even in medical literature, there is a growing discontentment with randomized clinical trials and how they have been used in clinical research. Ioannidis (2005) examined 49 highly-cited clinical trials and concluded that when there was a small number of subjects, subsequent studies show quite different effects. Others have called this the “evaporation effect”—when the results using a small number of carefully selected study subjects disappear or are less impactful than when a larger number of more heterogeneous subjects use the drug (Leaf, 2013).

**A better alternative: design-based research**

If randomized case-controlled experimental studies used in predictive research are not the most appropriate approach in the educational field, what are other viable options? One that is recommended in constructing and evaluating authentic learning environments is design-based research (Herrington, Reeves, & Oliver, 2014).

**Design-based research defined**

What is referred to in this work as design-based research is also known by different names and with subtle variations in how the process is accomplished as noted by Nieveen (2006). These variations include development research, design research, developmental research, educational design research, design experiments, and formative research (cf., McKenney, & Reeves, 2012; Wang & Hannafin, 2005).

As more attention and thought have been given to design-based research, its definition has evolved. Since the concept of design-based research has a range of variations (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006) it requires a broad definition, as given by Barab and Squire (2004) who define design research as “a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings” (p. 2).

Others, such as Wang and Hannafin (2005) define design-based research as “A systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings” (p. 6). McKenney and Reeves (2012) state, “[E]ducational design research... [is] a genre of research in which
the iterative development of solutions to practical and complex problems also provides
the context for empirical investigation, which yields theoretical understanding that can
inform the work of others” (p. 7).

While there may be differences in how design-based research is defined, its key
approach and its characteristics can be extracted from the literature.

What it is: Characteristics of design-based research
A more comprehensive and richer understanding of design-based research can be
achieved by identifying and describing its characteristics. Wang and Hannafin (2005)
listed and explained five characteristics of design-based research (Table 2.1).

Table 2.1. Wang and Hannafin’s (2005) Characteristics of Design-Based Research

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Summarized explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pragmatic</td>
<td>There is a practical, as well as theoretical intent in what is being done.</td>
</tr>
<tr>
<td>Grounded</td>
<td>The research is based on theories, work done by others, and real-world contexts.</td>
</tr>
<tr>
<td>Interactive, iterative, and flexible</td>
<td>The research and the learning solution that is created is based on a dynamic collaboration with the participants (learners), key stakeholders (sponsors and developers), and researchers; the research has the intent of collecting information and using “lessons learned” in making revisions and improvements in subsequent versions of the solution.</td>
</tr>
<tr>
<td>Integrative</td>
<td>A variety of different approaches are used in acquiring information at various points in the design, development, and implementation stages that, together, provide a much richer understanding of the created learning solution.</td>
</tr>
<tr>
<td>Contextual</td>
<td>All steps of the research as well as the design, development, and implementation stages are documented; reflection on what has been learned helps to make the research applicable to other situations and broader contexts.</td>
</tr>
</tbody>
</table>

Herrington, Reeves, and Oliver (2010, p. 176; Reeves, Herrington, & Oliver, 2005)
expanded further on these characteristics. To them, design-based research
• focuses on broad-based complex educational problems
• requires collaboration between researchers and those directly involved in the
  problem of interest
• integrates known and hypothetical design principles and technology in achieving
  a solution
• utilizes rigorous and reflective inquiry to test and refine innovative learning designs and identify new design principles
• involves improvement of the design through evaluation
• contributes to both theoretical understanding while solving real-world problems.

From these definitions and the characteristics, design-based research
• is practical and pragmatic – a useful solution or artifact is produced
• is goal-oriented – it is meant to solve a real problem and have a benefit
• does not happen all at one time – there is more than one “cycle” as the learning solution is developed, implemented, tested, and refined
• contributes to theories (usually in the form of design principles) from which others will benefit.

Nieveen (2006) further identified two key applications of design-based research, one being validation studies that are intended to prove or disprove particular learning theories and the other being development studies that are used in addressing a particular educational need. The design-based research project described here is aligned with development studies.

How design-based research was used to gather data to address the research questions (provided in Chapter 1) is presented in the following section.

**How design-based research was used in this research**

Reeves (2006a) illustrated how design-based research can be accomplished using a four-phase model (Figure 2.1).

![Figure 2.1. Four-phased design research model (Reeves, 2006, p. 59)](image)
While the model shows that development of the learning solution generally proceeds from left to right with the refinement of the solution started when the first two phases are completed, there can be smaller iterations within and between the phases as information is acquired. McKenney and Reeves (2012) incorporated this into a more recently published model as shown in Figure 2.2.

![Generic Model for Conducting Educational Design Research](image)

**Figure 2.2.** McKenney and Reeves’ Generic Model for Conducting Educational Design Research (2012, p. 77)

The pattern of iterations used in this research is illustrated in summary form in Figure 2.3, showing overlapping activities and smaller iterations between the major phases.
The next sections present a description of key research activities (arranged chronologically with activities numbered 1 to 22 as shown in Figure 2.3) that correspond with the four phases of Reeves’ (2006a) design-based research model.

**Phase 1: Analysis of practical problem by researchers and practitioners in collaboration**

**Purpose of Phase 1**

Design-based research is intended to be problem-focused (Herrington, et al., 2010) so it is important to have a thorough understanding of the problem: what it is, why it exists, what knowledge, skills, and other types of supports are needed to solve the problem, how people will use the knowledge and skills, and expectations that stakeholders (including the learners) have of the learning solution. From this information, the goals of the learning solution can be developed.

The analysis is performed by the researcher(s) and practitioners—those who have knowledge and expertise related to the problem—working together. In their description of the first phase of design-based research, McKenney and Reeves (2012) call this phase “exploration” (p. 85), a word that connotes discovery, diligent investigation, and
activity. Exploration could include visits to the field where the action is happening, literature surveys, discussions with other professionals or experts, and observation. The authors also recommended that the analysis be done at different points throughout the research project to identify what is new or what might be viewed as having increased relevance.

**Chronology of Phase 1 activities (analysis of the problem)**

**January 2009 – Impetus for the course (1) (Refer Fig. 2.3)**

At a meeting of stakeholders (including the World Health Organization (WHO) scientist who would later become the project sponsor, the learning consultant, and the researcher) in Antalya, Turkey, a comment was made by a representative of WHO’s Southeast Asian Regional Office (SEARO) about the need to expand training on handling of time and temperature products beyond what was being done at the time. Specifically, the existing learning opportunities were limited to 15 people per year who attended the *Pharmaceutical Cold Chain Management Course on Wheels* (PCCMoW) courses given in Turkey. At the end of this meeting, the researcher was asked to participate in the PCCMoW course in June, 2009 with the purpose of being a facilitator (or mentor), becoming familiar with the content, instructional methods, and the experiences of typical participants, in order to develop expertise in handling time- and temperature-sensitive pharmaceutical products (TTSP).

**June 2009 – Participation in first wheels course (2)**

While participating as a mentor in an actual PCCMoW, the researcher became more knowledgeable on the issues. This came about from visiting facilities where TTSP were stored, distributed from, or used, by talking to practitioners (i.e., the other mentors and participants) and learning more about the knowledge and skills important to them.

**July 2009 - March 2010 – Initiation of research project (3)**

Informal discussions continued about the potential of an e-learning alternative to the physical *Pharmaceutical Cold Chain Management Course on Wheels* course. The decision was made on the part of the researcher to use this project as the basis for a doctoral degree in education. Factors that were present that provided an appropriate setting for this research included a cross-functional team of professionals who could
execute the project, funding for the project’s completion, and the ability of the research
to influence the design, development, and implementation of the e-learning solution.

**JUNE 2010 – BECOMING MORE IMMERSED IN THE CONTENT AND LITERATURE (4)**
The researcher participated in a second physical *Pharmaceutical Cold Chain
Management Course on Wheels* course in Turkey with the specific purpose of
identifying ways the whole experience—not solely the content—could be made
available for larger numbers of people, using web-based technology. Plans were made
to have an initial meeting of key people (project sponsor, design director, learning
consultant, and researcher). Additionally during this time, the researcher conducted an
initial literature review that was used to better understand the theoretical foundations for
the undertaking.

**SEPTEMBER 2010 – FIRST MEETING OF DESIGN TEAM (5)**
A daylong meeting was held in Antalya, Turkey with the project sponsor, design
director, learning consultant, and researcher to brainstorm what a virtual course might
look like. Course goals were created and learning objectives of the existing physical bus
course were revised so they would be more applicable to a virtual course (see Appendix
2). Different instructional models and technological/delivery options were examined
with the decision to move forward with a web-based delivery that was similar to a post-
graduate online course that involved geographically dispersed learning groups. Also, the
project team decided that a major component of this learning solution would include an
authentic learning activity (Herrington, et al., 2010) (see Chapter 3–Literature Review
for a discussion on authentic learning).

**OCTOBER 2010 - JUNE 2011 – FURTHER ANALYSIS (6)**
Throughout this initial period, the design team members met or used Skype to discuss
content, instructional approaches, and technological issues critical to the success of the
learning solution. At a February 2011 meeting, the design team and course facilitators
discussed ways to assess the learners’ knowledge to determine if the learning solution
had a positive impact.

By the end of the Phase 1 investigation, the problem had been identified, practitioners
had been consulted, the theoretical foundations for a solution were identified, and the
design team began with a common understanding of the overall plan. In the next section, activities associated with design-based research Phase 2 are described in more detail.

**Phase 2: Development of solutions informed by existing design principles and innovations of technology**

**Purpose of Phase 2**

In this phase, a more extensive literature review was performed that went beyond the initial exploration conducted in Phase 1. This literature review was intended to more deeply research relevant studies to develop draft design principles that could be used and operationalized in the prototype solution to the problem described in Phase 1, thereby providing the grounding-in-theory offered by Wang and Hannafin (2005). Reeves (2006) suggested that technological affordances—described as “the perceived and actual fundamental purposes of a thing that determines how the thing can be possibly used” (Kirschner, Strijbos, Kreijns, & Beers, 2004, p. 49)—be considered during this second phase.

A set of requirements was developed based on several factors including the defined problem, the draft design principles, and an understanding of the potential tools and technologies that could deliver the learning solution. From this, an iterative process of creative design was begun. Rough sketches, drawings, prototypes, and models were created and informally and formally critiqued (see Phase 3) so that what was being proposed in the design met the requirements, embraced the draft design principles, and accomplished the goal of the project.

**Chronology of Phase 2 activities (development of the solution)**

**APRIL–DECEMBER 2010 – IDENTIFICATION OF KEY LEARNING THEORIES AND DESIGN PRINCIPLES (7)**

The researcher began an in-depth literature review of three areas of particular theoretical interest that would inform the design of the learning solution, specifically

- cognitive apprenticeship
- authentic learning
- community of learners.
From these three learning theories, draft design principles were developed and their meanings explored. The initial design principles were presented and discussed with the design team as important components to include in the learning solution. During this time, the project sponsor and design director continued to discuss and sketch out visual approaches for the web pages and for presenting the information. They also identified the requirements that the ideal learning and technology (delivery) solution would include. These were discussed with potential developers and a web developer was identified and commissioned to start work on the project. A detailed sequenced course outline with topics was prepared and provided to the developer.

**JANUARY - JUNE 2011 – CREATION OF SKETCHES AND OUTLINES (8)**
The development team (including the researcher, project sponsor, design director and programmer) worked on creating the illustrations, user interfaces, and modules that would be included in the learning solution. Subject matter experts (including the researcher) contributed and reviewed content (lessons or modules they found or had written), case studies, scenarios based on actual events, and learning activities. By June, enough material (e.g., sketches of screens, requirements documents for how screens would work, detailed outline of course modules) had been developed to allow for the first formative evaluation of what is now called “Version A” of the e-learning course.

**JANUARY - DECEMBER 2011 – CONTINUED INVESTIGATION OF DESIGN PRINCIPLES (9)**
The researcher continued the more intensive and extensive literature review (Chapter 3–Literature Review) towards developing a more complete set of initial design principles, and explored specific ways the design principles would be included in the learning solution (Chapter 4–Design Principles). These were discussed with the design team members throughout the year.

**JUNE 2011 - APRIL 2012 – DELAYS IN DEVELOPMENT (10)**
Development of Version A was taking longer than planned because certain initial requirements proved difficult to accomplish. For example, the development team wanted a fully integrated self-sufficient web-based solution that could be used without additional applications or tools like Skype or Microsoft Word. Despite repeated attempts by the design director and project sponsor to support the developer to complete
the version as required, it became apparent that a different development approach was required. This caused long delays in the development of the program. Nevertheless, during this delay, other course elements such as short video lectures, animations, activities, and exercises were being completed.

**MAY - JULY 2012 – CONSIDERATION OF MOODLE (11)**

An alternative approach was discussed by the design team, specifically to move away from the unique, custom-developed web-based solution to a learning solution that could be optimized for Moodle, an open-source course management system/virtual learning environment. WHO had an installed instance in Moodle and, within some groups, had experience in using it. The project sponsor and design director, along with WHO’s Information Technology staff developed a trial site (now called “Version B”) that was evaluated by the design team.

**AUGUST 2012 – ELIMINATION OF MOODLE AS A SOLUTION (12)**

Because of difficulties with Moodle’s display of certain learning materials (particularly videos), internal server/security issues, and the compromised ways in which instructional activities and resources were displayed, the project sponsor and learning consultant began looking for yet another alternative solution. Meanwhile, other members of the development team continued to complete additional course elements that were independent of the delivery platform.

**OCTOBER 2012 – FEBRUARY 2013 – NEW DEVELOPER BEGINS WORK (13)**

A new developer was engaged to create a web-based interface and structure to provide access to the course materials. Since 2010, when the original requirements for the learning solution were developed, other free, “cloud”-based applications like Google Drive had become widely available and could be incorporated into the overall learning solution without the need for custom development. This effort became known as “Version C”.

By the end of Phase 2, development of the learning solution was underway using the design plan that resulted from Phase I. During Phase 2 different versions of the learning solution were produced and each subjected to testing and refinement. These formative
evaluation activities that are conducted in design-based research Phase 3 are described in the next section.

**Phase 3: Iterative testing and refinement of solutions in practice**

**Purpose of Phase 3**

Phase 3 of design-based research typically implements and tests—or more precisely, evaluates—an intervention working prototype. In a design-based research context, evaluation “provides information to make decisions about a product or process that is being investigated” (Phillips, McNaught, & Kennedy, 2012, p. 15). Evaluation is often associated with things—systems, programs, courses, materials—in contrast to assessment that has its focus on a learner’s knowledge, skill, or performance (Reeves & Hedberg, 2003). Evaluation is often characterized as being used for formative (i.e., finding ways to improve something) or summative purposes (i.e., making decisions about something’s value) (McKenney & Reeves, 2012). Often, an evaluation will provide information that fits into both of these categories. Other types of evaluation have been described, such as confirmative, meta, goal-based, and goal-free evaluation (Dessinger & Moseley, 2003; Patton, 2002; Scriven, 1991).

If evaluation is driven by the need to make decisions, then questions must be asked and answered in order to have a rational basis for making those decisions (Phillips, et al., 2012; Reeves & Hedberg, 2003). A number of questions can be asked depending on the intended decision to be made, the stage of the life-cycle of the project, the question to be asked, and the intended party that is qualified to answer the question (e.g., participants, supervisors, or facilitators). When using a design-based research approach, it is also important to ask questions to evaluate how theory-based design principles have been incorporated into the learning solution (Weiss, 1992, 2004).

To answer these questions, a variety of methods can be employed that vary in the types of data collected (quantitative, semi-quantitative, or qualitative), technological sophistication, type of researcher/participant contact (e.g., interviews or e-mailed questionnaires), the specific question to answer, and the number of people who would
be contributing data. At different points, the researcher/evaluator needs to ask, “What do we need to know now?” (McKenney & Reeves, 2012, p. 133), and then determine the best way to collect the relevant data. Multiple methods provide a richer understanding but also help to cross-validate the results. (See Data Collection and Analysis below for more detail on this process.) Because learning with others (i.e., social learning) can be probabilistic (Kirschner, et al., 2004), that is, people may learn things that were not part of the initially defined requirements or course outline, evaluation practices should try to go beyond questions of whether stated objectives were achieved to discover the side-effects and unintended consequences (Scriven, 1991).

In planning and documenting the evaluations to be conducted, Reeves and Hedberg (2003) recommended that an evaluation plan be established to integrate the decisions, the questions to be asked, and the methods used to answer the questions. The activities that were implemented in planning and conducting the iterations of formative evaluation are presented below.

**Chronology of Phase 3 activities (iterative testing and refinement of the solution)**

**April - June 2011 – First iteration, expert evaluation (14)**

An initial over-all formative evaluation plan that was consistent with the principles/characteristics of design-based research described earlier in this chapter was created, along with a protocol for the first formative evaluation using experts. This evaluation was completed with a report written submitted to the project sponsor in June 2011. Chapter 6 contains the evaluation protocol, examples of what was examined by the expert evaluation panel, and the results of this first formative evaluation.

**Expert evaluation panel**

For the evaluation, three experts from different fields of expertise were selected by the researcher. Selection criteria included

- training and experience as instructional designers or graphics/interface designers
- experience in a range of e-learning projects
• experience designing and developing e-learning projects used in the life-sciences, particularly in the pharmaceutical/medical device industries and in healthcare delivery.

One expert (pseudonym GD1) chosen was a graphic designer with extensive experience (>20 years) in designing interfaces and the “look and feel” of e-learning programs that have been used by large, international pharmaceutical and medicinal product manufacturers such as The Lonza Group, Pfizer, and the American Red Cross Blood Services. This expert reviewed the overall visual design and the user interface design, but did not comment on the instructional design elements of the course.

Two experienced instructional designers were also used as experts. Each had more than 30 years working as instructional designers producing a variety of learning solutions including those used by BMS, Astra-Zeneca, US Department of Defense, and Pfizer. One of the instructional designers (pseudonym ID1) had developed e-learning courses and simulations which were used to train physicians and military medics. The other instructional designer (pseudonym ID2) also worked in healthcare training settings. The instructional design experts reviewed the user interface and instructional designs, but did not comment on the visual design aspects of the course.

All experts had previous experience with Good Manufacturing Practice (GMP) regulations and requirements, and all primarily worked with adult learners.

**Instrumentation and review criteria**

The three experts conducted their evaluations independently from each other during a four-week period in 2011. Each was provided, via a common web-based file server (DropBox) the same set of materials to review (Version A), including course descriptions, learning objectives, target audience, information on how the course was intended to be implemented, estimated timeframes for activities, sketches of proposed interfaces, and examples of activities. Reviewers reported spending 3-5 hours performing their reviews and completing the protocol/data collection sheets.
Additionally, an evaluation protocol was created and provided for the experts to use in reviewing the design documents. Several attempts were made in developing the protocol. The first version gave relatively little specific guidance to the experts, the intention being that they would look at the materials through the lens of their individual expertise. Testing the protocol revealed that having too little structure did not generate information that was meaningful, useful and comparable. A second, more extensive protocol was created, but it was judged to be too long from a practical point of view. The third and final version had evaluation protocols that covered three sections:

- **overall visual design**—the collection of visual elements such as drawings, photos, formats, arrangements, fonts, type sizes, colors, and symbols used in the learning program
- **interface design**—the methods, mechanisms, and “tools” used by the user to interact with the learning program and control movement through the program
- **instructional design**—the systematic approach using valid learning principles and learning theories, the desired outcomes, and the needs of the learners in order to create the specifications for the learning solution.

Each section of the protocol included a number of specific evaluation criteria that were based on criteria suggested by Reeves and Hedberg (2003), Herrington, Reeves, and Oliver (2010), and Clark and Mayer (2008). Additionally, the course goals and draft design principles were used as further evaluation criteria. The evaluation protocols also included a range of closed- and open-ended options for feedback: rating options; a space for the reviewer to list specific examples, comments, or suggestions; and the reference source of the theoretical basis for each of the criteria. Figure 2.4 shows a small portion of the protocol/data collection sheet used.
The complete protocol/data collection worksheet used in the expert reviews is shown in Appendix 8.

**Data collection and analysis–iteration #1: Expert review**

Data collection proformas were provided to the experts to guide them through their review and collect data. Follow-up informal interviews were conducted to clarify their comments. The data were analyzed qualitatively, themes were identified, and findings were developed to inform the revisions and improvements made to the course prior to Iteration 2.

**JULY 2012 – INDEPENDENT EVALUATION OF MOODLE PROTOTYPE (15)**

An expert evaluation on Version B (the version using Moodle) was conducted by the learning consultant. (This was outside the scope of interest for this doctoral study; however this evaluation had an impact on the direction of the research). In doing this evaluation, the learning consultant determined that due to issues concerning the server and security (because the Moodle instance was housed on secure servers hosted by the WHO), easy integrated access to videos proved difficult. Additionally, the various “stops” on the virtual bus trip and activities were displayed in ways that would make it too cognitively challenging for course participants who were not familiar with Moodle.
or other virtual learning environments. Based on this evaluation, the team decided to look for another delivery option for the course.

**February 2013 - May 2013 – Mentor evaluation (iteration #2) and field testing of prototype (iteration #3) (16, 17)**

With the web-based Version C nearing completion, protocols were developed for two different, additional iterations of formative evaluation:

- **Formative evaluation 2 (Iteration 2)** – Facilitators evaluating a full working version of course, using Version C – alpha (16)
- **Formative evaluation of the prototype course (Iteration 3)** using Version C – beta) (17).

In consultations between the researcher, design team members, and learning consultant, it was determined that these two iterations of formative evaluation, in addition to the previous expert review, would provide enough data to move the e-learning project to an acceptable state for implementation and also meet the needs of the researcher.

**Mentor evaluation, iteration #2 (16)**

This evaluation was conducted in February 2013 and concluded with a report submitted to the project sponsor in late February 2013. Chapter 7 contains the evaluation protocol, examples of what was examined by the expert evaluation panel, and the results of this specific formative evaluation activity.

**Mentor evaluator team**

The evaluation team consisted of five individuals who were chosen by the project sponsor, based on their knowledge, skills, and experience in cold chain activities. Specifically, each member of this team had experience either handling time-temp sensitive pharmaceutical products (TTSPPs) or had worked as mentors in the WHO bus course (WHO, 2008) that was the conceptual model for the e-learning course.

The evaluation team included (in addition to the researcher “JV”) (pseudonyms used):

- “M1” — an architect by education and profession who was involved writing WHO guidelines on handling TTSPPs and evaluating vaccine distribution systems around the world. M1 was a mentor in one of the WHO bus courses.
• “M2” — a packaging engineer with expertise in the transport of TTSPPs. M2 had been a mentor in two WHO bus courses.

• “M3” — the project sponsor from WHO; he has practiced as a public health physician and been involved in the transport and distribution of vaccines for most of his career. M3 originated the WHO bus course and had lead more than five of the bus course trips. M3 was also on the design team for this e-learning course.

• “LC” – pseudonym of the learning consultant from the University of Georgia College of Education with expertise in e-learning and evaluation/assessment. LC had been a member of the design team throughout the design and development of this e-learning course.

All of the evaluation team members had worked with one or more of the team members on previous projects or served together as mentors on the WHO bus courses.

The evaluation process
The evaluation team met together near Atlanta, Georgia, USA, in February 2013 to conduct the evaluation using a six step process:

1. facilitators/mentors completed a pre-session questionnaire
2. project sponsor provided an overview of the e-learning course
3. evaluation team performed a risk analysis of the e-learning course and developed a risk management plan
4. evaluation team went through all sections of the e-learning course in detail raising questions and problems and discussing possible solutions
5. facilitators/mentors agreed upon roles and responsibilities
6. evaluation team prepared a video discussing their process.

1. Pre-session questionnaire
The researcher developed a questionnaire (see Appendix 3) to document and better understand the experience level of the facilitators/mentors regarding e-learning programs and to identify ways to better support them before and during the course. The written responses from the facilitators/mentors were transcribed into an electronic online survey form (in SurveyMonkey) that was used to tabulate the responses. Of particular note was that none of the instructors had facilitated an online course before:
only one of the four had participated in any type of e-learning course. The mentors identified several concerns they had going into this project including internet connectivity and server problems, time management, working with virtual and worldwide groups, and doing something outside of one’s own comfort zone. When asked about ways that their work as mentors could be made more enjoyable or effective, ideas offered included having a facilitator’s guide, frequent teleconferences between mentors, and close collaboration between the mentors. All of these ideas were incorporated into the prototype course.

2. Overview of the e-learning course
The project sponsor led the team through the entire e-learning course with each team member going through the screens on their individual laptops in order for the team to be oriented to the e-learning course and become familiar with its affordances. The evaluators were presented the “big picture” view of the e-learning course and how the course was intended to be implemented.

3. Risk assessment
Having seen the course and understood the implementation plan, the researcher led the evaluation team in a risk assessment to identify potential risks associated with the e-learning course and then to find ways to reduce those risks. The researcher, because of this background and experience in risk assessment and risk management (Vesper, 2006) led and facilitated the exercise. The development of the risk assessment is described in detail in this section below.

4. Detailed review of alpha version
With an understanding of the overall structure of the e-learning course and its risks, the project sponsor took the evaluation team on a detailed walk-through of the course. The intent of this more detailed examination was to

- gain more familiarity with the course
- identify areas for improvement and problem solutions
- discuss expectations for participant-mentor and mentor-mentor communication
- identify other risks or risk-treatment opportunities.

This detailed review was led by the course sponsor who took the reviewers through the course sequentially, covering each virtual visit and task within each visit. Review team members discussed each visit and task so the team had a common understanding of the
goals, the underlying intent, the background or context of the activity, the role of the participants and mentors, and the assignment results that would be expected from the virtual students. Team members brought up suggestions, improvements, corrections, and concerns that were collected by the researcher. From this, a list of solutions and improvements was prepared (Appendix 4), confirmed by the course sponsor and reviewers, and provided to the development team.

5. Defining facilitator/mentor roles and responsibilities
The facilitators/mentors agreed to share the responsibilities of providing support and feedback on various tasks. This was based, in part, on aligning the tasks with the particular expertise of the facilitators/mentors. An assignment sheet was created for use during the field test of the prototype course that identified the primary mentor and a second member who would serve as a backup (see Figure 2.5).

<table>
<thead>
<tr>
<th>Section/site</th>
<th>Task</th>
<th>Primary mentor</th>
<th>Support mentor</th>
<th>Group feedback due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-course</td>
<td>Exploration of course website (public/password protected)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Pre-course</td>
<td>Google Doc setup</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Farmalojistik</td>
<td>Steps 1-3 – Objectives, video tour, 360 degree photos</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Step 4 – Task: Who am I?</td>
<td>Umit</td>
<td>NA</td>
<td>THU 7 March</td>
</tr>
<tr>
<td></td>
<td>Step 5 – Group Task: Inspecting GDP</td>
<td>Kevin</td>
<td>Andrew</td>
<td>TUE 12 March</td>
</tr>
<tr>
<td></td>
<td>Step 6 – Group Task: Analyzing a temperature excursion</td>
<td>Kevin</td>
<td>Umit</td>
<td>THU 14 March</td>
</tr>
<tr>
<td></td>
<td>Step 7 – Group Task: Quality agreement</td>
<td>Jim</td>
<td>Andrew</td>
<td>MON 18 March</td>
</tr>
<tr>
<td></td>
<td>Step 8 – Group Task: Application of risk assessment</td>
<td>Jim</td>
<td>Umit</td>
<td>FRI 22 March</td>
</tr>
<tr>
<td></td>
<td>Step 9 – Learning diary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2.5. Section of leader assignment sheet used during the field test of the prototype e-learning course

Data collection and analysis–iteration #2: Mentor/design team review
Surveys were given to mentors prior to their review of the working “alpha” version of the e-learning course. During the course of the review, a list of items that required modifications was generated and provided to the development team for implementation. In addition, a risk assessment was conducted using an accepted method of a preliminary
risk assessment. At the end of their review, the mentors and design team members were interviewed by the researcher. The interviews were recorded on video and transcribed for analysis. An inductive, open-coding analysis was conducted of the transcripts to identify implications for refining the e-learning program (Merriam, 2002; Thomas, 2006).

The results from this formative evaluation were incorporated into the e-learning application. Feedback from the formative evaluation was also incorporated into the implementation plans for the field testing, which is discussed next.

**Field testing evaluation of prototype e-learning solution, iteration #3 (17)**

This evaluation was conducted over a four-month period, from March to June 2013. It concluded with a summary report written and an extensive list of recommendations to enhance the “Version C–beta” course that was used with participants. Chapter 8—Formative Evaluation 3, Field Testing contains the evaluation protocol, results, and recommendations from this field test.

Leading the field test was the project sponsor/course director who was assisted by three mentors (including this researcher); the course director also served as a mentor. Fifteen people were invited by the course director to participate in the field test. The following section provides more information about the mentors and the participants, along with how they were selected to participate.

**The mentors**

In addition to the researcher, three mentors facilitated the field testing of the prototype e-learning course:

- M1: An architect by education and profession who has been involved writing World Health Organization (WHO) guidelines on handling time and temperature sensitive pharmaceutical products (TTSPPs) and evaluating vaccine distribution systems around the world. M1 was a mentor in the 2010 WHO Pharmaceutical Cold Chain Management on Wheels (PCCMoW) bus course (Vesper, et al., 2010; WHO, 2008) and participated in the February formative evaluation involving the design team and mentors (discussed in Chapter 7).
M2: A packaging engineer with expertise in the transport of TTSPPs. M2 was a mentor in the 2010, 2012, and 2013 WHO bus courses; he also participated in the February formative evaluation involving the design team and mentors.

M3: The project sponsor from WHO; he practiced as a public health physician and had been involved in the transport and distribution of vaccines for most of his career. M3 originated the WHO PCCMoW bus course and lead more than five of the trips. M3 was also on the design team for this e-learning course and was the course director (and mentor) for the e-learning course. He participated in the February formative evaluation.

None of the mentors had facilitated an e-learning course previous to this implementation. Throughout the course, the mentors, (and often the learning consultant, LC [pseudonym]), had Skype calls to discuss the progress of the course, issues, potential adjustments to timelines, and the like. An example summary from these calls is found in Appendix 5.

The participants
Fifteen individuals were invited by the course director to participate in the field testing of the prototype e-learning course. Criteria for their inclusion in the field test included their previous participation in a bus course, English-language skills (a pre-requisite in the bus course as well), willingness to complete questionnaires (for this researcher and for the formative evaluation), and agreement to the informed consent document. Additionally, the course director wanted a selection of participants who could “cluster” in several time zones (making group work easier to arrange), be from a mix of industry, non-governmental organizations (NGOs), drug/vaccine national authorities (i.e., national regulatory bodies), and be representative of future learners. Table 2.2 provides more detail on the participants, their nationality, and job functions.

Although 15 participants originally agreed to go through the field testing, nine people completed the course. Four of the initial participants withdrew during the course: the course. “A” and “H” withdrew before the pseudonyms (P1-P13) were assigned; P5 and P10 after. Two other participants (P3 and P6) withdrew but continued as observers, joining in the final evaluations.
Table 2.2. Participants in field test of the prototype e-learning course

<table>
<thead>
<tr>
<th>Initials (Pseudonym)</th>
<th>Country of residence</th>
<th>Job title</th>
<th>Public or private sector</th>
<th>Year of bus course</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>India</td>
<td>Founding Director, cold-chain equipment and products</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>P2</td>
<td>Switzerland</td>
<td>Business Developer, consultant</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>A (withdraw)</td>
<td>Sudan</td>
<td>Medical Director of national immunization program</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P3 (withdraw/observer)</td>
<td>Switzerland</td>
<td>President, firm that makes electronic temperature monitoring equipment</td>
<td>Private</td>
<td>2008</td>
</tr>
<tr>
<td>P4</td>
<td>Switzerland</td>
<td>Scientist, prequalification of vaccines, NGO</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P5 (withdraw)</td>
<td>Indonesia</td>
<td>Inspector, national regulatory authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P6 (withdraw/observer)</td>
<td>Albania</td>
<td>National Immunization Program Manager</td>
<td>Public</td>
<td>2008</td>
</tr>
<tr>
<td>H (withdraw)</td>
<td>Indonesia</td>
<td>Manager, vaccine manufacturer</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P7</td>
<td>Egypt</td>
<td>Inspector-Pharmacist, national regulatory authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P8</td>
<td>Turkey</td>
<td>Managing Director of a pharmaceutical firm</td>
<td>Private</td>
<td>2008</td>
</tr>
<tr>
<td>P9</td>
<td>Egypt</td>
<td>Deputy Manager of cold chain monitoring system, national authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P10 (withdraw)</td>
<td>Netherlands</td>
<td>Quality Assurance Specialist, vaccine manufacturer</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>P11</td>
<td>India</td>
<td>Deputy Manager of vaccine exports, vaccine manufacturer</td>
<td>Private</td>
<td>2009</td>
</tr>
<tr>
<td>P12</td>
<td>China</td>
<td>Deputy Manager, biologics manufacturer</td>
<td>Public</td>
<td>2008</td>
</tr>
<tr>
<td>P13</td>
<td>Swaziland</td>
<td>Logistics Officer, national vaccination program</td>
<td>Public</td>
<td>2012</td>
</tr>
</tbody>
</table>

**Implementation and execution of the field test**

Prior to the official start-date of the course, the course director provided all participants and mentors links and passwords in order to access the password protected e-learning site and shared document (Google Drive) folders. All participants were asked to become familiar with Google Drive as that would be the primary site for sharing of group work and feedback from the mentors.

The field trial of the prototype e-learning course consisted of five “virtual visits” to sites where TTSPPs were handled. At each site, participants—as individuals or in small teams—performed several different tasks that were considered to be authentic and
relevant to that site and the activities typically performed there. As a culminating activity, an expanded authentic task was assigned to teams.

Integrated into the course was an online diary where each participant could reflect on what they learned, ideas, concepts and actions that they could take back and apply, and comments (e.g., observations, suggestions) related to that task. Additionally, a link to an online questionnaire (using SurveyMonkey) for each task was provided in order to collect information pertinent to the formative evaluation of the field-tested course. The course director monitored the diary and questionnaire activity, frequently giving participants reminders to complete them.

**Data collection and analysis—iteration #3: Field test of prototype e-learning course**

Prior to starting the field test of e-learning course, the participants in the course (i.e., the research subjects) were asked to complete a pre-course survey. Participants also completed surveys at the mid-point and conclusion of the course. Data included quantitative measures using Likert scales that were statistically summarized as well qualitative data in the form of answers to open ended questions. At the conclusion of the course, participants, mentors, and the researcher participated in a group discussion by audioconference that was recorded and transcribed. Additionally, diary entries made at the end of each virtual visit (or e-learning module) were collected and examined. Table 2.3 identifies the data that were collected in the course and the abbreviations that are used in quote attributions found in Chapter 8 and 9. Activities/assignments by individuals and teams were also analyzed by the researcher. The quantitative and qualitative data were transformed into specific recommendations intended to enhance the e-PCCM course. They were also used to create a set of general recommendations that could be applied to other e-Learning courses (Chapter 7) and ultimately as criteria that informed or refined design principles (Chapter 8).
Table 2.3. Listing of surveys, diaries, and feedback sources referenced in this chapter

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Title of document</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V# PQ</td>
<td>Pre-course participant questionnaire</td>
<td>Web-based questionnaire (hosted on SurveyMonkey) intended to collect information about e-learning experience of participant, technologies to be used during course.</td>
</tr>
<tr>
<td>V# DQ#</td>
<td>Post-visit participant diaries</td>
<td>Text entries intended to facilitate and collect learner reflections on what was valuable and how information can be used.</td>
</tr>
<tr>
<td>V# SQ#</td>
<td>Post visit questionnaire</td>
<td>Web-based questionnaire used at conclusion of each site visit.</td>
</tr>
<tr>
<td>PCS Q#</td>
<td>Post field-test course survey</td>
<td>Survey conducted at end of course used to collect final ratings and comments.</td>
</tr>
<tr>
<td>FCE</td>
<td>Post course phone call—final course evaluation</td>
<td>Transcript of a one-hour conference call held with participants, mentors, and learning consultant.</td>
</tr>
<tr>
<td>PCMQ Q#</td>
<td>Post course mentor questionnaire</td>
<td>Survey conducted at end of course to collect comments from mentors.</td>
</tr>
<tr>
<td>DTMR</td>
<td>Design team and mentor review</td>
<td>Transcript of video interviews made during design team and mentor review of working prototype.</td>
</tr>
</tbody>
</table>

**JUNE 2013 – LESSONS LEARNED (18)**

At the conclusion of the field test, the researcher, mentors, and design team members conducted an informal “after action review” of the e-learning prototype implementation as well as those things the team felt might be done differently in the next project. These ideas were incorporated into the recommendations made and presented to the course sponsor/director.

With three iterative cycles of testing completed and refinements made to the e-learning application and the implementation process, the third phase of design-based research was concluded. The e-PCCM course was ready to be used in a normal, full-on implementation. From the researcher’s perspective, however, the research continued with the fourth phase of the design-based research model.
Phase 4: Reflection to produce design principles and enhance solution implementation

Purpose of Phase 4
In contrast to the activities required by the first three phases of design-based research—active collaboration to understand and define the problem, conducting literature reviews, design and development of a potential solution, and preparing and executing evaluation plans and protocols—the fourth phase calls for the researcher to pause, think, ponder, reflect, and discuss with others.

The results of this phase included preparing a set of design principles that became more refined with each iteration, producing the learning solution (also known as the product or artifact), and creating a product with societal impact, the value that the learning solution provides to the user and beyond (Herrington, et al., 2010).

Chronology of Phase 4 activities (reflection to produce design principles)

**JUNE 2011 – REFLECTION AFTER FORMATIVE EVALUATION, ITERATION #1 (19)**
When writing the evaluation report of the first round of formative evaluation, the researcher carefully considered the expert review panel’s comments and critiques. In all cases, the thought process included asking the “So what?” question, and trying to understand the impact on the learners and ways of measuring the success of the course if the intended changes in the design, sketch, or plan were to be implemented. A risk rating and prioritization was performed to help the project sponsor and design team make more informed decisions. Ideas to improve the learning solution were given and prioritized in the evaluation report (see Chapter 8).

**JANUARY - DECEMBER 2013 REFLECTION WHILE CONTINUING TO REVIEW LITERATURE (20)**
At different points during the year, the researcher reviewed progress-to-date, the ongoing literature review, and the draft design principles. The draft design principles were sometimes modified as the researcher gained more understanding and clarity of how they could be used.
In developing the protocols and specific questions to be asked during the formative evaluations, the researcher went back to the literature reviews and draft design principles as well as the primary and secondary research questions (see Chapter 3) that this study proposed to answer. Reflection helped in revising the evaluation protocols and assuring that data was being collected to answer the evaluation and research questions. After each of the two last formative evaluations prior to launch of the field testing of the prototype course, the researcher and other design team members discussed the findings of the evaluation deciding on how to improve the course.

As the data generated during the study were being analyzed, the researcher spent considerable time reflecting upon the results and their implications. This included reflecting on the diary entries, responses to questionnaires, interviews, mentor feedback given to the participants, and conversations with the study director, learning consultant, and other mentors. In some cases, processing the feedback utilized graphics and visual displays and in other situations, this involved writing up observations in a research notebook. Another approach used by the researcher in reflection was to consider the results of the first and second rounds of formative evaluation through the lens of risk assessment, a practice that aligns with the principle of structured reflection described by McKenney and Reeves (2012). Together, these methods helped the researcher to better understand what happened, why the results were what they were, and how the lessons could be applied more broadly.

**Ethical considerations**

In keeping with the Australian Code for the Responsible Conduct of Research, the National [Australian] Statement on Ethical Conduct in Human Research, and Murdoch University’s Responsible Conduct of Research Policy, the proposed research was reviewed and approved by the Murdoch University Human Research Ethics Committee (HREC). The committee granted its approval following clarifications made to the initial application as Project 2011/02. Annual reports for the HREC were submitted as required in 2012, 2013, and 2014.
The course participants were required to provide their informed consent to be involved in the study. They were provided with details about the study, potential risks, and their right to withdraw once the study had commenced. (Appendix 6 contains the information sheet and informed consent letter given to the course participants.) The original signed informed consent documents were retained by the researcher. Key elements in the informed consent document included the following:

- **Potential risks to study subjects.** No risks to the study subjects were identified.
- **Reimbursement.** No monetary or similar gifts were given to the participants. Those participating in the course did this at no cost to them (or their organizations); participants in future courses who work for industry will be charged a nominal fee. All participants and evaluators were sent a letter of appreciation from WHO.
- **Results of the research.** Participants were told how the data collected would be used and how they could be kept informed of the results of the study.

As expected, there were no ethical or harm issues arising from this study.

**Summary**

This research study was conducted using a design-based research approach that was best suited to creating a useful solution—an e-learning course—that would fulfill a real-life need, using a strong theoretical base and, at the same time, collecting data that would improve that solution and contribute to the expanding practical knowledge base that others can use in the future. In keeping with the requirement that design-based research is grounded in theory, the following chapter comprises a literature review that examines the research and theory on expertise and the three learning theories that informed the design of the e-learning solution.
CHAPTER 3

Literature review

Introduction

In Chapter 1—Introduction, the need for an e-learning course that would contribute to developing the knowledge and skills in a large number of people who handle time- and temperature-sensitive pharmaceutical products (TTSPP) was established. It was also clear from interactions with the project sponsor at the World Health Organization (WHO) that he did not wish to develop a run-of-the-mill e-learning program of the kind commonly found in industry with the kinds of shortcomings that often put learners into a passive, “click for the next screen” mode. The challenge was to develop a very different type of e-learning course that avoids these deficiencies. One of the first steps in design-based research is to identify a viable theoretical basis for the innovative solution to be developed. Literature review, as described in this chapter, is a critical part of this process.

This chapter begins with a more detailed description of the problem and what the solution was intended to achieve, specifically helping a targeted group of professionals develop expertise in a particular domain of knowledge. The chapter continues with a survey of expertise—what it is and how one acquires expertise in a given field. Then, three learning theories will be examined in light of how they contribute to the understanding of how a person gains expertise and becomes an expert. From these theories, principles will be presented (in Chapter 4–Design principles) that informed the design of the learning environment used in the prototype solution.
The broader problem: Creating an effective e-learning solution

Throughout history, technologies of varying types have supported education and learning. As monks worked in monasteries copying and reproducing manuscripts—a simple technology involving parchment, hand-made inks and quill pens—they reflected on the text and its meaning (Trithemius, 1974). In 1450, Gutenberg’s movable type printing press contributed to homogenous repeatability and standardization of language, grammar, and punctuation (McLuhan, 1962); it also revolutionized education: “the printed book was a new visual aid available to all students and it rendered the older education obsolete. The book was literally a teaching machine where the [hand-copied] manuscript was a crude teaching tool only” (p. 144). Electricity powered more instructional tools like “magic lanterns”, film strip- and overhead-projectors; electronics enabled educational radio and television, and early computer-based instructional systems like PLATO (Saettler, 1968). Today, a variety of web-based instructional and learning applications, some of which incorporate Web 2.0 social software are used throughout education and training, albeit with often disappointing results (Bonk, 2009; Hattie, 2009; McLoughlin & Lee, 2007; Reiser, 2001).

Intrinsic with any technology are its affordances, that is, characteristics or features that enable a user to perform a particular action. The term was originally defined by Gibson (1979) in an ecological context (i.e., animals and environment) and adapted by Norman (1988) and adopted more broadly in technology circles (Maier & Fadel, 2009). Norman’s (1988) definition of affordance is:

The perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords (‘is for’) support and, therefore, affords sitting. (p. 9)

Norman (1988) discusses two different sets of people associated with affordances: those who design or produce the thing and those who make use of it. He gives an example of designers of a British Rail train station shelter who used glass but repeatedly had to replace it because of vandals—one set of ‘users’—who kept shattering the glass. The designers finally selected plywood for the siding. Even though plywood could not be broken, it still provided the affordance of being a suitable surface for graffiti artists, another set of users. Those who design learning solutions are also faced with decisions about what materials, methods, and media to use. Instructional designers need to
understand the intended goals of the learning program, the learners, and opportunities and constraints in order to produce a solution that takes advantage of affordances in a positive way as well as considers constraints that are present (Dick, Carey, & Carey, 2008; Dirksen, 2012), so that there is alignment between the organizational goal, the characteristics of the learners (audience), content, instructional methods and technology, and assessment (Reeves, 2006b).

With the key goal presented in Chapter 1—Introduction, that is, ensuring that TTSP are properly handled, and with the need to provide a learning solution that can be used by individuals around the world, it will be useful to examine how acquiring knowledge, skills, and experience contribute to a practitioner developing expertise.

**The more specific problem: Developing expertise**

Experts—those displaying expertise within a specific domain—are found in every endeavor. In some cases, expert performers in sports, music, and science are given societal recognition, large paychecks, and prestigious awards. In other areas, experts who can work through complicated procedures or maintain complex mechanical equipment that are essential to the organization, seem to be recognized only when they—and their expertise—are absent (Prietula & Simon, 1989).

What then is an expert? Definitions range from the folksy—like this from American humorist, Mark Twain: “An ordinary fellow from another town,” to the common: “A person with a high degree of skill in or knowledge of a certain subject” (American Heritage Dictionary, 2010). Dreyfus and Dreyfus (2005) quoted Socrates who said that the expert “straightaway does the appropriate thing at the appropriate time in the appropriate way” (p. 788). The expert has something, which non-experts do not have: expertise. Germain and Ruiz (2009) defined expertise as “the combination of knowledge, experience, and skills held by a person in a specific domain” (2009, p. 614).

**What experts know**

Dreyfus and Dreyfus (2005) said that experts do not rely simply on rules or principles in order to take appropriate action. In fact, if they were asked to describe the process of solving a problem, experts may not be able to answer—they may not be aware of the
underlying skills and knowledge that they are applying in a situation. Feigenbaum and McCorduck (1983) also captured this idea: An “expert’s knowledge is often ill-specified or incomplete because the expert himself doesn’t always know exactly what it is he knows about his domain” (p. 85). Schön (1987) described that the actions by competent practitioners do not depend on the ability of that person to describe what they know how to do or that the person has conscious thoughts about those actions. Put simply by Polanyi (1962): “there are things we know but cannot tell” (p. 601) which he described as tacit knowledge.

Polanyi—a physician, chemist and philosopher—identified tacit knowledge that is critical in the performance of a skill, but cannot be fully described (Polanyi, 1962). Tacit knowledge can include a variety of information—concepts, sensory inputs, and images—that one uses to interpret a situation or phenomenon. Nonaka (1991) expanded on this, saying that tacit knowledge is highly personal, not easily shared, and deeply rooted in action and in a significant context. He contrasted this with explicit knowledge which he described as formal, systematic, easily communicated and shared through written words, specifications, formulas, and the like. While Polanyi and Nonaka’s concept of tacit and explicit knowledge can be viewed as a dichotomy—a given unit of knowledge is either tacit or explicit—Hildreth and Kimble (2002) considered that these two types of knowledge are dualistic: knowledge can be seen as simultaneously having both characteristics. In a similar way, light can be thought of as having both particle- and wave-like attributes. Hildreth and Kimble went further, using the terms hard knowledge that described what a person can articulate and soft knowledge as that which a person cannot articulate. Using the terminology from Ryle (1949), explicit knowledge would be akin to knowing that; tacit knowledge would be akin to knowing how (Brown & Duguid, 2000). Another view of tacit and explicit knowledge has these two types being opposite ends of a spectrum; “most knowledge of course exists between the extremes. Explicit elements are objective, rational, and created in the ‘then and there’, while the tacit elements are subjective, experiential, and created in the ‘here and now’” (Leonard & Sensiper, 1998, p. 113).

Marcus (2012), a cognitive psychologist, described a neurological basis for this separation of know what from know how: knowing what is stored in the medial
temporal lobe and the temporal and frontal cortices of the brain, parts that have become optimized for conscious knowledge; knowing how is encoded in the cerebellum and central ganglia, parts of the brain that excel in reflex response—units of the brain that do not consciously express themselves.

Some of the characteristics of tacit and explicit knowledge as described by various authors are summarized in Table 3.1. The specific characteristics of these two types of knowledge, tacit and explicit, are important considerations. But what is more important to this research is exploring how tacit and explicit knowledge can be acquired by someone who is trying to develop expertise in a given field.

Table 3.1. Comparisons of tacit and explicit knowledge

<table>
<thead>
<tr>
<th>Tacit Knowledge</th>
<th>Explicit Knowledge</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understood without being expressed; unvoiced, unspoken</td>
<td>Clearly expressed, leaves nothing implied</td>
<td>(Hildreth &amp; Kimble, 2002)</td>
</tr>
<tr>
<td>Known but cannot be told; internalized in the mind; conceptual and sensory</td>
<td></td>
<td>(Polanyi, 1967; Smith, 2003)</td>
</tr>
<tr>
<td>information and images used to understand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly personal, hard to formalize and communicate, deeply rooted in action,</td>
<td>Easily transmitted, captured, stored and retrieved; shared through specifications,</td>
<td>(Nonaka, 1991)</td>
</tr>
<tr>
<td>includes technical skills, mental models, and belief</td>
<td>procedures, drawings</td>
<td></td>
</tr>
<tr>
<td>“Know how”; acquired on its own by way of interactions with objects, people</td>
<td>“Know what”</td>
<td>(Cook &amp; Brown, 1999)</td>
</tr>
<tr>
<td>Embedded in work practice, difficult to spread, coordinate, or change; easy to</td>
<td>Moves with ease, difficult to protect; easy to separate from the “owner”</td>
<td>(Brown &amp; Duguid, 1998)</td>
</tr>
<tr>
<td>protect; difficult to separate from the “owner”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Results in insight, intuition; embodied in muscle memory and cognitive skills;</td>
<td>Objective, rational, created “then and there”</td>
<td>(Leonard &amp; Sensiper, 1998)</td>
</tr>
<tr>
<td>subjective, experiential, created “here and now”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic, involves constructions, used in “professional artistry”</td>
<td>Static, little professional artistry involved</td>
<td>(Schön, 1987)</td>
</tr>
</tbody>
</table>

**Becoming an expert**

Becoming an expert in a domain means developing expertise, that is, acquiring the relevant tacit and explicit knowledge, skills—both cognitive and psychomotor—and attitudes that will enable expert performance. Brown and Duguid (2000) described this as “learning to become” which involves not just knowing the facts (i.e., explicit
knowledge) but being intimately involved in practice where tacit knowledge can be acquired.

Considerable research has been done examining how expertise is acquired, for example, by athletes (Hodges, Starkes, & MacMahon, 2006), nurses (Benner, 1984), physicians (Norman, Eva, Brooks, & Hamstra, 2006), musicians (Lehmann & Gruber, 2006), chess players (Gobet & Charness, 2006), and financial auditors (Bonner & Lewis, 1990). A frequently used model was developed by Dreyfus and Dreyfus in 1980 and has since evolved (Dreyfus & Dreyfus, 1980, 2005). The Dreyfus Model of Skills Acquisition has five stages that the person moves through:

**Novice.** Learners enter the novice stage without real background or understanding in the given domain. They are dependent on an instructor who provides a path into and through the facts, rules, and procedures. The learners strictly follow these as they execute a process or task. Drill and practice routines are important in the learning process.

**Advanced beginner.** In the second stage, learners face real situations in a real environment and start identifying (or having pointed out to them by an instructor) more and more examples from which they can generate maxims or rules of thumb. The instructor acts as a coach, helping them organize and make sense out of the material.

**Competence.** In this stage, learners begin performing with increased technical and work-organizational skills. As they see the complexity of factors and procedures that need to be considered in accomplishing the required tasks, learners discover mechanisms and mental models for organizing these factors; they start being able to sort out and prioritize. They also begin seeing their activities as part of a larger whole or in terms of larger goals. Learners start considering their taking risks, such as when to deviate from a standard approach or given procedure. An important strategy that occurs at this stage is for the learners to have an emotional attachment to their decisions—that is, having a sense of satisfaction when their course of action or plan works and taking responsibility when an action does not have the intended consequences.

