Evaluating the Usability and Usefulness of an E-Learning Module for a Patient Clinical Information System at a Large Canadian Healthcare Organization

by

Tarig Dafalla Mohamed Dafalla
B.VM, Assuit University, 1987

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

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SUPERVISORY COMMITTEE

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Supervisory Committee

Dr. Andre Kushniruk
Supervisor

Dr. Elizabeth Borycki
Departmental Member

ABSTRACT

Supervisory Committee
Dr. Andre Kushniruk
Supervisor
Dr. Elizabeth Borycki
Departmental Member

Alberta Health Services (AHS) has introduced e-learning for health professionals to expand their existing training, offer flexible web-based learning opportunities, and reduce training time and cost. This study is designed to evaluate the usability and usefulness of an e-learning module for a patient clinical information system scheduling application. A cost-effective framework for usability evaluation has been developed and conceptualized as part of this research. Low-Cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA), and Heuristic Evaluation (HE) criteria for web-based learning were adapted and combined with the Software Usability Measurement Inventory (SUMI) questionnaire. To evaluate the introduction of the e-learning application, usability was assessed in two groups of users: frontline users and informatics consultant users. The effectiveness of the LCRUE, CTA, and HE when combined with the SUMI was also investigated. Results showed that the frontline users are satisfied with the usability of the e-learning platform. Overall, the informatics consultant users are satisfied with the application, although they rated the application as poor in terms of efficiency and control. The results showed that many areas where usability was problematic are related to general interface usability (GIU), and instructional design and content, some of which might account for the poorly rated aspects of usability. The findings should be of interest to developers, designers, researchers, and usability practitioners involved in development of e-learning systems.

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DEDICATION

In the Name of ALLAH, the BENIFICIENT, the MERCIFUL, I dedicate this study to my parents, my blessed wife, and my lovely children who made, after ALLAH, my success in this educational journey possible

CHAPTER 1: INTRODUCTION

Web-based learning, also referred to as electronic learning (e-learning), has “been widely adopted as a promising solution by many companies who offer learning-on-demand opportunities to individual employees in order to reduce training time and cost” (Wang, Wang, & Shee, 2007). According to Wang et al., (2007), organizations spend a considerable amount of time and money annually in developing online alternatives to traditional types of education and training systems (p.1793). For example, U.S corporations spent $11.4 billion annually on training in 2003 (Hodges, 2009, p. 72). More recently, U. S corporations spent more than $58 billion annually on formal training (Derouin, Fritzsche & Salas, 2005). Creation of computer-based and Web-based training programs by training vendors is costly (Derouin et al., 2005, p. 936). Mugnai, Jones and Wong (2002) argued that e-learning design is driven more by advancement in technology and ”bells and whistles” than by a long-standing understanding of cognitive scientific research and learning theory (Derouin et al., 2005). The e-learning technology offers “a good learning opportunity for improving employees’ skills”. However, poor implementation of e-learning can lead to a costly failure at the financial and organizational levels (Schreurs, Gelan & Sammour, 2009).

In response to this, Derouin et al., (2005) argued that many organizations have undertaken e-learning strategies to enhance user satisfaction, usability and learnability among the users of e-learning technology and to avoid failure for the system to be adopted (Lorenzi & Riley, 2003; Wu, Shen, Lin, Greens & Bates, 2008). From this perspective, Derouin et al., (2005) argued for the need for more research measuring the

behavioural and organizational outcomes of e-learning "to evaluate whether it is truly worth the investment" (p.936).

In health informatics, usability engineering has been applied for improving system development, where aspects of user interaction are evaluated to improve a system based on user's feedback (Kushniruk & Patel, 2004). Despite advancements in computer technology and communication systems, the usability of e-learning systems, their educational effectiveness, practical efficiency, and the general level of satisfaction of users with e-learning systems has yet to be fully understood and "little has been done to critically examine the usability of e-learning applications" (Arh & Blazic, 2008; Zaharias, 2009).