The point, however, is not to analyze one’s mistakes and insights, but just to let them sink in. Experience shows that only then will one become an expert. After one becomes an expert one can rest on one’s laurels and stop this kind of
obsessing, but if one is to be the kind of expert who goes on learning, one has to
go on dwelling emotionally on what critical choices one has made and how they
affected the outcome. (Dreyfus & Dreyfus, 2005, p. 786)

Proficiency. In this fourth stage, learners become more involved in the task and can
more clearly understand what needs to happen to reach the goals; they begin to view
the situation more holistically. The actions taken are not automatic or instinctive;
rather, they are actions based on decisions made with rational deliberation.

Expert. When learners arrive at this final stage in the Dreyfus model, they do not have
to ponder the options and how to accomplish them; they have a deep understanding
of what to do and how to do it. Experts create and refine useful mental models
(cognitive constructions) of situations and intuitively know what to do. They,
however, have another set of skills to use: when confronted with an unusual
situation or one where the results are not achieved when the “intuitive” response is
implemented, experts can use their analytical skills to try to arrive at a new, more
accurate conclusion.

In moving through this progression, Dreyfus and Dreyfus described three ways that the
person’s performance changes. First, the person relies less on abstract theories and
draws more on real-life experiences. Second, the person’s way of looking at a situation
is much more holistic, seeing the shape and workings of the forest instead of specific
trees. Finally, the person becomes an active participant in the activity, not someone
watching on the periphery (Daley, 1999).

Psychologist Daniel Kahneman (2007) described two complementary approaches to
approaching a problem and learning: System 1 and System 2. While System 1 involves
intuitive problem solving, System 2 involves analytical reasoning. Both are equally
valid and are used when experts and non-experts alike face a situation and respond to it,
regardless if the problem is logical, ethical, systems-related, or technical.

System 1, also called intuition, attempts to address the issue first. It operates quickly
and automatically and is effortless. Intuition is learned slowly but it is also hard to
“unlearn.” It works by what Kahneman described as “associative coherence”—
associating ideas in the mind of the expert through a network of connections. “Intuition
is the way we translate our experiences into judgments and decisions” (Klein, 2004, p. 23).

System 2, known as analysis, operates slowly. The person has a choice in using it—it is controlled and flexible. Analysis has many forms but takes effort to use as one applies rules and deals with doubt and ambiguity in a stepwise manner. System 2 can override System 1 but System 2 demands the person’s attention.

Psychologists and popular authors, Klein (2004) and Gladwell (2005), respectively, have written about the “marvels” of intuition whereby experts are sensitive to the most subtle of external cues or signs. They provided anecdotes where lives have been saved (e.g., firemen and nurses) and fortunes made (e.g., entrepreneurs) by experts who “trust their gut” feelings. Kahneman (2007) has not disputed this, but pointed out that intuition can be significantly affected by biases. The very features of System 1 that make it work so efficiently and automatically can also be interfered with unconsciously and uncontrollably. Kahneman’s message was that intuition is powerful and useful, but we need to understand its limits and how it can be compromised.

A model that is similar to Dreyfus and Dreyfus’ is the Fitts and Posner Model (Fitts & Posner, 1967) that describes three stages of a continuum in which a person develops motor skills. The stages are:

**Cognitive stage.** As a learner acquires a new skill, he or she first learns the “rules” of the activity such as the specific requirements, definitions, and components of the skill. When beginning to perform the task, the learner makes mistakes, many that the learner neither recognizes nor knows how to correct. This information needs to be provided to the learner by a more experienced person, teacher, or coach.

**Associative stage.** At this stage the learner is more aware of what needs to be accomplished, how to do it, and is actually performing the skill. Mistakes are still being made during the performance, but they are fewer and less “gross” in nature. With more and more practice, and feedback from experienced performers or coaches, the learner’s performance improves, as does the learner’s skill at self-improvement.

**Autonomous stage.** This is the point where the learner is performing the skill without thinking about its fundamentals, and is able to focus on other, more subtle aspects of
the activity. Performance continues to become more refined, consistent, and predictable.

One last model that provides additional insight about acquiring expertise and becoming an expert is called *Conscious Competence*; it has an unclear provenance. The *Conscious Competence Model* was described in an interview with W. Lewis Robinson (Anonymous, 1974) and has four stages:

**Stage 1: Unconscious incompetence:** the person has no awareness of what they don’t know. For example, someone might look at a performer and say, “That’s so easy—I could do that!” A real-life situation given by Kruger and Dunning (1999) shows that a person without knowledge or skills can “reach erroneous conclusions and make unfortunate choices, but their incompetence robs them of the metacognitive ability to realize it” (p. 1121).

**Stage 2: Conscious incompetence:** the person becomes aware of the knowledge and skills needed to perform an activity as well as his or her inability to perform this activity. At this stage, the person might say to an expert performer, “I don’t know if I’ll be able to do it as well as you can!”

**Stage 3: Conscious competence:** here, the person can perform the task without assistance from a mentor or expert, although the performer is very aware and closely monitoring his or her actions.

**Stage 4: Unconscious competence:** at this stage, the skill or performance becomes second nature to the performer; they do it without thinking about it. Frequently, the performer has a difficult time describing what is done. This is where “muscle memory” and intuitive thinking are demonstrated.

In considering these models of becoming an expert by acquiring expertise, there are some areas in which they are useful. For example, all models show that there is a progression from non-expert to expert. According to Ericsson (2007), this progression take time—10,000 hours or 10 years.

On the other hand, there are aspects of the models that are not fully satisfying. For example, the models are linear, suggesting that the learner moves step-wise in path from one stage to another. Other understandings of expertise take into account that a variety
of knowledge and skills lead to becoming an expert and that these are acquired “in
degrees rather than in an all-or-none fashion” (Cianciolo, Matthew, Sternberg, &
Wagner, 2006, p. 614). The knowledge and skill acquired may be highly specific to one
endeavor or they could be used in helping in other roles as well, for example, statistical
thinking or design of experiments.

Another deficiency in the models is they can be interpreted to mean that reaching the
“expert” level (e.g., “expert”, “proficient”, “unconsciously competent”) is the end of the
journey—the goal has been attained. In reality, expert performance and expertise need
to be maintained through practice and new challenges. Surgeons, athletes, ballet
dancers, and musicians need to practice and stay in shape. The same is true with those
performing cognitive tasks. Beyond this routine of practice—maintaining their prowess,
for example—experts keep gaining expertise. They create and apply rules that haven’t
yet been made explicit (Schön, 1987). This is consistent with Kahneman’s description
of System 2 when an expert needs to carefully and slowly analyze a situation when the
expert’s intuition (System 1) does not yield the desired result; the analysis provides a
new pattern that can be stored in the expert’s memory (Kahneman, 2007).

Wiggins (1989) described a well-known phenomenon familiar to anyone who is
developing expertise in a field: the more you learn, the more you realize you don’t
know. An implication of this is that the models described above are not linear, but that
there is a cycling that goes on, for example, when conscious competence is being
achieved, as a person realizes that there is more to know in a narrow domain, the person
becomes “consciously incompetent” in that domain.

A potential limitation is the situation that occurs when an expert (at unconsciously
competent or autonomous levels) may have a difficult time communicating knowledge
and skills with a novice. The novice has learning needs that are not met by the expert
because the expert uses language and mental models to which the novice does not yet
have access. Nathan and Petrosino described this as the “expert blind spot,” cautioning
that just because one is a subject matter expert (SME) does not make the SME an
effective teacher or mentor (Nathan & Petrosino, 2003). Another factor that contributes
to this blind spot is that quite often, the SMEs are looking at their communication from only their point of view, not from the learner’s point of view (Brown & Duguid, 1996).

A further limitation of these models per se is that they describe the what, not the how of developing expertise. In their work, Ericsson, Krampe, and Tesch-Romer (1993) elaborated on this process, saying that deliberate practice is essential in developing expert performance:

[Deliberate practice is] focused, programmatic, carried out over extended periods of time, guided by conscious performance monitoring, evaluated by analyses of level of expertise reached, identification of errors, and procedures directed at eliminating errors. Specific goals are set at successive stages of expertise development. It involves appropriate, immediate feedback about performance. The feedback can be obtained from objective observers—human teachers and coaches—or it can be self-generated by comparing one’s own performance with examples of more-advanced expert performance. Such objective feedback helps the learner to become aware of the standards of expertise, to internalize how to identify and correct errors, to set new goals, to focus on overcoming weaknesses, and to monitor progress. (Horn & Masunaga, 2006, p. 601)

Klein (2004) also described how intuition—one of two ways that expertise is exhibited (Kahneman, 2007)—used in decision making can be developed using a three-part process (p. 37):

1. *Identify and understand the decision requirements*. People with experience—expertise—in the knowledge domain need to do this though they are often assisted by facilitators who can help them articulate the questions that are asked, how the answers are interpreted, the decisions that are made, and situations that require these skills. As Brown and Duguid (2000) observed, knowledge is hard to detach from its human owner.

2. *Practice difficult decisions in context*. With knowledge of the decisions that need to be made and the context in which they are made, novices are given opportunities to make these decisions. It is here that Klein applies the concepts of deliberate practice: the novice obtains experiences randomly but does so accomplishing clearly defined objectives. This can be done in a variety of ways ranging from case studies to full-fidelity simulations.

3. *Review decision-making experiences*. After a decision is made, one can reflect on the process, outcome, and results. Feedback from those mentors, other
experts, and those who experienced the decision-making process can be valuable.

Kahneman (2011) added two important conditions: first, the space in which the expertise is developed is “an environment that is sufficiently regular to be predictable” and, second, that there is “an opportunity to learn these regularities through prolonged practice” (p. 239). It is repeated experiences that are linked together that contribute to intuition (Klein, 2004).

Based on his model of explicit and tacit knowledge, Nonaka (1991) described a “spiral of knowledge” (Hildreth & Kimble, 2002) and provided additional recommendations for converting knowledge between its tacit and explicit forms:

- Tacit to tacit knowledge—learning occurs through observation, imitation, and practice; it requires that the learner be socialized into an activity. The drawback of this is that the learner has not acquired any systematic understanding because the knowledge has not become explicit.
- Explicit to explicit knowledge—learning occurs because the knowledge has been articulated and thus can be transferred and combined in different ways.
- Tacit to explicit knowledge—learning occurs when the learner can “find a way to express the inexpressible” (p. 31) through using metaphors, analogies, and symbols.
- Explicit to tacit knowledge—learners internalize the explicit knowledge and can use, recombine, and extend its application for their own use.

Cook and Brown (1999) are aligned with much of Nonaka’s view of tacit and explicit knowledge, but strongly disagree with the idea of “conversion”—they believe that one type of knowledge is generated from the other by interacting and negotiating with the social and material world. They described the negotiation this way: “Each form of knowledge can be used as an aid in acquiring the other” (p. 56). To Cook and Brown, conversion is akin to changing from one different unit of measure to another, for example, feet to meters. To Cook and Brown, generation isn’t simple like that, often requiring the person who has the tacit knowledge to use stories, physical objects, hands-
on interactions, and work practices to help generate tacit knowledge in the mind of the learner.

Cook and Brown (1999) also emphasized that knowing is distinct from knowledge:
“Each of the forms of knowledge is brought into by knowing when knowledge is used as a tool in the interaction with the world. Knowledge, meanwhile, gives shape and discipline to knowing” (p. 70). Schön (1987) took this further when he referred to “knowing-in-action—the types of know-how revealed in intelligent activity (p. 25) and “reflection-in-action” which is conscious critical thinking used to understand and resolve unexpected situations (“surprises”) that do not fit the expected knowing-in-action outcome.

**Requirements for developing expertise**
Experts have expertise that includes explicit (i.e., knowing what—factual knowledge) and tacit knowledge (i.e., knowing how—procedural knowledge). Developing expertise has these attributes and requirements:

- the learner progresses through stages as he or she gradually acquires expertise
- it takes time
- it requires the learner to acquire both explicit and tacit knowledge
- the learner must interact with the social and material world (i.e., people and physical objects, respectively) as he or she acquires explicit and tacit knowledge
- there must be opportunities for the learner to have multiple, varied interactions in as real situations as possible that will result in a repertoire of experiences or patterns that the expert can later call upon and use
- the learner must be able to obtain timely, useful feedback on his or her action or decisions
- the learner must be able to reflect on and incorporate the feedback.

If these are considered valid requirements for developing expertise, how can they be achieved? Where can a designer/developer find an evidence-based foundation for a particular solution that will meet these requirements and in selecting the affordances to be incorporated in an e-learning application? What theories would be useful in this pursuit?
Theoretical considerations in guiding the study

Before looking at the theoretical basis that was the foundation for this research, it is incumbent to ask the question, “Why use theories at all?” Wilson (1997) described a theory as a cluster of related concepts based on observations and evidence that are used to explain something or help understand how something works in a given domain. He gave three roles that theories play in the work of educational practitioners:

- they help practitioners see the world differently, allowing us to envision new possibilities
- they help link the theoretical to the practical—the science to the technology
- they are a standard or reference that can be revisited when evaluating actions or practices. (p. 23)

A frequently cited quote punctuates the irony and utility of this abstraction: “Nothing is as practical as a good theory” (Lewin, 1951, p. 169). In the following sections, three learning theories are examined: cognitive apprenticeship, authentic learning, and community of learners. The theories have their roots in behavioral, social, and neurological fields, and are influenced by other philosophies and learning theories such as constructivism, behaviorism, cognitivism, and humanism (Schunk, 2012).

Three key theories

Three theories show particular relevance in informing the design of a proposed solution, specifically:

- **cognitive apprenticeship** — when a novice works with a more experienced mentor or guide
- **authentic learning** — when an individual or a group addresses a complex, realistic problem and creates genuinely useful products
- **community of learners** — when others who are also interested in acquiring the same knowledge or skill can learn together; when someone arranges the facts and examples and can effectively communicate this to a peer.
Cognitive apprenticeship

Cognitive apprenticeship is a way to provide the learner a variety of social and material interactions as he or she works with a practitioner. For much of history, the way that a young person would develop skills and knowledge — expertise — in a particular craft or trade was through apprenticeship. For example, a child would be indentured to a master in what was an economic contract, as illustrated in this document from 1602:

Philippa Wilford, daughter of Henry Wilford, late of London, gent., binds herself to learn the art and trade of seamstress to John Haydon, citizen and merchant tailor, and Jane Haydon his wife, seamstress, of London for four years in return for meat, drink, linen, hose, shoes, and one penny wages. (Luard, 1602)

The essence of the contract was that the technical knowledge (what would now be referred to as “intellectual property”) of the master would be transferred to the apprentice for a combination of money and/or labor (De Munck & Soly, 2007). The apprentice would learn in stages and through a combination of observation and trial and error, with the master identifying what went wrong and what could be improved. Lave and Wenger (1991) provided examples of how apprenticeship, despite its sometimes negative history of abuse and exploitation, is still widely used around the world today.

It was this model of apprenticeship, that Collins and Brown considered in the 1970s and 1980s as they looked for ways to revolutionize education using computer technology (Collins, 2006).

We propose an alternative model of instruction that is accessible within the framework of the typical American classroom. It is a model of instruction that goes back to apprenticeship but incorporates elements of schooling. We call this model ‘cognitive apprenticeship’. (Collins, Brown, & Newman, 1989, p. 453)

Collins later pointed out that cognitive apprenticeship shifted the emphasis from physical skills and activities to cognitive ones (Collins, 2006).

Cognitive apprenticeship is “a domain that enables students to acquire, develop, and use cognitive tools in an authentic domain activity” (Brown, Collins, & Duguid, 1989, p. 39). Collins, Brown, and Holm (1991) described cognitive apprenticeship as a model that could be used to teach a complicated task to learners with the intent of developing expertise in that learner.
Collins (2006) described the similarities and differences of traditional and cognitive apprenticeship. The two are similar in that they use an expert to guide a novice in performing complex tasks; this learning is done in context, using real-life problems. On the other hand, traditional apprenticeship is concerned primarily with physical activities where the resulting product is external to the person and visible to (and subject to easy evaluation by) others. The setting for a traditional apprenticeship is the workplace with tasks based on the skills needed to accomplish a task. In a cognitive apprenticeship, the emphasis is on “thinking” or cognitive skills that are unseen unless steps are taken so they can be seen. Cognitive apprenticeships can be conducted in a variety of settings with problems or methods that are selected to the utility of particular techniques in such a way that they can be generalized as principles for use in different contexts.

**Cognitive apprenticeship and development of expertise**

Central to the cognitive apprenticeship model is defining how an expert performs a task or activity, particularly the cognitive strategies that the expert uses to integrate the appropriate knowledge and skills. As noted earlier, while concretely identifying explicit knowledge can readily be achieved, it is more difficult to identify the tacit knowledge that exists in the mind (and body) of the master. Additionally, the master must find a method to transfer this ability to the learner with activities that allow the learner to participate in knowing-in-action (Schön, 1987), interacting with the master who coaches the learner through “guided participation” (Collins, 2006, p. 48). During cognitive apprenticeship, the novice is moving through the cognitive, associate, and autonomous phases described earlier (Fitts & Posner, 1967).

**Foundations of cognitive apprenticeship**

In addition to being heavily influenced by traditional apprenticeship with its emphasis on observation, coaching, and practice (Lave, 1996), three other theories—sociocultural theory of learning, Vygotsky’s zone of proximal development, and situated cognition—are important in understanding cognitive apprenticeship (Ghefaili, 2003).
**Sociocultural theory**

Sociocultural theory holds that an individual’s learning and development requires interactions with other people, institutions, culture, tools, and symbols. Bandura (1977, 2001) was instrumental in developing this view of human development (Tudge & Winterhoff, 1993).

Learning and development involves not just acquiring facts and skills; rather, it is a dynamic transformation of a person who participates in an activity—a person acquires a new or different identity (Rogoff, Baker-Sennett, Lacasa, & Goldsmith, 1995). “Learning thus implies becoming a different person with respect to the possibilities enabled by those systems of relations. To ignore this aspect of learning is to overlook the fact that learning involves the construction of identities” (Lave & Wenger, 1991, p. 53). We see this reflected in the names used to describe roles in apprenticeships: apprentice, journeyman, and master.

**Zone of proximal development**

Vygotsky’s writings included a concept that he named the *zone of proximal development* (ZPD) (Vygotsky, 1978). It is the difference between what a person can do independently and what they can do with the assistance of another, more capable person. Coupled with the ZPD is the concept of the *more knowledgeable other* (MKO)—that is, the person (or, in the view of Collins (2006) and others, a computerized system) that is more capable than the learner.

The role of the MKO is to provide temporary support or “scaffolding” to the learners as they move through the ZPD. As the learner gains more knowledge and skills, the MKO gradually repositions the scaffolding from where the learner displays new competence and an expanded ZPD. As the person learns and performs more, the MKO will gradually withdraw the support, a process called *fading*.

**Situated cognition**

In contrast to how most people are taught in academic settings, those who subscribe to situated cognition theory agree that “knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used” (Brown, et al., 1989, p. 32). Lave (1988) described the benefits of teaching arithmetic in a supermarket—an environment where a learner can see the practical application of percentages and conversions of units of measure, for example, rather than in a disconnected-from-real-
The classroom, “like any method that tries to teach abstract concepts independently of authentic situations, overlooks the way understanding is developed through continued, situated use” (Brown, et al., 1989, p. 33). Brown and his colleagues contended that learning comes about by acting in situations.

The results of learning in the real-world can be seen in research conducted in Brazil. Nunes, Schliemann, and Carraher (1993) found adult fishermen who had no formal schooling and yet were able to solve complex proportion problems related to fishing and agriculture. The researchers stated: “The concept of proportionality does not have to be taught. It can develop on the basis of everyday experience” (p. 126). They also made the claim that “mathematics learned in everyday life may result in a better performance in problem solving than school learning” (p. 74).

Dimensions of cognitive apprenticeship

Collins and his colleagues developed a “framework” for cognitive apprenticeship that consists of four dimensions (Brown, et al., 1989; Collins, 2006; Collins, Brown, & Holum, 1991; Collins, et al., 1989): content, method, sequencing, and sociology.

Content

Content consists of both explicit and tacit knowledge of the domain. Collins (2006) broadened the concept of tacit knowledge to include “strategic knowledge” or strategies that the expert has (p. 49). Collins identified three strategies:

1. **Heuristic strategies** are rules of thumb that usually (but not always) work in solving a problem. Collins said these are acquired by solving different problems or challenges.

2. **Control** (or metacognitive) strategies monitor, diagnose, and remediate, providing guidance on whether to proceed with and beyond the task. The person would be able to determine if certain goals were met and if not, take actions to correct the situation. Marcus (2012) asserted that “a good part of expertise comes from diagnosing… one’s own likely mistakes” (p. 177).

3. **Learning strategies** are used for acquiring domain knowledge and heuristic and control strategies. Daley (1999) described how learning differs between novices and experts: novices focus on making concepts real and fear making mistakes;
experts are more self-directed and constructivist in their learning approaches, expanding their own knowledge bases with new information and experiences.

**Method**

Methods are ways learners are presented with the content so that they can gain expertise. Collins described six methods that contribute to the development of expertise.

1. **Modeling** has the expert perform the task with the learner watching. The expert might tell the learner to ‘copy exact’—a master musician requiring the student to “reproduce every detail of performance, achieving example copies of the master’s sounds by mimicking his every procedure and gesture” (Schön, 1987, p. 178). Or, it could more of a subtle emulation of what the expert does. For example, medical residents are much more likely to frequently wash their hands after observing the attending physician—their role model—doing this behavior.

2. **Coaching** is when the expert observes the learner as he or she performs the task and provides feedback, suggestions, and critiques. The expert’s comments are specific to the activities that are being performed.

3. **Scaffolding** is narrower than coaching. Specifically, scaffolding consists of the “supports provided to the learner” (Collins, 2006, p. 51) so as to help the learner succeed. Scaffolding can be in the form of instructions, advice, or tools. Burton, Brown, and Fischer (1984) described how wearing shorter skis and selecting a gentle hill provided scaffolding to someone learning the winter sport of downhill skiing. As the learner develops more skill, the instructors move the learner to more standardized equipment and more challenging hills, thus “fading” away the support.

4. **Articulation** is when the learner “states their knowledge, reasoning, or problem solving processes” (p. 51). The ski instructor might ask novice skiers about their stance or which part of the foot is used to initiate a turn, giving the instructor insight into how novices think through the process. By way of coaching, the instructor can reinforce or correct the learner.

5. **Reflection** permits the learner to look at his or her performance and evaluate it—perhaps in contrast to another learner’s performance or to that of an expert performer. The expert musician may imitate the articulation of the student violinist and then play the same phrase in a different way, asking the learner to describe the differences (Schön, 1987). As the learners develop their own
cognitive construct, they become more self-critical, having learned self-coaching techniques from their instructors (Ericsson, et al., 2007). Kolb (1975) said reflection occurs when the learner transforms the concrete experience and finds its meaning. The learner is attempting to understand what they have experienced—why it is important, how it compares to other experiences, and how it fits into a larger system. Marcus (2012) gave an example of how even accomplished, expert musicians can reflect on their performance by making a detailed diary entry after every concert.

6. **Exploration** is letting the learners engage in the activity on their own—solving a problem of interest, skiing a different ski trail, or improvising on a musical theme in the moment (Schön, 1987).

**Sequencing**
Collins’ (2006) third dimension of cognitive apprenticeship is sequencing, the way the learning events and activities are arranged so that the learner acquires a rich, robust repertoire of experiences (Klein, 2004). The learning events are assembled in such a way that provides scaffolding and fading, preventing the learner from being overwhelmed. Skiers, for example, work their way up to higher, more progressively challenging runs. Sequencing considers three dimensions (Collins, 2006):

1. **Increasing complexity** allows the learner to use more knowledge (explicit and tacit) and skills as the learning activities get progressively more difficult. In this way the learner is drawn more deeply into the domain.

2. **Increasing diversity** provides different types of situations and problems so the learner can broaden the knowledge and skills. The learner may see when certain rubrics may or may not be useful.

3. **Global before local** permits the learner to see the whole before getting into the parts. The learner is able to make sense of the “big picture” as well as the pieces and recognize potential problems.

**Sociology**
Previous sections showed that learners generate both tacit and explicit knowledge by interacting with the material and social world (Cook & Brown, 1999). People learn from and with each other—learners from masters, learners from learners, masters from learners, and masters from masters. Nonaka (1991) described how stories, metaphors,
and analogies all are useful in helping others acquire tacit knowledge. The interaction between people is the last dimension in Collins’ framework for learning via cognitive apprenticeship (Collins, 2006) and has four characteristics:

1. **Situated learning** is having people learn by presenting tasks, problems, and challenges as they appear in the real world (Collins, et al., 1989). “Situated learning” is very similar to “situated cognition” that was described earlier.

2. **Community of practice** involves people voluntarily discussing, creating, and solving challenges together in a particular domain (Lave & Wenger, 1991). Novices observe and gradually participate more and more as their knowledge and skills increase and as they see that the group’s collective knowledge is greater than the sum of the knowledge of individual experts.

3. **Intrinsic motivation** is a powerful force that can be defined as “the doing of an activity for its inherent satisfactions rather than for some separable consequence” and that the reward in doing the task or performing the action is the task or action itself (Ryan & Deci, 2000, p. 56). Factors that contribute to intrinsic motivation include challenge, curiosity, fantasy, pleasure, and self-determination/self-direction (Garris, Ahlers, & Driskell, 2002). An aspect of intrinsic motivation is the concept of *conation* that Reeves (2006b) defined as the “will, desire, drive, level of effort, mental energy, intention, striving, and self-determination to actually perform at the highest standards” (p. 297).

4. **Exploiting cooperation** is making use of learners working together, sharing the solving of problems, and reaching common goals.

In examining these four dimensions of cognitive apprenticeship, it can be seen that they are influenced by the traditional apprenticeship model, sociocultural theory, Vygotsky’s zone of proximal development, and situated cognition. For example, in apprenticeship, the master sets up tasks in a typical workroom that will result in useful, real products (as described in situated cognition). Similarly, the master guides, coaches, and provides support to the learner (as reflected in the zone of proximal development, more knowledgeable other, and sociocultural theory).
While cognitive apprenticeship provides a theoretical basis for explaining how someone might learn complex, real-life tasks by working with an expert, critics contend it is impractical to implement in certain learning situations as examined below.

**Criticisms of cognitive apprenticeship**

A caution raised by Nathan and Petrosino (2003) is that subject matter experts who are working with a novice—even those experts who are trained/certified teachers—may not be effective at communicating what novices need or want to know. Specifically, the expert may be “blind to the learning processes and instructional needs of novice students and that educators with such expertise often are entirely unaware of having such a blind spot” (p. 906). The authors referred to this situation as the “expert blind spot.” An example given by Nathan, Koedinger and Alibali (2001) is when an expert math teacher demonstrates different efficient and effective ways to solve a complicated problem while the student is wrestling to understand the basic underlying concepts.

Tripp (1996) raised concerns regarding learning in a real-life context, using an example of adults learning a second language, specifically “fossilization.” Here, the learning results in a satisfactory level of communication but the resultant spoken communication is not precisely correct due to errors in grammar and pronunciations. Soon the incorrect language becomes fossilized within the learner who is then unlikely to learn correct usage. To prevent this, instead of a totally immersive experience, he recommended initial classroom sessions that bring in a higher level of structure and instructor control. (Tripp does concede that language learning may be different from learning job skills.)

Dreyfus and Dreyfus (2005) mentioned a benefit and a potential risk of cognitive apprenticeship: “observation and imitation of the activity of an expert can replace a random search for better ways to act” (p. 788) that provides to the learner both advantages and disadvantages. On the positive side, the learner can take advantage of some of the mental models the expert utilizes and can associate those with actions that are (usually) correct. On the negative side, by avoiding making—and more importantly learning from—those mistakes, the learner may have lost a powerful, rich, learning opportunity. Dreyfus and Dreyfus, however, saw the “observation and imitation” of the expert a net-positive advantage.
Going beyond cognitive apprenticeship
Cognitive apprenticeship provides useful, theory- and practice-grounded ideas that can guide designing and producing an e-learning application to help develop expertise. Specifically, the method and sequence in which the content is presented and the interactions between people—learners and learners, and also learners and mentors—are keys to the success of the approach. However, there are some limitations. For example: How are tasks and activities selected or created that will build expertise? How can the learning environment be situated and optimized (related to the method and sociology) so it contributes to learning? And in what ways can learners demonstrate their achievements as they gain expertise?

To answer these questions, authentic learning can provide a useful theoretical foundation.

Authentic learning
The earlier discussion of experts and cognitive apprenticeship identified several elements that are necessary for someone who is developing expertise. Specifically, five active practices have been identified:

- practicing difficult decisions in context (Klein, 2004)
- knowing in action and reflection in action (Schön, 1987)
- interacting with the social and material world (Cook & Brown, 1999)
- using situated learning / situated cognition (Collins, et al., 1989)
- exploring (Schön, 1987).

Certainly, most apprenticeship programs would include these elements, but are there other ways to provide the learner with such an opportunity? Or, as asked by Brown and Duguid (1996), “How can these situated [learning] theories be operationalized?” (p. 47). Authentic learning may provide such a path forward.
**Authentic learning defined**

With its roots in pragmatism (Elkjaer, 2008; Petraglia, 1998b), constructivism (Dewey, 1973; Kolb, 1984), situated learning theory (Brown, et al., 1989) and social-constructivist theory (Tudge & Winterhoff, 1993; Vygotsky, 1978; Woo, Herrington, Agostino, & Reeves, 2007), authentic learning occurs when learners are “engaged in an inventive and realistic task that provides opportunities for complex collaborative activities” (Herrington, Reeves, & Oliver, 2010, p. 1). Maina (2004) described authentic learning as having three key elements: [1] activities that mimic real world situations, [2] learning that takes place in meaningful situations that are extensions of the learner’s world, and [3] the learner being at the center of the instruction (p. 4). Lombardi (2007b) further explained:

> Authentic learning typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice. The learning environments are inherently multidisciplinary… authentic learning intentionally brings into play multiple disciplines, multiple perspectives, ways of working, habits of mind, and community. (p. 2)

Other researchers have described the long-term value and importance of authentic learning to the learner: Having an authentic learning environment and an authentic task shows students the relevance of what they are learning (Bennett, Harper, & Hedberg, 2002) and stimulates them to develop competencies that are relevant for their future professional lives (Gulikers, Bastiaens, & Kirschner, 2004).

**Models of authentic learning**

In the past several decades, different models of authentic learning have emerged with a range of variations on what is meant by “authentic.” Two models that emphasized the learning environment were described by Radinsky, Bouillion, Lento, and Gomez, (2001): the simulation model and the participation model. The simulation model emphasizes factual authenticity (the learning environment is as similar as possible to the real world), procedural authenticity (the process used is as similar as possible to the real world), and task authenticity (the tasks are similar to those done by practitioners). The simulation model uses practice fields that can be created in classroom or laboratory. Instead of creating a solution or product that can be used in real-life, the results are used as the basis for an assessment or grade (Barab, Squire, & Dueber, 2000).
The second model described by Radinsky, et al., (2001) was the participation model. In this model, factual, procedural, and task authenticity are supplemented with ecological authenticity that emphasizes the learners’ identification with members of the practicing community. This occurs when the learners are immersed into a real community of practice where they are confronted and challenged not just by simulations but also by the real world. To do this requires additional resources—time and travel for the learner as well as access and support from a real-life site or opportunity (Barab, et al., 2000).

Shaffer and Resnick (1999) also saw the importance of integrating factors that contribute to authenticity. In reviewing extant literature, they found four meanings of authenticity that were linked to pedagogy:

- activities aligned with the outside world
- assessment aligned with instruction
- topics aligned with what learners want to know
- methods of inquiry aligned with [the] discipline. (p. 197)

They concluded that these were not independent or used in isolation; rather, they argued for a “thick authenticity” that integrated the “personal, real world, disciplinary, and assessment” components (p. 210).

Renzulli, Gentry, and Reis (2004) described the use of authentic learning in a middle school setting. For these authors, authentic learning can be used to convey basic, foundational skills up through advanced content which can all be integrated into a useful, practical deliverable. Central in their model is the “real life problem” that has four criteria:

- a personal frame of reference that pulls the learner into the problem with an emotional or some other connection
- no agreed-upon solution or defined strategy for solving the problem
- a solution that can change actions, attitudes, or beliefs
- a real audience that will be targeted by the solution. (p. 74)
Based on an analysis of literature and research associated with situated learning and anchored instruction, Herrington (1997) developed, and later refined (Herrington & Oliver, 2000; Herrington, et al., 2010), a framework for authentic learning that included nine characteristics that they proposed could be used as design guidelines. Authentic learning

1. provides authentic contexts that reflect the way the knowledge will be used in real life
2. provides authentic activities
3. provides access to expert performances and the modeling of processes
4. provides multiple roles and perspectives
5. supports collaborative construction of knowledge
6. promotes reflection to enable abstractions to be formed
7. promotes articulation to enable tacit knowledge to be made explicit
8. provides coaching and scaffolding by the teacher at critical times
9. provides for authentic assessment of learning within the tasks.

Herrington and Oliver (2000) further defined the relationship among four constituent elements: the learner, assessment, task, and environment, a point elaborated by Barab, et al:

Authenticity [is] not in the learner, the task, or the environment, but in the dynamic interactions among these various components. Said another way, authenticity is manifest in the flow itself, and is not an objective feature of any one component in isolation. (Barab, et al., 2000, p. 38)

In the sections that follow, these four elements and their connections will be examined in more detail.

**Authentic environment**

The authentic environment incorporates all the elements that contribute to the authentic learning experience, including the authentic task or activity with the setting in which the task is performed, an authentic assessment, and the learner. Barab, Squire, and Dueber (2000) have noted, “In general, learning environments are considered authentic when there is a similarity between the structured learning activities and some meaningful
context for that activity” and “authenticity lies in the learner-perceived relations between the practices they are carrying out and the use value of these practices” (p. 38).

An authentic learning environment provides the participants the goals and stimulus for learning (Savery & Duffy, 2001) as well as the context for the authentic learning experience. Petraglia (1998b) said that the challenge is not providing learners with information or a structure of some sort in which to situate those facts; rather, it is creating a process that can help guide the learners and articulate their understanding of that information.

Having an authentic context answers the underlying question of why: “Why am I needing to learn this information in this particular way with these specific activities?” In authentic learning, context cannot be torn way from content (Barab, et al., 2000). They are two sides of the same coin. Lave (1988), for example, described the teaching of arithmetic (content) in a supermarket (context): learning about proportions, percentages, and units of measure were positioned in a real-life situation where people were immersed in solving problems that mirrored what they would do in their own lives. The context allows the learner to see the relevance and importance of what they are learning, making the lesson more interesting and meaningful (Gulikers, et al., 2004).

Having a learning problem set within an authentic context can support the learner’s motivation. Ryan and Deci (2000), in discussing internal and external motivation said, “because intrinsic motivation results in high-quality learning and creativity, it is especially important to detail the factors and forces that engender versus undermine it” (p. 55). Their view is that “many educational activities in schools are not designed to be intrinsically interesting” (p. 60) implying that often there is little within the activity that generates inherent satisfaction in the completion of the activity. In other words, “inauthentic” learning (be it in a classroom or mediated through technology) results in low satisfaction and low internal motivation. We can expect that more engaging learning activities will promote higher internal motivation. Supporting this expectation is work by Frankola (2001) who identified lack of motivation as a key reason for students dropping out of online learning courses. In contrast, highly immersive and authentic environments can motivate learners as they start learning content that may be unfamiliar and challenging (Herrington, Oliver, & Reeves, 2003a). Bennett, Harper and
Hedberg (2002) further confirmed that professionals working on real design problems were able to appreciate the complexities that occur in real life situations.

**Planning for an authentic learning context**

Herrington, et al., (2010) proposed three questions that should be answered in order to describe an authentic context:

- What knowledge, skills, and attitudes will students ideally have after completing the course?
- Where and how would students apply this knowledge in real life?
- What context might be possible and appropriate in an e-learning course to enable students to learn the knowledge, skills, and attitudes of the course? (p. 19)

This information could be acquired during a needs assessment and used when designing the learning solution.

Two key elements within an authentic environment that need to be explored in greater depth in relation to the research are the following: the authentic task or activity, and the setting in which that task or activity is placed.

**Authentic tasks and activities**

An authentic learning environment includes the tasks and activities the learner will perform. The emphasis is not simply on knowledge and skill acquisition—learning the facts and how to use the tools—but applying them in a true-to-life situation: “Recalling laws and manipulating symbols becomes a means, not the ends” (Clancey, 1992, p. 13). Here, within the task and its setting is where the learning is situated. Del Bueno (2005) cited that “only 35 percent of newly graduated nurses meet entry-level expectations for clinical judgment” (p. 278). Del Bueno reinforced this later as she said, “Knowing about does not equal making clinical decisions” (p. 281).

An authentic task or activity can be defined as a problem or challenge given to learners that has “real-world relevance and which presents a single complex task to be completed over a sustained period of time, rather than disconnected examples” (Herrington, et al., 2010, p. 21). Beyond the real-life experiences that authentic learning provides, there are at least two other benefits. First, authenticity promotes interactivity
(with the content, the task, and other people) and engagement (between the learners and the task) (Savery & Duffy, 1996). This, along with context (discussed above) helps the learners develop intrinsic motivation. Second, real-world tasks promote the acquisition of knowledge, skills, and attitudes that the learners will be able to more effectively and efficiently transfer when they encounter similar situations outside of a formalized learning environment (Herrington, Reeves, & Oliver, 2006b).

**Characteristics of authentic tasks**

Of all the elements that comprise an authentic learning environment, arguably it is the task that students complete that is most important (Herrington, et al., 2010). Authentic tasks and activities are at the heart of authentic learning, and the design of a meaningful activity to engage learners with the desired curriculum is paramount. In a deeper exploration of authentic learning elements, Herrington, Reeves, Oliver, & Woo (2004) explored the nature of authentic tasks, suggesting they

1. have real-world relevance
2. are ill-defined, requiring students to define the tasks and sub-tasks needed to complete the activity
3. comprise complex tasks to be investigated by students over a sustained period of time
4. provide the opportunity for students to examine the task from different perspectives, using a variety of resources
5. provide the opportunity to collaborate
6. provide the opportunity to reflect
7. can be integrated and applied across different subject areas and lead beyond domain-specific outcomes
8. are seamlessly integrated with assessment
9. create polished products valuable in their own right rather than as preparation for something else
10. allow competing solutions and diversity of outcome. (pp. 11-13)

Four other descriptors of authentic tasks have been described in the literature and confirm some of the characteristics listed by Herrington, et al., (2004): that they have
been chosen by the learner, the learner is committed to the task, the task is “messy” by design, and the activity has fidelity. These descriptors are described in more detail below.

**Activities chosen by the learner**
In her review of authentic learning articles selected by members of her university’s faculty as representing authentic learning, Rule (2006) observed that the first item on the list above, choice, contributes to the second, commitment. “Students are empowered through choice to direct their own learning in relevant project work” (p. 2). Maina (2004) also found that when performing activities that were of their own choice, students acquire more ownership of their education.

**Learner commitment to the task**
Renzulli, Gentry, and Reis (2004) identified another characteristic of the authentic task: learners need to have an emotional or internal commitment to it that goes beyond simply an intellectual interest. Rule (2006) developed this further when she argued that the authentic task can impact people beyond the students. By being part of a solution, students become “emotional stakeholders in the problem” (p. 2).

**“Messiness” of the task**
When describing or characterizing an authentic task or activity, most authors refer to having tasks and learning environments that are complex, not necessarily easy to perform, or that are, in other words, “messy” (Herrington, et al., 2010; Lombardi, 2007b; Rule, 2006; Savery & Duffy, 2001; Schön, 1987). Problems that can be solved with a formula or procedure are more suited for a simple training exercise (Renzulli, et al., 2004) while authentic problems are more akin to the true inquiry performed by the practitioners in the field (Reeves, Herrington, & Oliver, 2002). Problems faced by real practitioners “aren’t solved ‘by the book’… but by improvisation, inventing, and testing” (Schön, 1987, p. 5). The intent is to “have the learner ‘play the game’ of the expert, using content-knowledge as contextually appropriate, to recognize, pose, and solve authentic knowledge problems” (Wiggins, 1989, p. 47). By doing this, learners will be able to experience what it is like to work with—and be challenged by—different disciplines, multiple perspectives, various work methods. Learners will have an opportunity to see how data and formulae can become tools used in solving a problem (Lombardi, 2007b).
**Fidelity of the task**

The last characteristic of an authentic task that is of interest concerns fidelity: How real does the learning task need to be (Herrington, Reeves, & Oliver, 2007)? That is, how much—and in what ways—does the task and the setting where it performed need to authentically align with “real-life”? And what about “simulators”? Do they provide an authentic learning experience?

Simulation and simulators are becoming widely used in education particularly in areas such as the nuclear power industry (CASL, 2012; Janosy, 2011), aviation and aerospace (BBC, 2011; Gabbai, 2001), health care (Kunkler, 2006; Nehring & Lashley, 2009), and military (Dede, 2009; Swartout, Gratch, Hill, Hovy, Lindheim, Marsella, Rickel, & Traum, 2006). In all of these applications, the simulation “is a technique—not a technology—to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner” (Gaba, 2004, p. i2). The simulation is one where the user/learner can integrate theory and engage in deliberate practice (i.e., getting prompt, useful feedback) in a low-risk situation (Decker, Sportsman, Puetz, & Billings, 2008; Maran & Glavin, 2003).

“Simulators” can range from trained actors presenting themselves with illness-specific symptoms for assessment, to a virtual world created by computer, to haptic devices that allow the user to interact with tactile feedback. Simulations can be used for both instructional purposes and performance assessment and certification (Nehring & Lashley, 2009).

“Fidelity” is the term used to describe the degree to which the simulation replicates the physical and performance characteristics of the task (Maran & Glavin, 2003). Maran and Glavin cited the work of Miller (1953) who differentiated between engineering or physical fidelity that described the “degree to which the training device and environment replicate the physical characteristics of the real task” (p. 23) and the more important “psychological” or “functional fidelity.” This latter category being the “degree to which the skill or skills in the real task are captured in the simulated task” (p. 23).
It is easy to assume that the more real-life a simulation is, the better it is in terms of learning outcomes. Ironically, extreme verisimilitude or realism may be counterproductive in certain situations. In facing a highly realistic simulation, a novice may get lost in the complexity of the simulation (Alessi, 1988) and experience cognitive overload (Fadde, 2009). High fidelity is not always required. Indeed, effective transfer of learning from a simple paper and cardboard models has been shown to occur (Maran & Glavin, 2003). Research by Herrington, et al., (2007) proposes that the task design and engagement of the learners is more important than the physical fidelity. It is the “cognitive realism” of the learner’s performance that is important.

Simulations, in-and-of-themselves, are no guarantee of authenticity. For example, a business simulation may not be an adequate or correct representation of the real world; that is, it may not have “external representational validity” (Stainton, Johnson, & Borozicz, 2010). Simulations—particularly those produced using computer technologies—can be used to create and present an authentic learning task and environment. Authentic learning solutions, however, encompass other approaches and technologies as well.

Beyond simulations that may or may not involve environments created or augmented by computers, there are other types of authentic settings where learning can occur. Hunt (2006) discussed how academic institutions and workplaces can work together providing authentic activities and settings for learners through work-study programs. Field trips, such as those in which journalism students visit a major newspaper and talk to reporters and editors about their work (Sackstein, 2013) may be an authentic task if, for example, the student journalists write and publish their experiences in a school newspaper. Problem-based learning, used initially in medical schools, has a task (and often a setting) that is authentic: medical students are presented a patient with certain signs and symptoms for diagnosis which initiates student discussion and research (Savery & Duffy, 2001). The U.S. National Aeronautics and Space Administration (NASA) has created opportunities for students at schools to design experiments, allowing the students to actively collaborate with astronaut scientists (Chang, 2012).
**Authentic learning setting**

A factor that has an impact on the authenticity of the task or activity is the setting where the task takes place. The emphasis here is *where* the learning is to occur. Classrooms, the typical learning environment for students, are usually at the far “inauthentic” range of the authenticity spectrum (for example, students will learn about large animal physiology in a lecture hall). Maran and Glavin (2003) recommended improving the psychological fidelity of model-driven, engineering simulators by placing students into a realistic clinical environment so they are required to apply nontechnical skills (e.g., teamwork, inter-personal communications) in order to successfully complete the task.

There is evidence to show that immersive learning and where it happens can have an impact on brain processes. Specifically, the neurological impact of the learning setting on the brain was shown in a study by Morgan-Short, Finger, Grey, and Ullman (2012). Two groups of learners were both taught an invented language, one group learning in an explicit classroom setting, while the other group learned it in a more implicit, “immersive” or authentic setting. After five months of not using the language, both groups were tested and had similar proficiency in the language. However, neural studies showed that those who used the immersive learning approach showed more native-like processing that indicated that the type of training also affects achieving native-like language processing in the brain.

As the learner accomplishes the authentic task and creates a product that has utility and value, the task has another function: it can be used to assess the learner’s knowledge and skills (Herrington, et al., 2006b). How this is accomplished is discussed below.

**Authentic assessment**

One of the characteristics of an authentic task as described by Herrington, et al., (2006b) is that a task is seamlessly integrated with assessment. Professionals in the field of program evaluation generally differentiate between *evaluation* (of things) and *assessment* (of people) (Reeves & Hedberg, 2003).

Authentic assessment can be defined as “an assessment requiring students to use the same competencies or combinations of knowledge, skills, and attitudes that they need to apply in the criterion situation in professional life” with the “level of authenticity of an
assessment defined by its degree of resemblance to the criterion situation” (Gulikers, et al., 2004, p. 69).

While there are a multitude of approaches used in assessing learning—such as “traditional tests” like multiple choice, true/false, short answer, essay, and the like—two tenets of authentic learning related to assessment are

- the assessment method is seamlessly integrated with the authentic task, and
- an outcome of the authentic task is the creation of a “polished product” that has value in its own right (Herrington, et al., 2010, p. 48).

If these two principles are followed, the assessment approach used will be quite different from the traditional, tests mentioned above which are simplistic (but efficient) ways from which learning can be inferred, albeit with limitations in terms of relevance and predictive validity (Wiggins, 1990). The theoretical basis for the differences between traditional and authentic assessment that contribute to richer learning outcomes can be explained by examining Bloom’s Taxonomy.

Bloom chaired a committee of educators in 1956 that developed a handbook that could be used, among other things, “as a means for determining the congruence of educational objectives, activities, and assessments in a unit, course, or curriculum” (Krathwohl, 2002). What has become known as “Bloom’s Taxonomy”—a framework that was intended to help lecturers share test items—is the most enduring result of his work. In the early 2000s, the taxonomy was revised by Anderson and Krathwohl (2001) where, among other things, the language was made more consistent. Figure 3.1 shows a model of the revised taxonomy that (as with the original work by Bloom) applies to the cognitive domain of knowledge. The intent is, as learners gain more knowledge in a given content area, they can move upward in the pyramid, expressing or constructing their knowledge in more complex or sophisticated ways. Whereas Bloom had “evaluation” as the apex of his model, Anderson and Krathwohl placed “creating,” an action that connotes needing a broader set of knowledge, skills, and insight to produce something new.
In an authentic learning approach, the goal for the learner is to move to the higher levels of the pyramid—evaluating, generating, or creating something that is a robust integration of the knowledge and the critical thinking/problem solving skills associated with a specific topical area. More specifically, authentic assessment “requires students to demonstrate relevant competencies through a significant, meaningful, and worthwhile accomplishment” (Gulikers, et al., 2004, p. 69). If learners are to be assessed to see if they have acquired these higher, more sophisticated levels of learning, traditional assessment methods and tools that are more aligned with the lower levels (e.g., multiple choice, matching, true/false tests) will not be adequate. Gulikers, Bastiaens, Kirschner, and Kester (2006) said these “so-called objective, standardized test instruments… focus on measuring atomized bits of knowledge at the expense of more complex, higher-order knowledge and skills” (p. 382). It is more appropriate then to use more realistic and real-life, authentic assessment approaches (Herrington, et al., 2010; Mueller, 2005). Table 3.2 shows a comparison of traditional (or lower-level) assessment approaches to those that are more authentic (higher level). As Wiggins (1993) wrote, authentic assessments should be “engaging and worthy problems or questions of importance, in which students must use knowledge to fashion performances effectively and creatively. The tasks are either replicas of or analogous to the kinds of problems faced by adult citizens and consumers or professionals in the field” (p. 229).
Table 3.2. Comparison of approaches used in traditional and authentic assessments (Mueller, 2012)

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Authentic</th>
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<tbody>
<tr>
<td>Selecting a response</td>
<td>Performing a task</td>
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<tr>
<td>Contrived</td>
<td>Real life</td>
</tr>
<tr>
<td>Recall / recognition</td>
<td>Construction / application</td>
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<tr>
<td>Teacher structured</td>
<td>Student structured</td>
</tr>
<tr>
<td>Indirect evidence</td>
<td>Direct evidence</td>
</tr>
</tbody>
</table>

If an authentic assessment approach is to be used with the learner producing “polished products,” solving “worthy problems,” or answering “questions of importance,” how is this done? What should the assessment include? Gulikers, et al., (2004) identified five “dimensions” that an authentic assessment should incorporate:

1. **The task**—a problem that a professional would face in real-life.
2. **A physical context**—where and when the authentic assessment task is performed should be consistent with where, when, and how a professional would accomplish the task in real-life situations.
3. **The social context**—the involvement and collaboration with other people in the authentic assessment task need to reflect how the task is performed.
4. **An authentic product**—the output of the authentic assessment task is consistent that of a real-life product.
5. **Criteria and standards**—explicitly defining what attributes (criteria) the resulting product or performance is to have and the specifications (standards) to which result will be compared.

Herrington and Herrington (1998, 2006) proposed that the essential characteristics of authentic assessment could be conceptualized into four key factors:

1. **Context**—requires that the task and the conditions in which it is performed have fidelity with real-life and there is a strong connection between what is done in the learning situation and the real world.
2. **Student factors**—learners use higher-level problem solving and thinking skills as they spend considerable time producing a polished performance or product with others.
3. **Task factors**—the resulting product or performance is the assessment that involves many other tasks, steps, judgments, and responses.

4. **Indicators**—the results provide multiple ways to show the learners have acquired the knowledge, skills, and attitudes of a practitioner in a way that has validity, reliability, and can be consistently applied.

Creating authentic assessments that include these dimensions and factors entails situating the learner’s cognitive experience in an authentic activity (Brown, et al., 1989). Proper alignment between the objectives, content, as well as the authentic environment, task, learner, and particularly assessment (Herrington & Herrington, 2006; Reeves, 2006b) is essential for the authentic learning solution to be successful. Despite the front-loaded work required by the instructor to research, design, and develop the authentic assessments, a wide variety of examples have been produced.

**Examples of authentic assessments**

There are a number of examples of what authors claim to be authentic assessments of performances or products or blends of the two (Messick, 1994) that can be found on various websites (Edutopia, 2011; Mueller, 2012). In one specific domain, economics, a variety of online simulations exist where students, in grades ranging from Grades 3-12 to university levels, can create stock portfolios and compare their paper-returns—the resulting performance of their trading—with classmates and those at other schools (MarketWatch, 2014; Stock-track, 2013).

Messick (1994) provided guidance to help one determine if it is the **performance** or the resulting **product** that should be assessed: performance should be assessed if the task procedures are critical; the product should be evaluated if there are different but equally valid or acceptable ways of achieving the end result. To evaluate an assessment’s authenticity, Burton (2011) developed a framework of 10 yes/no questions, the results of which assessment developers can use in making changes so as to increase the authenticity of the assessment. Examples of questions that were recommended by Burton include the following:

- Is the student required to mimic a professional in the real world?
- Is the student required to complete the assessment task using resources similar to that in the workplace?
• Is the student required to complete the assessment task under realistic conditions? (p. 25)

When looking at specific authentic assessments, one can distinguish between what Cumming and Maxwell (1999) described as first order and second order expectations. First order expectations focus on the fundamental requirements of a task that indicate the learner has the intended knowledge and skills. Second order expectations refer to the context in which the knowledge and skills are displayed. Herrington and Herrington (1998) wrote of the importance of ensuring that the second order expectations are realistic so as to create a truly meaningful assessment. Cumming and Maxwell (1999) further cautioned the instructor to avoid making a traditional assessment “authentic” by simply including real-world elements in a tokenistic way, such as by using real names in a mathematics problem (e.g., “If Graham flew directly east of Toronto Pearson Airport at 600 km per hour on Air Canada Flight #241 and Colin flew directly west of Toronto at 400 km per hour on WestJet Flight #818, how far apart would they be after 75 minutes, assuming they left at the same exact time?”). The authors called this “camouflage” which they argue serves only to confuse and, in reality, make the assessment even less authentic.

With authentic assessment firmly aligned with the authentic task and the environment, there is another important component to examine in the authentic learning framework: the learner.

**The learner**

At the center of an authentic learning solution is the learner or student—the person who is developing expertise. But for whom is the assessment to be authentic? The designers? The teachers/facilitators? The experts? The student? Can an authentic learning system be truly authentic simultaneously to all stakeholders? Does it need to be? Does using an authentic environment and task in a learning situation render it inauthentic—similar to Heisenberg’s 1927 “Uncertainty Principle” which in essence says that the act of measuring something (a subatomic particle in Heisenberg’s case) affects the properties of that which one is measuring?
Petraglia (1998a) provided an example of what *could* be an authentic task—balancing a checkbook. This task may be authentic for a 21 year-old university student but not for a five-year-old. Additionally, what an instructional designer or teacher may create as an authentic task may not be viewed the same way as by an expert or a different expert in the field. Petraglia’s position was that authenticity is a “judgment rather than an objective state” (p. 60) and that learners may need to be “persuaded that they are participating in an authentic learning environment” (p. 60).

**Suspension of disbelief**

Herrington, Oliver, and Reeves’ (2003b) proposed that learners accept authenticity when they willingly suspend disbelief—the learners “buy-into” what they are experiencing even though they know it is not real. This suspension of disbelief requires a scenario or situation into which the learner is immersed, an authentic context, a role that the learner performs, and a significant problem that they are to solve. In interviews with teachers and students, Herrington, Oliver, and Reeves found that realism—high-quality photos or video—does not necessarily add to the suspension of disbelief—drawings and sketches can be just as effective. According to Herrington et al., some learners may resist suspending disbelief if these learners are rooted in a more traditional classroom/instructivist model.

It is the learner who, ultimately, has to make the decision if he or she accepts the authenticity of the environment, task, and assessment: “The learner chooses whether their learning will be authentic or inauthentic. That is, whether they will be open, present in their being and approach learning in an attitude of care” (Ashton, 2010, p. 16).

As was argued earlier, one of the learner benefits of an authentic task is increased motivation, which is discussed in more detail below.

**Factors affecting motivation**

In examining how children were taught to read, Turner and Paris (1995) found that literacy tasks that were “open”—where students were able to set their own goals, develop and use their own process, and assess the final results—were much more motivating and engaging than “closed” tasks which were characterized by highly
specified outcomes with students having very little control (p. 644). They identified six features of motivating tasks:

- **Choice**—students select what they want to read and write about what they were interested in
- **Challenges**—the most motivated students were involved in moderately challenging activities where they were learning new things and coming up with new understandings
- **Control**—students and teachers sharing control with students thinking strategically, making decisions that were in support of the desired outcomes
- **Collaboration**—students working together with their peers, sharing ideas, observing others, and helping each other
- **Constructive comprehension**—students making sense of what was presented to them, making meaningful interpretation of the information
- **Consequences**—tasks not necessarily having one “right” answer. If students took a path that was not productive, they could go back and try another, learning from their “error.”

Turner and Paris’ (1995) list can be compared to the characteristics of an authentic learning task as described by Herrington et al., (2006b), see Figure 3.2. In this figure, the relationship of the motivating task factors of Turner and Paris and the authentic task design principles of Herrington, et al., (2006) are side-by-side with connections between both sets of factors. Some factors have at least two connections. For example, “challenge” is a learner motivator in an authentic setting because the task has real-world relevance and would be considered to be complicated, requiring time and effort to solve. In a similar way, “collaboration” is a learner motivator because of the task needing to be accomplished with others (see the discussion on community of learners below) who may provide diverse opinions based on their vantage points—all of which can contribute to equally valid ways of achieving the solution to the problem. “Constructive comprehension” occurs in the process of constructing a mental model and actual product and through reflection of various types.
Impact on the learner

If the purpose of utilizing an authentic learning environment, task, and assessment is to have learners collaboratively acquire the relevant cross-functional knowledge, skills, and critical thinking (Windham, 2007) that are similar to what an expert in a given field uses, what impact does this have on the learner? One impact is that authentic learning puts the learner in the role of a practitioner: “Learning thus implies becoming a different person with respect to the possibilities embedded by these systems of relations. To ignore this aspect of learning is to overlook the fact that learning involves the construction of identities” (Lave & Wenger, 1991, p. 53). Ashton (2010) quotes Fromm (1976) saying, “learners ‘do not simply acquire knowledge that they can take home and memorize. Each student has been affected and has changed’” (p. 13). Ashton proposed that in authentic learning, learners “are ‘disturbed’ by new things or ideas—it shakes them up” (2010, p.10).

Once learners accept the authenticity of the environment and task and are motivated to accomplish the task, they begin to change: they evolve from being simply students to practitioners who are gaining expertise. They have taken considerable time and been involved in creating a polished product that has real-world relevance. In doing this, however, they are not working independently. They are working with others, including
more knowledgeable others (Vygotsky, 1978), such as other learners or instructors and mentors. The role of instructors and mentors in helping the learner become an expert through authentic learning is discussed next.

**The role of the instructor or mentor in an authentic learning system**

A misconception of authentic learning is that students are put into learning situations, given complex tasks to complete, and then left to sink or swim on their own (Herrington, et al., 2010). Instead, what happens is that the role of the instructor in authentic learning situations is significantly different from that which is seen in a strictly didactic model of instruction. In an authentic learning approach, the instructor moves from the all-knowing "sage-on-the-stage" to a role that is more consistent with the master-apprenticeship relationship. The instructors guide a less experienced learner through complex problem solving (Petraglia, 1998a). They demonstrate, advise, question, and criticize the learner (Schön, 1987). Schön provided an extended example of an experienced architect working with a student, going through multiple attempts in solving a design problem and then, finally, intuitively, realizing that the best solution had been found. Collins, et al., (1987) provided a similar example of a mathematician and student trying various approaches and struggling before coming up with a valid mathematical solution. They conclude:

> Seeing how experts deal with problems that are difficult for them is critical to students' developing a belief in their own capabilities. Even experts stumble, flounder, and abandon their search for a solution until another time. Witnessing these struggles helps students realize that thrashing is neither unique to them nor a sign of incompetence. (p. 11)

The role of the instructor/mentor changes yet again when e-learning is used as the delivery tool. Effective instructors/mentors need to demonstrate a high social presence (Tu & McIsaac, 2002) as they interact with learners with responses to postings and emails. Frankola (2001) stated that timely personal feedback from the instructor is critical in preventing e-learners from dropping out of a course. The instructor/mentor also has a leading role in keeping the learning environment (whether real or virtual) a safe place for all participants (Wang & Reeves, 2007). This includes recognizing that ethnic and cultural differences affect how people interact using asynchronous networks. Sedef and Uzuner (2009) gave examples of how non-native language speakers, males
and females, and those of Arab and Asian cultures communicate and participate
differently from their North American and European peers.

Another responsibility of the instructor/mentor is to provide support or “scaffolding” to
the learner. This, in part, can be done through the selection and arrangement of the tasks
the learner executes (discussed below as part of instructional design) but also in the
guidance the instructor/mentor provides. “The student cannot be taught what he needs to
know, but he can be coached” (Schön, 1987, p. 17) particularly because much of what
the coach has is tacit knowledge that is difficult to put into words. As such, expertise is
transferred through socialization and practice (Brown & Duguid, 1998; Hildreth &

The skilled instructor/mentor who provides the appropriate level of support and the
learners who participate in an authentic environment are part of a larger system. For an
authentic learning event (as well as all other types of learning activities) to be successful,
all the various elements in the system need to be intentionally designed and produced
with careful consideration given to the goals, requirements, and constraints of the
learning context. This can be achieved through instructional design (Dick, et al., 2008).

The criticality of instructional design

Putting together the authentic environment, the authentic task/activity, the authentic
assessment, and the roles of the learner and instructor/mentor is the province of the
instructional designer.

The designer of an authentic learning solution can work from a well-known, generic
ADDIE (Analysis, Design, Development, Implement, and Evaluate) process (Branch,
2009), a systems approach (Dick, et al., 2008), or one of the other processes like Rapid
Prototyping (Tripp & Bichelmeyer, 1990) or Backward Design (Wiggins & McTighe,
2005). Regardless of the process used, the designer of an authentic learning solution
must integrate the key characteristics of an authentic situation into the solution.
Herrington, et al., (2010) provided two approaches for creating an authentic learning solution. The first includes the use of the nine elements of authentic learning as heuristics that designers can check as they create their learning environments:

1. Create the authentic context.
2. Create the authentic task.
3. Define the expert performances and provide modeling of those activities.
4. Provide for multiple roles and viewpoints.
5. Provide opportunities to construct knowledge.
6. Provide opportunities for learner reflection.
7. Provide opportunities for articulating what was accomplished and learned.
8. Include ways for coaching and scaffolding.
9. Include an integrated authentic assessment.

The second approach suggested by Herrington, et al., (2010) has the designer examining the learning tasks, the learning resources, and the learning support in a more holistic, integrated way. Figure 3.3 shows elements that result by using this approach.

In addition to the recommendations above given to designers of authentic learning solutions, the next section considers how people move from competent to expert performers and the kind of additional guidance this can provide to instructional designers as they create authentic tasks that embed authentic assessment.
Moving from competence to expert performance

In the earlier discussion on expertise, deliberate practice (Ericsson, 2006) was examined along with the importance of the expert-in-training developing a repertoire of experiences (Klein, 2004) in a stable, predictable environment with the opportunity to learn with feedback (Kahneman, 2011). Expert performances that involve recognition, decision, and action/reaction skills require recognition-primed decision-making based on the expert detecting and discerning critical attributes of the situation (Fadde, 2009). Fadde proposed an instructional design model that designs “representative tasks to train expert recognition skills…by repurposing the types of tasks designed to measure [this type of] expertise in laboratories” (p. 360). There are four steps in creating a recognition-skills training program:

1. Locating the recognition aspect of a reaction performance skill.
2. Devising tasks to test and/or train the recognition sub-skill.
3. Conducting a systematic recognition training program.
4. Enhancing and evaluating transfer of training using performance-based tests. (pp. 369-370)
While this approach may be useful for developing a type of expertise, it is also interesting because it shows the value of alignment between an authentic task, authentic assessment, and real-life application. Fadde’s four-step process meshes with recommendations given by Herrington, et al., (2010).

Another consideration for the instructional designer is the delivery approach that will be used, for example creating an authentic learning solution in classroom environment or using a technology-based platform. These may give additional—or at least different—possibilities and problems to the designer.

**Designing a technology-based authentic learning solution**

Computers, telecommunications and the internet, along with its near-global availability allow for authentic learning environments, tasks, and assessments to be developed and used more easily and by more people than ever before (Herrington, et al., 2010; Kreijns, Kirschner, & Jochems, 2002; Wang, Ran, Liao, & Yang, 2010). Wang and Reeves (2007) suggested five other considerations for designers of collaborative learning:

- language, writing structures, and writing styles
- media such as illustrations, photos, and video
- reasoning pattern differences
- availability of technological infrastructure
- familiarity with the technology to be used.

It is the instructional design process that creates the “blueprint” that will be used in developing and implementing the authentic solution. As discussed above, for the authentic learning solution to be effective, the environment, task, assessment, learner role(s), and the instructor involvement must be carefully considered and crafted.

**The spectrum of an authentic learning solution**

Authentic learning should not be considered in an either/or context: either an authentic learning solution having an environment, task, and assessment that meet all the criteria earlier mentioned are present or they are not. For the elements that comprise an authentic learning solution, Herrington, et al., (2010) identified characteristics that were the endpoints on a continuum of authentic activities rather than a yes/no checklist. Table 3.3 presents an example of the continuum regarding authentic tasks. The goal then, in
creating an effective authentic learning solution, is to move each of the principles shown in Table 3.3, as far to the right as possible.

Table 3.3. Continuum of authenticity in designing instructional tasks (Herrington, et al., 2006b)

<table>
<thead>
<tr>
<th>Non-authentic task</th>
<th>Design principle</th>
<th>Authentic task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decontextualized or classroom based</td>
<td>Have real-world relevance</td>
<td>Match as close as possible the real-world tasks of practicing professionals</td>
</tr>
<tr>
<td>Easily solved by applying existing algorithms</td>
<td>Are ill-defined</td>
<td>Learners must identify their own unique tasks and subtasks</td>
</tr>
<tr>
<td>Completed in minutes or hours</td>
<td>Are comprised of complex tasks to be completed over a period of time</td>
<td>Completed over days, weeks, and months; require investment of considerable time and intellectual resources</td>
</tr>
<tr>
<td>Task examined from one point-of-view, using reference material provided</td>
<td>Provide opportunities to examine the task from different perspectives with a variety of resources</td>
<td>Task examined from a variety of theoretical and practical perspectives and using a variety of references including those not provided</td>
</tr>
<tr>
<td>Task performed by individual learner</td>
<td>Provide opportunities for collaboration</td>
<td>Task requires involvement of others</td>
</tr>
<tr>
<td>Learner does not look back on what happened and consider what could be learned</td>
<td>Provide opportunities for reflection</td>
<td>Learners – individually and together – are encouraged to look back on what happened and see what can be learned</td>
</tr>
<tr>
<td>Task focuses on one single domain or field of practice</td>
<td>Can be integrated and applied across different subject areas and lead beyond domain-specific outcomes</td>
<td>Tasks encourage interdisciplinary perspectives and enable diverse roles and expertise</td>
</tr>
<tr>
<td>Separate, artificial assessments</td>
<td>Are seamlessly integrated with assessment</td>
<td>Assessment strategy in integrated in the task and reflects real-world practice</td>
</tr>
<tr>
<td>Exercise or sub-step in preparation of something else</td>
<td>Create polished products valuable in their own right</td>
<td>Tasks culminate in the production of a whole, useful product</td>
</tr>
<tr>
<td>Single, correct response</td>
<td>Allow competing solutions and diversity of outcomes</td>
<td>Range and diversity of multiple original outcomes</td>
</tr>
</tbody>
</table>

From the authentic learning tasks, the learner gains domain-specific knowledge and skills—not only the explicit “whats” and “whys,” but also, because of the hands-on nature of the learning, the “knowing in action” described by Schön (1987) and the difficult-to-communicate “tacit knowledge” (Nonaka, 1994). Additionally, the learner acquires a set of “portable skills” (Lombardi, 2007b) that can be used in a variety of endeavors, such as:

- judgment to distinguish reliable from unreliable information
• patience to follow longer arguments
• synthetic ability to recognize relevant patterns in unfamiliar contexts
• flexibility to work across disciplinary and cultural boundaries to generate innovative solutions (p. 3).

Criticisms of authentic learning
As the literature about—and the use of—authentic learning has expanded in the past years, so have critiques of the model and some of its foundational theories, such as constructivism and social learning. Two particular criticisms are discussed below.

Oversimplification of the authentic task
In a dissension to one of the characteristics of an authentic task, specifically that it be complex and require a significant amount of sustained effort to accomplish (Herrington & Oliver, 2000), van Merriënboer and Brand-Gruwel (2005) wrote that “authentic tasks must be carefully sequenced from simple to complex, that these tasks need to be performed in environments that gradually increase fidelity” (p. 414). Herrington, Oliver, and Stoney (2000) had earlier cautioned against oversimplifying content in initial learning events because this could be a barrier as learners move further into a complex topic. The authors cited examples of how misperceptions on the part of medical students were rooted in oversimplification of information that was initially presented. Instead of relying on simplification to make content more accessible to a learner, they pointed to methods of supporting the learner in the authentic environment, for example, by limiting options for a new user of an e-learning program, and then gradually making a wider set of options available.

van Merriënboer and Kirschner (2007) developed a different approach regarding the design of almost any learning solution that emphasizes the sequencing of activities or core “real tasks” that a person would perform. While each task is a complete “real-life” task set in a real (or simulated) context/environment, simpler ones are performed first giving the learner confidence and providing scaffolding for more complex tasks. Their emphasis does not seem to be oversimplification, but rather strategically sequencing what the learner does, akin to a master assigning a simpler project to an apprentice first or a ski instructor starting the novice skier on a “bunny hill” before attempting a steep
run (Burton, et al., 1984). The key difference in more complex, and higher-order authentic learning environments is that the learner has a role in determining the method of solving the problem or creating the end product, rather than simply following the ‘carefully sequenced’ instructions created by the instructor (Herrington, Reeves & Oliver, 2014).

**Preauthentication**

In examining how constructivism is misapplied when producing an authentic learning solution, Petraglia (1998a) used the term *preauthentication*, which he described as educational technologists “creating problems and environments that *they* have determined to be authentic” (p. 59, emphasis added) as a practice that views the learner as “uncomplicated, inexperienced, and complacent” (p. 60). One way for the learner to accept a situation as authentic, as discussed earlier, would be to create an authentic situation and task that allow the learner to suspend disbelief, an approach that Petraglia supported. The more fundamental issue that Petraglia focused on with preauthentication was the process of “creating problems and environments,” implying that the educational technologists created them in isolation, solely on their own view of the problem.

Herrington, et al., (2006b) pointed to design-based research as a model for developing authentic learning solutions which “involves intensive collaboration between researchers and practitioners” (p. 99), who would have first-hand, practical knowledge and experience of what “authentic” looks and feels like. Preauthentication, wherein a team of practitioners creates a valid authentic experience, then, could arguably be recast not as a negative, but rather as a positive characteristic that could contribute to the learners’ success when they have completed the authentic activity.

In the initial description above of authentic learning, one of the characteristics identified by Herrington and Oliver (2000; Herrington, et al., 2010) was that of an authentic learning solution, which provides opportunities for collaboration between learners and enables a more varied and robust construction of knowledge and a finished, useful product. To achieve effective collaboration and learning amongst the learners, it is useful to explore this area in more detail. This is done in the following section that focuses on the third and final learner theory examined in this chapter: community of learners.
Theory 3: Community of learners

*Community of learners* and *learning community* are terms commonly considered synonymous but they have definitions that vary due to the perspective that authors wish to emphasize. Brown and Campione (1996) proposed that the fundamental activities of a community of learners are to conduct research, share outcomes, and perform a consequential task. Perry and Edwards (2010) defined an online learning community as a “shared culture in the online classroom, including shared values, norms, and beliefs” (p. 132). Boyer (1995) said that a community of learners shares a “purpose, good communication, and a climate with justice, discipline, caring, and occasions for celebration” (p. 20). Other writers, for example McLoughlin (1999), used the term *community of learners* in the context of providing a learning environment and solution that meet the needs of a diverse group of learners, whether geographically or culturally dispersed.

Another way to understand a community of learners is to use an ecologist’s definition of community: “A group of interdependent organisms inhabiting the same region and interacting with each other” (Wiktionary, 2014). This view emphasizes the concept of learners working together for the benefit of all. The “same region” could be interpreted as either a shared geographical location or a virtual connection that links the learners.

Indeed, communities of learners can exist as a study group in a dorm or library study room that may be “self-organized” (Amhag & Jakobsson, 2009, p. 656) to “an intentional structuring of the students time, credit, and learning experiences to build community, and foster more explicit connections among students, faculty, and disciplines” (Smith, 2001, p. 5). A distinguishing aspect of a community of learners is that whether they self-organize or are randomly or selectively placed into a team, the members actively learn through cooperative and collaborative communication and activities (Biasutti, 2011) that are described in more detail below. Additionally, when a learner is more academically and socially involved with other learners (and instructors), the more persistent the learner is (Tinto, 1998).

How does a community of learners differ from a community of practice? Wenger (1998, p. 45) described a community of practice where “collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations. These practices are thus the property of the community created over time by the sustained
pursuit of a shared enterprise.” Wenger later said that a community of practice “includes learning, not only as a matter of course in the history of its practice, but at the very core of its enterprise” (p. 215). Learning occurs in both communities of practice and communities of learners, but “the enterprise” of a community of practice is to help the community member to develop an identity: “we accumulate skills and information, not in the abstract as ends in themselves, but in the service of an identity” (p. 215). But the benefits go beyond just learning: Ravi (2001) summarized some of the additional advantages found in a community of learners, such as increased persistence in courses, an increased flow of information, cooperation among group members, heightened sense of engagement, and feelings of less stress.

What makes a community?

Several researchers have identified several distinguishing characteristics for a successful community of learners. In their research on communities in general, McMillan and Chavis (1986) identified four elements of a community: (1) membership—“a feeling of belonging,” (2) influence—a sense the “individual makes a difference to the group” and the group makes a difference to the individual, (3) reinforcement—“fulfillment of needs,” and (4) “shared emotional connections” (p. 9). Two other important characteristics, collaboration and cooperation (Paulus, 2005), refer to how the learners work together in their learning enterprise:

- Collaboration occurs through the “interactions of individuals with other individuals” and as “individuals exercise, verify, solidify, and improve their mental models through discussion and information sharing” to construct a shared understanding. The more knowledge that is shared, the more that is learned (Leidner & Jarvenpaa, 1995, p. 268). When collaborating, two or more people are sharing in their creation of a product (Schrage, 1990).

- Cooperation is when members of the group take a task and divide it so different members can individually complete the subtasks (Henri & Rigault, 1996). Nam and Zellner (2011) identified three components of cooperation: (1) positive independence, involves each learner realizing every member of the learning community needs to succeed if the community is to succeed; (2) individual accountability is when the success of one individual is shared fairly with other
members of the community; and (3) group processing is when the members of the learning community evaluate the members and outputs of the group in order to make improvements to the group’s activities.

In addition to how learners work together in their community are additional factors that affect the overall success of the community. Of particular interest in this research is a community of learners that is linked together through technology.

**Success factors for an online community of learners**

A community of learners can exist physically or virtually, the latter being connected through computer mediated communication (CMC). Because of the growing use of e-learning, online communities of learners has been the subject of increased research.

To create a successful online community of learners, that is, a situation in which the desired outcome of learning and the additional benefits described above can occur, several factors must be present. As described below, some contributors to success are external to learners while other contributors are internal.

**Retention of community members**

If a community of learners is to be successful, the learning environment (whether online or face-to-face) needs to first acquire and then retain learners in that community. Frankola (2001) cited literature reports where dropout rates for online learners ranged from 20 to 50 percent and were 10 to 20 percent higher than dropout rates of face-to-face courses. MOOCs, or massive open online courses, have shown to have even higher dropout rates: in a review of 16 of its courses offered as MOOCs, the University of Pennsylvania found that an average of four percent of those starting the courses actually completed them (PennGSE, 2013). Frankola (2001) identified reasons for attrition in more traditional e-learning programs that are internal and external to the learners, such as

- learners do not have enough time
- lack of management oversight
- lack of learner motivation
- technical problems
• lack of learner support
• individual learning preferences
• poorly designed courses
• substandard/inexperienced instructors.

Besides these reasons for learner attrition, success factors have been identified that are important in preventing attrition of learners. These are internal individual learner characteristics, such as self-regulation, self-direction, mastery orientation, and self-learning—four factors described below in more detail.

Online learning is often touted as being available when and wherever the learner has the opportunity of taking advantage of it; however, the learner must have the motivation and discipline to engage with it in substantive ways. Salomon and Almog (1998) argued that in constructivist, technology-intensive learning environments, learners must be “self-regulated” and “much of the responsibility for learning is shifted over to the learners, either individually or in teams, while teachers’ control is relatively weaker than in more traditional learning environments” (1998, p. 237). Additionally, the online learners need to be able to self-monitor their behavior.

Learners need to be self-directed (Chang, 2006) which Chang defines as

Learning something proactively, independently, and patiently; being responsible to learn; learning which is a challenge; a self-training ability; high curiosity; intense impetus to learning; self-assurance; enabling a fundamental learning skill; scheduling time for learning; and planning the integral learning and enjoying learning toward an objective. (p. 269)

Additional characteristics of a successful user of distance learning tools such as the one described here include “mastery orientation…emphasizing comprehension over performance” (Salas, Kosarzycki, Burke, Fiore, & Stone, 2002, p. 144).

Often, however, those involved in e-learning lack the ability to self-learn. Because many learners have only had traditional classroom experiences, they are not prepared to function in a distant e-learning environment (Rossett & Schafer, 2003). Rossett and Schafer suggested the use of a simple questionnaire so that potential distance e-learners can determine if they have the qualities to be successful. This tool can also help communicate the expectations that the course sponsor has for the learner.
Other factors that contribute to a successful community of learners

Social presence. Another significant area of interest for a community of learners is centered around the theory of social presence which was first defined as “the degree of awareness of another person in an interaction and the consequent appreciation of an interpersonal relationship” (Short, Williams, & Christie, 1976, p. 65). Garrison (1997) defined social presence as the “degree individuals project themselves through the medium verbally or nonverbally” (p. 6). Perry and Edwards (2010) concluded that the interaction of learners in an online learning environment is connected to the “experience of social presence” (p. 132). They described designs and methods that can be used to facilitate interaction and social presence, strengthening a community of learners. As is discussed in more detail below, social presence is influenced by factors both external and internal to the learner.

In their original work, Short and colleagues (1976) examined different types of person-to-person interactions: face-to-face, video, and audio (e.g., telephone), and proposed that these media would provide different levels of social presence. If a medium like video had a high level of social presence, those using it would be judged as being more social or warmer than those using a medium like audio where fewer “cues” were available to those on the receiving end of the communication (Lowenthal, 2009). Two key parts of social presence that were identified were intimacy (e.g., eye contact, physical proximity, and the topic being discussed) and immediacy (defined as the psychological distance that separates parties involved in a communication) (Tu & McIsaac, 2002). How these factors are accomplished in an online course differ significantly from a traditional classroom. Nevertheless, they have a critical role in achieving “community,” in part because of their reliance on technology.

Work by Tu and McIsaac (2002), using quantitative and qualitative methods, identified four dimensions that positively influence social presence. Figure 3.4 illustrates these dimensions along with variables that have a positive effect on them. The dimensions are affected by

- underlying technology and technological environment (e.g., some types engendering a more positive or negative response, due, in part to ease-of-use; affordances; availability and location of equipment)
• design of the course (e.g., selection of group size for learning activities and tasks)
• characteristics, skills, and attitudes of the participants (e.g., keyboarding and literacy skills, timely response to messages)
• characteristics, skills, and attitudes of the facilitator/instructor (e.g., communication strategies, informal conversation style).

![Diagram of social presence dimensions and variables](image)

**Figure 3.4.** Dimensions and variables that have a positive effect on social presence (Tu & McIsaac, 2002)

Individuals involved in an online community of learners face particular challenges as they work together to accomplish a task or assignment. Koh and Hill (2009) identified strengths in online group work, such as flexibility, convenience, and the application of critical thinking and reflective skills, but the authors also pointed out weaknesses that
are inherent in group work. These included participants not having a sense of real community, a lack of connectedness among participants and between participants the instructors, and delays in communication caused by the asynchronous nature of postings and emails. These weaknesses can be overcome by the design of the activities, the engagement of the learners and instructors, and by an increased social presence of all participants.

Beyond the factors mentioned above that contribute to the success of a community of learners are three fundamental elements that connect the members of the community to each other: safety, respect, and trust.

**Safety, respect, and trust**

Several authors (Quan-Haase, 2005; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006; Tu & McIsaac, 2002) have identified trust as a critically important element in a community of learners. Taylor (2002) put it simply: “Collaborative teamwork is too risky to happen without a culture of trust. [The learners] must believe it will be OK if they make a mistake or try something new and it doesn’t work out” (p. 43). In order to establish a culture of trust within a community, learners must feel that they are participating in a safe, reliable learning environment in which they can work and communicate (Bruffee, 1993; Hill, 2002).

Based on surveys, Tu and McIsaac (2002) found that for students working in a CMC environment, developing and maintaining trust takes more time and effort. Kilpatrick, Barrett, and Jones (2003) said that respecting the diversity of those in the community of learners contributes to learning because of a climate of trust and the encouragement of risk taking. Conversely, learners who feel less comfortable and safe in a learning community are those who contribute less in various forms of communication (Haythornthwaite, Kazmer, Robins, & Shoemaker, 2000).

An important element in developing a safe community of learners includes establishing either formal or informal boundaries that separate who is in and who is not in a community (McMillan & Chavis, 1986). The benefit of defining participants is a sense of emotional security for those within the community that contributes to freedom to share needs, feelings, and personal/intimate information. Also contributing to safety is...
when there is respect and sensitivity for different cultures, or what has been described as cultural competency (Grote, 2008), which is defined as “a set of congruent behaviors, attitudes and policies that come together in a system, agency or professional and enable that system, agency or professional to work effectively in cross-cultural situations” (Cross, 1988, p. 1).

**Multi-culturalism**

Beyond participants and instructors having cultural competency, there are factors in the design and implementation of the authentic learning solution itself that broaden its appeal to different cultures, an important consideration as the growth in e-learning is happening not just in Europe and North America but world-wide. This means that, in the broadest sense, the community of learners is becoming more and more diverse in terms of nationalities, backgrounds, and culture (Wang & Reeves, 2007). E-learning solutions need to contribute by educating learners to appreciate and empathize cross-culturally. The current understanding of culture extends beyond the writing of Hofstede (1980) who considered a person’s “culture” to be primarily limited to the person’s nationality and ethnic origins. Today, culture is seen more broadly, requiring an e-learning design team to be much more aware and attentive to potential sensitivities (Branch, 1997). For example, e-learning designers need to be mindful of factors like interface structure, icons, color, tasks, internal/external support, and examples (Chen, Mashhadi, Ang, & Harkrider, 1999; McLoughlin & Oliver, 2000; Wang & Reeves, 2007). Ke and Chávez (2013) discussed the relative lack of empirical research on older and “nontraditional” students (i.e., adults over 24 years old who are typically employed) and their approach to web-based e-learning. Specifically they cited the value of having shorter modules or lessons, allowing more flexibility, and having real world examples and activities.

There is one last category of external factors that has a significant influence on the community of learners and their retention in that community: the role of instructors/mentors.
Instructos/mentors

In creating and maintaining a community of learners, a critical factor external to the learners is the instructor. Garrison, Anderson, and Archer (2000) noted that learners and instructors act together in forming a community. One of the ways this is accomplished is through “teaching presence—the core roles of the online instructor” (Shea, Swan, Li, & Pickett, 2005 p. 175). In particular, they found that “directed facilitation” (p. 59)—meaning that the instructor has a strong and active presence in discussions, for example—corresponds to learners’ feelings of connectedness and learning. Instructor presence could help overcome what Lee and McLoughlin (2010) identified as special challenges facing distance learners using web technology. These included, “lack of feedback and instructor contact, … feelings of isolation and alienation, … lack of experience in studying at a distance, and lack of technical training in using the technologies involved with web-based learning” (p.65). The authors discussed that physical separation prevents in-person connections and contacts that reduce learners’ motivation and enthusiasm.

Criticism and limitations of community of learners

Criticisms concerning community of learners are related to its underlying foundation, specifically social learning theory. Two particular criticisms that are meaningful in this research are presented below.

Probabilistic learning

One criticism aimed at the community of learners theory is that if small groups or teams are learning together, the learning outcomes are not predictable but rather probabilistic (Kirschner, et al., 2004). In an authentic learning solution, when teams are working on the same authentic task assignment, and since there may be different potential solutions for that task (Herrington, et al., 2006b), different teams may learn and apply different facts and skills. While some may see this as a negative, others see this as something very positive and beneficial: one learns more than just the objectives—for example, critical thinking, problem solving, acquiring the values of an organization (Salas, et al., 2002). Thus, the learning from team to team and individual to individual will not be consistent. “By functioning in an activity, participating in its meaning, people
necessarily make on-going contributions whether in concrete actions or in stretching to understand the actions and ideas of others” (Rogoff, et al., 1995, p. 53).

Wiggins (1989), one of strongest proponents of authentic assessment, takes the position that it is impossible to cover all the objectives in a given course, particularly through didactic instruction. Instead, his emphasis is on having students, through authentic learning activities, develop skills in asking questions: “One therefore learns self-confidence as a student only by seeing that one’s questions, not one’s current store of knowledge, always determine whether someone becomes truly educated” (p. 48). The questions that each person and each small group raise can be different based on previous experiences and points-of-view. Sharing these different outcomes and experience between team members could be creatively done through articulation.

**Preferring to work alone**
A community of learners has another limitation: some people prefer learning and working on their own and not as part of a group or community. Jung (Casement, 2001; Jung, 1921) identified two attitude types, introversion and extraversion as well as two additional dimensions in his descriptive system. (Myers and Briggs added a fourth category and developed a testing instrument known as the Myers-Briggs Type Indicator Assessment (Quenk, 2009) that is based on Jung’s work). Jung’s dimensions have also been incorporated into descriptions of learning styles (Coffield, Moseley, Hall, & Ecclestone, 2004; Pritchard, 2014) and in prescriptions of how to most effectively teach students who have different learning styles (Brightman, 2013; Coffield, et al., 2004).

While those who are introverts can often adapt and function with extraverts, it requires mental discipline and energy (Cain, 2012). In an academic setting, getting introverts to work in group or team activities can be a difficult challenge but a grading method that includes group participation is seen as a key motivator (Felder & Brent, 1996). In other team-based projects, having ground rules that promote participation by all members by encouraging those who are more introverted, and moderating the participation of extroverts, can benefit introverts and the functioning of the team (Levasseur, 2011).
Conclusion

This literature review began by examining expertise, focusing on what it is and how someone, by building a large repertoire of experiences, develops intuition and analytical skills in a particular domain which is the hallmark of an expert. In order to create a path for developing expertise in the handling of time- and temperature-sensitive pharmaceutical products, three learning theories—cognitive apprenticeship, authentic learning, and community of learners were explored along with their underlying roots in constructivist, social, and situated cognition theory.

From a broad examination of these theories in the literature, a more in-depth and targeted review of key research was conducted in order to obtain draft design principles to inform the design of the learning solution. This review and the resulting design principles are presented in the following chapter.
CHAPTER 4

Design principles

Introduction

One of the characteristics of design-based research, as discussed in Chapter 2, is that it incorporates into the learning solution known design principles that are extracted from the literature, and hypothetical design principles based on the researcher’s explorations (McKenney & Reeves, 2012). In this chapter, initial or draft design principles identified from a targeted literature review are listed and described in detail. These guiding principles are grouped by the three learning theories of particular interest that were examined in the Literature Review (Chapter 3).

Cognitive apprenticeship

The definition of cognitive apprenticeship is a domain that enables students to acquire, develop, and use cognitive tools in an authentic domain activity (Collins, et al., 1989). Design principles have been identified from a wide body of literature (described in Chapter 3) and further refined to create guiding principles for the design of a learning intervention that might address the problem area described in Chapter 1.

Table 4.1 lists the draft design principles related to cognitive apprenticeship (in Column 1), together with the source from the literature (Column 2), and the relevance and meaning of each as it relates to this research (Column 3).
Table 4.1. Draft design principles related to cognitive apprenticeship

<table>
<thead>
<tr>
<th>Draft Design Principle</th>
<th>Source/Reference</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anchor and index knowledge in the context in which the learning occurs.</td>
<td>(Collins, et al., 1989) (Ghefaili, 2003) (Hansman, 2001)</td>
<td>Learning is most effective when learners can acquire the knowledge and skills in a “real life” environment.</td>
</tr>
<tr>
<td>2. Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>(Ghefaili, 2003)</td>
<td>Learning occurs when learners can construct a mental or physical representation of it; the learner is not a “passive” receiver of information, but engaged in various ways.</td>
</tr>
<tr>
<td>3. Design the learning solution so that there are “increasingly complex micro-worlds” (ICMs) where a learner can succeed in developing a skill.</td>
<td>(Burton, et al., 1984) (Collins, 2006)</td>
<td>Structure the learning solution with “scaffolding” and support so the learner feels challenged without being overwhelmed; create a progressive development of knowledge and skills in a way that maximizes the learning, keeps the learner challenged, but does not frustrate the learner.</td>
</tr>
<tr>
<td>4. Mentors guide learners through activities and experiences using modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
<td>(Dreyfus &amp; Dreyfus, 2005)</td>
<td>Mentors need to take an active, timely role in supporting learners.</td>
</tr>
</tbody>
</table>

**Authentic learning**

Authentic learning is when learners are engaged in an inventive and realistic task that provides opportunities for complex collaborative activities (Herrington, et al., 2010, p.1). Table 4.2 lists the draft design principles related to authentic learning, their source from the literature, and what each means in this research.
Table 4.2. Draft design principles related to authentic learning

<table>
<thead>
<tr>
<th>Draft Design Principle</th>
<th>Source/Reference</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Incorporate authentic tasks that reflect the “ordinary practices of the culture” or community.</td>
<td>(Brown, et al., 1989, p. 34) (Herrington &amp; Oliver, 2000)</td>
<td>Utilize experts and practitioners when creating authentic learning activities.</td>
</tr>
<tr>
<td>2. Develop activities that challenge the learners; give support that provides guidance, not specific answers.</td>
<td>(Brown, et al., 1989)</td>
<td>The paths that people use when solving a challenging problem can result in learning even if the problem isn’t successfully addressed; allow for less than optimal results but have a way to capture learning from the experience.</td>
</tr>
<tr>
<td>3. Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
<td>(Ghefaili, 2003, p. 7)</td>
<td>This reinforces what “authentic” means and how the learners working together, with their tools and resources, and the product produced all need to be aligned with how practitioners do their work.</td>
</tr>
<tr>
<td>4. Allow for unanticipated learner outcomes.</td>
<td>(Wiggins, 1989)</td>
<td>Participants often learn things that were not included in the specific learning objectives because of their interaction with others in the course or as a side-product of the work and research they do.</td>
</tr>
<tr>
<td>5. Create opportunities for cross-functional collaboration.</td>
<td>(Herrington, Oliver, &amp; Reeves, 2006a)</td>
<td>Be intentional when creating teams and in designing activities to maximize the potential learning for all involved.</td>
</tr>
<tr>
<td>6. Provide opportunities for articulation.</td>
<td>(Herrington, 1997) (Herrington &amp; Oliver, 2000) (Herrington, et al., 2006b)</td>
<td>Create different ways that individuals and teams can express what they are learning in ways that are consistent with how a professional would do this in a “real life” situation.</td>
</tr>
</tbody>
</table>

Community of learners

Community of learners is defined as a group of individuals who conduct research, share outcomes, and perform a consequential task (Beishuizen, 2008). Table 4.3 lists the draft design principles related to community of learners, their source in the literature, and what each means in this research.
Table 4.3. Draft design principles related to community of learners

<table>
<thead>
<tr>
<th>Draft Design Principle</th>
<th>Source/Reference</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide support and monitoring of the learning environment to ensure learners are engaged and included.</td>
<td>(Shea, et al., 2005) (Lee &amp; McLoughlin, 2010)</td>
<td>In a technology-based learning solution, it is possible for participants to be passive and not be involved which is contradictory to the social, participative learning solution that is anticipated.</td>
</tr>
<tr>
<td>2. Ensure that the interface and technologies used are simple and reliable so they contribute to a positive learning experience and retention of community members.</td>
<td>(Frankola, 2001)</td>
<td>Technologies and how they are used by the learners have an important role in the success of the course. If not they are not simple or reliable, they will be barriers to the learning and frustrating to the users.</td>
</tr>
<tr>
<td>3. Provide learner flexibility in completion of course activities and tasks.</td>
<td>(Chang, 2006) (Ke &amp; Chavez, 2013)</td>
<td>Consideration must be given to the time and location (and time-zones overlap) of the learners who will be working together. Also, time required for task completion (time on task and also time “window”) must not be onerous.</td>
</tr>
<tr>
<td>4. Provide opportunities for facilitators and learners to contribute to developing trust and safety within the course.</td>
<td>(Grote, 2008) (Taylor, 2002) (Tu &amp; McIsaac, 2002)</td>
<td>Without a learning environment that is respectful and safe for all participants (learners and facilitators), participants will not be willing to share ideas, ask questions, or take even small “risks” that would enhance their learning process.</td>
</tr>
</tbody>
</table>

The draft principles

During this research, the researcher used the design principles listed above to guide the design of the learning intervention. At critical points throughout the implementations and formative evaluations of the alpha, beta and prototype e-learning solution, these draft design principles were periodically revisited, to reflect on their meaning and relevance, and to determine how they contributed to the authentic e-learning solution that was produced. (Chapter 9 presents the revised and refined design principles that were finalized as the research was concluding.)

As can be seen in Tables 4.1, 4.2, and 4.3 above, design principles focus not only on the design of the learning environment prior to launching, but also on aspects of the implementation, that is specifically how certain design principles are executed during the course.
The draft design principles listed here may relate to either course design or course delivery (execution), or both. *Design* encompasses the content, the activities, and the technologies associated with the planned activities, resources and tasks; *execution* emphasizes the role of the mentors as they implement certain design principles. Table 4.4 lists the draft design principles and the design and execution categories that might apply.
Table 4.4. Draft design principles and categorization of when they apply

|--------------------------------------------------|---------------------------------------------|---------------------------------------------|
| 1. Anchor and index knowledge in the context in which the learning occurs.  
   Design: Content, Activities | 1. Incorporate authentic tasks that reflect the “ordinary practices of the culture” or community.  
   Design: Content, Activities | 1. Provide support and monitoring of the learning environment to ensure learners are engaged and included.  
   Design: Content, Activities, Technology |
| 2. Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.  
   Design: Content, Activities | 2. Avoid making problem solving as explicit as possible.  
   Design: Content, Activities  
   Execution: Role of mentor | 2. Ensure that the interface and technologies used are simple and reliable so they contribute to a positive learning experience and retention.  
   Design: Content, Activities  
   Execution: Role of mentor |
| 3. Design the learning solution so that there are “increasingly complex micro-worlds” where a learner can succeed in developing a skill.  
   Design: Activities, Technology | 3. Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.  
   Design: Activities, Technology | 3. Provide learner flexibility in completion of course activities and tasks.  
   Design: Activities, Technology |
| 4. Mentors guide learners through activities and experiences using modeling, coaching, scaffolding, articulation, reflection, and exploration.  
   Design: Content, Activities  
   Execution: Role of mentor | 4. Allow for unanticipated learner outcomes.  
   Design: Activities  
   Execution: Role of mentor | 4. Provide opportunities for facilitators and learners to contribute to developing trust and safety within the course.  
   Design: Activities  
   Execution: Role of mentor |
| 5. Create opportunities for cross-functional collaboration.  
   Design: Activities  
   Execution: Role of mentor | 5.  
   Design: Activities  
   Execution: Role of mentor | 6. Provide opportunities for articulation.  
   Design: Content, Activities  
   Execution: Role of mentor |

Incorporating design principles in course design and execution

All of the draft design principles emphasize design of content, activities, or technology and the underlying analysis needed to arrive at a design. While analysis and design are common elements in instructional systems design (Clark & Mayer, 2008; Dick, et al., 2008; van Merrienboer & de Groock, 2002), these two phases seem even more important in creating an authentic learning solution in order to provide content and
activities that are rich, robust, and aligned with real life contexts. Critical in this is the involvement with practitioners (Herrington, et al., 2010) who have the knowledge, skills, experience, and practical wisdom—such as the more knowledgeable other from Vygotsky (1978) and the skiing coach described by Burton, Brown, and Fischer (1984). These practitioners help in the design of an authentic activity but also in its execution when the practitioners take on the role of mentors.

A substantial number of the draft design principles emphasize the role of the mentor during execution. This means that the terms “instructor” or “teacher” do not convey all the subtleties of the desired interactions between the learner and the more knowledgeable other. “Coach”, as used by Burton, et al., (1984) does a better job. In the actual bus course (Vesper, et al., 2010) and the e-learning course, the term “mentor”—a word implying experience and wisdom—is used. Lombardi (2007a) presented case studies of how a mentor in an authentic learning situation worked side-by-side with a learner, providing coaching in new situations. Palloff and Pratt (2007) discussed the importance in an e-learning course to having the instructor role shift from teacher to facilitator. These authors used the terms “cheerleaders” and “guides” (p. 111) as roles the facilitator takes on. The design and implementation strategy of the course needs to prepare the mentors so they are comfortable and successful in their new roles. Only four of the 14 draft design principles include or suggest specific aspects of information and communications technology (ICT) used in the e-learning course. This implies that technology itself is not the “star” of an authentic learning experience but the vehicle used to convey and enable it (Woo, et al., 2007).

**Conclusion**

The draft design principles described in this chapter were used in conceptualizing and guiding the design of the e-learning course—the intervention or learning solution. These draft design principles were revised using the analysis of data collected as the program was evaluated and implemented, and are presented in their refined form in Chapter 9. The next chapter describes in detail the design of the learning solution, that is the e-learning course entitled: Pharmaceutical Cold Chain Management (e-PCCM).
CHAPTER 5

The e-learning solution

In Chapter 1, key aspects of development of an e-learning solution were described, specifically the needs that the resulting intervention was intended to fulfill. In Chapter 2, the planning and processes used in developing the e-learning version of Pharmaceutical Cold Chain Management (e-PCCM) course were presented in conceptual terms and in chronologic order by phases, and in Chapter 3, the learning theories upon which the e-learning solution would be designed and developed were discussed in detail. Chapter 4 presented the draft design principles derived from the literature that were used to guide the design of the e-learning intervention.

In this chapter, the development of the complete course is described in detail, including the evolution of the e-learning solution’s design and some of the challenges that the production team encountered as it developed the initial pilot course. This chapter presents and illustrates the e-learning environment in its completed and revised state (effectively after the third iteration of formative evaluations), and summarizes how each design principle was instantiated in the final product.

The e-learning course

The e-learning course was developed over a four-year period by a team of developers and academics (including the researcher) working on the project for the World Health Organization (WHO). The process was described briefly in the chronology of the development and research in Chapter 2. Details on the development of the course are provided below, including changes made as a result of the first and second iterations (formative evaluations), together with a description of the prototype solution as field tested in the third iteration.
Evolution of the design

From the point in 2009 when the decision was made to develop an e-learning course based on the physical Pharmaceutical Cold Chain Management on Wheels (PCCMoW) course to the point of the first sketches (see Chapter 1), design team members (including the researcher) engaged in conversations in person, on conference calls, and through email to develop concepts and potential approaches for the virtual course.

Early concepts (2010)

The first preliminary outlines based on the draft design principles were prepared by the researcher in early 2010 and presented to the design team as a “strawman” that the design team could react to, and provide further comments and suggestions. This initial concept included:

- video and documents available as resources
- a constructivist learning approach, as participants “assembled” the elements of a cold chain system
- support, commentary, and feedback (some of which would be pre-recorded or pre-written) from mentors
- real-life problems or challenges that teams would solve
- opportunities for participants to collaborate virtually
- options for participants to be assigned roles, such as auditors or consultants.

This process served its purpose well: it stimulated conversation between the course director/sponsor and team members, tested the draft design principles in practice, and helped to establish an alternative concept that was used in early sketches and designs.

Kick-off meeting (2010)

During a meeting of the design team that took place in Antalya, Turkey, late in 2010, concepts started to become more tangible. Team members (Figures 5.1 and 5.2) brainstormed ideas, often sketching them on flipchart paper as shown in the photograph in Figures 5.3.
Figures 5.1 and 5.2. Design team members conceptualizing and brainstorming e-learning course

Figure 5.3. Example of concept map sketch showing relationship of possible course goals and topics

Having this face-to-face creative interplay between the design team members resulted not only in new ideas, but also in establishing a common vision of the functionality and
look-and-feel of the e-learning course. An important aspect in this discussion was the use of analogies, in this case by mentioning well-known applications as short-hand code for what was wanted. For example, if some sort of face-to-face communication functionality was required, it would be referred to as “working like Skype”, and threaded discussions were envisioned as “similar to Facebook.” Additionally, references were made to the actual PPCMoW bus course, for example, the desire to have a “virtual café” where participants could interact, not just about technical matters, but also on areas of personal interest—sharing stories, photos, recipes, music, and the like.

At the conclusion of this work session, a meeting summary (see Appendix 7) was prepared and sent to the meeting participants by the researcher. This served as a high-level design document that would guide the development of the e-learning course. Most of the design elements identified here were informed by the draft design principles established for the course, and were included in the e-learning course that was piloted in 2013. Two portions of the meeting summary are of particular interest. First, the goals of the e-learning course were intended to require high involvement of the participants, specifically, (from the summary, Appendix 7)

- develop an enhanced, robust mental model of a pharmaceutical cold chain
- enhance the critical observation skills related to time-temperature sensitive pharmaceutical products (TTSPPs)
- trouble-shoot a problem related to TTSPPs
- create and evaluate a solution to an actual TTSPP-related problem.

To accomplish these goals, the design team recognized the need for real-life situations or problems that participants would work on and solve in an authentic activity. These real-life situations would include (again, from the summary)

- An activity/challenge – a problem that is presented to the learners or an opportunity to discover a problem and solve that problem. These problems would be based on (unidentifiable) real-life examples or composites of such examples. In some cases, the situation presented will not have any problems.
Second, the design team wanted to include a more complex final activity that aligned with the characteristics of an authentic task (Herrington, et al., 2004).

**Initial sketches (2010-2011)**

The design team was fortunate that two of its members were accomplished illustrators who were able to create high quality and detailed sketches. Figure 5.4 shows an early design (subsequently abandoned) that uses an office desktop metaphor. Many of the objects had functional capabilities as shown.

![Figure 5.4. Early sketch of course interface design based on an office desktop metaphor](image)

This interface (Figure 5.4) was abandoned relatively early in the development because the metaphor of an office desktop did not align itself with the actual physical bus course that involved travel to difference sites and virtual visits.
Content development (2010-2011)

Concurrent with the creation of the e-learning application by one group, content was being developed by another. This included videos and 360-degree photographs of the sites that would be visited virtually by the participants, and activities and case studies of problems that participants would try to solve individually or in teams. The video production team created short (3-15 minute) videos of subject matter experts giving illustrated lectures on topics like packaging design, thermodynamics, risk assessment, and standard operating procedures. Figures 5.5 and 5.6 show some of the activities of the video crews working onsite with subject matter experts.