In the study described in this thesis, an evaluation framework was developed for the evaluation of the usability and usefulness of an e-learning module for a patient clinical information system IT scheduling application. The framework was conceptualized based on two concepts: usability and usefulness. Specifically, this framework was used for evaluating the usability and usefulness of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM), as published and interfaced in a Web-Based Training (WBT) Manager for e-Learning, at Alberta Health Services (AHS). The MCEC-eLM was developed and designed to provide employees with core competencies for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics in AHS (Kitchin, personal communication, paper document, 2011). AHS's Learning and Leadership Development group produced a testing checklist for e-learning and they are required to test e-learning courses for

functionality and usability prior to uploading the course on the provincial Learning Management System (LMS) (Melnychuk, personal email, March 2013). The complete learning process and e-learning interface specification were discussed as part of this process (AHS's Learning Style Development Guide, v.09, 2013).

At a corporate level, the work described in this thesis has the objective of making a significant contribution to ensure that the requirements and information needs of users and the healthcare organization have been met (Kushniruk & Patel 2004). Academically, the study investigates the usability and usefulness of e-learning applications by using internationally recognized approaches for the evaluation of interface usability. In this study, Low-cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE) criteria for web-based learning techniques were adapted and combined with the Software Usability Measurement Inventory (SUMI) to evaluate the usability and usefulness of the MCEC-eLM. The LCRUE and CTA techniques have emerged as rapid and modern approaches that involve video recording of subjects as they conduct selected tasks (Kushniruk & Patel, 2004; Kushniruk & Borycki, 2006). Kushniruk, Patel and Cimino described the CTA approach in 1997. This article described the method as involving subjects 'thinking aloud' as they interact with a system. The observation of users while they are using a system in their working environment and asking them to think aloud has been found to be an appropriate methodology for the assessment of the usefulness and usability of systems (Burkle, Ammenwerth, Prokosch & Dudeck, 2001).

CHAPTER 2: REVIEW OF THE LITERATURE

2.1. Introduction

Alberta Health Services (AHS) planned a new e-learning module for a patient clinical information system IT scheduling application as part of its strategy to expand the available learning and training methodologies in the organization. Accordingly, the Learning Supports (LS) Unit of Learning Services – Human Resources has been mandated to develop and implement an infrastructure so that AHS employees have access to job-related learning (AHS, Learning Style Development Guide, v.09, 2013). As implementation management of new technologies has been challenging to public and private organizations (Cooper & Zmud, 1990), many newly implemented information systems have failed for a number of different reasons, including: lack of communication, system complexity, organizational, technological and leadership issues (Lorenzi & Riley, 2003). To facilitate the wide-spread adoption and successful implementation of e-learning in AHS, effective evaluation of individual, organizational and technological aspects of e-learning implementation is essential.

As part of strategic planning for evaluation and testing of e-learning, Alberta Health Services (AHS) Learning and Leadership Development produced a testing checklist for e-learning and required that e-learning courses be tested for functionality and usability prior to uploading the course on the provincial Learning Management System (LMS) (Melnychuk, personal email, March, 2013). The e-learning interface specification and checklist is discussed in the AHS' Learning Style Development Guide, v.09, 2013. Based on this guide, AHS required the testing of e-learning applications for

functionality and for learner usability from an end user perspective. This was supported by this quote from the guide:

> When testing for usability it is important to test by putting yourself in the "learner's shoes" and experiencing the course as the learner would. The learner may try things in a different sequence than we would and this may identify bugs [that] the developer is unaware of. It is a good idea to have a fresh set of eyes test the course as a "student" to see that the course is easily navigated, the course content is easy to follow, and all buttons and quizzes are functional, ensuring that any technical glitches are found at the testing phase (AHS' Learning Style Development Guide, v.09, 2013, n.p.).

To fulfill the testing and evaluation criteria of AHS, there is a need for user-centred evaluation methods. To explore this, I reviewed the literature about user-centred usability evaluation. From a review of the literature, two concepts emerged in the research on user-centred evaluation: usefulness and usability concepts. The first aspect focuses on the interaction between user and content, while the second concentrates on the interaction between user and system features (Tsakonas & Papatheodorou, 2006).

Based on these concepts, I designed an evaluation framework for evaluating the usability and usefulness of an e-learning module for a patient clinical information system IT scheduling application. For the purpose of this study, I used this framework for evaluating the MCEC-eLM, as used in the Alberta Health Services' LMS, namely, the WBT Manager for e-learning. This module was developed and designed to provide employees with core competencies in managing patient identification for waitlists and

scheduling patient appointments in outpatient clinics in AHS (Kitchin, personal communication, 2011).