Figures 5.5 and 5.6. Video crew working with mentor for material used in illustrated lectures

Sketches used in expert reviews (2011)

As the design evolved and the initial sketches were refined, the development progressed to the point where the design and sketches were stable enough to ask experts to perform a formative evaluation to inform future decision making on the design (see Chapter 7 for a full description of the formative evaluation, along with the recommendations made by the expert reviewers). What then followed was a dialog between the course sponsor/director and the researcher in exploring options to address the issues. Table 5.1 presents one example of this dialog.
Table 5.1. Sample of dialog between researcher and course sponsor/director regarding results of the expert formative evaluation

<table>
<thead>
<tr>
<th>Context</th>
<th>Sample dialog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher’s recommendations based on expert formative evaluation</td>
<td>The design team should look at the activities/work required and determine if they can be done in the weekly course time estimates. Perhaps there could be prioritization of activities/cases with the lower-priority ones kept in “reserve” if time permits. Additionally, there should be a table created to match the course and modular objectives with the activities/course content to be sure activities are appropriately distributed.</td>
</tr>
<tr>
<td>Course sponsor/director’s response</td>
<td>It is not clear to me how reviewers came to a point that activities may take learners longer than planned. When we met at the very beginning in Antalya (names of team members), we went through the learning objectives first. If we want to achieve what we listed there, we have to make sure that necessary time is allocated to achieve this. We will go through each task and develop the timeframe accordingly taking into account all limitations of users being located in different parts of the world. Based on this, we may end up with a programme that may require 1 month work, or if necessary 2 months. The issue for me is that we have to give enough time to learners to achieve what we want them to achieve.</td>
</tr>
<tr>
<td>Researcher’s follow-up response</td>
<td>As in the real bus course, we had some time constraints that would limit what we could see / how long we could stay at a site. We are certainly wanting to present as many situations as possible to the learners (as that is what helps to develop expertise) but the mentor team will need to be monitoring how long things are taking. We may want to prioritize the activities – what may be eliminated if the learners start falling behind. (And we will want to know why that happens – people not communicating in a timely way, too much discussion, etc.) I totally agree that the endpoint is for the learners to achieve the course goals; we need to set the expectations (particularly for the beta/pilot version) that our schedule is not cast in stone.</td>
</tr>
<tr>
<td>Action items taken for beta version</td>
<td>Activity task times were reviewed. Participants in pilot course will be asked to track amount of time used in the activities; task times will be evaluated after pilot course.</td>
</tr>
</tbody>
</table>

Prototyping the e-learning course (2011)

During the time that the design team was considering the recommendations from the first round of formative evaluations, it became apparent that the production group (a firm external to WHO) responsible for creating the application that would provide the course with its functionality, was not going to be able to produce such a sophisticated e-learning course. In considering potential options, the design team looked at ways to simplify the course, reduce the development effort, and explore other e-learning platforms, such as Moodle, that could organize and launch the e-learning content. In essence, the design team was looking for alternatives to accomplish the same goals. A
decision was made to trial the Moodle platform as an alternative vehicle for delivery of the course.

**Moodle attempt**

A prototype using Moodle (an open-source learning management system widely used particularly in academic environments) was developed. Figures 5.7 and 5.8 show screen captures of two sections from one page of the Moodle prototype.

![Moodle Prototype Screenshot](image)

Figures 5.7 and 5.8. Screen captures of the Moodle prototype showing page that required scrolling

A formative evaluation was conducted of the prototype by the learning consultant. This evaluation found that “the prototype Moodle version of the e-PCCM course lacks the usability required for supporting the types of group-based collaborative authentic learning tasks originally envisioned for this course” (Reeves, 2012). Additionally, the layout of the screens was very linear with severe limitations on how text and graphics could be presented: moving through the content required extensive scrolling. For these
reasons, the evaluator recommended that the course be developed using HTML so that links and other web functions could be used. Another recommendation was that instead of (re-)creating tools for collaboration (“like Skype”), that widely available and cost-free applications themselves (e.g., Skype, Google Drive) should be employed. At this point, consideration of Moodle as the e-learning platform was abandoned.

**Developing the pilot course (2012-2013)**

In early 2012 the course sponsor/director engaged a different externally contracted group to develop the e-learning application. This change provided an opportunity to reconceptualize the user interface, moving from an illustration-type interface incorporating a metaphor of a journey around an island (Figure 5.9) to one that was simpler in visual design and easier to develop, deploy, and update (Figure 5.10).

![Figure 5.9. Original user interface, 2011](image1)

![Figure 5.10. Revised user interface, 2012](image2)

It was this revised user interface that was used in both the mentor formative evaluation (discussed in Chapter 7) and in the field test of the prototype course (discussed in Chapter 8). A description of the full revised program, as implemented in the review and field test version, is given in the next section below.

**Overview–final beta version of course**

The e-PCCM course can best be thought of as an e-learning environment that gives learners a virtual tour of six different facilities that store, distribute, or provide time- and temperature-sensitive vaccines or other pharmaceutical products to patients. Figure 5.11 illustrates the initial entry screen showing the virtual visit sites, with the task/activity links on right side, and resources and access to tools on bottom of screen.
The e-learning application is based on an actual bus trip/learning event that the World Health Organization (WHO) conducts almost every year in Turkey (WHO, 2008). At each “stop” on the virtual bus trip, a particular step in pharmaceutical cold chain management is investigated and authentic tasks completed. For example, at the first location visited, participants watch a narrated video tour of a warehouse facility where time- and temperature sensitive pharmaceutical products are stored and from where they are distributed as shown in Figure 5.12. This is intended to replicate the experience learners would have on the actual bus course when their first stop is at a pharmaceutical products warehouse (Vesper, et al., 2010).
In each location, learners are able to explore the environment by interacting with a series of 360-degree photos (see Figure 5.13).
While visiting the site, learners must complete at least one challenging task based on real-life situations (or composites of problems that have occurred). Some tasks are performed individually while others require teams of participants to complete the tasks. For most tasks, the resulting report or project is posted in a Google Drive folder and other participants are asked or assigned to comment on the work by their peers. While all the tasks are considered authentic to some degree, the final task much more fully embraces the framework described by Herrington (1997) and her collaborators (Herrington, et al., 2010; Herrington, et al., 2004) because it is conducted for and reported to real world clients. In this final task (the sixth virtual visit), teams of participants are given several documents, including some authentic documents produced by WHO audit teams, concerning how vaccines are handled and stored at the national level in a real country—Albania was used in the prototype of the course that was field tested. Using these documents, as well as access via email, Skype, and telephone to key management people at the Albanian Institute of Public Health, team members conducted a “desk audit,” wrote a report, and produced a short PowerPoint presentation of their findings that were distributed to other participants as well as to members of the Albanian Institute of Public Health.

**Online resources**

In addition to the videos and documents available for each virtual visit, the e-learning course also includes a number of different resources that the participant can access. These include short illustrated lecture videos on topics such as thermodynamics, risk assessment, procedures and records (Figures 5.14 and 5.15).
Figure 5.14. Video library resource showing sample of videos that are available

Figure 5.15. Frame from video describing different types of packaging materials
All videos were produced for this course, often with presenters in the video who were past or current mentors on the annual physical WHO PCCMoW bus course (Vesper, et al., 2010). Additionally, printed material, in the form of scientific papers, book chapters, and journal/publication articles were supplied, many authored by the course director and mentors. Figure 5.16 shows the interface of the document library resource.

![Document library resource showing book chapters and articles available](image)

Participants can watch or read these resources for general information or to help them as they work through assignments.

**Audience/participants and mentors**

Like its physical counterpart, the e-PCCM learning course was designed for 15 participants who can come from a variety of backgrounds and job assignments related to the cold-chain management of pharmaceutical products. Public health professionals, warehouse managers, nurses, packaging engineers, makers of equipment, and quality assurance managers from pharmaceutical manufacturers would all be considered as potential course candidates in the target audience. Participants must apply and be approved by the WHO course director, and a certified proficiency in English is required.
to begin the course. Profiles of participants and mentors are provided online to help build relationships and community (Figure 5.17).

Leadership in the course is divided amongst a course director from WHO and two or three mentors who share responsibilities for reviewing and giving feedback on assignments. All mentors have significant experience in the pharmaceutical industry, pharmaceutical cold chain, pharmaceutical product handling and distribution, and risk management. Feedback from the mentors is given in several ways. For individual or group assignments, the mentor gives personalized feedback directly on the Google Drive report or document. Mentors also create a more general summary about their overall observations and suggestions. During the field testing, mentors created their own short video summaries that provide clarification or amplifications on a topic discussed.

Online discussions
The computer application that was created specifically for this course provides for an online discussion forum. Participants can pose questions to other participants and
mentors. Mentors will also pose questions—often based on real life situations they are experiencing in their own practice and work so as to challenge the participants. The online application allows for postings to be pre-approved by a mentor, if required.

**Reflection opportunity and diary**

At the end of each virtual visit, participants are asked to reflect on what they learned and respond to three questions using an online diary that only each individual and the course director and mentors can access. Learners write responses to reflective questions in a web-based form provided to them, as illustrated in Figure 5.18. The three prompt questions are

1. What did I learn in this section?
2. What am I going to take back to my work and use?
3. What comments, suggestions, ideas, or issues do I want to communicate to the mentors and course leaders?

![Figure 5.18. Detail of part of diary tool used to promote and capture learner reflections](image-url)
Study commitment
Completing the course takes approximately 12 weeks from start to finish. Each week, assignments require that participants commit 6-12 hours to watch the videos, read the suggested materials, perform the individual or team assignments, and review the work of their colleagues. Mentors spend approximately 6-15 hours a week monitoring progress, reading through and commenting on assignments, and responding to questions. Participants (and mentors) are obliged to meet the due dates and deadlines even when traveling.

Computer and communication technologies
Because this e-learning course is intended to be used by people world-wide, the application was designed to require relatively simple and standard laptop or desktop technology. Emphasis has been placed on using free, open-sourced software tools such as Mozilla Firefox (web browser), Google Drive (word processing using Google Docs) (Figure 5.19), and Skype (individual and team communications).

Figure 5.19. Detail of Google Drive site where participants save and share assignments

Incorporating changes from the field test of the prototype e-learning solution (2013)
Following the field test of the course which was conducted in the first half of 2013, a number of recommendations were presented to the course sponsor/director and discussed during a face-to-face meeting between the course sponsor/director and the
researcher in September 2013. (See Chapter 8, Table 8.12). All changes were accepted, initiated, and scheduled for implementation. With these recommendations articulated, the third iteration of the design-based research study ended, bringing the e-learning course to a state that is ready for full implementation. Although the portion of the design-based research study conducted for this dissertation also ended at that time, the project sponsor and other participants in the project, including the researcher, intend to continue the project going forward. One of the characteristics of this type of inquiry is that it is never really “done” in the traditional sense, but refinement continues until some point of diminishing returns in reached (McKenney & Reeves, 2012).

**Instantiating the draft design principles**

In Chapter 4, a set of draft design principles was developed based on consultation with practitioners, published literature, and research. The draft design principles were instantiated by incorporating them into different elements of the e-learning course. This began first by establishing the requirements for the e-learning applications, for example, using technologies such as Skype, threaded discussions, and online diaries and then later, by designing the authentic learning activities.

Some draft design principles, such as creating a rich variety of available resources and developing real-life cases, were applied during the development of the e-learning application and its content. Other draft design principles were applied during the execution of the e-learning course, for example, having mentors monitor online discussions and encourage contributions to the discussions by the learners. In this way, design principles derived from the theoretical constructs of cognitive apprenticeship, authentic learning and community of practice, guided the development of the e-learning course in order to provide the greatest chance of successfully capturing the critical elements of the real PCCMoW bus course experience.

Table 5.2 below provides specific information and examples of how the draft design principles were instantiated in the revised e-learning course. (Chapter 9 discusses how these design principles were refined based on experiences gained during the development process and three rounds of formative evaluation.)
<table>
<thead>
<tr>
<th>Theoretical construct</th>
<th>Draft design principle</th>
<th>How the principle was used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognitive apprenticeship</strong></td>
<td>1. Anchor and index knowledge in the context in which the learning occurs.</td>
<td>During the design of the course, content was included that was relevant to everyone involved in handling time and temperature sensitive pharmaceutical products (TTSPP) e.g., risk management.</td>
</tr>
<tr>
<td></td>
<td>2. Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>Activities were included at each virtual visit in order to engage the learners.</td>
</tr>
<tr>
<td></td>
<td>3. Design the learning solution so that there are “increasingly complex micro-worlds” (ICMs) where a learner can succeed in developing a skill.</td>
<td>Content was sequenced during design and development so that it had a logical progression of topics, knowledge, skills, and complexity of interactions with other virtual learners.</td>
</tr>
<tr>
<td></td>
<td>4. Mentors guide learners through activities and experiences using modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
<td>Ground rules and expectations for facilitators were established, discussed, and agreed to prior to the start of the course.</td>
</tr>
<tr>
<td>Authentic learning 1</td>
<td>1. Incorporate authentic activities that reflect the “ordinary practices of the culture” or community.</td>
<td>Practices and approaches that professionals/experts would use were included in the course: e.g., shake test and use of vaccine vial monitors (VVM).</td>
</tr>
<tr>
<td></td>
<td>2. Develop activities that challenge the learners; give support that provides guidance, not specific answers.</td>
<td>Problems with some level of ambiguity, and that can be solved with different approaches, were included in the course: e.g., contingency planning. Mentors available to answer questions and make suggestions as to approaches that can be used.</td>
</tr>
<tr>
<td></td>
<td>3. Provide for natural-type interactions, resources and tools that are similar or identical to those professionals use in real life.</td>
<td>Skype, Google Drive, and email along with links to websites and documents were used throughout the course.</td>
</tr>
<tr>
<td></td>
<td>4. Allow for unanticipated learner outcomes.</td>
<td>Content and resource materials included “nice to know” information and links to other sources so learners could better understand the broader contexts and explore other areas potentially of interest to them.</td>
</tr>
<tr>
<td></td>
<td>5. Create opportunities for cross-functional collaboration.</td>
<td>Teams to work together on assignments were established based on factors such as time zones/locations and job function to promote effective and useful collaboration. Individuals were also asked to review and comment upon the work performed by other individuals and teams so as to promote additional points of view.</td>
</tr>
<tr>
<td></td>
<td>6. Provide opportunities for articulation.</td>
<td>In most activities, individuals and teams created reports and recommendations that were very similar to those used in real situations. These documents also were used as ways to assess the knowledge and skill levels of the participants.</td>
</tr>
<tr>
<td>Community of learners</td>
<td>1. Provide support and monitoring of the learning environment to ensure learners are engaged and included.</td>
<td>Teams worked together in groups to perform tasks and comment on work done by others. A threaded discussion tool was included to promote conversations of interest to participants.</td>
</tr>
<tr>
<td>Theoretical construct</td>
<td>Draft design principle</td>
<td>How the principle was used</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>2. Ensure that the interface and technologies used are simple and reliable so they contribute to a positive learning experience and retention of community members.</td>
<td>Technologies and applications (e.g., Skype, Google Drive) were selected based on functionality, accessibility, and ease-of-use.</td>
<td></td>
</tr>
<tr>
<td>3. Provide learner flexibility in completion of course activities and tasks.</td>
<td>The course specified windows of time (days) for participants to complete tasks; time estimates for completing tasks were given.</td>
<td></td>
</tr>
<tr>
<td>4. Provide opportunities for facilitators and learners to contribute to developing trust and safety within the course.</td>
<td>During design and development, mentors and design team discussed how much mentor-control was needed on participant postings. Expectations on postings were shared with participants, specifically, the need for everyone to contribute to a safe, courteous learning environment. Mentors monitored and enforced this as needed.</td>
<td></td>
</tr>
</tbody>
</table>

This chapter has described the design and development of the e-learning course, together with a description of how the draft design principles were effectively instantiated in its design. In the next chapter, details will be presented on how the first iteration of formative evaluation was conducted along with the results.
CHAPTER 6

Formative Evaluation 1: Expert Review

In Chapter 2, an overview of design-based research and formative evaluation were presented along with the rationale for why these approaches were considered appropriate to specific research problem. In Chapter 5, the design and development process used to produce a specific e-learning course on the handling of time and temperature sensitive pharmaceutical products was presented. This chapter describes the formative evaluation that was conducted, the rationale behind this specific round of evaluation, how it was conducted, the results, and the impact this formative evaluation had on the design and redesign of the e-learning course as it continued to evolve. The second and third rounds of implementation and evaluation are discussed in the following two chapters.

**Purpose of an expert formative evaluation**

When trying to solve an education or training problem, there are many decisions that must be made that will influence the nature of any eventual learning solution, such as the specific instructional strategies to be used and the type of delivery system to be deployed. Ideally, such important decisions will be based upon accurate and timely information that has been collected using a systematic approach to inquiry. The purpose of formative evaluation is to provide the design team with the information required to make decisions and take the appropriate actions to refine or improve the prototype learning solution (Reeves & Hedberg, 2003).

There are many different ways of conducting a formative evaluation. One of the most widely used is expert review, especially early in the conceptualization and design of a prototype solution when there is still time to make substantive changes in the prototype
design (Reeves & Hedberg, 2003). Experts can provide insights that those unfamiliar with the content, technology, or utility may not be able to provide; these experts can identify problems that users may not be able to see.

In doing this first formative evaluation, experts with extensive experience in the design, development, and production of e-learning courses were selected and asked to critically examine early design documents (“sketches”) and identify and prioritize improvements that should be incorporated into the working prototype (“alpha version”) of the course. Additionally, data collected here contributed to answering the secondary research questions (found at the end of this chapter). Areas of particular interest to the researcher at this stage included:

- Overall visual design (including cultural appropriateness)
- Interface design
- Instructional design, in particular, whether the design of the course appeared to instantiate draft design principles of cognitive apprenticeship and authentic learning, and its potential to facilitate the formation of a community of learners.

**Goals of this use of expert formative evaluation**

Three primary areas of investigation guided the first formative evaluation by expert reviewers:

1. The overall **visual design** and how it contributed to the learning experience of a multi-cultural learning community, including suggestions on enhancing and improving the visual design.
2. The extent to which the **interface design** provided consistency and ease-of-use for the learners, and what could be done to enhance the interface design.
3. The extent to which the **instructional design** contributed to the goal of the learning solution through the objectives, learner activities, and course design, and what could be done to enhance the instructional design, particularly in relation to its authenticity for learners.

The findings of the expert review were intended to help the design and development teams make decisions regarding the e-learning course as it moved from the design phase
into development (Reeves & Hedberg, 2003). Consequently, the decisions that the design and development teams needed to make at this point focused on the related questions:

1. How should the proposed visual design be enhanced?
2. How should the proposed interface design be enhanced?
3. How should the proposed instructional design be enhanced?

In conducting this review, two additional outcomes were achieved: the documentation of the review process recorded the evolution of the design of the learning solution and information was gathered and used to refine the draft design principles (presented in Chapter 4 and finalized in Chapter 9).

**Selecting expert reviewers**

At the very start of the expert review process, it was incumbent to ask this fundamental question: Who is an expert? Tessmer (1994) gave very general guidance when he wrote about expert reviewers: “The expert may be a content expert, teacher, technician, or subject sophisticate” (1994, p. 4). Dreyfus and Dreyfus (2005) described an expert as someone who doesn’t have to ponder the options and how to accomplish them. He or she has a deep understanding of what to do and how to do it. They also wrote that an expert is someone who “knows what” (having high levels of declarative knowledge), “knows how” (procedural knowledge), and “knows when and where” (contextual flexibility). Ericsson, Prietula, and Cokely (2007) maintained that expert performance requires 10 years or 10,000 hours of deliberate practice to develop fully.

For the evaluation, three experts from different fields of expertise were selected by the researcher and invited to participate in the evaluation. Selection criteria included

- training and experience as instructional designers or graphics/interface designers
- experience in a range of e-learning projects
- experience in designing and developing e-learning projects used in the life-sciences, particularly in the pharmaceutical/medical device industries and in healthcare delivery.
One expert (pseudonym GD1) was a graphic designer with extensive experience (>20 years) in designing interfaces and with a great deal of experience in creating the “look and feel” of e-learning programs that have been used by large, international pharmaceutical and medicinal product manufacturers, such as The Lonza Group, Pfizer, and American Red Cross Blood Services. This expert reviewed the overall visual design and the user interface design, but did not comment on the instructional design elements of the course.

Two experienced instructional designers were also used as experts. Each had more than 30 years working as instructional designers producing a variety of learning solutions including those used by American Red Cross Blood Services, The Lonza Group, AstraZeneca, BMS, and the US Department of Defense. One of the instructional designers (pseudonym ID1) had developed e-learning courses and simulations used to train physicians and military medics. The other instructional designer (pseudonym ID2) also worked in healthcare training settings and with nontraditional, adult learners. The instructional design experts reviewed the user interface and instructional designs, but did not comment on the visual design aspects of the course.

All experts were familiar with Good Manufacturing Practice (GMP) regulations and requirements because of previous projects, and all primarily worked with adult learners in corporate training/learning environments.

Instrumentation and review criteria
The three experts conducted their evaluations independently from each other during a four-week period in 2011. Each was provided the same set of materials to review, including course descriptions, learning objectives, target audience, information on how the course was intended to be implemented, estimated timeframes for activities, sketches of proposed interfaces, and examples of activities. Reviewers reported spending 3-5 hours performing their reviews and completing the protocol/data collection sheets.

Additionally, an evaluation protocol was created and provided for the experts to use in reviewing the design documents. Several attempts were made in developing the
protocol. The first version gave relatively little specific guidance to the experts, the intention being that they would look at the materials through the lens of their individual expertise. Testing the protocol revealed that having too little structure did not generate information that was meaningful, useful, and comparable. A second, more extensive protocol was created, but it was judged to be too long from a practical point of view. The third and final version had three sections comprising evaluation protocols that were focused on

- overall visual design—the collection of visual elements such as drawings, photos, formats, arrangements, fonts, type sizes, colors, and symbols used in the learning program
- interface design—the methods, mechanisms, and “tools” used by the user to interact with the learning program and control movement through the program
- instructional design—the systematic approach using valid learning principles and learning theories, the desired outcomes, and the needs of the learners to create the specifications for the learning solution.

Each section of the protocol included a number of specific evaluation criteria that were based on criteria suggested by Reeves and Hedberg (2003), Herrington, Reeves, and Oliver (2010), and Clark and Mayer (2008). Additionally, the course goals and draft design principles were used as the basis for further evaluation criteria. The evaluation protocols also included: rating options; a space for the reviewer to list specific examples, comments, or suggestions; and the reference source of the theoretical basis for each of the criteria. Figure 6.1 shows a small portion of the protocol/data collection sheet used.
The complete protocol/data collection worksheet used in the expert reviews is provided in Appendix 8.

**Results of the expert review**

The responses to the questions on the individual protocol/data collection worksheets submitted by the experts were combined into a composite sheet maintaining the traceability to each of the experts by their pseudonyms. In written and verbal comments, all experts spoke highly of the project, its goals and the learning solution design. All experts also indicated a caveat that their comments should be considered in light of reviewing only the information that was available in the early design documents.

**Visual design**

The designated reviewer for the visual aspects of the e-learning program was GD1; the other reviewers also volunteered some verbal comments. All reviewers liked the look and “playfulness” of the visual design (as illustrated in Figure 5.9), but questioned whether and how it aligned with the content and whether it was appropriate for the intended adult users. GD1 commented that making changes to the design would be time and resource consuming since it was an illustration. As an alternative, he suggested
using cascading style sheets (CSS) with simpler graphics; this would also speed the loading of the web pages for those with slower Internet connections.

GD1 commented on the layout of the screens (which overlaps with the interface design dimension discussed below) and concluded that the layout conflicts to some extent with what is known about how the eye “tracks” through what is on the screen. Research by Nielsen and Pernice (2010) showed that when reading a webpage, users tend to move their eyes horizontally on one line, then move their eyes down to read another horizontal line and then move down the webpage on the left hand side, a pattern approximating the letter “F”. This expert comment prompted considerable discussion within the design team, in part on the comparability of the work done by Nielsen (2006), who used long web pages, to the non-scrolling web pages used in this e-learning course, and also because of a study (Shrestha & Lenz, 2007) showing that searching and browsing a web page with photos and illustrations elicits a different eye-tracking pattern than with text alone. Despite some disagreements among members of the design team about GD1’s review, as will be seen below, many of the expert GD1’s concerns were considered and addressed, and his suggestions were generally adopted to improve the overall visual design.

**Interface design**

While visual design is more concerned with how elements such as color, font, drawings, photographs, formats, and their arrangements contribute to the look and feel of the program, interface design is focused on the “tools” and conventions that the learner uses in moving through and around the e-learning program. All three expert reviewers felt that users would find the learning program’s primary interface (see Figure 6.2), as depicted on the sketches, difficult to use.
Two factors contributed to this conclusion by the experts. First, the screen contained a great deal of information—it was very “busy”—possibly presenting a high “cognitive load” that the user needed to process and take into account. It has been argued by educational researchers that as the cognitive load of the interface is increased, the cognitive resources on the part of the user that can be devoted to learning decreases (Clark & Mayer, 2008; Mayer & Moreno, 2003).

Second, in the sketches that were reviewed, there were inconsistencies: users were confronted with a new/different navigation system in different sections of the program as seen in a specific activity screen (see Figure 6.3). This perceived lack of consistency was predicted as being confusing for the learner.
Another point that the reviewers noted was that the prototype design lacked any clear indication of how far the learner had progressed through the material and/or how much farther they had to go. The reviewers felt that making changes to simplify and standardize screen design and adding a tool to visualize progress through the course would be beneficial to the user.

**Instructional design**

The two expert instructional design reviewers were both enthusiastic about the overall design of the e-learning course, specifically mentioning the virtual site visits and the practical case studies, problems, and activities. Both instructional designers commented on the large amount of material—they felt making use of the resource materials (e.g., videos, articles, book chapters) and completing the course assignments would take longer than the time periods that were estimated for the tasks. One instructional designer questioned the match between what was to be covered in the course and the needs of a diverse, world-wide audience. This expert also thought the video and print resources were good to include but observed there was not a direct linkage between the activities and the resources. Suggestions that were made included “streamlining” the content, perhaps to the areas of most importance to the accomplishment of the learning objectives of the program and distinguishing between “need to know” and “nice to
know” resource materials. The other instructional designer pointed out that the current design required a significant amount of mentor time and questioned if this might be a potential problem given the goal of training thousands of people on the topic of cold chain as mentioned in in the Course Information Material provided to the reviewers at the start of their evaluation. The comments from these experts on the instructional design confirmed that the team was on the right path in terms of the authentic, problem-based learning but that there were other elements such as time expenditures and scalability that needed to be revisited.

The expert instructional designers made positive comments on other aspects of the design, such as the facility tours:

The intent to engage the learner through activities and tasks (the authentic learning aspect of the program). I feel there is a lot of potential for creating meaningful engagement. (ID1 [2.2.a])

The other instructional design expert also endorse[d] the real-life nature of the tasks:

The case study descriptions provide information and pose questions for the learner to solve which they would find in real life on the job. (ID2 [3.1.p])

An idea included in the original sketches presented to the experts was an initial “icebreaker,” two truths and a lie (Fig 6.3). One instructional design expert was concerned about how well this would work in an e-learning environment:

The design document does not have enough detail to comment. I don’t think that the learner would take the time to virtually complete the 2 truths and 1 lie exercise. I think that is successful in a more instructor led classroom situation of interaction. (ID2 [3.1.f])

These and other comments made by the expert reviewers were taken into consideration when developing a risk assessment.

**Incorporating risk assessment into the evaluation**

To better determine the significance of the items that were evaluated by the experts, a risk assessment tool commonly used by engineers and the pharmaceutical industry—Failure Mode Effects Analysis (FMEA)—was used in the study by adapting a data collection table. In performing a FMEA on a design, different components or groupings are identified, with each examined in turn. For this evaluation, three components were
considered: visual design, interface design, and instructional design. For each component, the same questions were asked:

1. What (within that component) could fail? ➔ Hazard
2. What would happen if it failed? ➔ Impact
3. What would cause this to fail? ➔ Failure mechanism
4. How likely is this to happen? ➔ Likelihood
5. If it does happen, what would occur? ➔ Impact
6. Is this a risk that should be reduced? ➔ Evaluation and prioritization
7. What can be done to reduce it? ➔ Risk control and mitigation

Each risk was ranked and prioritized based on a risk score. This risk score was created by assigning values and computing (1) the severity of the negative impact, (2) the likelihood that the hazard would be expressed, and achieved. Based on relative risk ratings, priorities and recommendations for improvement were instituted. A sample of the instrument and its use is provided below in Figure 6.4.

![Table](image)

Figure 6.4. Table used in the FMEA as a way of prioritizing changes to be made based on risk

It was originally intended that the expert reviewers use the FMEA to prioritize their observations; however, in reviewing their use of the tool, it became clear that more instruction on the use of the tool and/or an example of its use would have been needed. Nevertheless, much useful data was derived from the tool as is described in more detail below.

Based on the written comments of the expert reviewers, the researcher completed the FMEA by adding risk items if they met the following criteria:

- There was a clear consensus by the experts (2 of 2 or 3 of 3 experts) OR
- There was a split in expert opinion (2 of 3) OR
• The observation was supported with comments/observations elsewhere in a different expert reviewer’s worksheet.

Appendix 9 presents the full results of the FMEA.

Based on the rating and scoring rubric that was established in advance, the five issues of highest concern (along with the risk score; 25 being maximum risk possible) for the reviewers were the following:

• look and feel of the visual design (15)
• user controls/navigation (12)
• time to complete course exceeded the expectations that were set (9)
• interface design (9)
• progress indicators (6).

As can be seen in the list of issues above, none of the salient issues involve the instructional design that was used in developing the course or in the authentic activities and solutions.

Using the evaluation criteria established in advance, all five issues were documented, analyzed in more depth, and discussed with the project sponsor and design team members prior to continuing to develop the course. In addition to the risks identified in the FMEA, the expert reviewers also made other more specific suggestions for improving the e-learning course relating the graphic design, user interfaces, and instructional design. These suggestions included

• providing a site map or something to give a “big picture view”
• providing quick level access to other sections
• considering use of “roll/hover-overs,” changes of state (e.g., a color change) indicating when a control or button is activated
• clarifying learner assessment—telling learners how they and their learning will be assessed
• showing cause and effect—what happens in the event of not meeting the TTSPPE expectations and having a failure
• considering how effective the proposed icebreaker, two truths and a lie, will function in an e-learning environment
• considering how the learner will know that they have mastered the concepts/that they are developing expertise.

The experts also offered a number of more specific recommendations as part of their reviews: e.g., “not relying on acronyms being defined only when they are first used.”

While the expert reviewers were new to the specific content in the e-learning course, their specialized points of view gave the design team very helpful information that could be used to improve the design of the course.

**Discussion**

As described earlier, the purpose of evaluation is to provide decision-makers with the information they need to make informed decisions. The three key decisions addressed by this expert formative evaluation were:

1. How should the proposed visual design be enhanced?
2. How should the proposed interface design be enhanced?
3. How should the proposed instructional design be enhanced?

Based on the expert formative evaluation with its recommendations and suggestions, and the further discussions and decisions made among the design team members, specific changes were incorporated into the alpha version of the e-learning course. Some of the changes were immediately noticeable in the visual design and interface design (which have some overlap), while in other cases, instructions were changed or the roles that learners were to assume were emphasized. Finally, some suggestions did not result in a change per se, but rather provided issues that would be more closely examined during the next rounds of formative evaluation. Some of the specific changes are listed below, arranged by the decision questions.

1. How should the proposed visual design be enhanced?

   The alpha version’s visual design was simplified with fewer illustrations (see Figures 6.5 and 6.6).
Typography/labeling was less stylized in the revised interface, changed from actual handwritten text to computer-generated fonts, such as Arial. Development was done using HTML cascading style sheets. Colors were changed to be less vibrant and more aligned with those found on “corporate” or business websites. These changes were also made on other screens in the course (see Figures 6.7 and 6.8).

2. How should the proposed interface design be enhanced?

All screens and their user interfaces were simplified and made more consistent (see Figures 6.5 and 6.6). Design included adding indicators as to where the user was in the course (e.g., Figure 6.8). Internal hyperlinks to resources (bottom set of buttons) and virtual visit tasks (right-hand set of links) made navigation more direct and simpler.
Documents such as worksheets and instructions were made available as PDFs to allow for easier printing.

3. How should the instructional design be enhanced?
Activities and instructions were reviewed and revised as needed to describe the role of the participant. Time estimates were reviewed and in some cases revised. Questions about time-on-task were included in course questionnaire used with the field testing of the prototype course. Survey questions using an online survey tool were written to be asked of participants after each virtual visit regarding realism of tasks and activities, use and perceived value of video and document resources, and clarity of instructions. In the assignment information, recommended videos and documents were listed. Plans were made to talk with the mentors about their roles and ways to support the course participants.

Addressing the secondary research questions in Iteration 1
In Chapter 1, four research questions—one primary and three secondary—were proposed to guide the research. The findings of the expert formative evaluation performed on the early sketches and outlines of course presented in this chapter provide some illumination on addressing particularly the first of the secondary questions. The first secondary research questions is given below along with an initial finding (in **boldface** type) together with supporting rationale and data. No findings in the expert review related to secondary questions 2 and 3.

**Question 2A:** *What are the factors that enable a technology-based e-learning solution and the affordances the technology provides to “mirror” an existing, experiential learning event and potentially improve on that event?*

**Alignment is needed between the visual “look and feel” of the course, the primary audience or learners, and the content being covered.**

In the actual bus course, there is a high level of “polish” put on all the elements, from the pre-course arrangements and communications, the written materials provided to the participants, and the presentations by the mentors. This does not mean that the bus
course is without fun or humor, but there is a level of professionalism. There was a consensus among the experts that based on the sketches they reviewed, there needs to be alignment between the “look and feel” of the e-learning solution with the audience that will use it. The graphic design expert elaborated on meeting the expectations of the users or audience:

Attractive colors and playful “hand-drawn” look and feel lend themselves to a very non-traditional approach to a very sober and technical subject matter. It may seem highly appealing to a younger (and me, of course) audience. I would not expect “Cold Chain” GDP training and education content to follow. (GD1, 2.2.a)

An instructional design expert had a similar comment:

I don't know the specifics of the audience however from an adult learner perspective I think the graphical user interface should be more streamlined and sophisticated. (ID2, 2.2.b)

In considering the feedback to the design documents, sketches, and sample activities that was provided by the expert reviewers, the design team made changes that would be included in the subsequent alpha version of the e-learning course. These changes included fewer colors, a more extensive use of HTML in creating pages, increased consistency, and a more “corporate” look and feel to the e-learning course.

**Conclusion**

Performing a formative evaluation relatively early in the design process, like that conducted here, is a means to obtain feedback—in this case, from experts—before significant time and effort is spent in development. Even if changes are not made, areas identified by the experts may be probed in subsequent formative evaluations involving mentors, potential users, and actual users who may have different points of view.

In the next chapter, the second iteration of formative evaluation, conducted by mentors and design team members will be discussed and how this contributed to the e-learning solution being developed.
CHAPTER 7

Formative evaluation 2: Mentor review

Introduction
As discussed in Chapter 2, iterative cycles of formative evaluation are essential components of the third phase of design-based research (as represented in the Reeves (2006) model shown in Figure 2.1 in Chapter 2) during which the learning solution is implemented, tested and refined. The first cycle of formative evaluation was described in Chapter 6. This chapter describes the second cycle.

As delineated in Chapter 6, experts in graphic design and instructional design were provided sketches, descriptions, and activities intended to be used in the e-learning course and asked to provide their expert opinions on visual design, interface design, and instructional design. Their comments and suggestions were incorporated into a full working alpha version of the e-learning course, which was then evaluated as the second iteration of the learning intervention.

This chapter presents the purpose of this second evaluation, why the reviewers were chosen and their role, how the review was performed, the outcomes of the review, and what was learned.

Purpose of this formative evaluation
This second cycle of formative evaluation involved the intended facilitators/mentors of the e-learning course (including the project sponsor and researcher) and in so doing, focused more strongly on the implementation aspects of the learning environment. It
also included the learning consultant. The aim was to examine the alpha version with a view to achieving the following goals:

- Optimize the learning environment before the prototype course was released for its field test
- Conduct a sequential walkthrough of the entire working version of course
- Identify potential issues with the learning materials (e.g., activities, instructions)
- Achieve consensus on expectations for the learning activities and tasks (e.g., acceptable/non-acceptable results)
- Begin to develop a reference guide for facilitators
- Identify significant risks and ways to control and mitigate them.

Data collected here contributed to analysis and findings related to the secondary research questions.

As discussed in Chapter 2, evaluation is done to answer critical questions (Reeves & Hedberg, 2003) and to provide a basis for decision making at each stage in the development of an interactive learning system. The relevant questions to be answered in this iteration included:

- To what extent do all the elements of the course (e.g., on-line components, instructions, printed materials) contribute to a learning event that is relatively easy to use, and what can be done to improve the elements?
- To what extent do facilitators have enough written general guidance on how to effectively facilitate the online course, and what can be done to improve the guidance provided to them?
- To what extent do the facilitators have a common understanding on what constitutes an adequate desired result for each of the participant activities, and what can be done to improve this understanding and its application in the course?
- To what extent can the facilitators effectively make use of the capabilities of the learning application, and, what can be done to improve their use of these capabilities?
• What are the risks in implementing this course that could cause unwanted results?
• If there are risks, how could these be controlled or mitigated?

Conducting multiple formative evaluations with different evaluators provides information about the course being studied from different points of view (Shrestha & Lenz, 2007). In the first formative evaluation (see Chapter 6), expert graphic and instructional designers evaluated the course with their critical perspectives. In this second evaluation, most of the reviewers (with the exception of the learning consultant) were experts in the content area of the e-learning course; they were effectively the practitioners who contribute to a design-based research solution (van den Akker, et al., 2006). Since they were to be mentors in the e-learning course, this group could also raise practical questions about interactions with participants, how to respond to problems, and other issues.

**Selection of the evaluation team**

The evaluation team consisted of five individuals who were chosen by the project sponsor because of their knowledge, skills, and experience in learning, handling of time- and temperature-sensitive pharmaceutical products (TTSPPs), and/or who had been mentors in the actual World Health Organization (WHO) bus course (WHO, 2008) that was the conceptual model for this e-learning course. All of the evaluators were also potential mentors on the virtual e-learning course.

The evaluation team consisted of the following three mentors and one learning consultant (in addition to the researcher “JV”) (pseudonyms used below):

- “M1”—an architect by education and profession who has been involved writing WHO guidelines on handling TTSPPs and evaluating vaccine distribution systems around the world. M1 was a mentor in one of the WHO bus courses.
- “M2”—a packaging engineer with expertise in the transport of TTSPPs. M2 has been a mentor in two WHO bus courses.
• “M3”— the project sponsor from WHO; he has practiced as a public health physician and been involved in the transport and distribution of vaccines for most of his career. M3 originated the WHO bus course and has led more than five of the bus course trips. M3 was also on the design team for this e-learning course.

• “LC”— pseudonym of the learning consultant from the University of Georgia College of Education with expertise in e-learning and evaluation/assessment. LC had been a member of the design team for this e-learning course.

All of the evaluation team members had worked with one or more members on previous WHO-sponsored projects or served together as mentors on the WHO bus courses.

The evaluation process

The evaluation team met near Atlanta, Georgia, USA, in February 2013 to conduct the evaluation using the following process:

1. Facilitators/mentors completed a pre-session questionnaire.
2. The project sponsor provided an overview of the e-learning course.
3. The evaluation team performed a risk analysis of the e-learning course and developed a risk management plan.
4. The evaluation team examined all sections of the e-learning course in detail raising questions and problems and discussing possible solutions.
5. Facilitators/mentors agreed upon roles and responsibilities.
6. The evaluation team prepared a video discussing their process.

Each of these processes is discussed in more depth below.

1. Pre-session questionnaire

The researcher developed a questionnaire (see Appendix 3) to document and better understand the experience level of the facilitators/mentors regarding e-learning programs and to identify ways to better support them before and during the course. The written responses from the facilitators/mentors were transcribed into an electronic survey form (in SurveyMonkey) that was used to tabulate the responses. Of particular
note was that none of the instructors had facilitated an online course before; only one of
the four had participated in any type of e-learning course. The mentors identified
several concerns or worries they had going into this project including internet
connectivity and server problems, time management, working with virtual, worldwide
groups, and doing something outside of one’s own comfort zone. When asked about
ways their work as mentors could be made more enjoyable or effective, ideas offered
included having a facilitator’s guide, frequent teleconferences between mentors, and
close collaboration between the mentors. All of these ideas, except a written facilitator’s
guide, were incorporated into the field testing of the prototype course.

2. Overview of the e-learning course
The project sponsor led the team through the entire e-learning course with team
members examining each screen on their individual laptops in order for the team to be
oriented to the e-learning course and become familiar with its affordances. The
evaluators were presented the “big picture” view of the e-learning course and how the
course was intended to be implemented.

3. Risk assessment
Having seen the course and the implementation plan, the researcher led the evaluation
team in a risk assessment to identify potential risks associated with the e-learning course
and find ways to reduce those risks. The researcher, because of his background and
experience in risk assessment and risk management (Vesper, 2006), led and facilitated
the exercise. The development of the risk assessment is described in detail in this
section below.

Background on risk assessment and risk management
Risk assessment and risk management processes are used in almost every industry and
profession. They provide useful tools to make data-supported, proactive decisions on
how to best use resources to prevent the occurrence of unwanted events, and—should
they occur—to protect assets of value. Despite the usefulness of risk assessment in
enabling potentially problematic events to be articulated and then possibly
accommodated, such assessments are rarely performed in planning e-learning
environments. Nevertheless, risks do exist. While e-learning environments have
inherent (and easily predicted) risks related to data security, data loss, and technology
failure, more subtle risks related to learning activities and assessment can create critical obstacles for students engaged in e-learning. These risks are compounded when e-learners in different countries and different cultures must collaborate online.

Risk assessment has been defined as the “overall process of risk identification, risk analysis, and risk evaluation” (ISO, 2009). In performing a risk assessment, one seeks answers to five basic questions (Kaplan & Garrick, 1981):

1. What can go wrong?
2. How bad can it get?
3. How could it happen?
4. How likely is it to happen?
5. Should we try to do something about this?

With answers to these questions, one can then move into risk management where three further questions are asked (Haimes, 1991):

1. What can be done to control, mitigate or prepare for this unwanted event?
2. What are the best options given the circumstances?
3. What other risks or issues might the selected option(s) create?

These questions are asked in a series of phases using well-defined methods and tools to document the process and results. Figure 7.1 shows a model of a typical risk assessment and risk management process that uses a cross-functional team.
In the first step, the system under study is described or defined. In the second step, hazards—defined as sources of harm—are then identified which typically answer the questions, “What can go wrong?” and “How could it happen?” Risk estimates are then made based on the impact of the unwanted event and its likelihood of occurring and causing the impact.

After answering these initial questions, the risk is evaluated to determine if action needs to be taken and the priority of taking that action. In some cases, the risks are already low and they simply need to be periodically reviewed and monitored to ensure the conditions and assumptions have not changed. If the risks are high, some type of risk treatment in the form of control and mitigation is taken. Communication to stakeholders and documentation of the activities, decisions, and results concludes the risk assessment and risk management part of the process. Finally, risk estimation can be performed using a variety of tools (such as those illustrated in the right section of Figure 7.1). Some tools are very basic and may be informal, for example, simply asking “What if?” questions. Other tools, like fault tree analysis (FTA) and failure mode effects analysis
(FMEA) are highly structured and well defined (Stamatis, 2003; Vesely, Goldberg, Roberts, & Haasl, 1981). Certain tools are optimized to help identify hazards – hazard analysis or hierarchical holographic modeling – while others like hazard analysis and critical control points (HACCP) go through the entire risk assessment and risk management process (Vesper, 2006).

There is limited literature on risk assessment in relation to formative evaluation, and no model could readily be used or adapted for the purpose of analyzing risk in the e-learning course. Lynch and Roecker (2007) recommended that risk assessment be used as part of an evaluation, and presented a simple form to collect data to be used in the assessment. Similarly, Benson and Brack (2010), in their planning guide for online learning and assessment, noted that an important administrative function in planning online assessment was the completion of a risk assessment of (1) student support factors (such as access and equity issues), (2) technical issues (such as access to hardware and software, bandwidth, etc.), (3) authentication (such as cheating, collusion, plagiarism, etc.), and (4) consideration of the instructor’s administrative skills (such as ability to use software, manage online grading, copyright, etc.). However, while these models were helpful, no appropriate model or framework of risk assessment appeared to exist that provided guidelines for the assessment of a complex online authentic learning environment involving a community of learners. The design and development of such a framework are described below.

**Defining the scope of the risk assessment**

Before starting a risk assessment, what is being assessed must be clearly defined. This can be done by a written description, flowchart, or diagram (ICH, 2005). For this project, the scope of the risk assessment includes

- the e-learning application
- technological infrastructure enabling the use of the application
- all participants in the course (including the learners and the facilitators/mentors).

One other important but often overlooked element is clearly defining the “risk question” —the question that the risk assessment is meant to answer (Vesper, 2006). This is consistent with Reeves and Hedberg’s (2003) key reason for doing a formative
evaluation: answering questions that can be used to make decisions about development and refinement of a prototype program or product. Examples of risk questions include

1. What are the IT/technology risks associated with this e-learning project?
2. What are the risks related to the community of learners due to inappropriate communication?
3. What are all the risks that could arise when using this e-learning program?

As can be seen in these examples, risk questions can define the scope of the risk assessment from very narrow (e.g., Risk question 2) to very wide (e.g., Risk question 3).

**Identifying hazards**

Two important definitions to distinguish between are hazard – the source of harm – and risk – the combination of the likelihood of the occurrence of the unwanted event resulting in the harm and the impact of that harm (ICH, 2005). When starting a risk assessment, one first needs to identify the hazards. There are different ways to identify hazards. One way is to brainstorm lists of them, for instance by asking the question, “What might go wrong?” Another approach, and the one that was used in this situation, is to first list success scenarios that are short phrases identifying what should happen when using the e-learning solution. For example, users can successfully use the application on any computer running standard web browsers (e.g., Safari, Internet Explorer, Chrome).
In this formative evaluation, the evaluation team first brainstormed success scenarios—what would be necessary for a successful e-learning Pharmaceutical Cold Chain Management course (e-PCCM) (see Figure 7.2). The team then identified actions, events, or situations—the hazards—that could prevent or interfere with a successful e-PCCM course. The list was then condensed based on those hazards that were considered most relevant, and then discussed further using a preliminary risk assessment tool as described below.

**Determining the risks**

A preliminary risk assessment (PRA) can be used early on in a project when minimal information is available, or as a screening tool to identify risks that need to be examined more critically using other tools, such as fault tree analysis or failure mode effects analysis (Vesper, 2006). For the purposes of this evaluation, the researcher felt that the PRA alone would provide an appropriate level of detail of the risks so that actions could be taken to control or mitigate those risks deemed significant. For each of the hazards, specific questions were asked to help determine the risk. These included:
1. **What are the potential negative impacts to the learners and the desired course outcomes?** Answers to this question provided examples of the consequences, or harm should the hazard be expressed.

2. **What could cause this unwanted event to occur?** Here, the team identified the hazard scenario.

This data was summarized in a table (see Figure 7.3) and the team estimated the likelihood that the hazard would be expressed resulting in the harm, using a scale of low-medium-high (1-2-3, respectively) (Column 5). In a similar way, the impact was estimated, again using a scale of low-medium-high (1-2-3) (Column 6). Multiplying these two numbers resulted in a risk score – the higher the number the more risk being present (Column 7).

![Figure 7.3](image-url) **Figure 7.3.** Section from a preliminary risk analysis worksheet with red indicating high risks needing to be controlled or mitigated

The last step of risk assessment is risk evaluation: deciding on the risks that need to be reduced (Column 8). Generally, these are the high or medium risks that are “treated” through control and mitigation. As shown in Figure 7.3, high-risk scores were
highlighted in red. Other, low-level risks might be addressed as well if the benefit outweighs the risk-reduction cost. The complete PRA is found in Appendix 10.

Reducing the risks through “treatment”
Risk treatment (ISO, 2009) involves two key concepts: control and mitigation. Control is aimed at preventing the unwanted event from occurring in the first place; the focus is on reducing the likelihood by targeting the root and contributing causes. Mitigation assumes the unwanted event will occur but aims at protecting the “thing of value” (CSA, 2002). For example, one cannot totally prevent a server crash at a hosting site, but one can take protective measures should that happen. Whenever possible, multiple risk treatment approaches should be taken that have a “layering” of control and mitigation actions that are tied to the different causes or mechanisms that were identified. These layers result in a more robust solution should the hazard be expressed.

For each of the risks that were identified, the team identified a risk treatment plan. In some cases, it comprised providing information to the participants, for example, recommending browsers that were tested (and listing browsers that were not recommended). An example of an identified risk was certain governments not allowing access to a video website because of censorship restrictions. A mitigation plan was established to pre-produce DVDs of the video segments and send them by DHL courier to course participants upon the participant’s request.

Monitoring and review
The identified risks were addressed through control and mitigation, however, during and after the field test of the prototype course, the mentor team monitored and documented other risks that had not been identified initially. For example, the team had not foreseen that there would be a time change related to daylight saving time (i.e., a non-alignment of the start of daylight saving time in different countries). To mitigate the impact, a notice was sent to all participants alerting them to the change. Such identified risks can be included in the listing of risks to be compiled prior to commencement of each offering of the course. Another aspect of monitoring and review was to review the effectiveness of the controls and planned mitigations at the end of the field-tested course.
4. Detailed review of alpha version

With an understanding of the overall structure of the e-learning course and its risks, the project sponsor took the evaluation team on a detailed walk-through of the course. The intent of this more detailed examination was to

- gain more familiarity with the course
- identify areas for improvement and problem solutions
- discuss expectations for participant-mentor and mentor-mentor communication
- identify other risks or risk-treatment opportunities.

This detailed review was led by the course sponsor who took the reviewers through the course sequentially, covering each virtual visit and task within each visit. Review team members discussed each virtual visit and task so all had a common understanding of the goals, the underlying intent, the background or context of the activity, the role of the participants and mentors, and the assignment results that would be expected from the participants. Team members suggested improvements, corrections, and concerns that were collected and collated by the researcher. From an analysis of these data, a list of solutions and improvements was prepared (Appendix 4), confirmed by the evaluation team as a true reflection of the review, and provided to the development team.

5. Defining facilitator/mentor roles and responsibilities

The facilitators/mentors agreed to share the responsibilities of providing support and feedback on various tasks. This was based, in part, on aligning the tasks with the particular expertise of the facilitators/mentors. An assignment sheet was created for use during the field testing that identified the primary mentor and a second member who would serve as a backup (see Figure 7.4).
The team discussed how feedback should be given to participants and work-teams. Some options included comments on each participant’s or team’s work (e.g., report written using Google Drive), a summary of comments that go to all participants, video feedback, and guidance by phone/Skype/email for comments of a sensitive nature to one or two people. Additionally, the team agreed that feedback needed to be provided shortly after a task activity has been completed, generally within a 24-hour period.

The team also agreed that a key outcome from the field testing was a “Facilitator’s Guide” that could be used in upcoming courses. The project sponsor assembled this during the field test. It included mentor feedback to assignments, annotated answer sheets given to participants upon completion of their assignments, and other material as appropriate.

6. Facilitator/mentor video

At the conclusion of evaluation activity, the team members were interviewed by the researcher and videotaped about the course in general, its use of authentic learning and
cognitive apprenticeship principles, its potential to create a community of learners, and the review/formative evaluation process the team had just completed.

**Discussion**

Beyond the facilitators acquiring a better understanding of the course, the e-learning application, and the roles, responsibilities, and expectations of the facilitator team, the questions posed as the start of the formative evaluation were answered as shown below and appropriate actions were taken.

**Questions asked and answered**

Table 7.1 lists the questions that were posed at the start of this formative evaluation, the findings of the evaluation, and actions that were taken to improve the course or data that were to be collected in the third iteration.

<table>
<thead>
<tr>
<th>Evaluation question</th>
<th>Findings of the evaluation</th>
<th>Resulting actions taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To what extent do all the elements of the course (e.g., on-line components, instructions, printed materials) contribute to a learning event that is relatively easy to use, and what can be done to improve the elements?</td>
<td>During the high-level walk-through of the course and again in the detailed review of the alpha version, the team identified a number of inconsistencies (e.g., scroll bar positions, names of buttons), potential irritants that could cause frustration (e.g., downloads that might take too long to accomplish), and other items to improve (e.g., font sizes). These items were collected and given to the development team to correct.</td>
<td>Changes were made as requested. Time estimates for activities were reviewed and confirmed. Team confirmed plan to have participants and mentors in the field-tested course track actual time-on-tasks.</td>
</tr>
<tr>
<td>2. To what extent do facilitators have enough written general guidance on how to effectively facilitate the online course, and what can be done to improve the guidance provided to them?</td>
<td>This issue was also noted in the pre-meeting questionnaire given to the facilitators. Norms and guidelines needed to be established.</td>
<td>The team discussed norms and expectations during this review. For example, the importance of timely communication with participants and other mentors and the desired elapsed time for responding to questions and providing feedback on activities. This was examined further in the field testing by way of surveys with participants and mentors.</td>
</tr>
<tr>
<td>Evaluation question</td>
<td>Findings of the evaluation</td>
<td>Resulting actions taken</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>3. To what extent do the facilitators have a common understanding on what constitutes an adequate desired result (a “passing grade”) for each of the participant activities, and what can be done to improve this understanding and its application in the course?</td>
<td>Approaches for responding (e.g., use of individual comments, summary comments, video) had not been established until this point.</td>
<td>During the meeting, the norms and general expectations were discussed and agreed to. For example, feedback would be given individually to participants (and to teams if a group activity was involved) and also a summary of relevant points would be prepared for all the participants. A lead facilitator was identified who would create a document (i.e., “answer sheet” or “points to look for”) that could be used in the future by other facilitators. This was examined further in the field testing by way of surveys with participants and mentors.</td>
</tr>
<tr>
<td>4. To what extent can the facilitators effectively make use of the capabilities of the learning application, and, what can be done to improve their use of these capabilities?</td>
<td>During the evaluation, the facilitators tried different components of the application and also the tools (e.g., Google Drive) that existed outside of learning application. The team identified interactions that were complicated (e.g., using Google Drive) and ways to make it easier.</td>
<td>Prior to starting the field testing, mentors began experimenting with Google Drive. The course director created a job aid for participants and mentors on using Google Drive.</td>
</tr>
<tr>
<td>5. What are the risks in implementing this course that could cause unwanted results?</td>
<td>As described earlier, this was a major element in this evaluation. Risks were identified and prioritized.</td>
<td>During the implementation of the prototype course, mentors were alert to determine if additional risks were present.</td>
</tr>
<tr>
<td>6. If there are risks, how could these be controlled or mitigated?</td>
<td>For the risks that were identified, ways to prevent them (i.e., controls) and lessen their impact should they occur (i.e., mitigation) were specified.</td>
<td>A risk matrix was developed which became a live document. As risks were identified, causes and solutions were discussed and addressed.</td>
</tr>
</tbody>
</table>

As Table 7.1 above shows, the mentor and design team review answered the questions that were posed in the evaluation plan. Improvements in the course, the e-learning application, and in the implementation plan were made, increasing the likelihood for a successful initial implementation. This evaluation also led to other specific data collection activities during the field testing of the prototype course.

**Addressing the secondary research questions in Iteration 2**

In Chapter 1, four research questions—one primary and three secondary—were posed. The formative evaluation of the alpha version of the course that was presented in this chapter provides additional findings that are useful in addressing two of the three secondary questions. No data collected during the mentor review relates to secondary
question 2C. Chapter 10 responds to the primary research question using the findings found here and in Chapters 6 and 8.

Each of the three secondary research questions is listed below along with an initial answer (in boldface type) and supporting rationale and data.

**Question 2A:** What are the factors that enable a technology-based e-learning solution and the affordances the technology provides, to “mirror” an existing, experiential learning event and potentially improve on that event?

**Factors include:**

**(1) Useful, prompt feedback and responses from course leaders and mentors to individual and team projects and to participant questions.**

In the actual bus course, mentors are with the participants from the start of the day until it ends (usually 13-15 hours later). While riding on the bus, mentors and participants interact. At the end of the daily participant-team presentations, mentors provide comments, feedback, and contribute to discussions. For the e-learning course, the mentors agreed to have a 24-hour goal for reviewing participant assignments and responding with comments.

**(2) A level of belief that what you are experiencing is true.**

When walking into a cold room (two to eight degrees C), there is no doubt that a person is experiencing an environment that is suitable for storing certain TTSPP. In an e-learning course, this condition becomes impossible to replicate, requiring some degree of suspension of disbelief. (This is discussed in more detail in Chapter 8.) Creating an e-learning course that would contribute to this suspension of disbelief was important to the design team and the course director as well as the realization that computer technology had its limits:

One other thing that we do in this course is also they will be receiving some real stuff. For example, [participants] will receive three vials of vaccine when the course starts. When it comes to the [shake] test, one [vial] is frozen by us as [a] control. The other [two vials sent to the participant] are tests. They have to do this test as part of the activity with real tools. Then they have to report on it. (M3, VT reference)
Question 2B: *In what ways can a community of learners be established and enhanced when the participants are in different physical locations and of different cultures?*

(1) **Technological and local political constraints upon the user need to be considered.**
Without having availability to a defined baseline of technology—computers, bandwidth/line speed, and to the servers that held the content—individuals would not be able to participate in the community of learners. Technology was one of the sets of topics that the mentors and design team members identified as potentially problematic, especially for participants who did not have the bandwidth to stream video or who lived in a country with a government that blocked the web-based video servers (i.e., Vimeo). (Appendix 10 contains the risk assessment made during this iteration.) Contingency plans were put in place to have DVDs made in advance of all the video elements that could be shipped via courier to participants who could not successfully access the video server sites. Additionally, minimum requirements for computers and browsers were set and communicated to potential participants.

(2) **Thoughtful communication helps create and sustain a community of learners.**
A risk that was identified by the mentors and design team was that a participant might have personal issues (e.g., family, work, health) that would prevent them from completing assignments in a timely way. (See Appendix 10 for the risk assessment.) Mentors agreed to stress the importance of communicating potential problems like this with the mentors and team members so as to reduce frustration and develop alternatives if someone has a problem.

**Conclusion**
This formative evaluation conducted by the e-learning mentors—consisting of international practitioners with content expertise and who had mentored physical bus trips—was a considerable investment in time and resources on the part of the course sponsor. As was seen from the comments made during interview and the improvements that were identified, this review was essential in preparing for the field testing of the prototype e-learning course.
In the following chapter, the formative evaluation of the final iteration of the e-learning course will be presented and discussed.
CHAPTER 8

Formative Evaluation 3: Field Testing

Introduction

According to McKenney and Reeves (2012), “Tryouts are used to study how interventions work, what participants think or feel about them, and the results they yield. Tryouts take place when (a prototype of) the intervention is field tested in a natural setting” (p. 144). Field testing an innovative course is a well-accepted way to try out a learning solution with actual participants in order to make improvements and decide if the learning solution is ready to be launched in the natural context(s) for which it is intended. During a tryout or field test, significantly more data is normally collected and more comprehensively analyzed for formative and summative purposes than is done during the first full implementation of the course.

In this chapter, the field test of the e-learning course that was presented over 12 weeks in 2013 is examined, focusing on the course participants, the six course modules (including their objectives, a description, and the data gathered through researcher observations), participant reflection and comments, and mentor responses to questions. At the end of this chapter, conclusions about this full prototype course are drawn. The following chapter expands on what was learned from this field test of the e-learning course as it applies more broadly to e-learning generally, and to the revision and refinement of the design principles.
The conduct of the field test

The content and design of the prototype course were shaped by the two previous rounds of formative evaluation. First, expert instructional designers and a visual/graphic designer provided detailed feedback about initial sketches and design documents (see Chapter 6). This information was considered and used in creating a working prototype (the “alpha” version) that was evaluated by the mentors and learning consultant (see Chapter 7). Recommendations from this expert review were adopted by the design and development teams, and influenced not just the content, look, and feel of the e-learning course, but also the broader implementation plan.

With the changes made to the virtual bus tour and the mentors prepared through face-to-face discussions and some hands-on practice with the e-learning application, the beta version of the e-learning course was ready to be tested by actual learners.

The mentors

In addition to the researcher, three mentors facilitated this field testing. This team was described in Chapter 7 and further qualifications are as follows (pseudonyms used):

- **M1:** M1 was a mentor in the 2010 WHO Pharmaceutical Cold Chain Management on Wheels (PCCMoW) bus course (Vesper, et al., 2010; WHO, 2008) and participated in the February formative evaluation involving the design team and mentors.

- **M2:** M2 was a mentor in the 2010, 2012, and 2013 WHO bus courses; he also participated in the February formative evaluation involving the design team and mentors.

- **M3:** The project sponsor from WHO. M3 originated the WHO PCCMoW bus course and has lead more than five of the trips. M3 was also on the design team for this e-learning course and was the course director (and mentor) for the e-learning course. He participated in the February formative evaluation.

Throughout the course, the mentors (and often the learning consultant, LC) conducted regular Skype calls to discuss the progress of the course, issues, potential adjustments to timelines, and the like. An example summary of these calls is found in Appendix 5.
The participants

Fifteen individuals were invited by the course director to participate in the prototype course. Criteria for their inclusion in the field testing of the prototype included their previous participation in a bus course, English-language skills (a pre-requisite in the bus course as well), willingness to complete questionnaires (for this researcher and for the formative evaluation), and an informed consent. Additionally, the course director wanted a selection of participants who could “cluster” in several time zones (making group work easier to arrange), be from a mix of industry, non-governmental organizations (NGOs), drug/vaccine national authorities (i.e., national regulatory bodies), and be representative of future learners. Table 8.1 provides more detail on the participants, their nationality, and job functions.

Although 15 participants originally agreed to go through the field test, six withdrew at different points before completing the course. Most participants completed a majority of the activities and tasks; however, three of the nine participants who stayed enrolled in the course finished less than 50% of the assigned tasks due to demands of work or travel.
Table 8.1. Participants in the field testing of the prototype course

<table>
<thead>
<tr>
<th>Initials (Pseudonym)</th>
<th>Country of residence</th>
<th>Job title</th>
<th>Public or private sector</th>
<th>Year of bus course</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>India</td>
<td>Founding Director, cold-chain equipment and products</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>P2</td>
<td>Switzerland</td>
<td>Business Developer, consultant</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>A (withdrew)</td>
<td>Sudan</td>
<td>Medical Director of national immunization program</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P3</td>
<td>Switzerland</td>
<td>President, firm that makes electronic temperature monitoring equipment</td>
<td>Private</td>
<td>2008</td>
</tr>
<tr>
<td>P4</td>
<td>Switzerland</td>
<td>Scientist, prequalification of vaccines, NGO</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P5</td>
<td>Indonesia</td>
<td>Inspector, national regulatory authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P6</td>
<td>Albania</td>
<td>National Immunization Program Manager</td>
<td>Public</td>
<td>2008</td>
</tr>
<tr>
<td>H (withdrew)</td>
<td>Indonesia</td>
<td>Manager, vaccine manufacturer</td>
<td>Public</td>
<td>2012</td>
</tr>
<tr>
<td>P7</td>
<td>Egypt</td>
<td>Inspector-Pharmacist, national regulatory authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P8</td>
<td>Turkey</td>
<td>Managing Director of a pharmaceutical firm</td>
<td>Private</td>
<td>2008</td>
</tr>
<tr>
<td>P9</td>
<td>Egypt</td>
<td>Deputy Manager of cold chain monitoring system, national authority</td>
<td>Public</td>
<td>2009</td>
</tr>
<tr>
<td>P10</td>
<td>Netherlands</td>
<td>Quality Assurance Specialist, vaccine manufacturer</td>
<td>Private</td>
<td>2010</td>
</tr>
<tr>
<td>P11</td>
<td>India</td>
<td>Deputy Manager of vaccine exports, vaccine manufacturer</td>
<td>Private</td>
<td>2009</td>
</tr>
<tr>
<td>P12</td>
<td>China</td>
<td>Deputy Manager, biologics manufacturer</td>
<td>Public</td>
<td>2008</td>
</tr>
<tr>
<td>P13</td>
<td>Swaziland</td>
<td>Logistics Officer, national vaccination program</td>
<td>Public</td>
<td>2012</td>
</tr>
</tbody>
</table>

Prior to the start of the field test of the prototype course, all participants were invited to complete an online questionnaire (using SurveyMonkey; see Appendix 11) to help to determine their experience with e-learning courses and the technology that they were intending to use in accessing the course website. Responses from all 15 original participants provided more context that allowed the researcher to appreciate their involvement with the course, specifically

- All but one of the participants intended to use a Windows-based computer; one participant intended to use an Apple Macintosh computer.
• Web browsers that participants planned on using included (in decreasing order): Internet Explorer, Google Chrome, Mozilla Firefox, and Apple Safari.

• Four participants had participated in an e-learning course provided by their employer or one available from a regulatory agency (e.g., US FDA) in the past year.

• When asked if they had concerns about participating in the field test of the new online course, 12 of the 15 participants responded Yes. Of those, 10 said they were concerned about the time required for the course due to work, travel, or vacations that were scheduled. One of the ten also mentioned the availability to have internet access while traveling. Of the 10 people who were concerned about time availability, four withdrew permanently or partially from the course. Of these four, participant P10 withdrew because of an unplanned expansion of her workload (due to illness of a co-worker); two participants, “A” and P2, withdrew because of conflicts with work and travel schedules; a fourth, P5, withdrew due to difficulties in accessing the internet during her work-related travels in rural Indonesia. In these four cases there may have been an “optimism bias” present, whereby the individuals overestimated their chance of successful outcomes and underestimated the chances of things going wrong (Sharot, 2011).

Course chronology/significant events
During the field test of the prototype e-learning course, events deemed important in the course were documented (see Appendix 15 for the chronology) such as when tasks were started, when participants withdrew from the course, changes in the approach mentors used for providing feedback, and the like. Most of these events were further corroborated in additional documentation, such as email messages, and summaries of telephone or Skype conversations.

Implementation and execution of the field test of the prototype course
The prototype course consisted of five virtual visits to sites where TTSPPs were handled. At each site, participants—as individuals or in small teams—performed several different tasks that were considered to be authentic and relevant to that site and
the activities typically performed there. As a culminating activity, a more complex authentic task was assigned to each team.

Integrated into the course was an online diary where each participant could reflect on what they learned; ideas, concepts and actions that they could take back and apply; and comments (e.g., observations, suggestions) related to that task. Additionally, a link to an online questionnaire (using SurveyMonkey) for each task was provided in order to collect information pertinent to the formative evaluation of the prototype course (see Appendix 13). Table 8.2 identifies the data that were collected in the course and the abbreviations that are used in quote attributions below.

Table 8.2. Listing of surveys, diaries, and feedback sources referenced in this chapter

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Title of document</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCQ</td>
<td>Pre-course participant</td>
<td>Online survey questionnaire (using SurveyMonkey) intended to collect information about e-learning experience of participant and technologies to be used during prototype course (Appendix 11).</td>
</tr>
<tr>
<td>V# DQ#</td>
<td>Post-visit participant</td>
<td>Text entries intended to facilitate and collect learner reflections on what was valuable and how information can be used.</td>
</tr>
<tr>
<td>V# SQ#</td>
<td>Post-visit participant</td>
<td>Online survey questionnaire (using SurveyMonkey) at conclusion of each site visit (Appendix 12).</td>
</tr>
<tr>
<td>PCS Q#</td>
<td>Post prototype course</td>
<td>Survey conducted at end of prototype course used to collect final ratings and comments (Appendix 13).</td>
</tr>
<tr>
<td>FCE</td>
<td>Post course phone call</td>
<td>Transcript of a one-hour conference call held with participants, mentors, and learning consultant.</td>
</tr>
<tr>
<td>PCMQ Q#</td>
<td>Post course mentor questionnaire</td>
<td>Online survey questionnaire (using SurveyMonkey) conducted at end of the prototype course to collect comments from mentors (Appendix 14).</td>
</tr>
<tr>
<td>DTMR</td>
<td>Design team and mentor review</td>
<td>Transcript of video interviews made during design team and mentor review of working prototype.</td>
</tr>
</tbody>
</table>

The following sections describe each of the virtual site visits and the authentic task, listing the objectives, the tasks/activities performed, the results of the diary and questionnaire entries, and a discussion of the virtual visit. Comments from the post-visit diaries and surveys related to the proposed design principles will be discussed in detail in Chapter 9–Reflection and Revised Design Principles. Some visits (i.e., Farmalojistik,
Health Center, and the authentic task) are examined in more detail compared to the others because of some of the unique features of the visit and the activities performed.

**Visit #1: Farmalojistik**

*Description*

Farmalojistik is a wholesaler/distributor of pharmaceutical and health-care products, including those that are time- and temperature sensitive. Wholesalers like Farmalojistik are often the first major destination of drug products after leaving the drug manufacturer or arriving into the country via a logistics company like DHL. The goal of this visit was for the learner to see this first stage of the cold-chain process in Turkey and to be introduced to cold-chain terminology, quality agreements, potential risks, and ways to reduce those risks. As would be done with the other virtual visits, the participant was given a video tour that provided some context on the site, its function, and operations as well as 360-degree images that the participant could use in exploring different areas within the site. To accomplish the goal for this virtual visit, five learning objectives were identified by the design team and expert practitioners during the design phase.

*Objectives*

At the end of this virtual visit to the Farmalojistik facility, the learner should be able to

1. Identify the major operational components in a pharmaceutical cold chain.
2. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
3. For a given a mode of transportation, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP.
4. For a given a situation, select the appropriate methods and materials for packaging and shipping cold chain products to minimize risk.
5. For a given a situation, discuss specific requirements to be included in a quality agreement.

To achieve the goal and these objectives, a set of tasks/activities was developed.

*Tasks/activities*

There were five tasks that the participants performed in the first virtual visit.
1. The first task, *Who am I?* was a simple activity intended to develop and standardize the participants’ vocabulary related to TTSSP and cold chain operations.

2. The second task, *Inspecting GDP*, required the participant to watch a video of someone performing an activity, that is, packing a cold box, according to a written procedure and then critique the written standard operating procedure (SOP).

3. The third task, *Temperature Excursion*, had the participant examine a data-logger printout of the interior temperature of a package that exceeded its requirements (i.e., specifications).

4. The fourth task, *Quality Agreement*, required participants to work in teams for the first time; teams were assigned by the course director. In this task, each participant identified four important sections of a quality agreement (a definition of roles and responsibilities between a customer and the service provider). Working in their virtual teams, team members had to arrive at a consensus for five sections with each member defending their choices to their group.

5. The final task in this visit, *Risk Treatment*, had the participant view the facility tour video once again but look for controls that were in place to reduce risks.

Based on concerns from the expert reviewers in the first iteration concerning the amount of time required to complete a module, the participants were asked to track the time spent on each activity. Table 8.3 shows the time estimated by the design team to complete each task in this first visit together with the actual mean (average) time taken by the group.
Table 8.3. Comparison of estimated to actual time for completion of tasks for Visit #1

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated time (hours)</th>
<th>Actual time (hours) (mean of group)</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps 1-3—Objectives, video tour, 360-degree photos</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Step 4—Task: Who am I?</td>
<td>1</td>
<td>1.10</td>
<td>1.68</td>
<td>0.25</td>
<td>6</td>
</tr>
<tr>
<td>Step 5—Group Task: Inspecting GDP</td>
<td>2</td>
<td>2</td>
<td>0.67</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Step 6—Group Task: Analyzing a temperature excursion</td>
<td>1</td>
<td>1.34</td>
<td>0.48</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Step 7—Group Task: Quality agreement</td>
<td>3</td>
<td>1.71</td>
<td>0.65</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Step 8—Group Task: Application of risk assessment</td>
<td>4</td>
<td>1.79</td>
<td>0.55</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Step 9—Learning diary</td>
<td>1</td>
<td>.48</td>
<td>0.28</td>
<td>0.2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Time for all tasks</strong></td>
<td><strong>12</strong></td>
<td><strong>8.4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In examining the results from the first virtual visit, some tasks took slightly longer than originally estimated while others took less. Overall, however, the actual time was about 25 percent less than estimated. This difference could be due to the design team over-estimating the time required. Since the tasks in the e-learning course were significantly different than those in the physical bus trip, it is unlikely that participation in the bus course would account for the difference in estimated and actual times.

**Diary entries: Visit 1**

At the conclusion of the virtual site visit, participants were asked to complete an online diary that was also accessible by the course mentors. Three prompt questions were given to aid reflection, with the participants writing as much or as little as they chose. The questions were

- What did you learn?
- What can you take back to your work and use?
- What other comments would you like to provide?

A qualitative analysis of each module’s diary entries was performed, first, looking for themes that arose from the participants, and second, to identify if the respondents
mentioned concepts or specific examples that might be related to the draft design principles being developed.

Ten of the 11 diary writers spontaneously volunteered one or more topics specifically related to the objectives of the visit that they had learned, for example, risk assessments or quality agreements. Additionally, 6 of 11 writers identified other things that they learned from this visit that extended beyond the explicit learning objectives. Three writers wrote comments that connected this e-learning course to the physical bus trip that they had been on previously. In terms of the utility or intended use of the knowledge acquired during this visit, 7 of 11 diary writers gave very specific ways that they planned to apply what they learned related to the learning objectives in this course in their work, such as “review quality agreements.” Five of the writers identified items beyond the learning objectives that they intended to use in their work, such as “insert a ‘packaging centered’ vision into a wider point of view.”

**Post-visit questionnaire: Visit 1**
In addition to the diary entries that were intended to gather more reflective participant responses, course participants were asked (but not required) to respond to online survey questions (see Appendix 12). Some of the questions solicited feedback and ideas for improvement. Other questions sought information pertaining to the draft design principles, in particular on task authenticity and small group tasks. Some questions asked participants to rate an attribute, such as how challenging a task was. A 10 point scale was used with 1 being the lowest and 10 being the highest rating.

On average, all questions had a rating of at least 7 for each of 12 rating questions; 8 of the 12 questions had mean ratings of 8 or higher. In sum, this indicated that the respondents were positive about this first module of the e-learning course. The highest score (8.45) given by the participants was in their rating of the visit; the lowest score (7.45) was on the challenging nature of the tasks performed, meaning that participants viewed these tasks as easier than they would expect in a real situation.

**Discussion: Visit 1**
Of particular interest in the research study during this visit were issues related to (1) the realism of the task, and (2) the interactions between the participants during the small
group activities. These were directly connected to the design principles and research questions.

**Realism of the task**

In their responses, participants identified specific aspects of the visit that were useful to them, such as the temperature excursion activity and the way to virtually walk-through the warehouse facility using the 360-degree videos. While participants rated the realism of the tasks/activities in this virtual visit as 7.82 (mean) out of 10, one participant commented:

> The SOP was having such poor quality, that it was not very realistic. There was so much to comment on, it might have been better if there were also good parts in it. [P10 (V2 SQ4)]

This participant’s view may be shaped by her experience of working for a large, multinational pharmaceutical manufacturer that has well-written procedures. By comparison, the procedure included in the e-learning course was an amalgam of commonly seen deficiencies in a procedure. It would be unusual to see all the deficiencies in one document that had been reviewed and approved by the company’s quality control unit prior to its being released for use.

Another possible explanation for her comment could be that the procedure used in the scenario was not effective in suspending her disbelief, an important factor for motivation and participation in virtual environments (Herrington, et al., 2003b). Specifically, there was a significant or unacknowledged “inconsistency with the [participant’s] real world” (Standback, 2011). If one thinks of an “activity” being the same as an “assessment,” the work of Gulikers, Bastiaens, Kirschner, and Kester (2008) explains how experiences shape one’s view of authenticity when they stated

> Something is only authentic with respect to something else, for example a situation, place or profession… Whether a person sees an assessment as being authentic depends on the reference point that person has in mind against which the authenticity is measured. (pp. 402-403)

Gulikers et al., concluded, “This means that what one person perceives as being authentic is not necessarily authentic in the eyes of someone else” (p. 403)—a statement that is consistent with the observations of the participant who made the comment about the activity being unrealistic. For other participants—those who may
not have been exposed to as many well-written procedures and/or whose disbelief was suspended—they may have been able to better accommodate (i.e., suspend disbelief of) the procedure. Giving some evidence of this is that two participants commented in their diary entries on what they gained from using the SOP in the activity:

Clear, relevant and specific SOPs and ensure proper implementation of GDP [Good Distribution Practice requirements]. [P13 (V1 DQ2)]

Identify the important elements which should be present in well written SOP and also identify the gaps in SOPs. [P4 (V1 DQ1)]

Another participant commented on the authenticity of the course, particularly as it related to inspections of the facilities:

It is big work to make such a complicated course so simple. The organization was excellent. The videos—the facilities tour—you almost feel like walking with the camera. This is something that makes the course so lively. [P2 (FCE, pp. 5-6)]

**Recommendations for improvement:**
In future offerings of this course there are at least two ways to increase the suspension of disbelief that could be considered:

- First, a case study could be created showing an actual situation where a poorly written procedure had an impact on product quality or samples of a document that were actually seen during audits/inspections (Kantor, Waddington, & Osgood, 2000).
- Alternatively, a “backstory” for the document could be developed, for example, that it was the first procedure that a new writer ever wrote and it was put in place without a thorough review. Put more broadly, when designing an e-learning activity, create a richer context in which the specific task is set.

**Interactions between participants in team/small group work**
In the online survey (using SurveyMonkey) two questions, #9 and #10, were intended to explore how well small groups worked together as they completed a task (i.e., in this first visit the task of developing a quality agreement). The ratings given by the participants were moderately high (mean for question #9, 8.27 out of 10) indicating that team members contributed and participated. A follow-up question concerning how the workload was shared (equally by all or only borne by one or two participants) had a lower score (mean for question #10, 7.18). This can be interpreted to mean that
everyone on a team was involved to some degree but participants perceived that a subset of the group members exerted the majority of the effort.

Some of the underlying issues can be understood through the suggestions that participants made when asked for ideas to improve participation/contributions during the group work activities, for example having mentors participate in calls, better grouping learners by regions and time zones, and timing of assignments:

In our group most of the exchange was by email. I think at least one Skype call in [the] presence of [a] mentor will be a good idea to improve the involvement [of team members]. [P1 (V1 SQ11)]

Time zones are very important. To group the people in the near time zones might be better. [P8 (V1 SQ11)]

Mandatory Skype chats. [P4 (V1 SQ11)]

Due to busy agendas it is not always easy to meet each other. It might be [better] working if standard meeting hours are planned. [P10 (V1 SQ11)]

Taking the relatively long period of the e-course, dedication is another big problem which needs a radical solution. I would prefer to make group assignments through the weekend. This would help overcome the dedication problem and enhance communication among team members. [P7 (V1 DQ3)]

Two particular themes—technology issues and time zone differences/time availability—are apparent in these comments. From a technology perspective, email and emailed documents were a baseline communication and collaboration mechanism. In terms of time and timing, the use of weekends as suggested by P7 also presents challenges as some countries use Friday-Saturday as weekends while others define weekends as Saturday-Sunday. Religious and national holidays are also a challenge to accommodate the scheduling of an international group of participants.

In developing the course and planning its implementation, the design team was intentionally sensitive to technology and time zone differences, as discussed by Frankola (2001) and Charalambos, Michalinos, and Chamberlain (2004), for instance by the grouping of participants by relatively similar time zones. Additionally, the design team allowed for the groups to decide upon the communication tools that would work best for their team as a whole. Despite these attempts, problems were perceived by the participants. Charalambos, et al., spoke of two types of issues facing virtual
communities: technical and social. The responses to questions that were asked in the online survey and the comments made during the post-session participant phone call allude to both factors affecting this e-learning course. As mentioned above, document transfer by email and waiting for them to arrive (as contrasted to using real-time, online collaboration tools) would be considered a technological factor. Perceptions about the dedication of other team members, as well as their actual level of dedication to the group tasks would be considered a social factor.

**Recommendations for improvement:**
In future offerings of this course as well as in the design and implementation of other e-learning efforts that use virtual groups, examine how both technological and social aspects of the courses can reduce problems and contribute to better communication and collaboration within the work groups.

At the conclusion of the last task at Farmalojistik, in order to signal to participants to advance to the next virtual site, the course director sent an email to course participants announcing the next virtual visit:

Tomorrow the bus moves to BURSA VACCINE STORE. We expect that you spend your day discovering Bursa vaccine store facility by visiting the BURSA VACCINE STORE link in the navigation panel, as well as checking the Step 1 Objectives, Step 2 facility Tour and Step 3 360-degree photographs of the facility. Many thanks again for your work at the Farmalojistik and entering your notes to your diary. See you tomorrow in Bursa Vaccine Store…

**Visit #2: Bursa Provincial Vaccine Stores**

**Description**
Bursa Vaccine Stores is the storage and distribution for Turkey’s fourth largest city. Each month, using two custom-designed and -built distribution vehicles, the Stores provide vaccines to 27 institutions in the region. The goals of this visit were for the learners to see an example of a government-run storage and distribution facility, to further develop their skills in identifying risks and articulate ways to control/mitigate them, and then to prepare a contingency plan in the event of an unwanted event. Additionally, participants were to develop a heuristic for interpreting a simple, widely used vaccine monitoring device and create a plan for implementing an improved approach for transporting and protecting time- and temperature-sensitive products. As with the other virtual visits, participants were given a video tour that provided some
context on the site, its function, and operations as well as 360-degree photos that the participants could use in exploring different areas within the site. To accomplish the goal for this virtual visit, five learning objectives were identified by the design team and expert practitioners during the design phase.

**Objectives**

At the end of this virtual visit to the Bursa facility, the learner should be able to

1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. For a given mode of transportation, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP.
3. For a given cold storage facility, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with good distribution and good storage practices (GSP).
4. For a given situation, select the appropriate methods and materials needed to monitor temperature and/or humidity for cold chain products and to obtain necessary data for making decisions.
5. For a given a situation, develop a contingency plan.

To achieve the goal and these objectives, a set of tasks/activities were developed.

**Tasks/activities**

There were three tasks that the participants performed in the second virtual visit

1. The first task, *Contingency Plan*, required the participants to watch a video of a distribution van breaking down in an isolated area and then, working in teams, to create a contingency plan.
2. The second task, *Vaccine Vial Monitors (VVMs)*, provided an opportunity for participants to become familiar with and make decisions on the usability of a vaccine that had been exposed to temperatures beyond the required 2-8 degree C range. (VVMs are a label-like sticker on a vial that contains a chemical that changes color based on the temperature/time exposure.) Working individually, participants were asked to create five heuristics or
rules to guide their decision making (to use or not use the vaccine) based on the VVM.

3. The third task, *Introduction of Cool Water Packs*, participants, working in virtual teams, were put in the role of advisory committee members who were to create an action plan for introducing into Turkey this different approach for protecting time and temperature sensitive products. The teams needed to consider specific tasks to be undertaken, risks and controls, a timeline, and resources to be allocated to accomplish the project.

Table 8.4 shows the time estimated by the design team to complete each task in this first visit along with the actual mean (average) time taken by the group. The actual mean time for participants completing this virtual site visit was about 25 percent less than what was originally estimated. As in the previous virtual visit, the activities in this visit were quite different than those used in the physical bus trip.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated time (hours)</th>
<th>Actual time (hours) (mean of group)</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps 1-3—Objectives, video tour, 360-degree photos</td>
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<td>NA</td>
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<tr>
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<td>Step 6—Group Task: Introduction of cool water packs</td>
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</table>

**Diary entries: Visit 2**

At the end of this virtual visit, eight participants completed diary entries, again answering the questions

- What did you learn?
- What can you take back to your work and use?
- What other comments would you like to provide?
All eight participants volunteered that they learned at least one topic linked to a learning objective; two participants identified something they learned that was unintended by the design team. In commenting on the development of the contingency plan, Participant P4 noted that it directly connected what he learned to learning objectives #2 and #5 listed above:

I learnt how to prepare a contingency plan for cold chain distribution based on anticipated scenarios of expected risks and hazards. This helped me to visualize the criticality of back up plans even in short deliveries. [P4 (V2 DQ1)]

P4 also said he learned a technique (preparing a decision tree) that was not an intentional stated objective:

I also learnt on taking a decision or preparing a decision tree when more than one parameters or variables are involved. This matrix decision tree based thought process was new to me. [P4 (V2 DQ1)]

Participant P11 was very specific in listing what he gained in this site visit:

1. Importance of Cool water packs
2. Identification of VVM’s and their importance during supply
3. Contingency planning. [P11 (V2 DQ1)]

P11 identified a very specific action that he had planned to later implement in his own real-life context related to the learning objectives:

Review our contingency plan for dispatch of vaccine from Pune to Mumbai Airport. [P11 (V2 DQ2)]

Another participant, P12, spoke to the utility of the topics covered in this virtual visit and how he will be able to apply them in his role:

I’ll bring Contingency and water pack knowledge to my work and use. I spend a lot of time to read that interesting water pack article. It really can help me solve some problem I met before. [P12 (V2 DQ2)]

These comments reveal the potential of learning within the authentic environment to and then transferring the learning to real working problems and practice.

Post-task questionnaire: Visit 2
Eight participants completed the post-task online questionnaire at the end of this module. This module had the third highest “site visit” rating and the second highest overall rating. Of the three tasks that used virtual teams, this site visit had the highest
ratings for both participation by team members and the value of the contributions that they made.

Many of the comments in the post-task questionnaire echoed the issues and concerns noted in diary entries. For example, participant P7 wrote similar comments on what he found useful in the visit:

The new learnt concepts of developing contingency plan, action plan and risk management related concepts. [P7 (V2 SQ3)] [Post-task questionnaire]

What did I learn in this section? Developing a contingency plan; Developing an action plan; more knowledge about risk management. [P7 (V2 DQ1)] [Diary]

Other comments were a mix of suggestions and affirmations, such as:

Add a video to the task of the cool water packs. [P11 (V2 SQ4)]

Involve a mentor with each group! Just like what had been practiced during the real PCCMOW course. [P7 (V2 SQ4)]

… all links given to us [were] of great help… [P13 (V2 SQ20)]

**Discussion: Visit 2**

In considering the learning objectives and the tasks/activities for this visit that were listed above, it seems that the learning objectives did not fully encompass the learner-tasks. For example, Objective #5 includes the outcome that was intended (i.e., preparing a contingency plan in the event that a vehicle was to break down), however Objectives #1-4 could be improved. (The researcher was part of the design team that wrote these objectives originally.)

Although not reflected in the objectives, the design team’s intent can be seen in the instructions for the assigned tasks. For example, in Task #2–Vaccine Vial Monitors (VVM), the participants were required to complete two subtasks. First, they needed to identify batches to be dispatched to healthcare facilities. The cognitive skills used in this task required judgments to be made on the expiration date of the vaccine and how much heat the vaccine had been exposed to (based on the color change of the VVM). Second, they needed to reflect on how they made the determination so they could create a tool (e.g., procedure, decision tree) to communicate the “rules” or heuristic to be followed. This level of critical thinking goes beyond the original learning objective of “selecting
the appropriate methods and materials needed to monitor temperature and/or humidity for cold chain products and to obtain necessary data for making decisions.” A learning objective more fully aligned with the task could be:

*Given a variety expiration dates exposed VVMs, create a tool to simply and accurately communicate the rules used to select vaccines for use.*

Learning Objectives #3 and #4 are covered in Task #3–Cool Water Packs. While one of the verbs, “assess” is aligned with the category of “evaluate,” the second-from-the-top level of Krathwohl’s revision (2002) of Bloom’s work, the other verb, “identify,” is more consistent with “understanding” or “applying” which are in a lower-level category. In the actual task, participants are asked to develop an action plan for introducing a new way for transporting vaccines using cool water packs instead of ice. Given this, a better learning objective could be:

*Given a new approach for transporting time and temperature sensitive vaccines, assess risks of the currently used method and develop an integrated action plan for introducing and implementing the new, recommended approach.*

**Recommendations for improvement:**
Review all learning objectives in light of activities/tasks that the participants perform and revise as necessary so that the objectives are more reflective of the tasks being performed. This would apply to future offerings of this course as well as more broadly to other e-learning courses.

As was done after the virtual visit, the course director sent an email to all participants and mentors that announced the next visit—this time to a teaching hospital in Turkey’s capital city.

**Visit #3: Hacettepe University Hospitals**

**Description**
Hacettepe University Hospitals is a teaching hospital located in Ankara, Turkey. Its three separate hospitals—for adults, children, and oncology (cancer)—are fully certified by an international accreditation agency. The three hospitals are all served by a central pharmacy that has 85 professional and support staff. The pharmacy and the nursing
stations are all equipped for handling time- and temperature-sensitive pharmaceutical products. The goals of this visit were for the learners to see an example of a modern healthcare facility and further enhance their skills in risk identification, risk control and mitigation. As with the other virtual visits, participants were given a video tour that provided some context on the site, its function, and operations as well as 360-degree photos that the participants could use in exploring different areas within the site. To accomplish the goal for this virtual visit, three learning objectives were identified by the design team and expert practitioners.

Objectives
At the end of this virtual visit to the Hacettepe University Hospitals, the learner should be able to

1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. Illustrate the inputs, activities, and outputs of each operational component of a pharmaceutical cold chain.
3. For a given a supply chain system in a facility, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP/good storage practices (GSP).

To achieve the goal and these objectives, the course designers created one task/activity.

Tasks/activities
There was one task that the participants performed in this third virtual visit:

- Using a video of Hacettepe Hospitals, identify controls in place to prevent/reduce risks and then identify the specific risks that the controls were to prevent/reduce. This task was to be performed by work teams working virtually.

Table 8.5 shows the time estimated by the design team to complete each task in this first visit along with the actual mean (average) time taken by the group. The difference between the estimated and actual times is unlikely to be due to past participation in the physical bus course because the activities were not identical.
Table 8.5. Comparison of estimated to actual time for completion of tasks for Visit #3

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated time (Hours)</th>
<th>Actual time (hours) (mean of group)</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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<td>Steps 1-3–Objectives, video tour, 360degree photos</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Step 4–Group Task: Application of risk assessment</td>
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<td>3.25</td>
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<tr>
<td>Step 5–Learning diary</td>
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<td>0.30</td>
<td>0.14</td>
<td>0.2</td>
<td>0.5</td>
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<tr>
<td><strong>Time for all tasks</strong></td>
<td><strong>4</strong></td>
<td><strong>2.1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diary entries: Visit 3**

Six participants completed diary entries for this virtual site visit. Of the 6 respondents, 4 volunteered at least one thing they learned during the site visit that was connected to the learning objectives; 2 of 6 mentioned things they learned that were not specifically mentioned in the learning objectives. For example, P4 cited topics related to Objective #3:

I learnt [about] cold chain storage and distribution in a large usage facility. I also learnt also the risks and hazard involved in systems of such facilities. [P4 (V3 DQ1)]

P2 said he much gained a broader understanding of the hospitals, something that wasn’t an intentional outcome stated in the learning objectives:

[I learned] Mostly about the system in place at Hacetteppe hospital. Which is really high class. [P2 (V3 DQ1)]

Three participants identified actions that they could take back and use based on the learning objectives. One of these respondents was very specific:

Applying risk and risk control concepts in my work. For example, developing a risk based inspection plan as well as applying the risk management concepts during my inspections. [P7 (V3 DQ2)]

Four of the 6 respondents (67%) suggested enhancements to this site visit, the highest percentage of those suggesting improvements. By comparison, there were enhancement suggestions from 5 of 11 respondents (45%) for Visit #1 and 3 of 8 respondents (38%) for Visit #2. The results from the post-visit questionnaire provide insight on why this visit generated such a high number of suggestions for improvements.
Post-visit questionnaire: Visit 3

There were five respondents to the post-task questionnaire. They rated this virtual site visit the lowest of all the visits at 7.2 of 10; the mean of all site visits was 8.16. The rating for how challenging this task was one of the lowest at 6.6 of 10.

This site visit also showed the lowest ratings for the virtual teams—5.20 of 10 for participation/contribution of other team members and 5.60 out of 10 that compared the team member’s participation to his or her own participation. One participant gave a rating of 1 for both of these that significantly reduced the mean score; eliminating that score from both questions raised the ratings to 6.25 and 6.75, which still is below the scores for visits 1 and 2.

Discussion: Visit 3

Both the post-visit diary and survey results show that this virtual visit was not as highly rated as the other visits in the e-learning course. There are several potential explanations for this based on participant comments.

The sole task (identifying controls in place and then determining the risks that were prevented/reduced by the controls) in this visit was very similar to a task used when visiting Farmalojistic (Visit 1). This was recognized by the participants:

The assignment was good. However, it is the same like the risk management assignment of Farmalojistik. It would be great if you can make some amendments so added value would be gained. I am not an expert in risk management, however I would suggest for example to include a part in the task to rank the risks in a qualitative or quantitative way. [P7 (V3 DQ3)]

It’s better to assign task for this section in an alternative way. i.e., identify all potential risks in Hacettepe routine activities and give them suggestion for control. [P12 (V3 DQ3)]

I don’t know what other people might say but I think this task is very close from the risk assessment task so for me it is strengthening the idea. [P9 (V3 DQ3)]

It may be good to have a specific topic to be learnt at each step of the journey. Although repeating is a crucial part of a good learning process. [P2 (V3 DQ3)]

The last two participants saw value in reinforcing the topic whereas the first suggested an expansion of the risk-based thinking topic by using a more complex tool. Creating a more challenging, different way of approaching risk assessment and risk treatment in
this module is consistent with cognitive apprenticeship (Brown, et al., 1989). Additionally, modifying the “microenvironment” (Burton, et al., 1984) and repositioning the scaffolding and support in the new task stimulates more and deeper learning.

**Recommendations for improvement:**
Develop a different, more complex activity related to risk assessment and risk management. More broadly, for other e-learning courses, provide a range of learning activities with increasing complexity so learners can expand their repertoire of experiences.

This site visit also had the lowest scores related to the group work. Only one participant made any specific comments as to why he rated this so low:

> I shared my comments about the assignment with the other team members by e-mail on Friday, one day before the due date of the task. While not receiving any feedback from one member, I realized that this member submitted his individual work to the Google Drive without any consultation and/or discussion among the GROUP. Actually, this would not be considered as teamwork by any means. [P7 (V3 SQ13)]

As discussed earlier, factors like technology, social factor, time-zone differences, and culture (Charalambos, et al., 2004; Ebrahim, Ahmed, & Taha, 2009) are frequently cited challenges for virtual project teams and communities of learners. Team members in course were assigned by the course director to be within approximately ±3 time zones to minimize this from being a factor. There could have been other, more subtle issues that may have contributed to the low score. One is how some people work: many of us are deadline-driven. This was mentioned in the post-course teleconference by a participant describing the final authentic task but the underlying concern can apply here as well (emphasis added):

> I was a little worried because no one was asking me and I was thinking that people were not reading the documents… but then I received in the last days—because we know that people start to work in the last days—I was doing the same… [P6 (PCT p7)]

Another factor that could have contributed to ineffective group work was that the group had not really formed a cohesive team, moving through the “form, storm, norm, and perform” phases (Tuckman & Jensen, 1977). From a learning perspective, Siemens
(2002) identified a continuum of four phases of “connectivity” that learners go through when interacting in with each other:

- communication—“talking”, discussing
- collaboration—sharing ideas and working together (occasionally sharing resources) in a loose environment
- cooperation—doing things together - but each may still have their own purpose
- community—striving for a common purpose. (para 35)

Siemens said that for an online learning course, collaboration and cooperation are the farthest points on the continuum that a learning group can expect to achieve. Based on the one respondent’s comment:

this member [submitted] his individual work to the Google Drive without any consultation and/or discussion among the GROUP [P7 (V3 SQ13)]

It seemed that his group did not reach the cooperation stage.

Without more information from all the team members, a true root cause cannot be identified, but one contributing factor could be that team members did not talk about and agree to the norms by which they would work together. Palloff and Pratt (2007) discussed how norms and expectations must be established at the start of an online course by the instructor. Wenger (2000) took this further by saying that the members of a community of practice have a dimension of mutuality that requires the alignment of “roles, norms, codes of behavior, shared principles, and negotiated commitments and expectations that hold the community together” (p. 231). Palloff and Pratt suggested that before an online course actually starts, a “week zero” (p. 21) community-building event occur which will allow participants (and instructors) get to know each other and arrive at a common understanding of norms and expectations. These authors also asked participants to create learning contracts that they make with each other so as to improve mutual communication and accountability.

**Recommendations for improvement:**
Establish an opportunity for participants to set up and agree to the norms and ground rules that they want follow so as to facilitate their working together. Create a simple checklist (see Palloff & Pratt, 2007, pp. 239-269) of topics that groups can use in their
initial discussion, including timeliness of intra-group communications and assignment preparation. This would apply to future versions of this course as well as being a useful design feature in e-learning courses generally.

The third virtual visit again ended with a message from the course director and an invitation to continue the virtual trip with a visit to a neighborhood pharmacy that provides TTSP products to its customers.

**Visit #4: Ulutas Pharmacy**

**Description**
Ulutas Pharmacy is a retail pharmacy located in a suburb of Ankara, the capital city of Turkey and has three staff members along with its owner/pharmacist. The pharmacy stores its time and temperature sensitive pharmaceutical products in a refrigerator and has a backup generator and short message system (SMS) alarm system that will notify supervisory personnel in the event of a power failure. Power failures in this region are not an unusual occurrence. The goal of this visit was for the learners to see how a pharmacy, which is the last component of the drug distribution process, helps assure the quality of TTSPP. As with the other virtual visits, participants were given a video tour that provided some context on the site, its function, and operations as well as 360-degree photos that the participants could use in exploring different areas within the site. To accomplish the goal for this virtual visit, four learning objectives were identified by the design team and expert practitioners.

**Objectives**
At the end of this virtual visit to the Ulutas Pharmacy, learners should be able to

1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. For a given mode of distribution in the last mile, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
3. For a given situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decisions.
4. For a given situation, select the appropriate methods and materials for
packaging and shipping cold chain products to minimize risk.

To achieve the goal and these objectives, a set of tasks/activities were developed by the development team.

**Tasks/activities**

Two tasks were performed by the participants in this fourth virtual visit:

1. Using a video of a pharmacist preparing a product for a patient, identify risks and ways to control/mitigate those risks.
2. Using a video that shows a power failure at the pharmacy, identify risks and ways to control/mitigate those risks.

Both tasks were to be done individually by each participant and participants were asked to review and comment on the work done by one other participant.

Table 8.6 shows the time estimated by the design team to complete each task in this first visit along with the actual mean (average) time taken by the group. The actual mean time for participants completing this virtual site visit was approximately 25 percent less of what was originally estimated. Completing entries in the learning diary was the activity that differed most between the estimated and actual times.

<table>
<thead>
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<th>Activity</th>
<th>Estimated time (hours)</th>
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<th>Min</th>
<th>Max</th>
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<td>2</td>
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</tr>
</tbody>
</table>

**Diary entries: Visit 4**

Seven participants completed diary entries for this virtual site visit. Of the 7 respondents, all 7 identified at least one thing they learned during the site visit that was connected to the learning objectives; 2 of 7 participants mentioned items that were not specifically mentioned in the learning objectives. Four of 7 participants identified a
specific action that they would do in their jobs that were specific to the learning objectives. For example, P9 reflected on changes he would bring to his facility:

I will work on improving the way TTSP are dispensed [and the] application of appropriate refrigeration technology. [P9 (V4 DQ2)]

P2, in his diary entry, commented upon what he gained by looking at the work posted by other group members:

Good ideas from the participants on what is needed when using the pharma pouches. [P2 (V4 DQ2)]

Post-task questionnaire—Visit 4
Five participants answered questions in the post-task questionnaire. This virtual site visit received a rating score of 8.00, slightly below the average rating score of 8.16 out of 10. This site visit also received the lowest rating, 7.40 for “clarity of instructions” compared to the other site visits.

At the conclusion of Visit 4, P2 suggested an enhancement in the post-visit questionnaire and also his diary, specifically, having an ‘answer sheet’ prepared by the mentors to show how an “expert” would complete the task:

Each time, an "almost perfect answer" to the task given by a mentor could be useful. [P2 (V4, DQ3)]

Recommendations for improvement:
Provide feedback sheets developed by the mentors to show an example of a valid solution to the problem.

Consistent with the conclusion of the other virtual visits, the transition between sites was made by an email from the course director. The next site was also a venue where TTSP were given to patients.

Visit #5: Zeytinbagi Family Health Centre

Description
The Zeytinbagi Family Health Centre is located 12 km from Bursa and serves 7,200 people. The health center has two physicians and five other healthcare workers who provide a wide-range of services including immunization of children. The goals of this
visit were for the learners to see another arm of the drug/vaccine distribution process at the health center level and also to use the “shake test” (Kartoglu, 2003) to determine if a vaccine had not been frozen and can be used (if all other indicators are satisfactory). As with the other virtual visits, participants were given a video tour that provided some context on the site, its function, and operations as well as 360-degree photos that the participants could use in exploring different areas within the site. Unique to this site visit, three vaccine vials were couriered to each participant. At WHO Headquarters in Geneva, all had been specially labeled, with one vial frozen and identified as the “control”. Two other vials were “unknowns” and were included in the package, one of which had also been frozen, the other not. The task in the Shake Test, was for the participant to determine which of the unknowns was not frozen, and therefore, potentially safe to use in an immunization program. To accomplish the goal for this virtual visit, five learning objectives were identified by the design team and expert practitioners.

**Objectives**

At the end of this virtual visit to the Zeytinbagi Family Health Centre, the learner should be able to

1. Identify deficiencies in given situations using the good distribution practice (GDP) guidelines.
2. Given a mode of distribution in the last mile, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
3. Given a situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decision.
4. Given a specific temperature monitoring strategy, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP/GSP.
5. Conduct the shake test to identify whether a given freeze-sensitive vaccine has been affected by freezing.

To achieve the goal and these objectives, a set of tasks/activities were developed.

**Tasks/activities**

There were two tasks that the participants performed in this fifth and final virtual visit:
1. Perform a shake test and make a determination of which vial(s) was frozen using vials of vaccine that were provided and a protocol.

2. Make a decision on whether to use a vial of vaccine that was exposed to heat based on its vaccine vial monitor (VVM).

Both tasks were to be done individually by each participant. Participants were asked to upload photos of their shake test results. Table 8.7 shows the time estimated by the design team to complete each task in this first visit along with the actual mean (average) time taken by the group. The actual mean time for participants completing this virtual site visit was approximately 40 percent less of what was originally estimated. In this virtual visit, the only activity that was also used in the physical bus trip was the shake test that had the smallest percentage difference between the estimated and actual times.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated time (hours)</th>
<th>Actual time (hours) (mean of group)</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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<tr>
<td>Steps 1-3–Objectives, video tour, 360-degree photos</td>
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<td>2</td>
<td>1.06</td>
<td>0.57</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>Step 6–Learning diary</td>
<td>1</td>
<td>0.27</td>
<td>0.17</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td><em>Time for all tasks</em></td>
<td><strong>5</strong></td>
<td><strong>2.0</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diary entries: Visit 5**

There were seven participants who completed diary entries for this virtual site visit. Six of the seven respondents specifically mentioned at least one topic that they learned that was directly connected to the learning objectives for this visit. For example, P11 said he learned:

[How to] practically perform the shake Test, About the Shake Test Protocol [and], Identifying vaccines for immunization (Cold chain status / VVM / Expiry date etc.). [P11 (V5 DQ1)]

Six of the seven respondents identified something related to the learning objectives that they would take back and use in their work. Two respondents were very specific in what they intended to do with their newly acquired information and skills:
Train other people on [the] shake test, and reading correctly VVM. [P6 (V5 DQ2)]

Share the shake test with other colleagues. [P11 (V5 DQ2)]

The four other responses to this question, such as the following response, were not as specific:

Key points to be remembered while taking decision on use of vaccines for freeze sensitive, freeze dried and other vaccines. [P1 (V5 DQ2)]

**Post-task questionnaire: Visit 5**

Five of the 10 active participants at this point in the course completed the post-task questionnaire. They rated this virtual site visit the highest in multiple categories, such as site visit (in general)–9.00 out of 10; the challenge of the tasks/activities–9.00; realism of the tasks/activities performed–9.40; clarity of instructions–9.20; and the benefits that the resource documents–9.00 and illustrated lecture videos–9.00 provided.