A mixture of qualitative and quantitative methods for data collection and analysis were used in this framework. In the literature, researchers viewed usability as an objective quality criterion and the usefulness of an application as a subjective quality criterion of users' perceptions and satisfaction. While usability is determined objectively in terms of effectiveness and efficiency (e.g. conducting of tests to measure the time taken for carrying out tasks, number of errors and completion rate on specific tasks), it is assessed subjectively by user satisfaction measures with post-test questionnaires (De Kock, Van Biljon & Pretorius, 2009). According to Tsakonas and Papatheodorou (2006), usefulness is the degree to which a specific information item will serve the information needs of the user. It is an extension of the concept of relevance and system usage. Perceived usefulness and perceived ease of use are predictors of system usage in the Technology Acceptance Model (TAM) (p. 401).

In this thesis, a cost-effective rapid usability testing approach was used to evaluate usability and user satisfaction. I adapted the LCRUE technique, CTA approach and HE criteria for web-based learning and combined them with the SUMI method to evaluate the usability and usefulness of the MCEC-eLM. To understand how this framework could be applied for the evaluation of the usability and usefulness of an e-learning module, a literature review was first conducted, focusing on evaluation, usability, usefulness and e-learning. In the next section, I will begin with a review of the literature and theory relevant to e-learning.

2.2. Electronic Learning (e-learning)

2.2.1. Definitions

Electronic learning (e-learning) has "been widely adopted as a promising solution by many companies who offer learning-on-demand opportunities to individual employees in order to reduce training time and cost" (Wang et al., 2007, p. 1792). Wang et al., (2007) refer to e-learning as learning via the Internet (p. 1793). According to other researchers, e-learning has a number of synonyms, including Web-based learning, online learning, distributed learning, computer-assisted instruction, and Internet-based learning (Ruiz et al., 2006). Based on the formats and methodologies that are part of e-learning, the term has been widely applied to include a range of electronic learning technologies, whether Web-based or CD-based (Adebesin, De Villiers & Ssemugabi, 2009). Strategically, e-learning is defined as an instructional strategy for importing needed knowledge, skills, and attitudes into organizations (Derouin et al., 2005).

2.2.2. E-Learning in Education

In educational practice, e-learning has been defined as instruction delivered electronically via the Internet, intranets, or multimedia platforms such as CD-ROM or DVDs (Smart & Cappel, 2006). E-learning in education is viewed as a novel approach to education based upon electronic technology. E-learning is comprised of different ways of providing computer-provided support where teaching material can be delivered synchronously (e.g. Web-based videoconferencing, audio conferencing with presentation material, on-line chat) or asynchronously (e.g. Computer-managed instruction, intelligent tutoring systems, learning management instruction, learning content management systems) (Granic, Glavinic & Stankob, 2004). According to Granic et al., (2004), learning

management systems (LMSs) and learning content management systems (LCMSs) are a central point of interest in asynchronous delivery of teaching materials. The primary goal of LMSs, according to Granic et al., (2004), is learner management or keeping track of learner progress and performance across all activities in the learning and teaching process. LCMSs capabilities include management of either content or learning objects, which are provided to the “right learner at the right time” (p. 28.1). Both LMSs and LCMs are e-learning platforms.

Historically, there have been two common e-Learning modes: distance learning and computer-assisted instruction. Distance learning uses information technologies to deliver instruction to learners who are at remote locations far from a central site. Computer-assisted instruction (also called computer-based instruction) uses computers to aid in the delivery of stand-alone multimedia packages for learning and teaching (Ward, Gordon, Field & Lehmann, 2001). These two modes are listed under e-learning as the Internet becomes integrated with technology (Ruiz et al, 2006).

2.2.3. E-Learning in the Corporation:

According to Clark and Mayer (2003), e-learning applications, within the context of training, are used as a form of training that is delivered to support individual learning or organizational performance (Hodges, 2009; Zaharias, 2009). Within the context of corporate, AHS-planned e-learning there is an option to expand the available methods for learning patient clinical information system IT applications (Tutty, personal communication, 2011). This option was planned for a number of reasons, including: (1) the high volume of users to be trained concurrently for new site implementations, (2) adaptation of learning methods to better facilitate adult learners at the right time at their

site, (3) instructor-led classes were a huge resource demand, and (4) independent learning was hoped to provide sustained benefits financially (Kitchin, personal communication, paper document, 2011). According to Kitchin, AHS introduced e-learning attempts to provide individual employees with core competencies for using patient clinical information system IT applications and fulfil IT Access and Security requirements to obtain usernames and passwords for patient clinical information system IT applications in the real production environment. The e-learning option could provide AHS with a way to improve organizational efficiency and effectiveness by delivering work-based training to achieve targeted performance (Hodges, 2009).