**Discussion: Visit 5**

A unique feature of this visit was having participants do the Shake Test. As mentioned above, participants received vials dispatched by WHO. Participants received the same written instructions given out by WHO and watched a video of how the test should be performed. Participants and mentors then uploaded images to the website along with how long it took to make the decision on which test vials were frozen. One of the mentors then provided feedback on the participant’s results. Figures 8.1 and 8.2 show examples of the images that were shared by the participants and mentors.

*FIGURES 8.1 AND 8.2. TWO EXAMPLES OF SHAKE TEST RESULTS SHARED BY PARTICIPANTS AND MENTORS DURING SITE VISIT #5*
As mentioned above, this site visit received the highest ratings by the participants, including realism of the task. Several facets of how the task was designed and executed using authentic elements may have contributed to this:

1. **Samples**–while they had been prepared for this (i.e., the control vial previously frozen), the sample vials were actual vaccines, almost identical (the information on the label was slightly different) to what a health care practitioner would use.
2. **Instructions/protocol**–this is the same set of instructions used in WHO programs.
3. **Reference/background video**–this is the same video that WHO makes available to healthcare practitioners.
4. **Courier delivery**–receiving a specially-delivered courier package from WHO may have caused participants (and mentors) to consider that this activity was different and special in some ways.

Having a combined set of these authentic elements in the activity may have been synergistic in compelling the learner to suspend disbelief even though there was no specific role that the learner was assigned. This was supported by the survey respondents rating the realism of the activity 9 out of 10.

This fifth visit concluded the virtual visit portion of the e-learning course and its similarities to the actual WHO PCCMoW bus course. After a general discussion on the five virtual visits, the last of the activities—Examining Albania’s Immunization Program—will be examined in detail.

**Discussion of Virtual Site Visits 1-5**

In the previous sections, observations, issues, and recommendations for improvement that were rooted in specific visits were discussed. This section examines five key issues that emerged from the data observed during the field testing, and provides recommendations that are more general and would apply to all five virtual site visits as well as other e-learning productions.
Issue 1: Modeling expert performance after an activity

Collins, Brown, and Newman (1987) described the interaction between an expert and novice involving “reflection on differences between novice and expert performance by alternation between expert and novice efforts” (p. 4). Shared participation is one way of providing scaffolding to the novice learner.

In some cases, mentors created best-practice exemplars—effectively their solution to the problem—and shared them with the participants once they had completed their task. This gave the participants a view of how an expert would solve the problem, which is an example of the interaction discussed by Collins et al. In activities where examples of a solution were not given, participants asked for them:

Could we get a selection of Q-Agreement samples? Would be interesting to see and compare them with ours. [P3 (V1, DQ3)]

Each time, an "almost perfect answer" to the task given by a mentor could be useful. [P2 (V4, DQ3)]

Recommendations for improvement:

For each task, have one or more examples of a solution (e.g., correct procedure, best practice, completed quality agreement) that participants can consider. When appropriate, have several such exemplars, showing that there may be several ways of solving the problem or presenting a solution.

Issue 2: Participant roles in authentic activities

In an authentic learning activity, participants are not just students or learners: they take on a simulated role with a particular position and set of responsibilities. Earlier in this chapter (site visit 1), factors such as past experience that could affect one’s suspension of disbelief as they take on and perform a role were examined. One factor to consider at this point that contributes to authenticity in a task is the role that the learner takes on in solving the problem. Herrington, Oliver, and Reeves (2003a) identified examples of courses where learner engagement was achieved, in part, by giving the learners specific roles to play as they were working through a complex task.
In tasks that participants performed during the virtual site visits and final authentic tasks of the e-PCCM course, 8 of the 14 tasks had roles. Table 8.8 shows the distribution of and the title of the roles.

Table 8.8. Roles assigned to participants in tasks/activities in the e-PCCM course

<table>
<thead>
<tr>
<th>Site</th>
<th>Task/activity name</th>
<th>Role assigned to participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Who am I?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Inspecting Good Distribution Practices (GDP)</td>
<td>“You are an inspector…”</td>
</tr>
<tr>
<td></td>
<td>Temperature Excursion</td>
<td>“You are the logistics manager…”</td>
</tr>
<tr>
<td></td>
<td>Quality Agreement</td>
<td>“Farmalojistik is asking for your help…” [as a consulting expert]</td>
</tr>
<tr>
<td></td>
<td>Risk Treatment</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>Contingency Plan</td>
<td>“As a cold chain manager of Bursa…”</td>
</tr>
<tr>
<td></td>
<td>Vaccine Vial Monitors (VVM)</td>
<td>“You are a cold chain manager…”</td>
</tr>
<tr>
<td></td>
<td>Cool Water Packs</td>
<td>“You, as provincial immunization manager… and part of a committee…”</td>
</tr>
<tr>
<td>3</td>
<td>Risk Treatment</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>Pharmacy Practices</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Power Cut (outage)</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Shake Test</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>VVM Vaccine Management</td>
<td>“You are a nurse in a Family Health Center…”</td>
</tr>
<tr>
<td>6</td>
<td>Authentic Task–Working with Albania</td>
<td>Implied role as a consultant: “You are presented to a real client…”</td>
</tr>
</tbody>
</table>

Assigning roles helps move the participant from “learning about” to “learning to become” (Brown & Duguid, 2000). Schön (1987) describes the value of “thinking like a…” (p. 39) as a means for a learner to acquire both the general rules a practitioner would follow in a typical case as well as the way a practitioner would explore and find new rules and methods for special situations. Role assignment is also seen in educational games and simulations (Klopfer, 2008), a practice that gives learners a chance to expand on roles they may inhabit in their real lives or “walk a mile in someone else’s shoes” (p. 140). Instead of everyone taking the same role, Klopfer sees the value of having learners in an activity take on different roles so that the learners are challenging each other with the expectations and points-of-view inherent with their particular assigned role.

**Recommendations for improvement:**

In future presentations of this e-learning course:

- Assign and define roles for participants in each activity. Consider creating a short “backstory” for that role, for example, “You are a consultant with a
background in package design and engineering.” More broadly, for other e-learning projects, ensure that roles are established and defined.

- Revise at least several scenarios so not all participants have the same role. For example, in Site visit #1, Quality Agreements, continue to assign some participants the role of authors of a quality agreement, while others (or all participants at a later point in time) take on the role of the firm (i.e., the contractor acceptor or service provider) that needs to agree to the document. For other e-learning projects, look for ways to have multiple roles in an activity.

**Issue 3: Threaded discussions**

The e-PCCM application included a feature for threaded discussions; however it was used only to a limited extent by the participants and mentors. Table 8.9 summarizes the 12 discussion threads that were started throughout the prototype course. Three distinct types of discussion threads were identified: (1) e-learning application technical problems, (2) statements/comments which did not pose any type of question or request a response, and (3) questions or issues where a response from others was requested or implied. Participant P7 was the most frequent initiator of comments, starting 5 of the 9 questions/issues. P7 also responded at least once to 4 of the question/issue discussions (including those he started). P12 initiated three question/issue discussions; he also reported two technical problems with the e-learning application. Mentor M3 was the most frequent responder, helping resolve all three of the technical problems and contributing responses to 6 of 9 questions/issues; 2 of the other 3 mentors responded to at least one of the discussions. In total, only 3 of the 11 course participants were involved in threaded discussions related to questions or issues.

Several times, P7 expressed his disappointment and frustration with the lack of vibrant discussions on the e-learning course compared with those on the actual bus course. His first comment was at the end of virtual visit #1:

> Little attention is paid to the discussion page. I can recall that during the real PCCMOW, all we learnt were through discussion. Real PCCOW was unique in the learning way. [P7 (V1 DQ3)]

This participant also helpfully suggested a mentor be involved with each group: 
For the discussion page… I think this is a good idea but the implementation did not work well…it was not updated by the participants… not many commented… Maybe to involve a mentor in the discussion with each group. Just like the real course. [P7 (FCE p. 4)]

Table 8.9. Summary of e-PCCM threaded discussions

<table>
<thead>
<tr>
<th>Discussion title</th>
<th>Initiator</th>
<th>Responders</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of temperature mapping</td>
<td>P7</td>
<td>M3</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Out of cold chain</td>
<td>P7</td>
<td>P12, M3</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Exploring USP</td>
<td>P7</td>
<td></td>
<td>Question/issue</td>
</tr>
<tr>
<td>Vial septum</td>
<td>P12</td>
<td>P7, P12</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Diary problem</td>
<td>P12</td>
<td>M3</td>
<td>Technical problems</td>
</tr>
<tr>
<td>Contingency plan</td>
<td>P9</td>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Protecting drug from [heat] conduction</td>
<td>M2</td>
<td>P7, M3, P7, M3, M2</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Can freeze-dried drug be frozen</td>
<td>P12 (via M3)</td>
<td>P7, M3, M11</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Deviations vs OOS</td>
<td>P7</td>
<td>P7</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Temperature excursions</td>
<td>P9</td>
<td>M3</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Group comment</td>
<td>P2</td>
<td>M3</td>
<td>Technical issue</td>
</tr>
<tr>
<td>Manufacturing response</td>
<td>P7</td>
<td>M1, M3, P8, M2</td>
<td>Question/issue</td>
</tr>
<tr>
<td>Cannot open step 2</td>
<td>P12</td>
<td>M3, M3</td>
<td>Technical issue</td>
</tr>
</tbody>
</table>

Participant P6 commented on her perception of the discussions at the end of the course, providing a suggestion that would make it easier for participants to know that a discussion was started or expanded:

[Participant P7] raised a discussion about the discussion points… It was maybe you, M3, who was telling us that there was a question [posted online or that] there was a discussion point that we should check it. So it [the e-learning application] should give an email if there is a question, so we get the email and so we can follow it with you. [P6 (FCE, pp. 6-7)]

Palloff and Pratt (2007) discussed the learning value of threaded discussions to both collaborative learning and in establishing the “presence” (Lowenthal, 2009; Tu & McIsaac, 2002) of a participant (or instructor or mentor) and suggested ways that can promote participation in threaded discussions. These include requiring each participant to respond to a discussion about initial course expectations—what the participants expect, how their expectations align with that of the course leaders, and having each participant facilitate an online discussion. Additionally, the authors recommended that
course leaders and instructors, at the start of the course, model how discussions are to be used.

Recommendations for improvement:
For future versions of this course, as well as more broadly for other e-learning courses, establish specific points at the start of the e-learning course where everyone is asked to use the discussion page, such as when teams arrive at agreement of course and team expectations. Ask participants to start and facilitate a threaded discussion, including their coaxing other course participants to contribute. Have course mentors participate early-on in the discussion forum, modeling the desired behavior.

Issue 4: Improving social presence at the start of the course
Social presence has been defined as, “the degree of awareness of another person in an interaction and the consequent appreciation of an interpersonal relationship” (Short, et al., 1976, p. 65). Palloff and Pratt (2007) describe how online icebreakers help participants and instructors get to know each other, increasing social presence, and resulting in large and small groups being more effective and productive in learning.

In the earliest sketches for this e-learning course, an initial icebreaker, “two truths and one lie” was proposed using a custom-made series of screens (see Chapter 5). Due to technical and timing issues this idea was not implemented; no other substitute or alternative was used. In this field test of the prototype course, some of the participants knew each other as they had been on previous physical PCCMoC bus courses. However, this will be highly unlikely in future presentations of the ePCCM e-learning course.

A variety of different, simple icebreakers have been recommended by different authors and websites (TWT; VCU; Woods & Ebersole, 2003), many of which can be implemented simply through discussions and self-postings to an online folder. Some of these ask the e-learning participant to share something about themselves—a short autobiography, interesting facts, favorite photos—as a way to establish a presence within the learning community. Palloff and Pratt (2007) suggest using icebreakers as a means for participants and instructors to use threaded discussions.
One participant in the e-learning course had this comment and idea that would certainly work as an icebreaker and contribute to a learning community:

[A] little more glamour and humor could be added during the participation. eg: Picture of the week. [P11 (V1 SQ3)]

*Recommendations for improvement:*
Create one or two simple icebreakers and activities that can be used regularly during the e-learning course that will promote the online presence of participants and contribute to a learning community.

**Issue 5: Time - estimated and actual**
Participants were asked to track their time spent in the course; this was compared to the amount of time the design team had estimated for each activity. As shown in the overview of each virtual visit above, the mean times taken by participants for each task were, with two exceptions, less than the design team’s estimates. Overall, the time participants spent on the activities was less than originally estimated although participants spent additional time watching videos and reading reference material.

The discrepancy between what was originally predicted to what was observed could have several reasons. First, the design team and mentors may have significantly over-estimated the amount of time required for some tasks. Second, participants may not have put in enough “time-on-task” that would result in the deep learning that was intended. Or, third, the tasks themselves were not engaging enough to hold the attention of the participants. A fourth possibility, since the participants had all been on a recent physical bus trip, is that their bus trip experience gave them an advantage. This is doubtful as most all the activities in the e-learning course were significantly different and also that in looking at the time-on-tasks, the completing the diary entries (an activity not used in the physical bus trip) usually showed the largest difference between estimated and actual times.

Some participants commented at the end of the course that overall time requirements were not adequately communicated, and they consequently could not ensure they could adequately commit to the course. For example, one participant commented:
I don’t know… I’m really sorry now that this course has ended. So when it started, like others said, nobody knew how long or much time things would take. I wish I knew before so I could postpone some of my travel and some of my duties… I think people need to know when things start and when they finish so they can plan ahead and they can do their agenda and participate in the course. [P4 (FCE p. 7)]

Another participant felt that the time expectations should be revised to include additional time to become familiar with technological tools (e.g., Google Drive):

You just need time [to participate in the course]… That is why I had to withdraw after the first task. I would recommend that … [people have] the discipline and the time that they need and that the moderators bring in people. It needs to be clear from the start that the people need to have the time. Particularly at the beginning with Google Drive and as [participants] become familiar with the tools. You also need time to organize yourself…maybe that needs to be taken into account. [P3 (FCE p. 5)]

**Recommendations for improvement:**
For future offerings of this e-learning course as well as other e-learning projects will stress in the promotional and introductory material and in the participant acceptance letter the time commitment that will be expected of course participants to utilize the resource materials (e.g., videos, publications) and complete the tasks and activities.

**Examining Albania’s immunization program**

**Description**
The final activity of the e-learning course was a complex and highly authentic task—asking small groups of participants to analyze Albania’s immunization program and its handling of time- and temperature-sensitive pharmaceutical products (i.e., vaccines) based on documents provided, other documents freely available on the internet, and specific information provided when requested by the participants from the manager of the country’s immunization program. To accomplish the goal for this virtual visit, one learning objective was created by the design team and expert practitioners.

**Objective**
At the end of this activity, the learner should be able to

- For a given a client, conduct a critical analysis of the cold chain management system and make recommendations to improve the performance of the
system in line with good distribution practices (GDP) and good storage practices (GSP).

To achieve the goal and objective, a very specific and complex task was developed.

**Tasks/activities**

This final activity was designed to be highly aligned with the characteristics of an authentic task as described by Herrington, Reeves, Oliver and Woo (2004). Table 8.10 identifies the characteristics described by Herrington, et al., and how they were manifested in this activity.

The course director assigned participants to teams based, primarily, on time-zone proximity. Team members were asked to have a planning meeting and establish their own path forward for completing the project. All teams were provided a written overview of the project and expectations of the mentors.
Table 8.10. Characteristics of an authentic task (Herrington, et al., 2006b, p. 46-48) and how they were applied in the final activity of the course

<table>
<thead>
<tr>
<th>Characteristics of an authentic task</th>
<th>Example from final activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have real-world relevance.</td>
<td>Recommendations from reports would be considered by Albanian Ministry of Health and possibly implemented.</td>
</tr>
<tr>
<td>2. Are ill-defined, requiring students to define the tasks and sub-tasks needed to complete the activity.</td>
<td>No report format or model of a report was given to teams, only a broad description of the goal and the due dates.</td>
</tr>
<tr>
<td>3. Comprise complex tasks to be investigated by students over a sustained period of time.</td>
<td>Time period was initially given as 4 weeks but was increased to 5 weeks.</td>
</tr>
<tr>
<td>4. Provide the opportunity for students to examine the task from different perspectives, using a variety of resources.</td>
<td>Some resource documents were identified and provided but participants were told they might find others on the internet. Mentors, if asked, could provide access to other information sources; manager of immunization program was available by phone or email for additional information.</td>
</tr>
<tr>
<td>5. Provide the opportunity to collaborate.</td>
<td>Teams had three members per team with assignments considering participant's time-zones.</td>
</tr>
<tr>
<td>6. Provide the opportunity to reflect.</td>
<td>Reflection, along with critical thinking, needed to occur when writing the report and making recommendations.</td>
</tr>
<tr>
<td>7. Can be integrated and applied across different subject areas and lead beyond domain-specific outcomes.</td>
<td>Critical thinking skills and applying concepts of good distribution practices and good distribution practices can be used in other situations handling TTSP.</td>
</tr>
<tr>
<td>8. Are seamlessly integrated with assessment.</td>
<td>The draft reports allowed mentors to give feedback as the teams prepared their final report.</td>
</tr>
<tr>
<td>9. Create polished products valuable in their own right rather than as preparation for something else.</td>
<td>All teams/participants were told that their final reports would be presented to the client, the Albanian Immunization Program.</td>
</tr>
<tr>
<td>10. Allow competing solutions and diversity of outcomes.</td>
<td>The source materials and resources covered a broad range of topics; there were several different areas where participants could focus and creatively come up with various potential solutions.</td>
</tr>
</tbody>
</table>

**Resources available to the participants in the authentic task**

Documents and online resources that were provided for team members to be used during the assignment were

- effective vaccine store management assessment of the national vaccine store
- information on Albania’s cold chain
- immunization schedule and vaccine needs
- improving temperature monitoring in the vaccine cold chain at the periphery
- LogTag data for each health center in ShM2er district
- Albania report, Project Optimize
- staff details of Immunization program
- preliminary results of EVM
• Joint Reporting Form 2011
• Albania pilots an immunization information system
• bringing online immunization registries
• demonstrating the benefits of an online immunization registry
• temperature monitoring for vaccine quality
• assessment of a remote alarm system for vaccine storage in Albania.

All team members were told in the activity instructions that they could use other resources. They were also introduced to the head of Albania’s immunization program, as a potential resource for information:

The documents provided for this task may not be sufficient. If this is the case, you may do your own internet research; you will find many other pages related to the Albania Immunization Program. Alternatively, you can communicate directly with the contact person from the Albania Immunization Program using the following contact details:

Dr Erida NELAJ
Expanded Program on Immunization Manager Albanian Institute of Public Health [email, SKYPE, mobile phone information provided]

**Key events during the authentic task**

Table 8.11 shows the chronology of this authentic task and specific milestones. Approximately half-way through the allotted time period for this activity, two mentors (M3 and JLV) initiated Skype conversations with the members of each team to determine the progress the teams were making, answer questions, and provide ideas and encouragement for moving forward.

Draft reports were examined by two mentors (M3 and JLV). Mentor M3’s review emphasized more of the specific, technical aspects of handling vaccines while the researcher (JLV) examined how the team assessed, evaluated, and reduced risks. The mentor’s comments were returned to the respective team members. All four mentors reviewed the final reports and provided comments to the teams.
Table 8.11. Timeline of authentic task activity

<table>
<thead>
<tr>
<th>Calendar date</th>
<th>Task day(s)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 25</td>
<td>1</td>
<td>Authentic task officially begins</td>
</tr>
<tr>
<td>May 3-8</td>
<td>9-14</td>
<td>Mentor-team Skype calls</td>
</tr>
<tr>
<td>May 10</td>
<td>16</td>
<td>Team enquiries to Albanian Immunization manager begin</td>
</tr>
<tr>
<td>May 14-19</td>
<td>20-25</td>
<td>Teams post draft version of reports on Google Drive (Due date: May 13)</td>
</tr>
<tr>
<td>May 16-20</td>
<td>22-26</td>
<td>Mentors complete comments on draft reports</td>
</tr>
<tr>
<td>May 22</td>
<td>26-31</td>
<td>Teams post final versions of reports on Google Drive (Due date: May 20)</td>
</tr>
<tr>
<td>May 24-26</td>
<td>30-32</td>
<td>Mentors complete comments on final reports</td>
</tr>
<tr>
<td>May 24</td>
<td>30</td>
<td>Decision by course director and mentors to ask teams to revise final reports to include suggestions from mentors</td>
</tr>
<tr>
<td>June 17</td>
<td>54</td>
<td>Response by course director to last team preparing “final-final” report</td>
</tr>
</tbody>
</table>

Results—draft and final reports

The draft reports, intended as the articulation or evidence of the participants’ knowledge, were submitted by all three teams but found by the mentors to be weak in the analysis of the issues and the presentation of the findings. Mentors made numerous critical comments in the draft reports, pointing out deficiencies such as

- participants viewing their work as an e-course exercise/activity rather than as consultants working for a real client
- not asking the client for additional, more current information
- technical misunderstandings
- not fully understanding risks and that certain practices do not contribute to unwanted outcomes given the context in which those practices are used
- not prioritizing recommendations based on some criteria such as quality risks
- making recommendations that are more robust
- making statements/recommendations without supporting data
- not correctly differentiating between different types of risk (e.g., unacceptable risk and residual risk).

The mentors recognized positive features in the reports as well, such as recommendations that showed very creative solutions and an understanding of vaccine procurement practices.
All mentors commented on the final reports that teams posted on May 22. Two of the three reports showed improvements in the content and in the way the information was presented, however, the overall results were still quite disappointing. Issues identified by the mentors in the final versions included

- not including information on the limitations of the data used (e.g., age of report)
- not linking a recommendation to a specific finding or need
- not referencing source documents
- not describing intended benefits of recommendations
- not having an initial introduction of what the report will include that gives the reader a mental map of what is ahead
- focusing only on certain issues but not other broader, important ones.
- imprecise use of terminology
- not using other resources (e.g., historical weather data) to help set a context and assess potential risks
- lack of or inconsistent formatting and headings/subheadings
- lack of a table of contents.

Because the “final” reports did not meet the expectations of the mentors as documents that could be passed on to the Albanian immunization manager, the course director asked that teams do an additional iteration focusing on improving their reports by incorporating the feedback given.

**Discussion**

From the earliest concept of the e-learning project, this final activity was viewed as a way for the learners to engage in a truly authentic task, an activity that would go beyond the time scope permitted in the week-long physical bus course. In examining a recorded interview (made during the mentor and design team review discussed in the Chapter 7, Formative Evaluation 2) in which the course director described his vision and intentions of the final activity, one can see how he incorporated nine characteristics of an authentic activity and ten characteristics of an authentic task (Herrington, 1997; Herrington & Oliver, 2000; Herrington, et al., 2010).
The course director wanted the activity to have real-world relevance with an authentic context and include a variety of resources—documents and people—in the process:

In this course, we are presenting Albania as a client to groups of participants because they will work in groups. We want them to analyze like [consultants] the available documentation that we provide to them that explains a vaccine supply chain operations in Albania. We have annual reports. We have some studies. Unpublished studies, we have some published studies. Tables, figures, explaining the staff, the culture and capacity, how it is distributed, the needs, temperature monitoring, and so on. All different aspects of the culture and operation for vaccines in Albania. (M3, DTMR)

As in a real-life case, the situation presented was naturally ill-defined. Not all information would be readily available or elements could be potentially conflicting requiring clarification from an expert. This collaborative project would need the initiative, creativity, and critical thinking skills on the part of the participants.

Of course, it's not the full package, again. There are some links. We also provide the National Immunization manager's address, telephone, Skype, fax, everything. Full communication details. This person is ready to take any calls, requests, because participants may think that, "Oh, I need this piece of information in order to do the real evaluation of this Albanian case." which is not provided in the package. (M3, DTMR)

Participants were expected to work through the “messiness” of the task; they would create and execute a process as they moved forward:

That person will contact the Immunization Manager in Albania and ask for it. There will be cases that this information will be available; there are cases that it's not available. You still have to make a judgment in the absence of that information. It happens sometimes. (M3, DTMR)

Since authentic tasks are complex and take significant amounts of time and effort, the time allowed for this final task was to be significantly longer than the more limited and better-defined activities assigned during the earlier virtual visits. During this final period, the course director expected participants to use what they had learned in the previous, shorter activities:

It is the most authentic one [compared to the other shorter tasks in the e-learning course] I would say that [the participants] will work in real time during this one month. We want them to put into practice everything that we have gone through the course in different facilities of seven weeks of work, thinking, learning that they have gone through, into this example and analyze this culture and operation in Albania. [M3, DTMR]
In the final activity, participants were told to articulate their results in the form of a final report for presentation to the Albanian Institute of Health. It was hoped that this would be useful for the country in enhancing their immunization efforts. The project director concluded with the mutual benefits he envisioned for the participants and Albania:

What are the strengths? What are the things that they are struggling with? What kind of solutions they can suggest to the Immunization program in Albania?... It's kind of our contribution back to Albania. I'm sure there will be some good pieces that they can really make use of. The rest is for us to learn. [M3, (DTMR, pp. 6-7)]

Given this intent and specific ways that this activity was designed to incorporate the characteristics of authentic learning (Table 8.10 above), there was a significant gap between the expectations, the process used by the participants and their final reports. Examples of these deficiencies and suggestions for improvement are provided in the following section.

**Deficiencies observed in the Albanian case's process and product**

At certain time points during and at the conclusion of the authentic task, mentors discussed their observations. One mentor, at the conclusion of the task wrote about both the process and final product (i.e., the report):

I was disappointed by these results. The groups did not seem to work cohesively and the work appeared to be last-minute. It [the report] was shoddy and in some cases incomplete. I wonder if either they ran out of energy/interest or they were allowed too much time and procrastinated... [M2 (PCMQ Q12)].

Another mentor who was very knowledgeable of the reports online and other reports that could be made available upon request found the work by the teams disappointing:

I thought that some of the analysis was a bit ‘thin’ and I was disappointed that participants did not follow-up on additional materials—for example the actual EVSM [Effective Vaccine Store Management] questionnaire, rather than just the report. [M1 (PCMQ Q12)]

**Five key areas for future improvement of the Albanian case**

In reading the team’s reports, the participants’ comments made during the post-course teleconference and in the post-course questionnaire, and the mentor’s comments, there were five areas or topics in particular that could be improved in future presentations of
this e-PCCM course and potentially in other e-learning courses that incorporate complex authentic tasks. This is presented in Table 8.12 below.

Table 8.12. Key areas that should examined for improvement

<table>
<thead>
<tr>
<th>Area for improvement</th>
<th>Description</th>
<th>Example evidence</th>
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<tbody>
<tr>
<td>1. Provide more support and structure to improve time management of participants and teams.</td>
<td>The final task required team members to work together and plan their approach. Team members did not seem to be proactive in this key area: in the conference calls between team members and two mentors, none of the teams had communicated about how they intended to share responsibilities. While authentic learners need to define their own process and steps, coaching may be useful here.</td>
<td>“Maybe there is a big difference in the authentic task [compared to the shorter assignments] where we are more left alone. I would say. Maybe having a few milestones instead of being left alone for 3 weeks with maybe one conference call together with you [Course Director] M3, would keep the rhythm throughout this learning experience…. but maybe just regarding the authentic task, a few more milestones to preserve the rhythm of the course would be good” [P2 (FCE, p. 3)].</td>
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</table>
| 2. Look for ways that teams can better work through issues on team dynamics and participation. | Several teams had less-than-equal participation because one or two members partially withdrew due to work, travel, family, or personal issues. This shifted the workload to other group members. Those who needed to withdraw were often cognizant of the impact on the remaining team member(s). The shifting of the workload onto the remaining members was noted by a participant. | “I typically did less than the other members of the team. It's a pity I had a lot of travels during authentic activity” [P12 (ATQ, Q18)].

“I typically did more than the other members of the team. Because of the fact that the authentic task was the 'hardest' one throughout the course and needed a lot of work, the problem of participants' commitment and dedication was worst throughout the course as well” [P7 (ATQ, Q18)].

“I typically did less than the other members of the team. Actually [P7] and [P13] did the task and I just go through” [P6 (ATQ, Q18)].

[Referring to tasks other than the final authentic activity but still relevant here:] “When other team members do not participate] you have to finish the work by yourself or by 2/3 of the team power. This means that you are further overloaded with the assignment work beside your routine work. This is ridiculous issue” [P7 (ATQ, Q17)]. |
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<th>Area for improvement</th>
<th>Description</th>
<th>Example evidence</th>
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<tr>
<td>3. Provide support on expectations for report layout, design, and presentation.</td>
<td>While there were improvements as the teams progressed to the final and “final final” reports, the documents looked very unprofessional and did not include formatting and content that one would expect in a consultant’s report.</td>
<td>[The work presented by some teams] was shoddy and in some cases incomplete” [Mentor M2 (PCMQ Q12)]. “The group has made a number of excellent observations but the overall presentation is tedious and difficult to follow due to its inconsistent format” [Mentor feedback on final report to P11, P12, and P1]. “Words/phrases should be spelled out before the use of acronyms; place acronym in parentheses after first usage, e.g., Non-Governmental Organization (NGO).” “Headings / consistency of layouts (placement of sessions) can help lead reader through the report. “An introduction helps give the reader a ‘mental map’ of how the report is laid out and what to expect. “The document is a little overwhelming to read as currently formatted. The outlining format is not correct or consistent, numerical headers with/without bold is inconsistent and confusing” [Mentor feedback on final report to group P7, P13, P8].</td>
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<tr>
<td>4. Support on accessing additional and more current data.</td>
<td>A number of documents were provided to the participants along with a statement that teams should look elsewhere on the web and ask questions of the contact. This may be a situation where participants did not know what to ask for or what might be available—they didn’t know what they didn’t know. At least one team found historical weather data online that they used in their report.</td>
<td>“I was disappointed that participants did not follow-up on additional materials—for example the actual EVSM [Effective Vaccine Store Management] questionnaire, rather than just the report” [Mentor M1 (PCMQ Q12)].</td>
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<tr>
<td>Area for improvement</td>
<td>Description</td>
<td>Example evidence</td>
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<td>5. Promote technical understanding and critical thinking.</td>
<td>Technical questions and issues were resolved as the teams moved from the draft to final report stages. In the final reports, however, there were gaps in critical thinking and in presenting information that the client could act upon.</td>
<td>“For the recommendations, it is useful to mention the benefit of the improvement and how it would reduce risk and help the organization better, more effectively accomplish its goals. Often in an audit, the auditors/consultants need to convince the organization to do something (like spend money) that they are reluctant to do! If you can show how this will make life better/easier, you have a better chance of convincing them!” [Mentor feedback on final report to P11, P12, and P1]. “Very difficult to find a one-size-fits-all solution. Qualifying for the worst case scenario (e.g., high summer temperatures) may create a risk if this solution is used in e.g., the winter. Hence the need for transport route profiling. In addition it is worth to mention that. Not just worst case scenarios as this can tend to lead to over-engineered packages which also can lead to failures” [Mentor feedback on final report to group P7, P13, P8].</td>
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</table>

**Recommendations**

Most of the suggestions below are targeted at future offerings of the e-PCCM course, and one is relevant to all authentic learning activities, specifically the importance of coaching and scaffolding by the facilitator/mentor at critical times, a characteristic identified by Herrington and Oliver (2000). The challenge for the facilitator/mentor is to strike the optimal balance between not-enough and too much support. This may most likely vary based on the project and the experiences, knowledge, and skills that learners have when they begin the authentic task. Other suggestions that are more specific to the e-PCCM are presented below.

**Being a consultant, fulfilling a role**

When discussing the virtual visits 1-5 above, emphasis was placed on the role of the participant in an authentic task. In this final activity, the role of the participant was implied (“For a given a client…”). This was emphasized in some of the feedback given to groups by the mentors after they had read the draft reports. In the first case, the team recognized who and what they were:
How you approached the project as shown in the “objectives of the assignment” were quite clear and authentic. We do not know whether you really considered and called yourselves like “consultants”, but it was clear that you understood that you were in the role of outside consultants. [Mentor feedback on draft report to team P11, P12, P1]

A different team seemed to struggle with their role and the perspective they were to take (emphasis added):

We were looking for something about outcome or intent—what was the real purpose—it [was] not just for the e-course exercise but rather to use the knowledge/skills of the participants and provide another “outside” look at the Albanian system. From this perspective, we strongly recommend that you rephrase the mission of this review. Do not forget that at the end, this is a real (authentic) case, all reports are real, you have a real responsible contact person, nothing is made up, and your report will contribute making Albania cold chain operation safer. You are like a consultant here. [mentor feedback on draft report to team P7, P13, P8]

In considering the participants and their own backgrounds, many worked for health authorities as inspectors or managers while others were engineers and packaging designers; only one, P2, worked as a consultant. A possible disconnect is that the course designers and mentors were asking participants to think like a consultant (Schön, 1987) without participants having knowledge or experience as consultants. (Three of the four mentors currently work as consultants to corporate and NGO clients.)

Recommendations for improvement:

- Expand an existing activity in earlier visits or include an introduction to the final activity that identifies and discusses the role of consultants—what they do, the value they can add to an organization, and the expectations that a client has of a consultant. For other e-learning courses using authentic activities, when establishing roles, ensure the learners have some knowledge about function and responsibility of those roles.

- Revise the task so that instead of looking at a large number of documents and identifying positive features and problems that could be improved, ask teams to focus on one particular aspect that the system owners have identified as needing improvement. This task would be very typical to a consulting engagement where the client observes that it is having problems or “pain” but does not have concrete solutions or a plan that the best solution can be implemented.
Time management—establishing a project plan

From participant comments like those shown above and information given in mentor-team phone calls, team members did not immediately begin working on their final activity on the start date. Mentors could see that the reports were rushed through in order to have them posted on Google Drive by the due date. One participant mentioned this in the final survey:

[I] Suggest intermediary milestones for the authentic task, and why not a work methodology (I had to do it myself and felt very directive with my peers). [P2 (PCS, #16)]

Having mentors assign specific dates for each small task does not contradict the authentic task characteristic of an ill-defined task (Herrington, et al., 2006b) if it is done in a way that is similar to approaches used by organizations. Requiring that teams establish, agree upon, and follow a project management plan is a task consistent with what a consulting team really does. This will contribute to authenticity. In most business and NGOs, establishing a project plan with a timeline or Gantt chart and reviewing it with key stakeholders is a normal practice. Creating such a plan and reviewing it with a mentor who could provide feedback and suggestions (i.e., scaffolding) could be built into the first stage of this activity. This way, supporting guidance is provided without the mentor giving detailed step-by-step instructions.

Recommendations for improvement:

- For this and other e-learning courses that include authentic activities, require that teams begin with a conference call or Skype to establish a project plan with due dates, work and travel schedule of all the team members. This should be shared with the mentors. Additionally, team members should discuss and agree on their expectations of working together on this last assignment.

Reporting the results

All the draft reports and final reports that were submitted to the mentors were poorly produced in terms of how the information was organized and presented. In early conversations with the mentor, it may be useful for team members to discuss expectations of quality and what the report can and should look like. Further, team members may want to find examples from the internet and other sources and share examples with their colleagues. Another option, before the teams write their final report, would be for each team to prepare and present an online PowerPoint-style presentation.
to the mentors for feedback. (Google Drive has a cloud-based application similar to PowerPoint.) This is a typical practice for consultants and quality auditors to help ensure their observations were correct and the recommendations are valid (Vesper, 1997). This presentation may also be useful to present to the client (after feedback from the team doing this for the mentors). (Oral, PowerPoint presentations are made by teams during the actual PCCMoW bus course.)

Recommendations for improvement:

- In earlier site visits, consider an activity that would have the participants work with a report written by a consulting team so the participants can become familiar with one. This activity could be expanded to have the participants critically analyze the report looking for gaps, recommendations not supported by data or needs, and general organization. Then during the final report stage, participants will have an easier time suspending disbelief regarding their roles as consultants.

- Consider having teams each do a short (e.g., 10 minute) PowerPoint-type presentation to the mentors and other teams for feedback. Mentor comments can be included in the team’s final reports. Additionally (or alternatively) PowerPoint presentations may be given to the client. For other e-learning projects with authentic activities, consider different options for articulation that practitioners could use.

Mentor support and scaffolding

In the surveys, participants spoke of the value of having mentors input and comments:

[What I liked] best was expert's/mentor's feedback. [P1 (V1 SQ3)]

Mentors were always on their toes and ever available to our concerns. [P13 (PCS, Q11)]

Several participants wanted more mentor involvement similar to the coaching provided in the physical PCCMoW course:

Involve a mentor with each group! Just like what had been practiced during the real PCCMoW course. [P7 (V2 SQ11)]

The amount of mentor involvement might vary depending on the needs of the individual team:
Motivation and follow ups [by mentors to] those who show less interest. [P13 (V2 SQ11)]

Another participant commented on a potential solution when there are unequal contributions by team members:

Let a mentor participate with each group in doing their assignment. It would help to a great extent. Frankly speaking, many times one or two of the team members may not contribute to the team at all. This makes the team work almost an individual one [-person effort]. This is because the mentors are not here and they are not watching. [P7 (PCS, Q16)]

While there was one Skype call arranged approximately one-third of the way through the final activity, it may be useful to have one or two more. During subsequent calls, mentors could help keep teams on track with their project management plan, discuss the challenges they are encountering, and suggest other approaches and sources of information. From an authenticity point of view, this is very consistent with how apprentices (Collins, et al., 1991) and consultants learn their craft (Kantor, et al., 2000).

Recommendations for improvement:
- For this and other e-learning courses, establish (more) frequent SKYPE teleconference calls between team members and mentors. Using these as an opportunity to answer questions, monitor timelines, and provide additional scaffolding and support.

Using the term “authentic task”
The title of the final activity used in the prototype course was “Authentic Task.” As described throughout this chapter, the overarching task of a virtual bus trip, and most all of the visits, had activities that incorporated a significant degree of authenticity as evidenced by the rating given by participants: “realism of the tasks/activities performed” ranged from 7.82 to 9.40 (out of a high score of 10). In order to prevent a misconception that some activities are less authentic than the final one, renaming the final activity should be considered.

Recommendations for improvement:
- Rename the final activity so that it does not convey the impression that it is an authentic task and the other activities are not. A new name, for example could be “Consulting on Albania’s Immunization Program.”
Positive responses to the learning environment

Up until this point, the emphasis of this chapter has been on aspects of the design and implementation of the learning environment that could be improved as a result of data collected during the third iteration. These data and their analysis have revealed key strategies for the improvement of the virtual bus course.

However, the analysis also revealed a great deal of positive feedback in all sources of data, usually in response to requests for overall or summary comments. Such comments provided clear evidence that many design and implementation elements were successful in promoting learning on the virtual bus tour. For example, participants provided a range of general comments relating to the overall look and feel of the course and its organization:

The site [was] beautifully designed. [P2 (FCE, p. 3)]

I really appreciate it was very well organized the information was there, links to help us go through the task and… thank you. [P13 (FCE, p. 5)]

I would like to first give a big compliment to the whole team … It is big work to make such a complicated course so simple. [P2 (FCE, pp. 5-6)]

Other participants commented positively on an aspect of the virtual course that was a key affordance of the online delivery mode, that is, the ability to return to re-read or re-play the source to ensure understanding. For example

What I found even better than the bus course, if you spoke a foreign language, you could rewind [the video] and listen 2-3 times… That was a big advantage of the e-learning. You just need time. [P2 (FCE, pp. 5-6)]

Similarly, other participants noted that they learned a great deal about technology as they completed the course that was over and above their learning of the substantive content. For example

It was a well-designed e-course but I’m not very accustomed to this. Even though I am supposed to use technology in my job, the course gave me more of a chance to use tools like Skype and Google Drive. [P8 (FCE, p. 5)]

At first I was not familiar with how to use Google Drive and the Google Documents but once we started it was easier. [P9 (FCE, pp. 9-10)]
Positive comments extended to how the look of the e-learning website supported learning, for example

And apart from the site being beautifully designed and the learning process which was very well put on. [P2 (FCE, p. 3)]

Two other participants found the resource information, such as documents and videos useful and applicable to their work:

Thank you very much… I really appreciate it was very well organized the information was there, links to help us go through the task and thank you for the (unintelligible) …. it was very useful to apply to my work and apply to… the course should continue because we have learnt. …. Really it was a good course. [P13 (FCE, p. 5)]

I would like to first give a big compliment to the whole team… The organization was excellent. The videos– the facilities tour– you almost feel like walking with the camera. This is something that makes the course so lively. [P2 (FCE, pp. 5-6)]

Another participant who had to briefly withdraw during two of the virtual visits concluded her post-course evaluation with this comment:

And now, that this is the end, I am really sorry. So I’m glad that I participated though I disconnected twice but I’m glad of I’m participating in this final discussion. I hope to meet you all in other occasions so we will remember each other by voice or by names… even though we’re not on the bus. So, more or less, this is the same that the others had covered… but it was really a great course. I really enjoyed it. [P6, FCE, p. 8.)]

Conclusions concerning the field test of the prototype course

Design-based research methods require that multiple iterations of a solution be developed, implemented and evaluated. With the completion of the prototype course, recommendations that are grounded in a strong theoretical foundation were made (see Table 8.13) that will make future deliveries of the e-PCCM course even more successful. In addition, many of the observations, through their influence on the design principles that emerge from the research, can be applied to other e-learning courses and particularly those that include authentic learning components. In considering the recommendations, almost all can be categorized into one or more of four themes: (1) collaborative task, (2) participant relationships, (3) learner role, and (4) norms and expectations. These four themes will be analyzed more closely in the following chapter– Reflection and Revised Design Principles.
<table>
<thead>
<tr>
<th>Recommendations specific to e-PCCM (with theme related words underlined)</th>
<th>Recommendations generalized for other e-learning courses</th>
<th>Connection to key learning theories of interest (if applicable)</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review all learning objectives to assure that objectives are aligned to module content and tasks.</td>
<td>(Same)</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>2. Review all learning objectives in light of activities/tasks that the participants perform and revise as necessary so that the objectives appropriately encompass higher levels of cognitive skills.</td>
<td>(Same)</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>3. Examine how both technological and social aspects of the courses can reduce problems and contribute to better communication and collaboration within the work groups.</td>
<td>(Same)</td>
<td>Community of learners</td>
<td>Participant relationships, Norms and expectations</td>
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<tr>
<td>4. Develop a different, more complex activity related to risk assessment and risk management.</td>
<td>Provide a range of learning activities with increasing complexity so learners can expand their repertoire of experiences.</td>
<td>Cognitive apprenticeship</td>
<td>Collaborative task</td>
</tr>
<tr>
<td>5. Establish an opportunity for participants to set up and agree to the norms and ground rules that they want follow so as to facilitate their working together. Create a simple checklist of topics that groups should discuss, including timeliness of intra-group communications and assignment preparation.</td>
<td>(Same)</td>
<td>Community of learners, Authentic learning</td>
<td>Norms and expectations</td>
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<tr>
<td>6. Define roles for participants for each activity as well as a short “backstory” for that role, e.g., “You are a consultant with a background in package design and engineering.” Ensure that participants understand the responsibilities and actions of that role.</td>
<td>(Same)</td>
<td>Authentic learning</td>
<td>Learner role, Collaborative task</td>
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<tr>
<td>7. Revise at least several scenarios so that not all participants have the same role. For example, in site visit #1, Quality Agreements, continue to have some participants be authors of a quality agreement while others (or all participants at a later point in time) take the role of the firm that needs to agree to the document.</td>
<td>(Same)</td>
<td>Authentic learning, Cognitive apprenticeship</td>
<td>Learner role, Collaborative task</td>
</tr>
<tr>
<td>8. Look for ways to create one or two simple icebreakers and activities that can be used during the e-learning course that will promote the online presence of participants and contribute to a learning community.</td>
<td>(Same)</td>
<td>Community of learners</td>
<td>Participant relationships</td>
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<tr>
<td>Recommendations specific to e-PCCM (with theme related words underlined)</td>
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<td>9. Stress in the promotional material and the participant acceptance letter the amount of time that will be expected of course participants to utilize the resource materials (e.g., videos, publications) and complete the tasks/activities. Ideally this will be based on actual data; if not available, provide an estimated range of time.</td>
<td>(Same)</td>
<td>Community of learners</td>
<td>Norms and expectations</td>
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<td>10. At the start of a major activity, include a requirement that teams immediately have a conference call or SKYPE to establish a project plan with due dates, work and travel schedule of all the team members. This should be shared with the mentors. Additionally, team members should discuss and agree on their expectations of working together on this last assignment.</td>
<td>(Same)</td>
<td>Authentic learning Community of learners</td>
<td>Collaborative task Learner role Participant relationships Norms and expectations</td>
</tr>
<tr>
<td>11. Revise the task so that instead of looking at a large number of documents and identifying positive features and problems that could be improved, ask teams to focus on one particular aspect that the system owners have identified as needing improvement.</td>
<td>When developing an authentic task, attempt to have it focus on a real need that is perceived as such by the “client” or involved parties.</td>
<td>Authentic learning</td>
<td>Collaborative task</td>
</tr>
<tr>
<td>12. In earlier site visits, consider an activity that would have the participants work with a report written by a consulting team so the participants can become familiar with one. This activity could be expanded to have the participants critically analyze the report looking for gaps, recommendations not supported by data or needs, and general organization.</td>
<td>When establishing roles, ensure the learners have some knowledge about function and responsibility of those roles.</td>
<td>Authentic learning Cognitive apprenticeship</td>
<td>Collaborative task Learner role</td>
</tr>
<tr>
<td>13. Consider having teams do a short (10 minute) PowerPoint type presentation to the mentors for feedback. Mentor comments can be included in the team’s final reports. Additionally (or alternatively) PowerPoint presentations may be given to the client.</td>
<td>Consider different options for articulation that practitioners would use.</td>
<td>Authentic learning</td>
<td>Collaborative task Learner role</td>
</tr>
<tr>
<td>14. Establish more frequent SKYPE teleconference calls between team members and mentors. These would function as an opportunity for the mentor to answer questions, monitor timelines, and provide additional scaffolding and support.</td>
<td>(Same)</td>
<td>Authentic learning Cognitive apprenticeship</td>
<td>Participant relationships Norms and expectations</td>
</tr>
<tr>
<td>Recommendations specific to e-PCCM (with theme related words underlined)</td>
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<td>15. Rename the final activity so that it is does not convey the impression that it is an authentic task and the other activities are not. A new name, for example could be “Consulting on the Albania’s Immunization Program”.</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>16. For each task, have one or several examples of a solution (e.g., correct procedure, best practice, completed quality agreement) that participants can consider.</td>
<td>(Same)</td>
<td>Authentic learning Community of learners</td>
<td>Collaborative task</td>
</tr>
<tr>
<td>17. Establish specific points at the start of the e-learning course where everyone is asked to use the <strong>discussion page</strong>, such as when teams arrive at agreement of course and team expectations. Ask participants to start and <strong>facilitate a threaded discussion</strong>, including their coaxing other course participants to contribute. Have course mentors/facilitators participant early-on, modeling the desired behavior.</td>
<td>(Same)</td>
<td>Community of learners</td>
<td>Participant relationships Norms and expectations</td>
</tr>
<tr>
<td>18. Create as many authentic elements as possible in an <strong>activity</strong> so as to provide a richer, more robust context to the authentic environment and task.</td>
<td>(Same)</td>
<td>Authentic learning</td>
<td>Collaborative task</td>
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</tbody>
</table>

The data that was generated, analyzed, and presented in this chapter help to refine the design principles that were derived from the literature review and consultations with practitioners conducted in Phase 1 of the research. The refined design principles will be presented in the following chapter.

**Addressing the secondary research questions in Iteration 3**

In Chapter 2, four research questions were posed. The field testing of the prototype provided a great deal of data that are useful in addressing the three secondary questions. Chapter 10 discusses the primary research question using the issues identified here and in the previous two chapters.

Each of the three secondary research questions is listed below along with an initial answer (in **boldface** type) and supporting rationale and data.
Question 2A: What are the factors that enable a technology-based e-learning solution and the affordances the technology provides, to “mirror” an existing, experiential learning event and potentially improve on that event?

A level of belief that what you are experiencing is true

In the actual bus course there is no question that a participant is immersed in a distribution facility or walking into a cold room because the physical factors are present. In an e-learning course, there needs to be a suspension of disbelief, meaning that on some level you believe what you are experiencing is true and that it is “real-life.” This can be a personal perspective, as was discussed earlier in this chapter, when one participant commented on the unrealistic nature of a standard operating procedure used in a task, while two others commented on the value nature of the task to them. Having a number of factors that reinforced real life was seen in the shake test performed in virtual visit #5. One participant recorded this in his diary relating to its value to him and how he will use it:

The Practical Shake Test is a superb idea. Use of picture to prove the result is welcomed. [I will] share the Shake test with other colleagues. [P11 (V5, DQ3)]

Another participant commented at the end on how the videos and 360-degree photos contributed to her sense of being there:

The videos – the facilities tour – you almost feel like walking with the camera. This is something that makes the course so lively. [P3 (FCE)]

Technology and its affordances, then, can contribute substantially to an e-learning solution and the learner’s belief and the suspension of disbelief.

“Mirroring”—or trying to duplicate a course created for a different delivery method may prevent one from taking advantage of the affordances offered by the new delivery method (or technology)

Trying to duplicate, clone, or “mirror” an existing course into one that uses a different delivery system or technology may be comparable to trying to force a square block into a round hole. Different delivery methods—placing participants in a bus or positioning them in front of a computer connected to the internet—demand that designers and developers understand the strengths and weaknesses of the methods and maximize the
strengths. One participant compared the two experiences she had had—on the physical course and the e-learning course:

[The e-learning course is] not just like the real bus course but different. What I found even better than the bus course, if you spoke a foreign language, you could rewind [the video] and listen 2-3 times… That was a big advantage of the e-learning. [P3 (FCE)]

Another participant spoke of the affordances provided by the use of shared documents placed on the Google Drive site available to all the participants, a technology not available in the physical version of the course:

We have the chance to go back to Google Documents and see our groups work and other groups and then, if we have some comments, we can add something more. [P6 (FCE)]

A different participant pointed out how the online resources contributed to his learning:

The visit experience during actual course of the bus was real due to one [on] one interaction with Farmalojistik team and mentors. But frankly I am gaining more through e-learning. Thanks to rich knowledge bank in the form of library documents and videos. [P1 (V1 DQ3)]

When designing the e-learning solution, emphasis should be placed on taking advantage of what the technology allows the learners to do, rather than just copying a learning solution that was intended for use using different technologies or delivery methods.

**Question 2B: In what ways can a community of learners be established and enhanced when the participants are in different physical locations and of different cultures?**

**Allow for flexibility in collaboration and timing but monitor and support the use of reasonable, agreed-to timelines, and fairness in accomplishing group tasks**

This e-PCCM course was intended for adult learners who were to participate in the course while they were working fulltime. Although their supervisors were informed by the course director of the estimate time commitments, often work, home, travel, or health priorities had the potential to affect a learner’s involvement in the course and its activities. Several learners mentioned this at different times during and after the course, for example this participant at the end of the third visit:

As I am travelling I could not be able to [do] the works in this part very well. [P8 (V3 DQ3)]
A participant realized the impact that his travel schedule had on his team as they worked on the Albanian Case:

Very sorry for my poor contribution for report due to travel and my crazy schedule in the past month. [P12 (V6 DQ3)]

Another participant recognized that his teammates did most of the work in the last extended activity:

I faced in the first 3 tasks I was in the group or leading the group. When it came to do other tasks and I needed to do more research I was lost. And because … of my job and work increase, I didn’t do as much. My team members did the work and I put my name on the work. [P8, FCE]

Conversely, team members who did most of the work felt that their share of the workload was unfair:

I typically did more than the other members of the team.