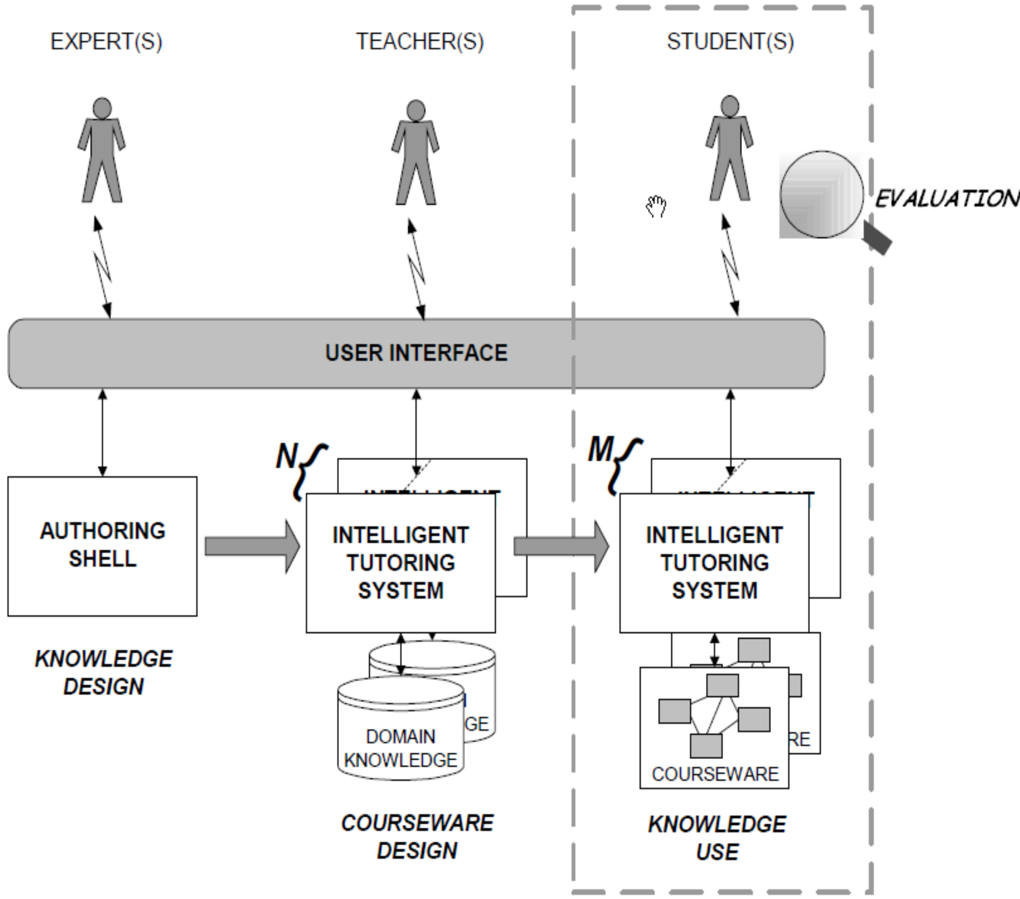
2.2.4. E-Learning in Health Informatics

In health informatics practice, e-learning is considered a subset of health informatics knowledge and it is defined as "the use of information and communication technologies in education" (Liaw & Gray, 2010, p. 487). According to Ruiz et al., (2006), e-learning is also called Web-based, online learning, distributed learning, computer-assisted instruction, Internet-based learning. E-learning is defined, according to Rosenberg (2001); Wentling, Waight, Gallaher, La Fleur, Wang and Kanfer (2000), as the "use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance (Ruiz et al., 2006, p. 206). According to Ruiz et al., (2006), before the Internet becomes the integrated technology, e-learning is called distance learning or computer assisted instruction. Ruiz et al., (2006) refer to distance learning as the usage of "information technologies to deliver instruction to learners who are at remote locations from a central site" (p. 207). Computer assisted instruction, or what is called according to Ruiz et al., (2006), computer-based learning and computer-based

training, refers, according to Ward et al., (2001) to the usage of "computers to aid in the delivery of stand-alone multimedia package for learning and teaching"(Ruiz et al., 2007, p. 207).

According to Liaw and Gray (2010), the ability to use educational technologies effectively is often assumed to be one aspect of clinical informatics competence. Model 1, below, illustrates how the relationship of roles in knowledge management for intelligent learning and teaching can be visualized.

The model illustrates the relationship among the expert(s), teacher(s) and student(s) – the main actors in the process of learning and teaching – and sequences the domain knowledge through the user interface in three phases: expert(s) create a domain knowledge base for an intelligent tutoring system using an authorized shell in the knowledge phase, teacher(s) create courseware and course structure in the courseware design phase, and student(s) – knowledge users – consume this knowledge in the knowledge use phase (Granic et al., 2004).



Model 1: Relationship of Roles in Knowledge Management for Intelligent Learning and Teaching (Granic, Glaninic & Stankov, 2004, 109, p. 28.3)

Many health professional educators support better use of e-learning to educate geographically dispersed and time-constrained clinicians. However, implementation of effective e-learning requires adherence to emerging standards as discussed by Falon and Brown (2002).

Unlike structured and process-based curricula, competency-based curricula focus on the expected outcomes of learning activities and the professional competencies learners are expected to attain (Harden, 2002). Competency-based education in health

informatics throughout the clinical workforce is required for sustainability in healthcare organizations for the following reasons: (1) to ensure regional and national healthcare systems achieve improvements in the safety and quality of care as new technology-based management tools are implemented within and between healthcare organizations, (2) to sustain the standing and influence of the clinical professions, (3) to support a skilled clinical workforce that needs to update its professional practice continuously, (4) to prepare clinicians to address consumer expectations about information and communication technology (ICT) enhanced quality of care, specifically in the era of worldwide online, open access to information, (5) to provide the international mobile clinical workforce with uses of ICT in a responsive way, and (6) to empower clinical professionals with the resources and technologies needed in response to major global health issues such as epidemic outbreak or natural disaster (Liaw & Gray, 2010). According to Liaw and Gray (2010), developing a set of competencies is only one part of the educational planning process that requires producing a competent clinical workforce. The other parts of the process are listed below:

- Curriculum design – mapping the desired competencies across various levels of clinical curriculum in the relevant discipline; aligning the desired competencies with planned learning activities and assessment tasks.
- Teaching/training – offering optimal delivery modes (which may range from scheduled classes through to independent self-paced learning), choosing relevant methods and resources, using an appropriate mix of staff and peer support, and providing timely feedback on learning.

- ❖ Assessment – assigning written work, observing performance or reviewing a portfolio of evidence of clinicians' learning in each competency, and granting externally validated (wherever possible) certification of learning achievements at predetermined levels of attainment.
- ❖ Evaluation – seeking feedback from learners, teachers/trainers and accreditation bodies, reviewing learning outcomes, teaching performance and curriculum relevance, and making regular improvements to educational quality as indicated.

Liaw and Gray (2010) listed many factors, adapted from Whetton, Larson and Liaw (2008) that determine the quality of e-learning. These factors include:

- Relevant, appropriate content and resources: The content and resources should be meaningful to learners and practitioners in their professional context.
- Learner engagement: This is achieved through a meaningful, enjoyable and interactive program, with regular and timely feedback from teachers and other learners. This is a particular challenge for programs offered to independent self-paced learners.
- Effective learning: This is facilitated by catering to the diverse ways in which learners work at their own pace, study on their own time, and pursue their own path through the material. The most effective programs offer alternative learning pathways, which cater to a range of learning styles and preferences.
- Ease of learning: This involves designing, chunking and sequencing learning activities so that they do not make unnecessary cognitive demands on the

learner. An e-learning program should be intuitive, requiring a minimum of technical training before use.

- Inclusive practice: Inclusive practice underpins good pedagogy by seeking to develop programs that cater to learners of different age, gender, ethnicity, and physical and intellectual ability. E-learning programs must also cater for different levels of access to technology and different ICT skill levels.
- Fitness for purpose: The choice among educational methods or modes of learning, including e-learning, will be determined as a balance of those which are most authentic in comparison with professional practice and those which are most efficient in the circumstances of the program provider.