Because of the fact that the authentic task was the “hardest” one throughout the course and needed a lot of work, the problem of participants’ commitment and dedication was worst throughout the course as well. [P7 (PCS Q18)]

Although such objections are frequently found in group-work activities, the role of the mentors could be instrumental in addressing this issue. One participant suggested that mentors could help the participants stay on track during the last extended activity:

Suggest intermediary milestones for the authentic task, and why not a work methodology (I had to do it myself and felt very directive with my peers). [P2 (PCS Q18)]

When mentors or the course director sent out updates and reminders, they were positively received by this participant:

[Receiving announcements and reminders when moving to a new task] was really good especially because we are busy and taken away by work issues. [P13 (PCS Q21)]

Participants noticed—and seemed to appreciate—when flexibility was provided in how and when they completed an assignment:

What is very nice about this is that everyone can do it from his own place… [P9, FCE]

And, when they could not keep up with the program, there were ways that participants could catch up:
I could not follow this part on time together with the others, but I spent some times later on. [P6 (V5 DQ1)]

A challenge for an e-learning course with a community of learners is finding the best balance between group work where there is equitable contribution and participation, timelines that need to be met, and unforeseen circumstances that learners face.

Create timely and comfortable ways that will develop participants’ social presence and encourage their participation

Developing and then sustaining a community of learners in a virtual e-learning environment depends on how frequently and in what ways the participant interacts with others in the virtual community. This process should start early on—at the start of the course—as one participant noted, comparing the e-learning course to the physical bus course:

Maybe we had to do an “obligatory” task of knowing each other through skype (before the course start) and let’s say we have to write to or three things for at least three of them. So when the course starts we already know each other. :) (More or less like we did in the first day of training in Turkey). [P6 (PCS Q16)]

The discussions on cold chain topics were predominantly initiated and contributed to by two participants; most of the other participants did not contribute to them. One participant spoke of the challenge she felt when communicating with other participants:

Frankly some people were much more experienced than me, this made it somehow [a more] difficult task, as it required extra effort to be able to discuss matters with them. [P9 (PCS Q15)]

Clear writing was a challenge that was faced despite the fact that other communication tools were suggested, such as audio/video tools like Skype. This is especially complicated when participants have primary languages other than the one used in the course:

The written communication made some unwanted wrong interpretation of the thoughts. [P8 [(CS Q15)]

In a virtual community of learners, extra care needs to be taken so participants feel comfortable to interact and communicate with others. Opportunities to create and sustain the community need to begin early and continue throughout the course.
Mentor and course leader involvement is essential as it contributes to a community of learners

In the e-PCCM course, as in the physical bus course, while everyone involved (including the mentors) are viewed as “learners,” the mentors are those who guide the participants and help facilitate activities and discussions. In most cases, mentors responded in a timely and appropriate way during the field testing of the course:

The mentors’ feedback on the individual and group assignments was great as well. [P7 (PCS Q11)]

Guidelines for mentors included the need to reply to queries and issues where possible within 24 hours, and participants appeared to appreciate the timeliness of the responses:

Videos and comments were always given in the very next days following the end of each tasks [and mentor M3] never sleeps and always answer your emails (very precisely) within 6 hours, whatever he is doing at the same time. [P2 (PCS Q11)]

The most favored way of getting feedback was through email or by mentors placing comments on the participant’s work using Google Drive. The ease of email use was noted by a participant:

[E-mail is] ever reliable since it is used every day and frequent even accessible in our mobile phones. [P13 (PCS Q13)]

One participant described why she prefers receiving mentor comments in a written form compared to the comments being in a video or audio format:

I like first to read the comments and to understand them by my own. This is why I ranked direct communication behind them. In case I have comments on the mentor's comments I would like to continue discussing on Skype or phone. [P6 (PCS Q13)]

Another participant gave two reasons why he preferred written comments:

1) Written comments on original work or by mail is easier for participants to follow and amend their work if necessary. 2) Myself, I found that watching someone, while talking with no supportive illustrations or visual effect is boring. [P7 (PCS Q13)]

In some situations, mentors did not provide the level of responsiveness expected by a participant:

Once I sent an email to one of the mentors explaining why I said something (for which I received a comment) and I did not get an answer, at least just "Ok I understand your point." [P6 (PCS Q24)]
During an e-learning course, participants are very aware of the timeliness and quality of the responses given by course mentors and leaders that contribute to retaining learners in the community and encouraging participant learning.

**Question 2C:** *How did e-learning course participants respond cognitive apprenticeship and authentic learning tasks which were intended to develop their expertise?*

Participants rated and valued tasks more highly that had variety compared to those that were slight variations on previous tasks

As was discussed earlier in this chapter, there were several tasks that were quite similar, tasks originally intended to reinforce the concepts of identifying ways that risks could be reduced at visited sites. While some participants saw that it was a useful reinforcement, as described by one participant:

> I don’t know what other people might say but I think this task is very close to the risk assessment task so for me it is strengthening the idea. [P9 (V3 D3)]

Others felt that adding some differences or complexity would be beneficial:

> Additional task so the current site visit would be differentiated from the similar Farmalojistik risk assessment would be great. I would suggest adding risk ranking to the assignment! [P7 (V3 SQ4)]

> This session was very interesting and useful. Maybe more scenarios would help to apply the knowledge. [P1 (V5 D3)]

Participants appeared to want more challenges to their critical thinking and problem solving skills as they moved through the prototype course.

Participants valued learning skills beyond those that were directly intended, including the use of technology like Google Drive and creating flow diagrams

In addition to the outcomes that were intended and planned for the e-learning course, participants gained additional knowledge and skills that they were not expecting, such as creating decision trees and PERT charts to visually present data:

> Thanks [to the mentors] for the valuable feedback especially introducing PERT Chart (Program Evaluation and Review Technique). [P1 (V2 D3)]
Another participant commented on the value of learning additional information and procedures on report writing:

How to write a complete report on cold chain mostly using documents. [P2 (V6 DQ1)]

In other cases, participants gained from experiencing and applying concepts such as “continual improvement,” a characteristic of all quality management programs:

I have learnt about the significance of conducting some research for a programme for continuous improvement. [P13 (V6 DQ1)]

Participants also used and gained proficiency in communication and online technologies that they could use in their job and everyday life:

Even though I am supposed to use technology in my job, the course gave me more of a chance to use tools like Skype and Google Drive. [P8 (FCE)]

All of these new skills or ways of representing data can be applied very broadly, developing not only domain knowledge, but also knowledge skills that are highly transferable. This was something that participants noticed and appreciated.

Participants wanted exemplars of how a practitioner would approach a solving a problem

At the conclusion of activities when the mentor did not initially provide a solution or description of best practice, some participants requested a document describing how an expert might approach or solve the problem:

Each time, an “almost perfect answer” to the task given by a mentor could be useful. [P2 (V3 DQ3)]

Participants saw this as helping to further develop their knowledge:

It will be helpful if we get “ideal and worst case flow charts” for involved processes or case study just to identify more scenarios or look for critical points. [P4 (V2, DQ3)]

For some activities, participants realized that while there is not a single correct answer to a complex problem, they did want to see a range of options:

Examples of best effective quality agreements, etc… [P2 (V1 SQ21)]
These requests illustrate the value that the participants saw as they worked with experienced, expert mentors and is consistent with the model of cognitive apprenticeship that was examined in Chapter 3—Literature review.

**Participants may not know how to proceed (the process) or create an artifact (the report) because they lack of experience/knowledge about what a practitioner does**

In the final, extended activity when participants conducted a desk review of Albania’s Institute of Health by examining documents, many participants and teams were challenged by the (implicit) requirement to go beyond the information that was provided to them. Mentors observed this and commented upon it at the end of the course:

> I thought that some of the analysis was a bit ‘thin’ and I was disappointed that participants did not follow-up on additional materials. [M1 (PCMQ12)]

An underlying issue was about the participants’ role in that activity as consultants:

> I was expecting better job from everybody. Most of them were using only the available data. Although design-wise, it was authentic, participants did not really get into the roles we wanted them to get. [M3 (PCMQ12)]

Some participants also commented on the challenging nature of the task:

> Myself and [another team member] mainly worked on the [Albanian Case] and tried to prepare the drafts of the reports based on available documents [and] information. But we somehow could not get exactly what are the gaps in our report and what was expected from the final report. We are going through once again and trying… to meet the expectations of mentors and course leaders. [P1 (V6 DQ3)]

For an authentic task to be successful, participants need to have a robust understanding of the role they are fulfilling or the opportunity early in the task to develop an understanding of that role.

This chapter has presented the details of the third iteration of formative evaluation, specifically the field testing of the prototype e-learning solution. The following chapter will present a more detailed analysis and discussion of the design principles in light of what was learned in the three iterations.
CHAPTER 9

Reflection and revised design principles

Introduction
In previous chapters, the need for an e-learning course that would help develop expertise of those handling of time and temperature sensitive pharmaceutical products (TTSPPs) was presented (Chapter 1) along with a description of the design-based research approach that was used to fulfill this need (Chapter 2). Subsequent chapters included examination of three key learning theories (Chapter 3) and the presentation of draft design principles that were derived from those theories (Chapter 4). The design and development of the e-learning application (Chapter 5) was described along with three iterations, each iteration having been subjected to a formative evaluation with the results used to improve subsequent versions (Chapters 6, 7, and 8).

A data-flow diagram (Figure 9.1) that is overlaid on the four phases of design-based research illustrates how data and information from earlier activities (shown as #1-4) contributed to the beta version used in the field testing of the prototype solution (#5). Data gathered from participants, mentors, and researcher observations (#6) was used to make specific recommendations (#7) for improvements to the learning intervention—the e-Pharmaceutical Cold Chain Management course (e-PCCM, #8) and, more generally, to other e-learning courses (#9). The data collected (#5), particularly during the field testing of the prototype e-learning solution (the third iteration) were used in re-examining the draft design principles (#10) and, as will be described in this chapter, recast into a different framework that has a pragmatic utility applicable to authentic e-learning (#11-12).
This chapter describes what was done during this reflective analysis and presents a reconfiguration of the finalized design principles. This chapter is aligned with a key principle of design-based research which is to communicate findings to inform the design of other e-learning projects, as noted in Herrington, Reeves, and Oliver (2010).

**Analysis of the design principles**

In order to obtain a richer understanding of the data, and in addition to the analysis of data presented in Chapters 6, 7 and 8, a more in-depth analysis of the recommendations and design principles was conducted. This was initially conceptualized by creating a relationship map considering five elements that were integral in the e-PCCM course: the learning solution/application, assignments and tasks, individual learners, mentors, and the learning community. The recommendations that were made to improve the e-PCCM course were summarized and positioned on the map so the recommendation would be seen in relationship to the course element(s) to which it most related.
In a similar way, the design principles were overlaid on the map (see Figure 9.2 for an illustration of the initial analysis process using removable/repositionable PostIt Notes™).

Figure 9.2. Map showing relationships between recommendations, design principles and five elements in the e-PCCM course

In examining the recommendations, four themes emerged that incorporated most of the recommendations, specifically (1) collaborative tasks, (2) participant relationships, (3) learner role, and (4) norms and expectations. These four themes not only embraced almost all of the design principles (as is shown below), but they also have a pragmatic quality allowing them to be utilized by a learning solution designer or developer. Each
design principle was also categorized as to when it was applied, specifically in designing the course, in the course’s execution, or in both circumstances. What follows is a description of each theme, the design principles it embraces, and how the theme may be applied in practice.

**Theme 1: Collaborative tasks**

In the e-PCCM course, there were tasks that required collaboration, such as selecting the most important elements of a quality agreement, preparing a contingency plan to reduce risk, creating a project plan for a major change in handling vaccines, conducting an analysis, and writing a report on vaccine storage and handling practices in Albania. Some of these collaborative interactions were relatively short as participants took only a few hours to complete it. The final task was much more complex and time consuming, requiring many hours over five weeks. These tasks each had two types of outcomes: the tangible and the intangible. The first outcome was a tangible artifact—the contingency plan or the report, for example. The second outcome was the intangible value of negotiating with other team members, working together—sometimes more successfully than others—and the mental construction of the various elements that formed that final artifact.

**Related design principles**

Nine of the design principles support collaborative tasks, meaning that when a collaborative task is used in an authentic e-learning course, these principles will contribute to its success. Table 9.1 lists (1) the principle, (2) if the principle is primarily used in the design or execution of the course or in both situations, and (3) the learning theory from which the design principle was derived.
Table 9.1. Design principles that support the theme of collaborative tasks

<table>
<thead>
<tr>
<th>Design principle</th>
<th>When used</th>
<th>Related learning theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor and index knowledge in the context in which the learning occurs.</td>
<td>Design – content, activities</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>Design – content, activities</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Design the learning solution so that there are “increasingly complex micro-worlds” (ICMs) where a learner can succeed in developing a skill.</td>
<td>Design – technology, activities</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Incorporate authentic tasks that are the “ordinary practices of the culture” or community.</td>
<td>Design – content, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
<td>Design – technology, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Avoid making problem solving as explicit as possible.</td>
<td>Design – content, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Provide opportunities for articulation.</td>
<td>Design – technology, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Design and implement the course so there is some (adequate) learner flexibility in their accomplishing the assignments and activities.</td>
<td>Design – technology, activities</td>
<td>Community of learners</td>
</tr>
<tr>
<td></td>
<td>Execution – role of mentor</td>
<td></td>
</tr>
</tbody>
</table>

**Applying this theme and the related design principles**

As can be seen in the second column of Table 9.1, the design principles apply at different points in the life cycle of the e-learning course (i.e., design, execution, or both) and to different elements of the design (i.e., content, learner activities, and technology selected). As the collaborative activity for the e-learning course is being designed, the design principles need to be considered together, not just as isolated, independent guidelines. For example, when “incorporating…the ordinary practices of the culture,” content (including resources like video and documents) must be identified so it is aligned with the authentic task to be performed. In other words, the role of the mentor/facilitator needs to be consistent with how an expert or master would provide guidance and feedback to a novice in an authentic, real-life context. Technologies that are selected to enable these interactions should be the same or as similar as possible to those used by practitioners but tempered with an understanding of the limitations of
specific technologies and the technological infrastructure available to the learners. Making these choices when designing the collaborative tasks is not a simple, linear process, but a more complex iterative one, with the design team optimizing authenticity with the constraints of the given situation.

Another important implication of these design principles is that they emphasize not just the end physical or informational product, but also the processes that the learners use as they produce the artifact and create an articulation of the outcome. Having the articulation consistent or aligned with how practitioners convey the products that emerge from tasks (e.g., report format used or presentation type) reinforces the authenticity of the collaborative task.

**Theme 2: Participant relationships**

Fundamental to authentic learning and a community of learners is the relationship between participants with each other and with the instructors, facilitators, or mentors who have a defined leadership role. Relationships in a virtual environment don’t just happen: a trigger or motivator must be present that initiates the relationship and then a rationale needs to exist for a continuation of the relationship. Those in the relationship must exhibit behaviors that will support the relationship and not engage in behaviors that would cause friction or fracture.

In the field testing of the e-PCCM prototype course, there was one motivator in particular that initiated the online relationships, which was the strong relationship that all participants had with the course director, established among them during a recent bus course in Turkey. Other relationships developed during previous bus trips were among some of the participants and some mentors. However, not all participants knew each other, forcing them to virtually “meet” as they were completing their tasks. As was discussed in Chapter 8, some teams were more successful at this than others. Communication between members, work/holiday/weekend schedules, and work styles all appeared to contribute to a team’s success or lack thereof.

**Related design principles**

Seven design principles support the theme of participant relationships. By definition, a collaborative task requires people to have a relationship as they work together; this
theme is meant to promote creating and sustaining functional relationships that will contribute to accomplishing the authentic task in a positive, professional, and enjoyable way. Table 9.2 lists these principles, whether the principle is primarily used in the design or execution of the course or in both, and the learning theory from which each was derived.

Table 9.2. Design principles that support the theme of participant relationships

<table>
<thead>
<tr>
<th>Design principle</th>
<th>When used</th>
<th>Related learning theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>Design – content, activities</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Mentors work closely with learners and guide the learners through activities and experiences with modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
<td>Design – content, activities, Execution – role of mentors</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
<td>Design – technology, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Create opportunities for cross-functional collaboration.</td>
<td>Design – activities, Execution – role of mentors</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Utilize inclusive and universal design principles that will permit all learners to be engaged and critically examine and monitor the learning environment to ensure no one is excluded.</td>
<td>Design – content, activities, Execution – role of mentors</td>
<td>Community of learners</td>
</tr>
<tr>
<td>Design and implement the course so there is some (adequate) learner flexibility in their accomplishing the assignments and activities.</td>
<td>Design – technology, activities</td>
<td>Community of learners</td>
</tr>
<tr>
<td>Design and conduct the course so that the interaction of the facilitators and learners contribute to developing trust and safety within the course.</td>
<td>Design – activities, Execution – role of mentors</td>
<td>Community of learners</td>
</tr>
</tbody>
</table>

**Applying this theme and the related design principles**

In the physical PCCMoW course, having 15 participants and three mentors in a bus for six days promotes relationships and camaraderie that can be a challenge to establish in a virtual environment. In early discussions and in sketches of the course, the design team intended to include this by way of features in the learning application. Due to various factors, these group bonding activities, such as Two Truths and a Lie, were not included in the prototype e-learning course, resulting in fewer opportunities for participants to develop their online social presence and relationships. Beyond any technological
features built into the e-learning application, however, are features in the design and execution of the tasks that will contribute to positive group relationships. As seen in Table 9.2, every principle should ideally be utilized in the design of the activities so that each team member understands that they can—and must—make a contribution to the group’s efforts. During the execution of the course, the mentors in particular have a role in monitoring activities, encouraging participation, and providing feedback to participants who act inappropriately.

**Theme 3: Learner role**

A recurring element in the literature of cognitive apprenticeship and authentic learning that was examined in Chapter 3 was that the learners do not simply learn about a practice but instead work at becoming practitioners and begin accumulating a set of experiences that can contribute to expertise. There were two particular aspects of the learner’s role that were found to be important in the e-PCCM course. First, the learner’s role(s) had to be identified. Second, the participants needed to know the activities and responsibilities involved in that role. Simply telling a participant, “you are a consultant to the Albanian Institute of Health” is not enough. Rather some information about consultants and what they do need to be incorporated in an authentic way or through another participant or mentor.

**Related design principles**

Four of the design principles, because of their emphasis on the activity, task, interactions, and opportunities, support this theme of learner role. As in the first theme, Collaborative Tasks, the focus must be that the roles are natural to the task, that is, the roles are authentic. Table 9.3 lists these principles, if the principle is primarily used in the design or execution of the course or in both, and the learning theory from which each was derived.
Table 9.3. Design principles that support the theme of learner role

<table>
<thead>
<tr>
<th>Design principle</th>
<th>When used</th>
<th>Related learning theory</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Design – content, activities</td>
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</tr>
<tr>
<td>Incorporate authentic tasks that are the “ordinary practices of the culture” or community.</td>
<td>Design – content, activities Execution – role of mentors</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
<td>Design – technology, activities</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>Create opportunities for cross-functional collaboration.</td>
<td>Design – activities Execution – role of mentors</td>
<td>Authentic learning</td>
</tr>
</tbody>
</table>

**Applying this theme and the related design principles**

Establishing clear roles for the learner in the authentic, collaborative task comes from working with practitioners and/or those who have a depth of knowledge about, first, the roles that are naturally involved in that task and, second, what the actions and responsibilities are of those in the roles. As seen in Table 9.3 above, the learner role is incorporated into the design, particularly for the activities, but also in the content and the technology chosen. Technology is the enabler—it allows learners to collaborate on a task, it can help create and sustain relationships when learners and mentors are in different locations. Optimally, the technology selected would be similar to that practitioners use—not designing a “Skype-like” tool within a learning environment, but having learners, use, if at all possible, Skype itself as they work together. Emphasizing the need for learners to use technologies that allow for a higher social presence—real time chat versus email, for example, if that is one of the tools that practitioners use—increases that tool’s value in the authentic learning environment. Mentors play an important role as they monitor what the learners are doing, provide guidance, and help the learners acquire a more nuanced understanding of their role.

**Theme 4: Norms and expectations**

Norms (the practices that a group uses to maintain its order and identity) and expectations (broader written or unwritten guidelines for behaviors and practices) can be considered to be “lubricants” to reduce friction within the group. In the context of an e-learning course, this would include norms such as timely, courteous, professional
communications (e.g., using email or audio/visual teleconferencing like Skype), and expectations, for instance completion of activities by the due date and active participation in a discussion forum. When norms are not adhered to or expectations are not met, team members can feel they are not valued or worse, that the group’s performance will be affected.

**Related design principles**

Five of the design principles, because of their emphasis on interactions, involvement of learners and mentors, and authentic activities support this theme of norms and expectations. While ideally there should be alignment between the norms and expectations used in an authentic learning course and those used by practitioners, it is more important that they effectively support the authentic environment, the task, and the learners and mentors. Table 9.4 lists these principles, if the principle is primarily used in the design or execution of the course or in both, and the learning theory from which each was derived.

<table>
<thead>
<tr>
<th>Design principle</th>
<th>When used</th>
<th>Related learning theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>Design – content, activities</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Mentors work closely with learners and guide the learners through activities and experiences with modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
<td>Design – content, activities Execution – role of mentors</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>Design and implement the e-learning solution specific tools of the interface and technology so they contribute to a positive learning experience and retention of community members.</td>
<td>Design – content, activities Execution – role of mentors</td>
<td>Community of learners</td>
</tr>
<tr>
<td>Design and implement the course so there is some (adequate) learner flexibility in their accomplishing the assignments and activities.</td>
<td>Design – technology, activities Execution – role of mentors</td>
<td>Community of learners</td>
</tr>
<tr>
<td>Design and conduct the course so that the interaction of the facilitators and learners contribute to developing trust and safety within the course.</td>
<td>Design – activities Execution – role of mentors</td>
<td>Community of learners</td>
</tr>
</tbody>
</table>
**Applying this theme and the related design principles**

Having explicit expectations in place at the start of an e-learning course provides structure and a level of confidence and comfort to the participants. The expectations identify what is required of them by the course designers and course mentors, in order for the individual and group to succeed. There needs to be an amount of flexibility and common sense in how these are applied to accommodate unexpected events that add complications. During the physical bus trip, norms and expectations—both what to do (prescriptive) and what not to do (proscriptive)—are enforced by the participants and mentors in different ways. Establishing the practice that presentations or large group activities do not begin until everyone is present puts pressure on people to be punctual and ready to begin at the stated time and place. Humor and pointed barbs made by others in the group aimed at a participant who repeatedly asks detailed hypothetical questions in a group setting can be a painful way for the questioner to learn that he or she is outside of the unspoken boundaries of the group.

In contrast to the previous three themes discussed, the design principles supporting this theme occur more in the execution of the course. Mentors are involved in monitoring discussions, reading emails and reports, and being available to take action when there is perceived or actual friction between participants or when expectations clearly are not met. There may be an increased formality of expectations based on situations that occur during an e-learning course in the hope of preventing similar problems in future offerings or courses.

There are other observations that can be made after further reflection on these themes and design principles. These are presented in the discussion below.

**Discussion across the four themes**

In considering the four themes—collaborative tasks, participant relationships, learner role, and norms and expectations—several particular implications are apparent that can be broadly applied to e-learning courses and projects.
Overlapping and reinforcing design principles

There were a number of design principles that support two or more themes as can be seen in a summary (Table 9.5). The table below illustrates the interconnectedness of the themes and design principles—how they necessarily weave together to form a fabric that supports the e-learning course.

Table 9.5. Themes with overlapping design principles

<table>
<thead>
<tr>
<th>Collab. tasks</th>
<th>Partic. relations</th>
<th>Learner role</th>
<th>Norms &amp; expect</th>
<th>Design principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td>Anchor and index knowledge in the context in which the learning occurs.</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>Design the learning solution so that there are “increasingly complex micro-worlds” (ICMs) where a learner can succeed in developing a skill.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td>Mentors work closely with learners and guide the learners through activities and experiences with modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
<td>Incorporate authentic tasks that are the “ordinary practices of the culture” or community.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>Avoid making problem solving as explicit as possible.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td>✔</td>
<td>Provide opportunities for articulation.</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>Allow for unanticipated learner outcomes.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>Create opportunities for cross-functional collaboration.</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>Design and implement the e-learning solution specific in terms of the interface and technology so they contribute to a positive learning experience and retention of community members.</td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>Design and implement the course so there is some (adequate) learner flexibility in their accomplishing the assignments and activities.</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>Design and conduct the course so that the interaction of the facilitators and learners contribute to developing trust and safety within the course.</td>
</tr>
</tbody>
</table>
Placing emphasis on relationships over technology

In examining the themes and design principles that contribute to a successful e-learning course, a salient point is relationships and ways to create and sustain them. It is not solely the relationships between learners, but the relationships among learners and mentors as well. The emphasis on relationships is something that can be overlooked when creating an e-learning solution because of the need to consider technology and the affordances of that technology. Certainly technology affordances are important in virtual relationships; however, relationships themselves are critical for the learner because they afford the learner opportunities to discuss concepts, establish friendships that might extend beyond the “classroom,” and communicate with peers who can empathize with the situation.

The initial design principles that were developed (Chapter 4) arose from an extended literature review of three key learning theories. The vast majority of people creating e-learning today, particularly those in industry, do not necessarily have the time or resources available to conduct original literature analyses, or have a framework for interpreting the design principles that come from particularly appropriate theories such as cognitive apprenticeship, authentic learning, or community of learners.

The synthesis of the four themes described in this chapter and the design principles that support them are meant to be a different and, hopefully, a more pragmatic way to communicate guidelines that will enable those creating e-learning courses to design them so they include tasks and activities that are built around authentic learning principles. In doing so, the e-learning course designers will be using a foundation that consists of cognitive apprenticeship, authentic learning, and community of learners.

Conclusion

Throughout the first two iterations of design, development, and formative evaluation, and particularly in the third iteration—field testing of the prototype e-learning solution—theory-based design principles were incorporated. Based on ratings data supplied and comments provided by the learners and mentors, and on the observations by the researcher, the researcher obtained a richer understanding of these design principles. This understanding included a pragmatic meaning of the design principles.
and how they can be used by others who are creating e-learning courses that incorporate authentic tasks and activities.

This understanding, and the discussion relating to the three secondary research questions discussed in Chapter 6, 7, and 8, can be used in the following, final chapter to address the primary overarching research question: *In what ways can a technology-based e-learning solution be used to facilitate the development of expertise of those involved in the distribution and handling of time- and temperature-sensitive pharmaceutical products?*
CHAPTER 10

Conclusions

Under the umbrella of a design-based research (Barab & Squire, 2004) study, the design, development, field testing, and iterative formative evaluation of an e-learning solution intended to help develop the expertise of those handling time- and temperature-sensitive pharmaceutical products (TTSPPs) has been described in this thesis along with the theoretical foundations used in creating the e-learning solution. In this final chapter, a summary of those activities is presented along with a summative response to the primary research question initially presented in Chapter 1. Additionally, this chapter addresses the limitations of the study, implications of the research, and areas for future research.

Recap of the research conducted

Based on a real-life problem, specifically, the need to develop the knowledge, skills, and expertise of those involved in (and those who support) the handling, storage, and distribution of TTSPPs, an e-learning course was proposed as a viable solution to this problem, especially if the e-learning could be designed to include authentic tasks and activities (Chapter 1). Production of this e-learning solution (Chapter 5) was accomplished using a design-based research approach (Chapter 2) with three iterative cycles of design/develop and formative evaluation used to improve the subsequent iteration (Chapters 5-8). Three theories, cognitive apprenticeship, authentic learning, and community of learners were examined in an extensive literature review (Chapter 3) and, along with consultations with practitioners (Chapter 2), were used to prepare design principles (Chapter 4). These design principles were refined throughout the research and, when the final iteration was completed, they were further refined and discussed (Chapter 9). During the three iterations, data were collected that helped
improve the e-learning solution, refine the design principles, and answer three secondary research questions. The three secondary research questions are listed below along with a summary of responses that emerged from the three iterations.

1. *What are the factors that enable a technology-based e-learning solution and the affordances the technology provides, to “mirror” an existing, experiential learning event and potentially improve on that event?*

Because of the differences in affordances provided by different delivery methods or technologies used in presenting a course, forcing one learning solution to match or mirror another may be futile, since each delivery method or technology has its own unique set of affordances that should be used and leveraged for the best possible outcome. Instead of trying to mirror, the emphasis should be to identify those characteristics or outcomes that are to be maintained in the new learning event. For instance, in any learning environment, learners expect and welcome timely, rich feedback from mentors, and learners have a strong belief that the situation or challenge they find themselves facing is realistic, worth addressing and authentic. Technology or tools that are capable of supporting these outcomes should then be selected and used.

2. *In what ways can a community of learners be established and enhanced when the participants are in different physical locations and of different cultures?*

When designing an e-learning solution that will have users located around the globe, one must consider not just the technological infrastructure participants can (or cannot) access but also the dynamic political realities that can affect websites and applications that they can access. Creating simple and enjoyable ways for learners and mentors to establish their social presence and get to know each at the outset can contribute to effective teamwork later in the course. While timelines and due dates for project work need to be established and achieved, there needs to be flexibility and fairness built into the schedule to account for local holidays and personal/professional factors that may intrude into the learner’s (and the course leader/mentor’s) plans. Mentors and course leaders need to be actively involved in monitoring, supporting, and sometimes explaining the consequences of the actions of participants who act outside of the group’s norms and shared expectations.
3. How did e-learning course participants respond to tasks and activities intended to develop their expertise, that were based on cognitive apprenticeship and authentic learning principles?

In the field testing conducted, participants more highly rated and valued tasks that were based on quite different challenges compared to those that were only slight variations on previous tasks. The participants valued acquiring knowledge in areas that were not the intended emphasis in the course, such as using new types of software or applying new project management techniques that were incorporated into a task or project. Participants were also interested in how others, particularly mentors, would address or solve a problem—how they would go about completing the task, what their results would be, the format they would use in presenting their results, and so on. In some cases, learners may not have enough background or experience to know how a practitioner would approach a problem or the types of questions that the practitioner would ask. Opportunities need to be available for the learner to acquire this knowledge.

The responses to these secondary questions presented above were essential in order to reflect on the primary, overall research question that guided the research.

Responding to the primary research question

In reflecting on the secondary research questions that were responded to in Chapters 6, 7, and 8 and in the observations made by the researcher, five particular points are presented below in response to the primary research question:

*In what ways can a technology-based e-learning solution be used to facilitate the development of expertise of those involved in the distribution and handling of time- and temperature-sensitive pharmaceutical products?*

1. **A technology-based e-learning solution can provide authentic environments that allow for a range of authentic tasks and activities**

   With caveats related to the extent to which participants view the environment and activity as authentic and to which they understand and accept their role(s) in the authentic activity, e-learning designers and developers are limited only by their creativity and the boundaries of what a practitioner actually does in real life. In addition to authentic activities or procedures that are performed by practitioners
that may be relatively short (e.g., requiring an hour or two to perform), more complex authentic tasks may take many weeks. In some cases, having materials or items incorporated into the course that are actually used in the real-life activity that go beyond what the e-learning technology can contribute a further dimension of hands-on realism. For example, in this specific course participants are mailed vaccine vials that they must subject to a physical “shake test.”

2. **A technology-based e-learning solution can support the varied learning requirements of a distributed, diverse learning population**

Providing a learning solution that is used globally has additional challenges that must be addressed such as language skills of the learners as well as time zone and cultural differences among the learners. When facing these challenges, some learners may be reluctant to reach out to other participants or to the course leaders. A technology-based e-learning course can be used to provide information and resources in different modalities—audio/video, print, graphical (diagrams)—that participants may prefer. A further advantage is the ability to go back and review the content when required or simply to clarify what was said. Some of the information may be on the primary path so that all participants are exposed to it, while other information may be available to those interested in the topic and willing to take short diversions on different pathways. Providing a rich set of resources contributes to participants going beyond the essential objectives, learning serendipitously in some cases and intentionally in others.

3. **The e-learning solution can allow for the use of technological tools and technology-supported methods that are commonly used by practitioners**

In most jobs and professions, there are tools and methods that are very specific to that field such as data loggers, vaccine vial monitoring, or the writing of a quality agreement. There are other tools and methods, however, that crossover and have wide applicability in other domains, such as critically reviewing professional documents or using Excel spreadsheets to manage a budget. These might be referred to as meta-skills. Incorporating both professional specific and general-purpose tools into an authentic e-learning environment has at least two advantages. First, the tools, if selected correctly, are part of the typical toolkit that the practitioner uses, a factor that contributes to the authenticity of the environment and activity. Second, for those learners who are working in the profession or those who
may be working in other jobs, professions or domains, developing or expanding
their competencies in more general tools like Excel spreadsheets or presentation
applications like PowerPoint can be easily transferred into other jobs or
professions; this is a value-added benefit.

4. **A carefully designed technology-based e-learning solution permits refinements and continual improvement**
Having an e-learning course that is designed from the outset to allow for relatively
easy changes will allow for simpler, lower-cost improvements and changes. If
elements in the course are “hardwired” or are closely linked to complex
illustrations produced at considerable costs, changes to improve the course—
perhaps identified during formative evaluations—may be difficult and costly to
implement. Beyond simple changes and improvements, having an underlying
structure that can be easily changed will allow developers to add cases or scenarios
that provide more and/or better challenges to the learners.

5. **A technology-based e-learning solution can provide support and scaffolding to the learners using different methods**
The authentic learning model does not represent a “sink or swim” approach to
improving performance. Rather, the mentor works with the participant, providing
different types of support at different times. An e-learning solution can contribute
to the support and scaffolding in different ways. Perhaps it can be through brief
illustrated lectures available on video, such as on the topic of thermodynamics or
demonstrations of how to perform a shake test. Participants can help each other by
commenting on another’s work, and at the same time, strengthen their own critical
thinking skills. Chats can happen in real time. This can be done in a classroom
setting as well, but having a technology-based solution permits most of these
supports to be used in an asynchronous way, helping to reduce the challenges of
time zone differences. On the negative side, this disconnect in real time
communication can bring challenges of its own, particularly when a learner needs
substantial amounts of support and feedback.
Implications of this study

Beyond the creation of 13 theoretically-based design principles discussed in Chapter 9 and presented in Table 10.1, and the production of the e-learning course that was an intended outcome/artifact of this study, the research has other implications for authentic e-learning projects and those involved in designing and implementing them. Four specific implications are described below.

Table 10.1. Finalized set of design principles and related learning theories

<table>
<thead>
<tr>
<th>Finalized Design Principle</th>
<th>Learning theory on which design principle is based</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anchor and index knowledge in the context in which the learning occurs.</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>2. Design a learning solution in which learning (i.e., knowledge construction) can occur through activity, participation, and involvement.</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>3. Design the learning solution so that there are “increasingly complex micro-worlds” (ICMs) where a learner can succeed in developing a skill.</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>4. Mentors work closely with learners and guide the learners through activities and experiences with modeling, coaching, scaffolding, articulation, reflection, and exploration.</td>
<td>Cognitive apprenticeship</td>
</tr>
<tr>
<td>5. Incorporate authentic tasks that are the “ordinary practices of the culture” or community.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>6. Avoid making problem solving as explicit as possible.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>7. Provide opportunities for articulation.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>8. Provide for natural-type interactions, resources and tools that are similar to those professionals use in real life.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>9. Allow for unanticipated learner outcomes.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>10. Create opportunities for cross-functional collaboration.</td>
<td>Authentic learning</td>
</tr>
<tr>
<td>11. Design and implement the e-learning solution specific in terms of the interface and technology so they contribute to a positive learning experience and retention of community members.</td>
<td>Community of learners</td>
</tr>
<tr>
<td>12. Design and implement the course so there is some (adequate) learner flexibility in their accomplishing the assignments and activities.</td>
<td>Community of learners</td>
</tr>
<tr>
<td>13. Design and conduct the course so that the interaction of the facilitators and learners contribute to developing trust and safety within the course.</td>
<td>Community of learners</td>
</tr>
</tbody>
</table>
Use of risk assessment and risk management during various stages of design and implementation
As discussed in Chapter 7, risk assessment and risk management are tools to proactively identify what might go wrong and, if deemed significant, ways to prevent it from happening or reducing the impact should that unwanted event occur. Risk assessment was used twice in this research study and, particularly in the second instance when a more formal, structured approach was applied, it was seen to have significant value. Conducting this relatively simple process with knowledgeable personnel will contribute to making any type of e-learning project more successful.

Applying the underlying design concepts to other e-learning projects
The design of the course and the structures that were then developed as the e-learning course was produced were grounded in three learning theories—cognitive apprenticeship, authentic learning, and community of learners—that shaped the design of participant activities. Comments from the participants and observations by the researcher during the field testing of the e-learning prototype showed that these three theories and their foundations of constructivism and social learning contributed to a learning experience that was engaging and practical. Using a similar design that includes access to various resources (e.g., documents, videos) and teams working on a range of authentic tasks with feedback from members of other teams and mentors would likely contribute to the development of expertise in knowledge and skill domains other than the domain studied here.

Four themes and the related design principles
The design-based research approach requires that the researcher identify design principles that are incorporated into the artifact being developed and then refine the design principles based on data that results from iterations of formative evaluation. As the design principles were being refined, four “themes” emerged in relation to the design principles: (1) collaborative tasks, (2) participant relationships, (3) learner role, and (4) norms and expectations. For those particularly in industry involved in developing e-learning courses (often using relatively simple and limited e-learning authoring tools), these themes and their associated design principles provide a very practical set of guidelines that would help them create more authentic learning environments. The integration of authentic tasks (Herrington et al., 2010) is the defining
aspect of these types of learning environments, but the design principles are necessary to the instantiation of such an approach.

**Relationships before technology**

The most intriguing observation made by the researcher during the field testing of the prototype solution was that when executing authentic tasks, positive relationships between participants and between participants and mentors were essential for the successful completion of the tasks. Open and early communication between participants—for example, alerting team members of travel schedules and their availability to contribute to the project—can contribute to effective collaboration. The failure to communicate and contribute to team efforts can result, as was seen in the field test, in some team members feeling put-upon for carrying the majority of the workload. Emphasizing relationships in an e-learning context is almost paradoxical as so much weight is usually given to the underlying information and communication technologies used in a course or program. As was seen in this research, even when given a set of tools like audio/video conferencing (e.g., through Skype) and short video messages, participants preferred email and written documents, sometimes because of ease-of-use and other times because of bandwidth and the technological infrastructure available to the participant. But more important than any specific technology per se is the simple human habit of good communication.

**Limitations of this study**

The results collected during this study provided data-driven rationales that shaped the initial design, improved the implementation of the e-learning solution, and informed the refinement of the design principles that can be used in other e-learning projects. There are, as in all forms of inquiry, qualifications that should be noted that were due to limitations in the study.

One limitation was that the number of participants involved in the field test of the prototype e-learning solution, while similar to the number and make-up anticipated in actual course, was small (11 people completed the course); a larger number of participants with different backgrounds may have provided more varied perspectives.
A second limitation was that all of the participants had been part of the physical bus course, Pharmaceutical Cold Chain Management on Wheels (PCCMoW) (Vesper, et al., 2010), and had some familiarity with the content. This was intentional because of the desire of the project director to compare the physical bus course to the e-learning virtual solution. While this knowledge by participants of the affordances of both environments provided some valuable insights, “naive” participants who are being exposed to the content and activities for the first time might provide different suggestions for course improvement or for refining the learning objectives.

**Areas for further research**

During the course of the research described here, a number of other topics of interest emerged that could either be extensions of the current research or expansions into other related areas of learning. Specifically:

- *Examining the impact / use by the participants in the virtual e-learning bus course.* Following up on how participants applied what they learned in e-Pharmaceutical Cold Chain Management course and the potential benefits accrued was beyond the scope of this research. Acquiring data on whether and to what degree participants transferred the learning from the course to practice could be used to determine the impact that the course had on the institutions involved and, eventually, to the public health.

- *Examining the impact of practitioners using the “four themes” presented in Chapter 9 Reflection and Revised Design Principles.* The four themes were proposed as a theoretical and practical foundation for those who develop e-learning solutions in other education and training contexts, and to assist them to incorporate authentic activities in their own e-learning solutions. Research would be useful to determine if these provided the intended benefit.

- *Applying other risk assessment and risk management approaches to e-learning projects.* There are many different risk assessment tools that are used in other endeavors. Creating a risk rating sheet—similar to a checklist—that provides a risk score and prescriptions to reduce those risks may be useful for those developing or implementing an e-learning course or strategy.
• **Use of authentic learning in industrial “training.”** Almost all of the published research examined as a part of this research involved academic endeavors, such as in the education of teachers or professions such as physicians and nurses. Very little published literature was found that discussed how authentic learning is being used in developing the knowledge and skills of laboratory technicians and production operators, for example.

• **Ways to further promote the effectiveness of the virtual teams that consist of non-traditional, adult students.** Literature was found on secondary and post-secondary students who are in virtual communities of learners, but not on adults who are faced with multiple professional and personal demands as they participate in online learning activities.

• **Retention of participants or ways to help participants know if the e-learning opportunity is the right course/option for them now.** While there are certainly valid reasons for participants withdrawing from an online e-learning course such as unexpected health challenges, family problems, or work issues, others are unable complete this kind of asynchronous online course for different reasons, including, possibly, not fully realizing the level of commitment required of them. Research into finding creative ways to enhance learner motivation and augment personal investment in online learning is needed.

• **Use of this model/architecture for other topics.** This research has shown that participants gained knowledge and skills in the area of handling time- and temperature-sensitive pharmaceutical products. The approach used here could potentially be an effective model for developing knowledge and skills in other professional and technical domains.

These suggested areas of further research relate to issues and knowledge gaps that have emerged in the conduct of this study. They indicate just a few of the areas of enquiry that could usefully further inform understanding of how practitioners develop expertise, and the theoretical frameworks that underpin the design of learning systems designed to support it.
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APPENDIX 1

Publications and peer review of research
## Publications and peer review of research

The following publications and presentations enabled aspects of the thesis to be open to public comment during preparation:

<table>
<thead>
<tr>
<th><strong>Type of publication</strong></th>
<th><strong>Aspect of thesis</strong></th>
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<tbody>
<tr>
<td><strong>Refereed journal publication</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Refereed conference proceedings</strong></td>
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</tbody>
</table>
APPENDIX 2

Course objectives
Course Objectives
Pharmaceutical Cold Chain Management on Wheels Course, June 2012
(Physical bus course)

By the end of the 6-day event, the participants will be able to:

- Identify the major operational components in a pharmaceutical cold chain.
- Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
- Illustrate the inputs, activities, and outputs of each operational component of a pharmaceutical cold chain.
- Develop a quality agreement that is appropriate to a given situation.
- Given a cold storage facility, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP and “good storage practice” (GSP) guidelines.
- Given a mode of transportation, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
- Given a mode of distribution in the “last mile”, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
- Given a situation, select the appropriate methods and materials for packaging and shipping cold chain products to minimize risk.
- Given a situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decisions.
- Given a specific temperature monitoring strategy, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP/GSP.
- Examine and assess documents and records that support a cold-chain process consistent with GDP/GSP.
- Identify work practices that contribute or reduce risks to a cold-chain worker’s health and safety.
- Conduct the shake test to identify whether a given freeze-sensitive vaccine has been affected by freezing.
Course Objectives
Pharmaceutical Cold Chain Management
March 2013
(as initially written for e-learning course)

Module 1
Farmalojistik
1. Identify the major operational components in a pharmaceutical cold chain.
2. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
3. For a given mode of transportation, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP.
4. For a given situation, select the appropriate methods and materials for packaging and shipping cold chain products to minimize risk.
5. For a given situation, discuss specific requirements to be included in a quality agreement.

Module 2
Bursa Vaccine Store
1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. For a given mode of transportation, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP.
3. For a given cold storage facility, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP/GSP.
4. For a given situation, select the appropriate methods and materials needed to monitor temperature and/or humidity for cold chain products and to obtain necessary data for making decisions.
5. For a given situation, develop a contingency plan.

Module 3
Hacettepe Hospitals
1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. Illustrate the inputs, activities, and outputs of each operational component of a pharmaceutical cold chain.
3. For a given supply chain system in a facility, identify hazards, and assess and identify methods to control the risks to pharma, biopharma, and vaccine products that are consistent with GDP/GSP.

Module 4
Ulutas Pharmacy
1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. For a given mode of distribution in the last mile, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
3. For a given situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decisions.
4. For a given situation, select the appropriate methods and materials...
materials for packaging and shipping cold chain products to minimize risk.

**Module 5 Health Center**

1. Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
2. Given a mode of distribution in the last mile, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP.
3. Given a situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decision.
4. Given a specific temperature monitoring strategy, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP/GSP.
5. Conduct the shake test to identify whether a given freeze-sensitive vaccine has been affected by freezing.

**Module 6 Albania Case**

1. Examine the processes used in temperature sensitive supply chain operation from the perspective of risk management.
2. Identify and comment upon strengths of the current programme.
3. Identify risks that may exist in the current programme and provide recommendations to reduce the risks.
4. Prioritize which risks should be addressed first.
APPENDIX 3

Pre-review session questionnaire (mentors)
Pre-session questionnaire (mentors)

1. Have you facilitated/mentored a “bus course?” YES NO
   If yes, in what year(s)? ____________________________

2. Have you facilitated/mentored an e-learning course before? YES NO
   If yes,
   Course name/sponsor: ________________________________
   When: ________________________________

3. Have you been a learner/participant in an e-learning course before? YES NO
   If yes,
   Course name/sponsor: ________________________________
   When: ________________________________

4. As you look ahead to facilitating the e-Pharma course, do you have anything that you are curious about?

5. Do you have any concerns or worries regarding the e-Pharma course?

6. Are there any specifics you could suggest that would make your facilitating more enjoyable or more effective?
APPENDIX 4

Solutions and improvements to design
(after mentor review, February 2013)
# Solutions and improvements to design

(after mentor review, February 2013)

<table>
<thead>
<tr>
<th>Item #</th>
<th>Location/document</th>
<th>Problem</th>
<th>Proposed correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Public site - behind the scenes</td>
<td>typos</td>
<td>revise as needed</td>
</tr>
<tr>
<td>2</td>
<td>Public site - about EPELA</td>
<td>confusion about what &quot;EPELA&quot; means</td>
<td>expand</td>
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<tr>
<td>3</td>
<td>Public site - new courses</td>
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<td>add “coming soon”</td>
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<tr>
<td>4</td>
<td>EPPCMOW</td>
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<td>fix</td>
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<td>5</td>
<td>Objectives for CC course</td>
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<tr>
<td>6</td>
<td>programme pdf and screen</td>
<td>long download time</td>
<td>replace / correct dates to account for holidays</td>
</tr>
<tr>
<td>7</td>
<td>all pdf docs</td>
<td>long download time</td>
<td>need to compress</td>
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<tr>
<td>8</td>
<td>document library</td>
<td>potential difficulty in finding documents</td>
<td>add a higher-level of classification system – use bookshelf metaphor with topic labels on shelves OR have topics in book shelf and use white space to have book names</td>
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<td>correct</td>
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<td>10</td>
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<td>CV</td>
<td>delete CV - use nothing or &quot;bio&quot;</td>
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<tr>
<td>11</td>
<td>who said what - pharma</td>
<td>line spacing different</td>
<td>make line spacing consistent – USE THIS FOR OTHER TEXT PAGES</td>
</tr>
<tr>
<td>12</td>
<td>who said what - pharma</td>
<td>drop pdf</td>
<td></td>
</tr>
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<td>13</td>
<td>video credits</td>
<td>spelling - e.g., assessment</td>
<td>fix to assessment</td>
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<td>14</td>
<td>apply on line</td>
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<td>some boxes need more room</td>
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<td>Mac firefox list on right goes beyond border - gets lost</td>
<td>fix</td>
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<td>pharmaceutical</td>
<td>fix spelling</td>
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<td>19</td>
<td>initial welcome video</td>
<td>map doesn’t appear when initial video plays</td>
<td>show map</td>
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<td>use final image for video</td>
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<td>22</td>
<td>How to use video library</td>
<td>use final image for document site</td>
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<tr>
<td>23</td>
<td>How to use document library</td>
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</tbody>
</table>
how to and site

Programme

Discussion

Discussion

Disclaimer

Visited site overview

Schedule

Scroll bar

WHO AM I?

General - Farmalog - Task 6

Diary (all)

Diary (all)

Diary (all)

Periodic course evaluations

GENERAL ISSUES

DISCUSSION TOOL

FARMALOJISTIK

Text in xls Turkish

who is who

"weekly" to "overview"

confusing code

add phrase about non-moderated discussion link doesn't work

consistently

Dates

degree signs are not right - e.g., 360°

Not consistently presented

Initial screen - highlight that this is an example for tasks where there is a recommended video or doc, create a link it is a

Requirement to add "site visited" in the diary

WRITE button

Collecting information

Collecting information

Add "Course time and date"

Font size on discussion page

too large

too large

on box

Make larger?

Make larger

translate
APPENDIX 5

Example summary of mentor teleconference calls
Example summary of mentor teleconference calls
(18 March 2013)

Mentors present on phone call: M1, M2, Jim (researcher)
[NOTE: Names of participants and mentors replaced with pseudonyms]

Topics discussed:

1) H and P5 haven't been actively involved in the course up until now. M3 had contacted them and they both said that workload, travel, and connectivity issues were limiting their availability. M3 will get in touch with them at the end of this first visit to find their intentions.

2) P12 was in the group with H and P5. M3 has talked with him about joining P2 and P8's team (they are down 1 person because A left) and this seems to be acceptable to all.

3) There have been several small issues that have been fixed - e.g. strange characters when certain characters are typed in the DISCUSSION section; 360 degree photos using Internet Explorer (now IE 7 works OK).

4) The two videos uploaded by M2 have had very limited viewing by participants. M3 is going to find ways of promoting these.

5) None of the mentors have received phone calls during the SKYPE times. In our phone call, M1 suggested that this is because our pilot participants have been in the real course and there isn't as much interest. We might want to pursue this more in the questionnaires and interviews. One idea would be to have different times - early in AM (US time) or evening to help make it easier for certain time zones.

6) The discussion board hasn't been used much - Mohammed has the only questions out there; M3 responded to those. This might be also because of participants who were on the real bus trip.

QUESTION FOR LC [learning consultant] - what are your ideas/suggestions for getting more participant-initiated discussions?

7) The group commented on how M3's periodic emails and schedule prompts have been very helpful.


(Anything else that I missed?)

Jim.
APPENDIX 6

Ethics Committee information and informed consent
Information Letter

27 Feb 2013

Dear e-PCCMoW Participant:

We invite you to participate in a research study examining developing expertise through the use of e-learning technology of those handling time-temperature sensitive pharmaceutical products. This study is part of my PhD research supervised by Professor Jan Herrington, PhD at Murdoch University in Perth, Western Australia.

Nature and Purpose of the Study

In conjunction with the World Health Organization’s (WHO) Global Learning Opportunities/Vaccine Quality, we are helping to develop a unique learning program on the handling of time-temperature sensitive pharma and biopharma products. This research study uses a “Design Research” method and incorporates “Rapid Prototyping”. What this means is that we are asking participants to give us feedback as we design and redesign our learning course, ending with what we believe will be an effective way of developing expertise as the learners work in groups and with mentors.

What the Study will Involve

If you decide to participate in this study, you will be asked to be involved with one or both of the following activities:

- You may be a participant the first or second time the course is offered. During the course, you may review photographs or videos of where pharmaceutical products are made, transported, stored or dispensed and identify deficiencies, take on the role of a consultant and recommend improvements, evaluate drawings and proposals to identify potential risks, and work, virtually, with an actual public health department on an authentic task. The time you spend in the course is estimated to be 5-8 hours a week for up to 12 weeks. You will do this with the support of the learning community, mentors, and other resources. In addition to your role as a learner, if you are a study participant, we will ask you to complete questionnaires before, during, and after the course and also be individually interviewed at the start and conclusion of the course. We would expect these interviews and discussions to take an additional 4-6 hours.