In summary, e-learning in health informatics refers to the use of information and communication technologies in education to educate geographically dispersed and time-constrained clinicians. The ability to use educational technologies effectively is often assumed to be one aspect of clinical informatics competence. Implementation of effective e-learning requires adherence to the emerging standards to achieve high quality and knowledge-based performance. Therefore, competency-based education in health informatics throughout the clinical workforce is required for sustainability of healthcare organizations. However, the user's level of competencies is dependent on the content, functional specification, and design of the general interface usability (GIU) of an e-learning system.

In this study, the evaluation of the usability and usefulness of e-learning is a part of a quality management process used to achieve higher standards and core competencies in learning. This is done by making e-learning: relevant, with appropriate content and

resources; facilitative for learner engagement; effective; easy; inclusive in terms of practice; and fit in purpose. The e-learning process involves careful planning, design and evaluation to ensure efficiency and simple use of the system (Debeve & Bele, 2008). Inappropriate system development, implantation, and/or evaluation in a large organization can lead to failure (Wu et al., 2008). In contrast, a successful e-learning implementation offers numerous advantages to the organization.

2.2.5. Benefits of E-learning

According to Reime, Harris, Aksnes and Mikkelsen (2008), e-learning has numerous advantages.

> [E-learning] combines important principles such as student activity, individual learning, rapid response, and repetition according to requirements. In addition, it fosters independent skills; allows flexible working; encourages the development of skills in time management, organization, and self-pacing; and provides an opportunity for practicing computer skills. It also contributes to methodological diversity and to changing the focus away from teaching to learning in the same way as lifelong learning (Abdelaziz, Kamel & Karam, 2011, p. 51).

In a recent dissertation, Hodges (2009) summarized the most cited benefits of e-learning. As examples of these benefits at a corporate level, corporate education and e-learning provide workers with the opportunity to keep their skills constantly updated. In addition, electronic content allows instructors to update lessons across the network simply and instantly, keeping information fresh and up-to-date. In one recent comparative survey study between U.S. and Canadian businesses, the researchers found that e-learning

is used primarily in information technology (IT) training (Derouin et al., 2005). Moreover, e-learning provides innovative solutions that explore and exploit informatics support on-the-job training (Einarson, Moen, Kolberg, Flingtorp & Linnerud, 2009). Despite the progress in understanding the benefits of e-learning, much remains to be investigated (Derouin et al., 2005). In the next section, e-learning platforms and evaluation frameworks are reviewed.

2.3. Evaluation in Health Informatics

2.3.1. Definitions and Process

Evaluation is defined as "the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context" (Ammenwerth, Brender, Nykanen, Prokosch, Rigby & Talmon, 2004). Friedman and Wyatt (2006) defined evaluation as the study of the "impact or effects [of software] or [its] effects on users and the wider world." In the frameworks, the evaluators, "need to describe methodologies that capture the processes integral to applications, the users and the world in which the users function" (Currie, 2005). Patton (1997) defined evaluation as a systemic collection of information to improve program effectiveness and/or generate knowledge to inform decisions about future programs (AHS, 2005). In the health informatics field and practice, the evaluations process "spans a continuum from project planning to design and implementation" (Kushniruk, 2001). Methods of evaluation in health informatics include conventional and modern methods and are discussed broadly by Kushniruk and Patel (2004).

Effective evaluation, as defined by Health Canada (1996), has many benefits that include:

1. Accounting for accomplishments of program funding
2. Promoting learning
3. Providing feedback to inform decisions
4. Contributing to knowledge
5. Assessing cost-effectiveness
6. Positioning high quality projects for future funding opportunities
7. Increasing the effectiveness of project and program management
8. Contributing to policy development
9. Identifying successes
10. Providing a plan for future work

The evaluation process can be based on a comparison. Evaluation starts during program development and can be split into verification, validation, and assessment of human factors and clinical assessment of clinical effect (Burkle et al., 2001). According to Burkle and colleagues (2001), verification is carried out during system design and development to answer the question "Did we build the system correctly?" and to check whether the system has met its specifications and to confirm the consistency, completeness and correctness of the system. Validation is performed later to answer the question "Did we build the right system?" In the process of validating a system, one checks as to whether the system performs the tasks for which it has been designed in a real working environment (Burkle et al., 2001). Validation refers to whether or not a device or method measures what it purports to measure and it refers to "proximity to the

'truth' of a measurement" (Ammenwerth, Iller & Mansmann, 2003; Currie, 2005; Waltz, Strickland & Linz, 1991).

Human factors evaluation answers the question: "Will the system be accepted and used?" (Burkle et al., 2001). In light of these perspectives, the concepts of usability and usefulness have emerged. The concept of usefulness is measured by examining user satisfaction dimensions that include system-dependent aspects such as content satisfaction, interface satisfaction and organizational satisfaction; and system-independent aspects such as individual dislike for computers (Ohmann, Boy & Yang 1997). Usability is measured in terms of effectiveness, efficiency, and satisfaction (ISO, 1998). Observation of a system and the system's users while they carry out tasks using it in a real working environment is an appropriate methodology that can be used for assessment of usefulness and usability together (Burkle et al., 2001). Finally, evaluation of the clinical effect is the last phase of system evaluation. It answers this question: "Which clinical effect [does the system have on patient outcome?]" (Burkle et al., 2001). From this perspective, "the clinical effect is best measured in a field study using an RCT [Randomized Clinical Trail]" (p. 367). In the next section, a review and discussion of theory relevant to evaluation of e-learning in healthcare organizations are presented.

2.3.2. Evaluation of e-Learning in Healthcare Organizations

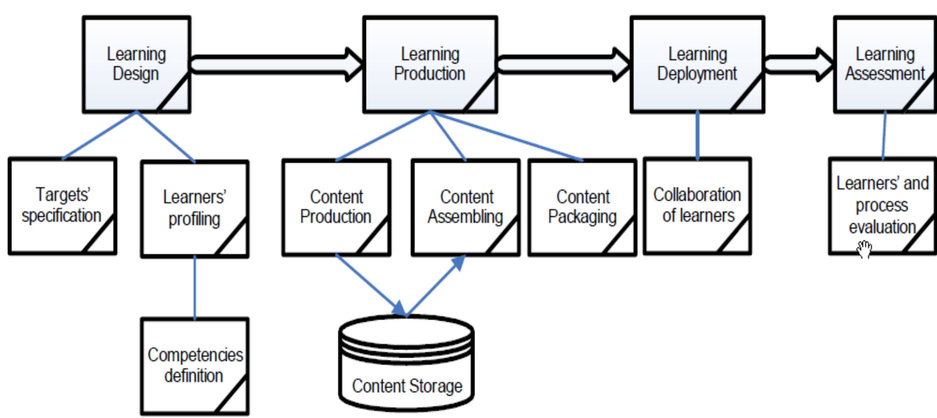
In the context of a large healthcare organization, such as AHS, e-learning is defined as," the delivery of instructional content or learning experiences enabled by electronic technology." A successful implementation of e-learning systems has to meet several conditions, depending on the levels of e-readiness of the organization and the focus of evaluation. The evaluation of e-learning can be conducted at a country,

organizational (industry, education), or individual level. At a country level, e-readiness criteria for evaluation can be divided into four components: connectivity, capability, content and culture. At the organizational level, e-readiness is determined by the organization itself. E-learning can be evaluated in terms of benefits and advantages. On an individual level, e-readiness includes the learners' ability to adapt to technological challenges, collaborative training, and synchronous and asynchronous self-paced training. Also, e-learning depends on the individuals' motivations and their discipline of practice, how they learn in a self-driven motivated approach and how they respond to online instructions (Schreurs et al., 2009). This research was a part of an e-learning quality management process aimed at developing an e-Learning module for a patient clinical information system IT scheduling application at a large Canadian healthcare organization. This evaluation was undertaken at the individual, end-user level to facilitate wide-spread adoption and successful implementation at individual, organizational, and technical levels. The evaluation is a part of the e-learning development lifecycle, as illustrated in Model 2. The evaluation process is composed of the following steps:

1. Curriculum validation evaluation – an essential phase of curriculum development in which one can discover whether a curriculum is fulfilling its purpose and whether students are actually learning (DiFlorio, Duncan, Martin & Middlemiss, 1989). This type of validation ensures that there is sufficient variety in scenarios and workflows and that core content provides adequate detail and relevance to a wide range of clinical areas.