Voluntary Participation and Withdrawal from the Study

Your participation in this study is entirely voluntary. You may withdraw at any time without discrimination or prejudice. All information is treated as confidential and no names or other details that might identify you will be used in any publication arising from the research. If you withdraw, all information you have provided will be destroyed, however, any suggestions that you may have made and that were subsequently incorporated into the improved design will be maintained.

If you consent to take part in this research study, it is important that you understand the purpose of the study and the activities in which you will be asked to participate. Please make sure that
you ask any questions you may have, and that all your questions have been answered to your satisfaction before you agree to participate.

**Benefits of the Study**

It is possible that there may be no direct benefit to you from participation in this study, except for the personal satisfaction that you may receive for contributing to this learning program that will be implemented globally by the World Health Organization. You will receive a letter of appreciation from the WHO for helping with this project

We will be very happy to share with you the results of our work, such as providing you with articles and presentations that we write.

If you are willing to consent to participation in this study, please **complete the Consent Form**. If you have any questions about this project please feel free to contact either myself, James Vesper via email (jvesper@learningplus.com) or on my mobile (+1 xxxxxx). Or, you can contact my supervisor, Dr Jan Herrington, at her university email (J.Herrington@murdoch.edu.au) or phone (+61 xxxxxx).

My supervisor and I are happy to discuss with you any concerns you may have about this study.

Thank you for considering helping us with this research project!

Sincerely,

(Signature)

James Vesper

---

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2011/021). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel. 08 xxxx [for overseas studies, +61 xxxx] or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
CONSENT FORM

Developing Expertise of those Handling Temperature-Sensitive Pharmaceutical Products Using E-Learning: A Design Research Study

I have read the participant information sheet, which explains the nature of the research and the possible risks. The information has been explained to me and all my questions have been satisfactorily answered. I have been given a copy of the information sheet to keep.

I am happy to complete questionnaires and be interviewed and for the interview to be audio / video recorded as part of this research. I understand that I do not have to answer particular questions if I do not want to and that I can withdraw at any time without needing to give a reason and without consequences to myself.

I agree that research data from the results of the study may be published provided my name or any identifying data is not used. I have also been informed that I may not receive any direct benefits from participating in this study.

I understand that all information provided by me is treated as confidential and will not be released by the researcher to a third party unless required to do so by law.

I can request and the researcher will provide copies of articles that are published and presented at conferences.

Participant’s name: ________________________

Signature of Participant: ____________________ Date: ..../....../......

I confirm that I have provided the Information Letter concerning this study to the above participant; I have explained the study and have answered all questions asked of me.

Signature of researcher: ____________________ Date: ..../....../......
APPENDIX 7

Summary of initial design team meeting
Summary of initial design team meeting

Date: 26 September 2010

Team members present: (Project Sponsor [PS]), (Visual Design Director [VDD]), (Learning Consultant [LC]), Jim Vesper [JV] researcher.

1. VDD and PS presented work that they and the development team created that had an office desktop metaphor (Figure 1). They demonstrated the functionality of the icons. For example: chat, resources, collaboration, etc.

   JV presented a learning/information module he designed on GMP Update.

   LC presented the course he is teaching on e-learning evaluation and how it is an example of authentic learning.

   All of these ideas were used to help the team better understand the capabilities of the tools/models available and to stimulate the creativity of the team.

2. The team discussed the scope of the e-learning Bus Course (ELBC), the goal and objectives of the current Pharmaceutical Cold Chain Management on Wheels (PCCMoW) course and how these should be modified for the ELBC.

   The team identified 4 goals, with one being an “umbrella” goal:

   • Develop an enhanced, robust mental model of a pharmaceutical cold chain.
     o Enhance the critical observation skills related to time-temperature sensitive pharmaceutical products (TTSPPs).
     o Trouble-shoot a problem related to TTSPPs.
     o Create and evaluate a solution to an actual TTSPP-related problem.

   • The team created a mind-map showing the elements and relationships for what the mental model would include (Figure 2).

3. To accomplish these goals, an initial list of objectives was developed with special attention placed to the performance so it would be consistent with an e-learning solution. These were based on the past PCCMoW course. The objectives for the ELBC are:

   • Identify the major operational components in a pharmaceutical cold chain
   • Identify deficiencies in given situations using the “good distribution practice” (GDP) guidelines.
   • Match 25 major concepts of GDP and their definitions
   • Illustrate the inputs, activities, and outputs of each operational component of a pharmaceutical cold chain
   • Develop a quality agreement that is appropriate to a given situation
   • Given a cold storage facility, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP/GSP
• Given a mode of transportation, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP
• Given a situation, select the appropriate methods and materials for packaging and shipping cold chain products to minimize risk
• Given a situation, select the appropriate methods and materials to monitor temperature and/or humidity for cold chain products to obtain necessary data for making decisions
• Given a specific temperature monitoring strategy, assess and control the risks to pharma, biopharma, and vaccine products consistent with GDP/GSP
• Examine and assess documents and records that support a cold-chain process consistent with all GxPs.
• Identify work practices that contribute or reduce risks to a cold-chain worker’s health and safety
• Conduct the shake test to identify whether a given freeze-sensitive vaccine has been affected by freezing
• Given a client, conduct critical analysis of the cold chain management system and make recommendations to improve the performance of the system in line with GxPs

4. The course would be designed as an asynchronous, mentored learning event that would have 16-20 participants (working in smaller teams), 2-3 mentors, and should take no more than 12 weeks to complete.

5. As new material is introduced into the course (more activities or challenges; different sites to visit), past participants would be able to see or get involved with these additions in some way (to be defined in detail).

6. The components of the ELBC were defined to be:
   • Big picture overview – photos/videos that are narrated to show the scope (what is included), size (how large it is), the complexity (relationships) of how TTSPPs are handled, and risk-points. Photos, videos, etc. would be collected from around the world to show different perspectives.
   • Site visits (see below) that include:
     o An overview or tour of that site (could be photos, videos, an audio statement by the site director, etc.).
     o A map or diagram of the facility (or a representation of important parts of it).
     o Background information as available (such as a web site, pdf documents, and/or a written description of what it is, what it does, its organizational structure, how it fits into the public health system, etc).
     o An activity/challenge – a problem that is presented to the learners or an opportunity to discover a problem and solve that problem. These problems would be based on (unidentifiable) real-life examples or composites of such examples.
   • Illustrated lectures on a relevant topic (see below). These might be video with 3D graphics, demonstrations, etc.
   • Resources – additional information such as guidelines, articles, interviews, etc. that learners would find useful as they “dig” deeper for more information.
• A social networking environment where current (and past?) participants can upload and share information about them, their interests, and lives. (This will be a controlled/moderated environment.)

• “Side trips” – small sets of information, fun facts, trivia related to cold chain. For example, questions that get people to think about thermodynamics – “What freezes faster? Hot water or cold water?”

7. The site visits/bus stops were identified:

- Pharma/biopharma manufacturer (e.g., [name] or [name])
- Service provider (e.g., DHL or PharmaLogistics)
- Public Sector (Provincial vaccine storage/distribution facility)
- University Hospital/Pharmacy
- Local health center
- Local pharmacy

At each site or bus stop one or more activities or challenges would be available. Over time more stops could be added (e.g., air transportation from the manufacturer to the service provider) as well as additional challenges.

A matrix that shows the relationship between sites, learning objectives, and problems/challenges will be developed (Figure 3).

8. Illustrated lectures and possible presenters were identified. This list might expand over time.

- Packaging Design: KD (US)
- (Thermodynamics: KD (US))
- Good Distribution Practice (GDP): _____ (___)
- Facility Design: AG (UK)
- Temperature Monitoring: _____ (___)
- Last Mile: PS (Geneva)
- Modes of Transportation: _____ SME from Univ of Florida (US)
- Why Bother? Why is this Important?: CA (Geneva)
- Documentation and Records: Jim Vesper (US)

After the learners complete the tour, they will be given an authentic task to complete as a group. This idea is based on the model that Tom uses in his e-learning evaluation course: small teams would work with a client/contact on an actual project – finding a problem, analyzing the problem and coming up with possible solutions. They would prepare a report for the client (a public sector organization) that would have benefit to the client/public health.

9. The project will include two environments: 1) A “free”, publically available website that would include the “big picture” overview covering the handling of TTSPPs, the illustrated lectures, links to publically available information (e.g., WHO documents). This would be provided as a public service and would be meant to provide as much information to as large/broad of a world-wide audience as possible. 2) The course
website that would be used by current course participants. (QUESTION – what about past participants? Is that another limited access area?)

10. Some of the considerations discussed included those below, presented as a question and the answer that was identified:

Question: How much time per “unit” would a participant be expected to spend?
Answer: Approximately 5 hours per week.

Q: How to balance the amount of content in the modules? A: This needs to be considered when identifying the activity/challenge.

Q: What are some considerations when identifying the learners? A: Be sure to consider time-zones of the learners so they can better communicate with each other.

Q: How much time should the mentors be expected to commit? A: Approximately 2-3 times the time expected of a learner. In this case, approximately 10 hours per week.

Q: How do we prepare the mentors for using this new learning environment? A: To be determined.

Q: What can be “repackaged” from this course and given away? A: (See comment above.)

11. The team discussed the importance of having “design principles” that would be used in designing and developing the modules. A preliminary list was started; Jim will be identifying additional design principles as part of his work.

• Utilize a geographic metaphor for the course that is in keeping with the idea of a “bus trip”.
• Use real cases as examples at different levels of the course.
• Maximize the user experience through stimulation of different senses (e.g., auditory, visual).
• Create “models of instruction and assessment” that can be re-used (in this course and in others) to make the design/development process as cost-effective as possible.
• Create a learning environment that encourages participants to return again and again over time and “dig” into the content.

12. Assignments:
• PS and Jim: Identify potential scenarios/examples that can be used in the course.
• PS, LC, and Jim: Continue to identify additional design principles.
• PS: Identify additional SMEs for presenting illustrated lectures.

J. Vesper
29 Sept 2010
APPENDIX 8

Expert evaluation protocol
# Expert Review Protocol/Worksheet, Round 1

## Element to review:

### 1. Overall visual design

**Definition:** the collection of visual elements, such as drawings, photos, formats, arrangements, fonts, type sizes, colors, and symbols used in the learning program.

**Documents/sources to consider when reviewing this element:**

**Reviewer:**

**Review completed date:**

**Rating Definitions:** SD – Strongly Disagree, D – Disagree, A – Agree, SA – Strongly Agree  
NA – Not Applicable, NEA – No Evidence Available in documents provided.

## 1.1 Evaluation criteria / ratings

<table>
<thead>
<tr>
<th>#</th>
<th>Criteria</th>
<th>Rating (see rating definitions)</th>
<th>Specific example /comment/suggestion</th>
<th>Source of criteria</th>
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</thead>
<tbody>
<tr>
<td>1.1.a</td>
<td>The overall design of the screens, icons, graphical elements are appropriate for a multi-cultural, international audience.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>Vesper design principles – community of learners</td>
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<tr>
<td>1.1.b</td>
<td>The overall design concept supports the learning goals, topics to be covered, and content.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td></td>
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<tr>
<td>1.1.c</td>
<td>The overall design, individual screen designs, and graphical elements are esthetically pleasing</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.d</td>
<td>The overall design, individual screen designs, and graphical elements are pleasing.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
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<td></td>
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<td>1.1.e</td>
<td>The design minimizes extraneous elements that place an unwanted cognitive load on the learner.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 757&gt;</td>
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<tr>
<td>1.1.f</td>
<td>Visuals support, complement or reinforce what is written or said, helping the learner achieve a richer understanding of the content.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 1040&gt;</td>
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<tr>
<td>1.1.g</td>
<td>Graphics used are relevant to the instructional purpose, not just decorative.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 1222&gt;</td>
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<td>1.1.h</td>
<td>Background colors, typefaces, font sizes, and color of type all contribute to readability.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>Asktog.com/basics</td>
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### 1.2 Open-ended questions

<table>
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<tr>
<th>#</th>
<th>Question</th>
<th>Response</th>
<th>Specific examples, screens, etc.</th>
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<tbody>
<tr>
<td>1.2.a</td>
<td>What do you see as strengths in the overall visual design of this learning program?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.b</td>
<td>What do you see as areas in need of enhancement?</td>
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<td></td>
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</table>

### 1.3 Summary/risk assessment – overall visual design *(Please consider the findings you consider the most significant.)*

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<tr>
<th>#</th>
<th>Failure mode</th>
<th>Failure effect</th>
<th>Failure mechanism</th>
<th>Extent of failure (scale)</th>
<th>Severity of effect (scale)</th>
<th>Risk Score (E x S)</th>
<th>Suggested improvements</th>
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</thead>
<tbody>
<tr>
<td>1.3.a</td>
<td>What could fail?</td>
<td>What could happen if this fails?</td>
<td>What could cause this to fail or contribute to the failure?</td>
<td>How prevalent is this failure mode in the design?</td>
<td>What would the impact of this failure be?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Scales are found on the last page of this document.*
### 2. Interface design

**Definition:** the set of visual elements (e.g., drawings, photos, formats, arrangements, fonts, type sizes, colors, and symbols) used in the learning program.

**Documents/sources to consider when reviewing this element:**

<table>
<thead>
<tr>
<th>Reviewer:</th>
<th>Review completion date:</th>
</tr>
</thead>
</table>

**Rating Definitions:** SD – Strongly Disagree, D – Disagree, A – Agree, SA – Strongly Agree, NA – Not Applicable, NEA – No Evidence Available in documents provided.

#### 2.1 Evaluation criteria / ratings

<table>
<thead>
<tr>
<th>#</th>
<th>Criteria</th>
<th>Rating (see rating definitions)</th>
<th>Specific example /comment/suggestion</th>
<th>Source of criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.a</td>
<td>The design of the user interface is intuitive and easy to use.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.b</td>
<td>Movements, patterns of movements, and symbols used are consistent with other commonly used interfaces.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td>Asktog.com/basics</td>
<td></td>
</tr>
<tr>
<td>2.1.c</td>
<td>The design of the user interface is consistent between sections and screens.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.d</td>
<td>The actions of controls are consistent throughout the program.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.e</td>
<td>Feedback is given when a control is activated (e.g., color change).</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.f</td>
<td>The design of the interface provides information to the user (e.g., system status, location in the course, progress completed).</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.g</td>
<td>A visual hierarchy is used to help show relationships.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td>Asktog.com/basics</td>
<td></td>
</tr>
<tr>
<td>2.1.h</td>
<td>Feedback messages are clear and understandable.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td>Asktog.com/basics</td>
<td></td>
</tr>
<tr>
<td>2.1.i</td>
<td>The design of the learning program helps prevent errors.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.j</td>
<td>The design of the learning program allows for easy correction/recovery of navigation and entry errors.</td>
<td>□SD □D □A □SA □SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.k</td>
<td>The learning program provides</td>
<td>□SD □D □A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Criteria</td>
<td>Rating (see rating definitions)</td>
<td>Specific example /comment/suggestion</td>
<td>Source of criteria</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td>contextual support/help.</td>
<td>□SA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Course maps in a simple hierarchical form are provided for learners.</td>
<td>□SD</td>
<td></td>
<td>&lt;Mayer 4160&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□D</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□SA</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>□NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□NEA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.2 Open-ended questions

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Response</th>
<th>Specific examples, screens, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What do you see as strengths in the interface design of this learning program?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>What do you see as areas in need of enhancement?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.b</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.3 Summary/risk assessment – interface design (Please consider the findings you consider the most significant.)

<table>
<thead>
<tr>
<th>#</th>
<th>Failure mode</th>
<th>Failure effect</th>
<th>Failure mechanism</th>
<th>Extent of failure (scale)</th>
<th>Severity of effect (scale)</th>
<th>Risk Score (E x S)</th>
<th>Suggested improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What could fail?</td>
<td>What could happen if this fails?</td>
<td>What could cause this to fail or contribute to the failure?</td>
<td>How prevalent is this failure mode in the design?</td>
<td>What would the impact of this failure be?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3.a

2.3.b

*Note: Scales are found on the last page of this document.*
### 3. Instructional design

**Definition:** The systematic approach using valid learning principles and learning theories, the desired outcomes, and the needs of the learners to create the specifications for the learning solution.

### Documents/sources to consider in review:

<table>
<thead>
<tr>
<th>Element to review:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Instructional design</strong></td>
<td><strong>Definition:</strong> the systematic approach using valid learning principles and learning theories, the desired outcomes, and the needs of the learners to create the specifications for the learning solution.</td>
</tr>
</tbody>
</table>

### Rating Definitions:

- **SD** – Strongly Disagree
- **D** – Disagree
- **A** – Agree
- **SA** – Strongly Agree
- **NA** – Not Applicable
- **NEA** – No Evidence Available in documents provided.

### 3.1 Evaluation criteria / ratings

<table>
<thead>
<tr>
<th>#</th>
<th>Criteria</th>
<th>Rating (see rating definitions)</th>
<th>Specific example /comment/suggestion</th>
<th>Source of criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.a</td>
<td>The design of the course includes activities to help learners construct their own mental models related to cold chain and handling of time and temperature sensitive pharmaceutical products.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>Course goal</td>
</tr>
<tr>
<td>3.1.b</td>
<td>Lessons within the program stimulate integration of new knowledge with prior knowledge.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 805&gt;</td>
</tr>
<tr>
<td>3.1.c</td>
<td>Lessons and examples provide a job or real-life context that promotes transfer of learning.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 831&gt; &lt;Mayer 2794&gt; Vesper design principle – cognitive apprenticeship</td>
</tr>
<tr>
<td>3.1.d</td>
<td>Real-life examples are used to show learners how to perform a procedure or task.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 2746&gt; Vesper design principle – authentic learning</td>
</tr>
<tr>
<td>3.1.e</td>
<td>Explanatory, not just corrective, feedback is given to correct and incorrect responses.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.f</td>
<td>Prior to working in teams or small groups, learners are provided with guidance and/or training to promote their virtual collaboration.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 3799&gt; Vesper design principle – community of learners</td>
</tr>
<tr>
<td>3.1.g</td>
<td>Instructions for team activities are specific and clear, e.g., give reasons to support a particular position or give a pro / con argument.</td>
<td>☐ SD ☐ D ☐ A ☐ SA ☐ NA ☐ NEA</td>
<td></td>
<td>&lt;Mayer 3703&gt; &lt;Mayer 3738&gt;</td>
</tr>
<tr>
<td>3.1.h</td>
<td>Teams are given adequate time to collaborate on their</td>
<td>☐ SD ☐ D ☐ A</td>
<td></td>
<td>&lt;Mayer 3799&gt;</td>
</tr>
<tr>
<td>#</td>
<td>Criteria</td>
<td>Rating (see rating definitions)</td>
<td>Specific example /comment/suggestion</td>
<td>Source of criteria</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td>assignments that allow for individual research and reflection.</td>
<td>☐SA □NA □NEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.i</td>
<td>The learning program enhances the critical observation skills related to time-temperature sensitive pharmaceutical products.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>Course goal</td>
</tr>
<tr>
<td>3.1.j</td>
<td>The learning program provides opportunities for learners to trouble-shoot problems related to time-temperature sensitive pharmaceutical products.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>Course goal</td>
</tr>
<tr>
<td>3.1.k</td>
<td>Words and grammatical structures used in the text and narration are at an appropriate level for an international audience.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>Vesper design principle – community of learners</td>
</tr>
<tr>
<td>3.1.l</td>
<td>The learning program contains only the essential information related to the topic and course objectives.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>↓Mayer 2194</td>
</tr>
<tr>
<td>3.1.m</td>
<td>The content text is written in an informal, non-passive conversational style that promotes engagement with the author.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>↓Mayer 2219, ↓Mayer 2282</td>
</tr>
<tr>
<td>3.1.n</td>
<td>Agents speak (not text) in an informal conversational manner and are used for a valid instructional purpose.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>↓Mayer 2417</td>
</tr>
<tr>
<td>3.1.o</td>
<td>Instructional text (or narration) is provided by a “visible author” who reveals personal information and highlights his/her perspective.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>↓Mayer 2435</td>
</tr>
<tr>
<td>3.1.p</td>
<td>The learning program provides a variety of job specific problems to solve that are “real-life”.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>Vesper design principles – cognitive apprenticeship, authentic learning</td>
</tr>
<tr>
<td>3.1.q</td>
<td>Learners are given opportunities to actively explain their correct answers.</td>
<td>☐SD ☐D □A □SA □NA □NEA</td>
<td></td>
<td>↓Mayer 4871, Vesper design principles – authentic learning</td>
</tr>
</tbody>
</table>
### 3.2 Open-ended questions

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Response</th>
<th>Specific examples, screens, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2.a</td>
<td>What do you see as strengths in the instructional design of this learning program?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.b</td>
<td>What do you see as areas in need of enhancement?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.3 Summary/risk assessment – instructional design *(Please consider the findings you consider the most significant.)*

<table>
<thead>
<tr>
<th>#</th>
<th>Failure mode</th>
<th>Failure effect</th>
<th>Failure mechanism</th>
<th>Extent of failure (scale)</th>
<th>Severity of effect (scale)</th>
<th>Risk Score (E x S)</th>
<th>Suggested improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.a</td>
<td>What could fail?</td>
<td>What could happen if this fails?</td>
<td>What could cause this to fail or contribute to the failure?</td>
<td>How prevalent is this failure mode in the design?</td>
<td>What would the impact of this failure be?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Scales are found on the last page of this document.
**Rating Scales**

<table>
<thead>
<tr>
<th>Extent of failure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program wide</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Multiple places</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Isolated - one screen</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>


**Severity of Effect**

<table>
<thead>
<tr>
<th>Cosmetic</th>
<th>Minor issue</th>
<th>Significant issue</th>
<th>Major issue</th>
<th>Critical issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cosmetic issues would may be noticed by user but would not affect learning outcome or user acceptance of the course.</td>
<td>Minor issues would be noticed and could be annoying to the learner but would not affect learning outcome.</td>
<td>Significant issues would be noticed and could be annoying and would affect acceptance of the program and potentially affect learning outcomes.</td>
<td>Major issues would be highly distracting to the learner; accomplishing the intended outcomes would be difficult and require extra, non-value adding expenditure on the part of the learner, mentor, or support team.</td>
<td>Critical issues would directly impact accomplishing the intended outcomes; the learner could not complete an activity or accomplish an objective or goal.</td>
</tr>
</tbody>
</table>

**Evaluation results**

- Must be addressed before release/use of course; highest priority items
- Should be addressed before release/use of course; second priority items
- Can be addressed as part of other modifications or at next release; third priority items
- Can be addressed at next release; lowest priority items.
APPENDIX 9

Expert review: Failure mode effects analysis (FMEA) worksheet
<table>
<thead>
<tr>
<th>#</th>
<th>Failure mode</th>
<th>Failure effect</th>
<th>Failure mechanism</th>
<th>Extent of failure (scale)</th>
<th>Severity of effect (scale)</th>
<th>Risk Score (E x S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Look and feel of the visual design</td>
<td>What could fail?</td>
<td>What could happen if this fails?</td>
<td>What could cause this to fail or contribute to the failure?</td>
<td>How prevalent is this failure mode in the design?</td>
<td>What would the impact of this failure be?</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Perceived disconnect between content and visuals</td>
<td>Illustrative style used</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Expectations of learners not met</td>
<td>Colors</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Extra errors in moving through program</td>
<td>Complexity of menus</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Extra time to recover from errors</td>
<td>Large number of options</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Extra cognitive load</td>
<td>Difficult to use</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Learner frustration</td>
<td>Inconsistency in screen-to-screen and program navigation</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Effort being put on an aspect of using the tool that has no relevance to learning/content</td>
<td>No “home” button</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Learner frustration</td>
<td>Complexities of menus</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Learner frustration</td>
<td>Large number of options</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Learner frustration</td>
<td>Difficult to use</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Learner frustration</td>
<td>Inconsistency in screen-to-screen and program navigation</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Learner frustration</td>
<td>No “home” button</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Learner frustration</td>
<td>Complexities of menus</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Learner frustration</td>
<td>Large number of options</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Learner frustration</td>
<td>Difficult to use</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Learner frustration</td>
<td>Inconsistency in screen-to-screen and program navigation</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Learner frustration</td>
<td>No “home” button</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Learner frustration</td>
<td>Complexities of menus</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Learner frustration</td>
<td>Large number of options</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Learner frustration</td>
<td>Difficult to use</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Learner frustration</td>
<td>Inconsistency in screen-to-screen and program navigation</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Learner frustration</td>
<td>No “home” button</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
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<td></td>
<td>23</td>
<td>Learner frustration</td>
<td>Complexities of menus</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Learner frustration</td>
<td>Large number of options</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>25</td>
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<td>Difficult to use</td>
<td>3</td>
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<td>6</td>
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<tr>
<td></td>
<td>26</td>
<td>Learner frustration</td>
<td>Inconsistency in screen-to-screen and program navigation</td>
<td>3</td>
<td>2</td>
<td>6</td>
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<tr>
<td></td>
<td>27</td>
<td>Learner frustration</td>
<td>No “home” button</td>
<td>3</td>
<td>2</td>
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<tr>
<td></td>
<td>28</td>
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<td>2</td>
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<td>29</td>
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<td>2</td>
<td>6</td>
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<td>30</td>
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<td>Difficult to use</td>
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<td>Complexities of menus</td>
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<td>2</td>
<td>6</td>
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<td>34</td>
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<td>Inconsistency in screen-to-screen and program navigation</td>
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<td>37</td>
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<td>38</td>
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<td>Complexities of menus</td>
<td>3</td>
<td>2</td>
<td>6</td>
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<td>43</td>
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<td>Complexities of menus</td>
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<td>2</td>
<td>6</td>
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<td>44</td>
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<td>Large number of options</td>
<td>3</td>
<td>2</td>
<td>6</td>
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<td>45</td>
<td>Learner frustration</td>
<td>Difficult to use</td>
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<td>2</td>
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</table>
APPENDIX 10

Mentor review: preliminary risk assessment (PRA) worksheets
<table>
<thead>
<tr>
<th>Risk ID: #</th>
<th>Unwanted Event/ Hazard</th>
<th>Consequences / Harm</th>
<th>Contributing Causes</th>
<th>Likelihood of Occurrence</th>
<th>Severity of Consequence</th>
<th>Risk Score</th>
<th>Possible Additional Controls/Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incompatibility of browser with website</td>
<td>&gt; Limited access to sections of course</td>
<td>&gt; Set-up of browser</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1) Recommendations of browsers NOT to use 2) Determine cause of problem if possible 3) Tell what browsers are supported</td>
</tr>
<tr>
<td>2</td>
<td>Bandwidth issue (user side)</td>
<td>&gt; User can't get timely access to videos, docs</td>
<td>&gt; Local provider bandwidth issue</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>1) Send out DVD of videos and docs</td>
</tr>
<tr>
<td>3</td>
<td>Government (of participant) blocks server sites (e.g., VIMEO)</td>
<td>&gt; User can't get any access to videos, documents, or course</td>
<td>&gt; Local political issues</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>1) Send out DVD (via express shipment e.g., DHL) 2) Have mirrored alternative sites for videos, etc 3) Make videos available as downloads (e.g., DROBOX or Yousendit) 4) Inform participants of the possibility; have them communicate to mentors if there is a problem</td>
</tr>
<tr>
<td>4</td>
<td>DVDs/downloads get distributed to others</td>
<td>&gt; Information (e.g., imbedded poor practices) gets distributed and used out-of-context</td>
<td>&gt; Information not controlled (e.g., via streaming)</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1) Have mirrored sites available for videos whenever possible 2) Put notice on DVD 3) Have participant agree not to transfer to others</td>
</tr>
<tr>
<td>5</td>
<td>Server problems or outages - at host sites (host server, VIMEO)</td>
<td>&gt; Non-availability of site and resources when needed by participant</td>
<td>&gt; Crashes - unplanned outages</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1) Find out about site's contingency plan 2) Communicate planned outages with participants in advance 3) Mirror materials on other hosting sites</td>
</tr>
<tr>
<td>6</td>
<td>Individual computer crash (participant's computer)</td>
<td>&gt; Can't get access to course materials or website</td>
<td>&gt; Delay holds up team or group during group projects</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1) Send out simple trouble-shooting sheet 2) Have participant communicate via text/phone alternatives with mentors 3) Insist that person prints out a sheet with info/contact numbers should a failure occur</td>
</tr>
<tr>
<td>Risk ID</td>
<td>Unwanted Event/ Hazard</td>
<td>Consequences / Harm</td>
<td>Contributing Causes</td>
<td>Likelihood of Occurrence</td>
<td>Severity of Consequence</td>
<td>Risk Score</td>
<td>Possible Additional Controls/Actions</td>
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</tr>
<tr>
<td>7</td>
<td>Power failure at individual person’s location</td>
<td>&gt; Can’t get access to course materials or website &gt; Delay holds up team or group during group projects</td>
<td>&gt; Local power supply issues</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1) Have participant communicate via text/phone alternatives with mentors 2) Insist that person prints out a sheet with info/contact numbers should a failure occur</td>
</tr>
<tr>
<td>8</td>
<td>Viruses or malware transferred between participants and mentors</td>
<td>&gt; Malware on individual computers &gt; Firewalls ban connections to sites</td>
<td>&gt; Transfer of infected files</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>1) Inform participants that direct sending of files/documents is discouraged 2) If something is to be sent, send out a separate email alerting recipient in advance 3) Encourage use of GOOGLE docs</td>
</tr>
<tr>
<td>9</td>
<td>Broken links within site</td>
<td>&gt; No access to linked items &gt; Frustration of participants and mentors</td>
<td>&gt; Changes by site or document owners</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1) Have as many documents within our site as possible 2) Use link checker software to go through links routinely to look for breaks</td>
</tr>
</tbody>
</table>
## Preliminary Risk Analysis Worksheet

### Item analyzed: e-PCCMOW Course (Feb 18 version)

**Risk analysis project:** Formative evaluation

**Risk Question:** What are the risks related to the SUSTAINABILITY of the e-PCCMOW course?

<table>
<thead>
<tr>
<th>Step</th>
<th>Risk ID</th>
<th>Unwanted Event/ Hazard</th>
<th>Consequences / Harm</th>
<th>Contributing Causes</th>
<th>Likelihood of Occurrence</th>
<th>Severity of Consequence</th>
<th>Risk Score</th>
<th>Possible Additional Controls/Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Not finding new, additional mentors for course</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Burn-out of current mentors</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Fewer new, different ideas</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Lack of different points-of-view</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>&gt; Not meeting other language needs (e.g., future non-English speaking audiences)</td>
<td></td>
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<tr>
<td></td>
<td>&gt; Lack of scalability of course</td>
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<tr>
<td></td>
<td>1</td>
<td>Not looking for mentors</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Not finding mentors</td>
<td></td>
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<td>2</td>
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<tr>
<td></td>
<td>1) During each offering of e-learning and physical bus course, look for potential mentors</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>2) Identify and consider people outside of bus course community</td>
<td></td>
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</tr>
<tr>
<td>#2</td>
<td>Course director not available</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>&gt; Course ends!</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>&gt; Difficulty/challenge in trying to administer course</td>
<td></td>
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<tr>
<td></td>
<td>&gt; Difficulty/challenge in having course changes made by development team</td>
<td></td>
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<tr>
<td></td>
<td>2</td>
<td>Serious illness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Personal issues</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>1) Identify back-up for Unit (perhaps task-based)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2) During beta course, create an administrator's document / reference for use by others</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>Development team (in Turkey) not available</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Course cannot be maintained, changed, supported</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>&gt; Lack of depth in development team (e.g., application developer)</td>
<td></td>
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<td>3</td>
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</tr>
<tr>
<td></td>
<td>1) Expansion of development team; back-ups of team members</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2) Course director has copies of all source materials – video, source code, native photo/ graphic files</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>#4</td>
<td>Learning application not fully documented</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Course cannot be maintained, changed, supported</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Program lost</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4</td>
<td>No details about course</td>
<td></td>
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<td></td>
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<td>9</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1) Course director has copies of all source materials – video, source code, native photo/ graphic files</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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</table>
### Preliminary Risk Analysis Worksheet

**Item analyzed:** e-PCCMOW Course (Feb 18 version)

**Risk analysis project:** Formative evaluation

**Risk Question:** What are ADDITIONAL risks related to the e-PCCMOW course?

<table>
<thead>
<tr>
<th>Risk ID #</th>
<th>Unwanted Event / Hazard</th>
<th>Consequences / Harm</th>
<th>Contributing Causes</th>
<th>Likelihood of Occurrence</th>
<th>Severity of Consequence</th>
<th>Risk Score</th>
<th>Risk Score (calculated)</th>
<th>Possible Additional Controls / Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participant has personal issues that interfere with their participating in course</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>3 1) Stress to participants early communication with mentors about problems 2) For short term issues, mentors to look for ways to accommodate participant 3) For longer-term issues, person may withdraw and be rescheduled for future session.</td>
</tr>
</tbody>
</table>
APPENDIX 11

Participant pre-course questionnaire
Pre-course Participant Questionnaire
Field test of prototype learning course: e-PCCM
(March 2013)

Name (participant)

Primary COMPUTER (the computer you intend to use most of the time to access the course).

1. What kind of computer will you use?
   a. Desktop
   b. Laptop
   c. Tablet
   d. Other: ____________

2. What operating system does your computer use?
   a. Windows – version ___
   b. Apple OSX – version ___
   c. Other: ____________

3. What kind of web browser do you use?
   a. Windows Internet Explorer
   b. Apple Safari
   c. Chrome
   d. Firefox
   e. Other: ____________

Secondary COMPUTER (Complete this section if there is another computer you intend to use some of the time to access the course.)

4. What kind of computer will you use?
   a. Desktop
   b. Laptop
   c. Tablet
   d. Other: ____________

5. What operating system does your computer use?
   a. Windows – version ___
   b. Apple OSX – version ___
   c. Other: ____________

6. What kind of web browser do you use?
   a. Windows Internet Explorer
   b. Apple Safari
   c. Chrome
   d. Firefox
   e. Other: ____________

7. Have you participated in an e-learning course before? Please supply details.

<table>
<thead>
<tr>
<th>Course name</th>
<th>Sponsor/provider</th>
<th>When (approximate date)</th>
</tr>
</thead>
</table>
8. In what year did you participate in the WHO “Wheels” course in Turkey?
   a. 2007
   b. 2008
   c. 2009
   d. 2010
   e. 2012

9. What are 3 things you learned during that course about time-temperature sensitive products (TTSP) and cold chain?
   a. 
   b. 
   c. 

10. What are 3 other things you found valuable during the Wheels course?
    a. 
    b. 
    c. 

11. When you returned to your job after the Wheels course, what are two or three examples of things you did or did differently because of your experiences?
    a. 
    b. 
    c. 

12. How realistic or authentic were the tasks and assignments you performed during the Wheels course?
    Not realistic at all 1 2 3 4 5 6 7 8 9 10 Extremely realistic

13. What do you specifically do related to TTSPP and cold chain?
    a. Work for national authority/board of health – vaccine or drug approvals
    b. Work for national authority/board of health – GMP/GDP inspector
    c. Work for national authority/board of health – warehousing/distribution/logistics
    d. Work for national authority/board of health – other (please describe below)
    e. Work for vaccine/drug manufacturer – manufacturing/packaging
    f. Work for vaccine/drug manufacturer – packaging engineer
    g. Work for vaccine/drug manufacturer – warehousing/distribution/logistics
    h. Work for vaccine/drug manufacturer – other (please describe below)
    i. Work for supplier – passive cooling equipment/supplies
    j. Work for supplier – active cooling equipment/supplies
    k. Work for supplier – temperature monitoring equipment/supplies
    l. Work for transportation company (air or land cargo)
    m. Other – Please describe below

14. How would you rate your own level of expertise in your area of work?
    Novice/beginner 1 2 3 4 5 6 7 8 9 10 Expert
15. How would you rate your own level of knowledge and expertise related to other tasks and components related to TTSPP and cold chain?

Novice/beginner 1 2 3 4 5 6 7 8 9 10 Expert

16. How would you rate your own English language skills?

Extremely basic English language skills 1 2 3 4 5 6 7 8 9 10 Native English speaker

17. Do you have any concerns about your participation in this e-learning course? What are they?

18. What suggestions or comments do you have for the course director and mentors as the course starts?
APPENDIX 12

Participant post-visit questionnaire
Post-visit Participant Questionnaire
Field testing of prototype learning course: e-PCCM
(March 2013)

Note: All scales used were 10-points, 1 2 3 4 5 6 7 8 9 10

1. **Please rate this site visit:**

   Poor/not beneficial 1…5…10 Excellent/extremely beneficial

   Follow-up: a) What did you particularly like during this visit?
   Follow-up: b) What would you change to improve this visit?

2. **Please rate the tasks/activities you performed during this site visit:**

   Too easy 1…5…10 Appropriately challenging

   Very confusing 1…5…10 Clear

   Follow-up: a) What would you change to improve the tasks?

3. **Please rate the participation and contributions of other team members in the group activities:**

   Poor participation by other team members 1…5…10 Excellent participation by other team members

   Contributions made by only 1 or 2 teams members 1…5…10 Equal contributions by each and every team member

   Follow-up: a) What would you change to improve this?
   Follow-up: b) Are there any particular concerns you have?

4. **Please rate how realistic or authentic did you think the tasks/activities were in this visit:**

   Not realistic 1…5…10 Extremely realistic

   Follow-up: a) What would you change to improve this?
   Follow-up: b) Are there any other activities you think would be useful?
5. Please rate the usefulness of the videos used in this visit:

   Poor quality 1…5…10  Excellent quality
   Not at all beneficial 1…5…10  Extremely beneficial

   Follow-up: a) What would you change to improve this?
   Follow-up: b) Are there any other videos you think would be useful? Do you have suggestions for who might be a speaker in the video?

6. Please rate the usefulness of the documents used in this visit:

   Poor quality 1…5…10  Excellent quality
   Not at all beneficial 1…5…10  Extremely beneficial

   Follow-up: a) What would you change to improve this?
   Follow-up: b) Are there any other documents you think would be useful?
   Follow-up: c) Are there any other links or websites you think would be useful?

7. Please rate the usefulness of the illustrated lectures suggested for this visit:

   Poor quality 1…5…10  Excellent quality
   Not at all beneficial 1…5…10  Extremely beneficial

   Follow-up: a) What would you change to improve this?
   Follow-up: b) Are there any other illustrated lecture videos you think would be useful?
   Do you have suggestions for who might be a speaker in the video?
APPENDIX 13

Participant post-course questionnaire
Post-Course Participant Questionnaire
Field testing of prototype learning course: e-PCCM
(June 2013)

1. To what extent did you feel you had flexibility in the process of how you completed your learning activities?
   Rating (1 [worst] - 10 [best])
   Comment

2. To what extent were the tools (such as Google Docs) a valuable mechanism to support your working with others?
   Rating (1 [worst] - 10 [best])
   Comment

3. What applications did you find valuable when communicating with your colleagues/team members?
   Cell/SMS
   Cell/voice
   Email
   SKYPE
   Video
   Comment

4. Did you have any problems seeing the mini-lecture, facility visit, and task videos?
   YES
   NO
   Comment

5. Did you have any problems seeing the mentor feedback videos?
   YES
   NO
   Comment

6. If you experienced problems with the videos, were the course organizers able to help you solve the problem?
   Comment

7. How would you rate the SKYPE application as a mechanism for person-to-person and person-to-group communication?
   Rating (1 [worst] - 10 [best])
   Comment

8. To what extent did the mentors contribute to a learning environment where you felt that you could raise issues and questions that were important to you?
   Rating (1 [worst] - 10 [best])
   Comment
9. **What type of mentor feedback did you prefer?**
   - Email
   - Comments on work
   - Phone calls
   - Skype
   - Video message
   - Other
   - Comment

10. **Why did you prefer that type of feedback?**
    - Comment

11. **What were the challenges you faced in working with team members located in different locations?**
    - Language
    - Time zone
    - Weekend/holiday
    - Work schedule
    - Comment

12. **Were there any other challenges you encountered when working with your team members in general?**
    - Comment

13. **What might be done to improve working with team members?**
    - Comment

14. **For the site visit activities, how much effort did you contribute compared to others on your team?**
    - Comment

15. **In the final, authentic activity, how much effort did you contribute compared to others on your team?**
    - Comment

16. **How well did the examples and tasks fit with the places (e.g., pharmacy, hospital, health care center) in which they were set?**
    - Rating (1 [worst] - 10 [best])
    - Comment

17. **When you performed the shake test task, how realistic or authentic did it seem?**
    - Rating (1 [worst] - 10 [best])
    - Comment
18. How useful were the announcements and reminders that went out as we were making a transition from one task to another?
   Rating (1 [worst] - 10 [best])
   Comment

19. To what extent is the Google Group (created to support all participants after completion of the course) a valuable way to stay connected, meet participants from future courses, and continue to share and learn?
   Rating (1 [worst] - 10 [best])
   Comment

20. How likely would you recommend this course to others involved in a variety of pharma cold-chain activities?
   Rating (1 [worst] - 10 [best])
   Comment

21. Are there any other comments you would like to make about this course?
   Comment
APPENDIX 14

Mentor post-course questionnaire
# Post-Course MENTOR Questionnaire

Field testing of prototype learning course: e-PCCM  
(June 2013)

<table>
<thead>
<tr>
<th>Q #</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thinking back as we started this virtual course, what were your</td>
<td></td>
</tr>
<tr>
<td></td>
<td>expectations?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Were there any positive surprises during the course? What</td>
<td></td>
</tr>
<tr>
<td></td>
<td>were they?</td>
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<tr>
<td>3</td>
<td>Were there any negative surprises during the course? What</td>
<td></td>
</tr>
<tr>
<td></td>
<td>were they?</td>
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<tr>
<td>4</td>
<td>What was difficult/challenging for you as you served as a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mentor for this course?</td>
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<tr>
<td>5</td>
<td>Did you sense that your interactions with the participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>contributed to their trust and safety within the course? Can you provide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>an example or two?</td>
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<tr>
<td>6</td>
<td>Did you have any experiences where you noticed the knowledge and skills</td>
<td></td>
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<tr>
<td></td>
<td>of participants increasing or growing? Can you provide an example or two?</td>
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<tr>
<td>7</td>
<td>What were some of the underlying reasons of why several people “left”</td>
<td></td>
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<tr>
<td></td>
<td>the course? Are there things that we could have done to reduce the</td>
<td></td>
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<tr>
<td></td>
<td>number of those who left? Examples?</td>
<td></td>
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<tr>
<td>8</td>
<td>Did you notice any positive differences in this type of “virtual bus</td>
<td></td>
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<tr>
<td></td>
<td>course” compared to the actual one in Turkey? Examples?</td>
<td></td>
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<tr>
<td>9</td>
<td>Did you notice any negative differences between the virtual and</td>
<td></td>
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<tr>
<td></td>
<td>actual bus courses? Examples?</td>
<td></td>
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<tr>
<td>10</td>
<td>Did you observe situations where the participants took on roles other</td>
<td></td>
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<tr>
<td></td>
<td>than just “learners”? Did these roles change or evolve during the</td>
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<td></td>
<td>course?</td>
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<tr>
<td>11</td>
<td>How “real-life” did you find the participant’s solutions to the</td>
<td></td>
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<tr>
<td></td>
<td>problems or challenges?</td>
<td></td>
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<tr>
<td>12</td>
<td>How satisfied were you with the results of the Authentic Task involving</td>
<td></td>
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<tr>
<td></td>
<td>the Albanian vaccination program? What were specific things you were</td>
<td></td>
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<tr>
<td></td>
<td>and were not satisfied with?</td>
<td></td>
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<tr>
<td>13</td>
<td>Did you sense that participants enhanced their expertise in some area</td>
<td></td>
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<tr>
<td></td>
<td>related to cold chain? Examples?</td>
<td></td>
</tr>
<tr>
<td>Q #</td>
<td>Question</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>14</td>
<td>Is there anything you suggest doing differently in the next virtual “Wheels” course? Regarding…</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Participants?</td>
<td></td>
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<tr>
<td></td>
<td>Assignments/tasks?</td>
<td></td>
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<tr>
<td></td>
<td>Being a mentor?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology?</td>
<td></td>
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<tr>
<td></td>
<td>Other?</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>What advice would you give to a new mentor who would join the course?</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>What would you tell a new participant who would be joining the next offering of this course?</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Do you have any other comments?</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 15

Chronology of key events during field testing of prototype
**Chronology of Key Events: e-PCCoW**  
**Pilot Course: March – June 2013**  
Field testing of prototype learning course

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MARCH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>• Pre-course questionnaire sent to participants</td>
<td></td>
</tr>
</tbody>
</table>
| 4 | • Kick-off of course  
• Participants asked to become familiar with site  
• Announcement sent to WHO personnel, PDA (Parenteral Drug Association) and other stakeholders and interested parties  
• 15 participants and 4 mentors  
• Schedule with dates published for participants and mentors | |
| 5 | • Introduction to Farmalojistik / Step 4 | |
| 6 | • Introduction to Step 5  
• Additional concern (in form of email) from participant regarding time requirements  
• Course director shares concerns with facilitators | Design team and facilitators had extensively discussed the time-on-task and elapsed time earlier. |
| 8 | • Due date message for Step 5 task  
• Realization about summer time changes (DST)  
• Email sent announcing specific times mentors would be available for SKYPE calls from participants; done to help promote communication. | |
| 10 | • Participant (A) withdraws from course | Withdrawal due to time constraints on behalf of the participant. |
| 11 | • First discussion questions posted by P7; emailed to all from M3  
• A’s departure announced  
• Announcement made about Step 6 | |
| 12 | • Mentor phone call | |
| 13 | • Reminder for task Step 6 / announcement for Step 7 | |
| 14 | • Log entry from P3 (of 10 Mar) forwarded by M1  
• Issue discussed by M1 and development team re 360º photos and Internet Explorer v8.  
• Issue resolved by development team/IT personnel  
• New issues surfaced on using Google Docs. |
|---|---|
| 15 | • H withdraws from course; new team arrangements made for P12  
• New poster made/published to promote “live chats with mentors”  
• Participant/mentor birthday list published/distributed.  
Q on Impact of withdrawals on community of learners? |
| 17 | • Reminder sent re: Q Agreement task X) / announcement sent re Risk Treatment.  
• Comments from P7  
Q on use of reminders and announcements |
| 18 | • P3 withdraws from course due to workload at work; wants to be able to continue to have access to course site as an observer. |
| 22 | • Reminder for diary / announcement for Bursa  
• Issues discussed regarding diary |
| 23 | • Data received regarding first feedback video viewings:  
  o M2 vid #1 – 10 views  
  o M2 vid #2 – 3 views  
  o Jim vid #1 – 5 views  
• Reminder on diary / announcement Bursa Task #1  
• Announcement made re: P2, P5, H  
Videos published in HD and MP4 formats |
| 24 | • More details on videos – loads and plays  
• Email from P5 re: mentor videos  
• H “officially” withdraw from the course;  
• Change in mentor video comment approach recommended by M3 – have videos that have different focus than the written version  
• New groupings announced due to withdrawal of H and P3 |
### 25
- P11 comments about feedback videos – he hasn’t watched them due to lack of time; says that he “is enjoying the project”.

### 27
- Reminder of Bursa task 4 / announcement of VVM task
- Improvement to primary screen/interface – of screen

### 29
- TechNet 21 publishes article on e-PCCM

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<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APRIL</strong></td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Email sent to participants to encourage use of discussion feature.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Reminder of VVM task and diary / announcement on cold water packs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Child Survival publishes article on e-PCOW</td>
<td></td>
</tr>
</tbody>
</table>
| 7 | Bursa e-diary is down  
   - Announcing move to Hacetepe Univ Hospital | |
| 9 | Announcement on shake-test vials being shipped  
   Add question about context of task | |
| 10 | E-diary problems occur again  
   - M2 publishes article in CONTRACT PHARMA  
   - E-diary problems fixed | |
| 11 | Diary problems continue; files disappear | |
| 12 | Reminders for diary / announcement for task 1 Ulutas | |
| 15 | • “Disregard Welcome message” |
| 16 | • Reminder for task handling RX / announcement re power cut  
• Sandra withdraws from course due to increased workload  
• Mentors reflect on use of reflection |
| 17 | • Diary working again  
• M2’s “who is in or out” question concerning participants  (sensing frustration about people not getting assignments done?) |
| 19 | • Mohamed’s question regarding min-max thermometers  
• Reminder about power cut / announcement of new visit to family health center |
| 20 | • Signpost online  
• Shaketest details and assignment sent |
| 21 | • Revised groupings for authentic task  
• Announcing video feedback from M1 on Uluta’s power cut  
Q – usefulness of video feedback  (When was decision made about not creating more video feedbacks?) |
| 22 | • Clarification on shake test photos – identifying time point when certain of result |
| 23 | • Mentor phone call – clarification on use of reflection (to be used in next course)  
• Reminder for task #2 Zeytingbagi Health Center  
• P5 “deactivated” |
| 24 | • Announcing move to Albanian Case  
• Announcing groups for Albanian Case  
• Feedback (from M3) on VVM |
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1</td>
<td>Email from P7 regarding off days/holidays</td>
<td></td>
</tr>
<tr>
<td>May 3</td>
<td>SKYPE with Albanian Case Group #1</td>
<td></td>
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<tr>
<td>May 6</td>
<td>Conversation (email) about use of blog or wiki as a discussion tool</td>
<td>Ask about SKYPE in q’aire</td>
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<tr>
<td>May 6</td>
<td>Blog for course developed for discussion; also provides background information on course design</td>
<td></td>
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<tr>
<td>May 6</td>
<td>Course dates for future (2013-14) published</td>
<td></td>
</tr>
<tr>
<td>May 6</td>
<td>Mentor phone call with discussion of days off / holidays</td>
<td></td>
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<tr>
<td>May 7</td>
<td>SKYPE with Albanian Case Group #2</td>
<td></td>
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<tr>
<td>May 7</td>
<td>M3 email regarding difficulties in using SKYPE</td>
<td></td>
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<tr>
<td>May 7</td>
<td>Blog authorship roles given to LC and Jim</td>
<td></td>
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<tr>
<td>May 7</td>
<td>Blog announced to participants</td>
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<tr>
<td>May 8</td>
<td>SKYPE with Albanian Case Group #3</td>
<td></td>
</tr>
<tr>
<td>May 8</td>
<td>Email from participant P7 regarding time issue (summer DST) and missed call</td>
<td></td>
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<tr>
<td>May 15</td>
<td>First draft report for Albanian Case received from Group</td>
<td></td>
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<tr>
<td>May 16</td>
<td>M3 and Jim review first draft of Albanian Case reports. Also getting feedback from Albanian contact who is reading the reports.</td>
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<tr>
<td>May 17-18</td>
<td>Feedback sent to groups by</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Comment</td>
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<td>-------</td>
<td>-----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
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<tr>
<td>17</td>
<td>M3; asking them to consider when preparing final reports.</td>
<td></td>
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<tr>
<td>17</td>
<td>• P7 raises new question in discussion forum.</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>• Request to complete post-course questionnaire sent to all participants from Jim</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>• Participants asked to complete final diary entries</td>
<td></td>
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<tr>
<td></td>
<td>• Participants asked to complete post-course questionnaire</td>
<td></td>
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<tr>
<td>28</td>
<td>• Reminders sent out to 5 participants to complete diaries</td>
<td></td>
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<tr>
<td>28</td>
<td>• Post course conference call with most all participants mentors, researcher, and learning consultant involved. Transcript of call made.</td>
<td></td>
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<tr>
<td>28</td>
<td>• Participants asked to make specific improvements in “final” Albanian case reports based on comments of mentors</td>
<td></td>
</tr>
<tr>
<td><strong>JUNE</strong></td>
<td><strong>13</strong></td>
<td><strong>Final feedback given to groups on Albanian case study reports. Only one group made significant changes/improvements as requested.</strong></td>
</tr>
</tbody>
</table>