2. Second level content review – Second level review is part of the content development process. Representatives from the clinical working groups were invited to provide input and validate the material as it was developed.
3. Pilot test – Pilot sessions were conducted prior to rollout to a wider audience. Members of clinical working groups will participate in these sessions and perform a final test and validation of the curriculum and related scenarios. The Concise Oxford Thesaurus defines a pilot study as “an experimental, exploratory, test, preliminary, trial or try-out investigation,” and the pilot test is synonymous with a feasibility study that is intended to guide the planning of a large-scale investigation. The main goal is to assess feasibility so as to avoid potential disastrous consequences of embarking on a large study – which could potentially “drown” the whole research effort. As a rule of thumb, the pilot study should be large enough to provide useful information about those aspects of the e-learning system that are being assessed for feasibility (Costabile, Marsico, Lanzilotti, Plantamura & Roseelli, 2005; Thabane L., Chu, Cheng, Ismaila, Rios & Thabane M. (2010). The above-mentioned steps were not included in the scope of this study.
4. Evaluation: In this research, a human factors evaluation study was conducted to measure the usability and usefulness of an e-learning module as published and used in the Alberta Health Services’ E-

Learning Management System called the WBT Manager for e-Learning. A framework for evaluation was conceptualized based on the usability and usefulness concepts. Before the concepts of usability and usefulness will be reviewed, e-learning infrastructure will be reviewed and discussed in the next section.



Model 2: E-learning Life Cycle Process (Varlamis & Apostolakis, 2006, p. 61)

2.4. E-Learning Systems Infrastructure

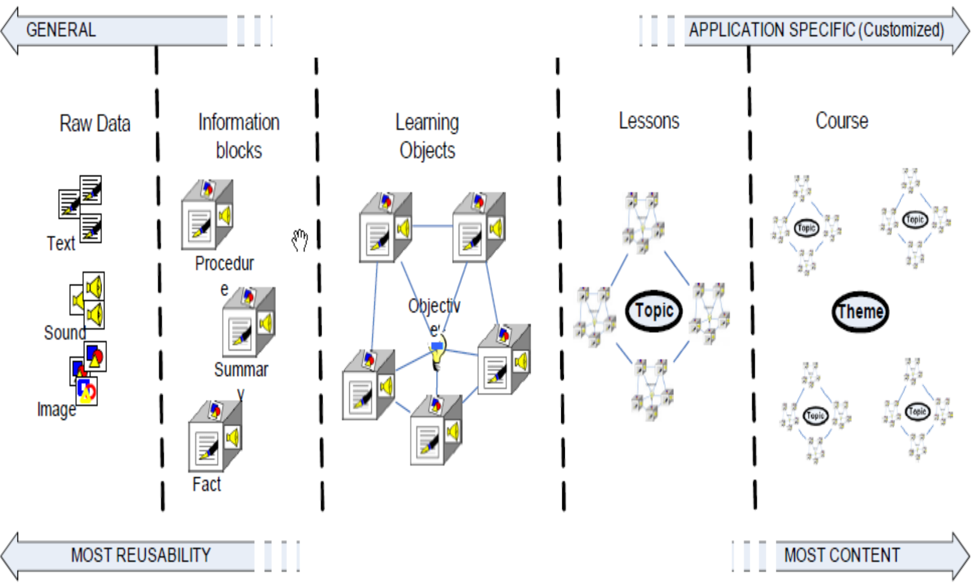
There are two main infrastructure components that are part of an e-learning system reviewed in this section: (1) learning objects and (2) e-learning system functional model.

2.4.1. Learning Objects

The learning object is an elementary part of an e-learning system (Varlamis & Apostolakis, 2006). According to Cohen and Nycz (2006), in recent paradigms the content is broken into much smaller, self-contained pieces of information that can be used alone or can be dynamically assembled into learning objects (Varlamis & Apostolakis,

2006). In the SCORM (2005) standard, the content has been referred to as "Sharable Content Objects or SCO's" (Varlamins & Apostolakis, 2006). According to Varlamis and Apostolakis (2006), the conceptual model of content objects, as shown below in Model 3, describes:

- A component-based approach
- Structured content based on a hierarchical model
- Metadata at each level of the content hierarchy
- A process methodology
- A technical infrastructure for developing, assembling and managing re-usable granular content objects that are written independently of delivery media and accessed dynamically through a database



Model 3: Content Object Model (Varlamis & Apostolakis, 2006, p. 63)

2.4.2. E-learning Functional Model

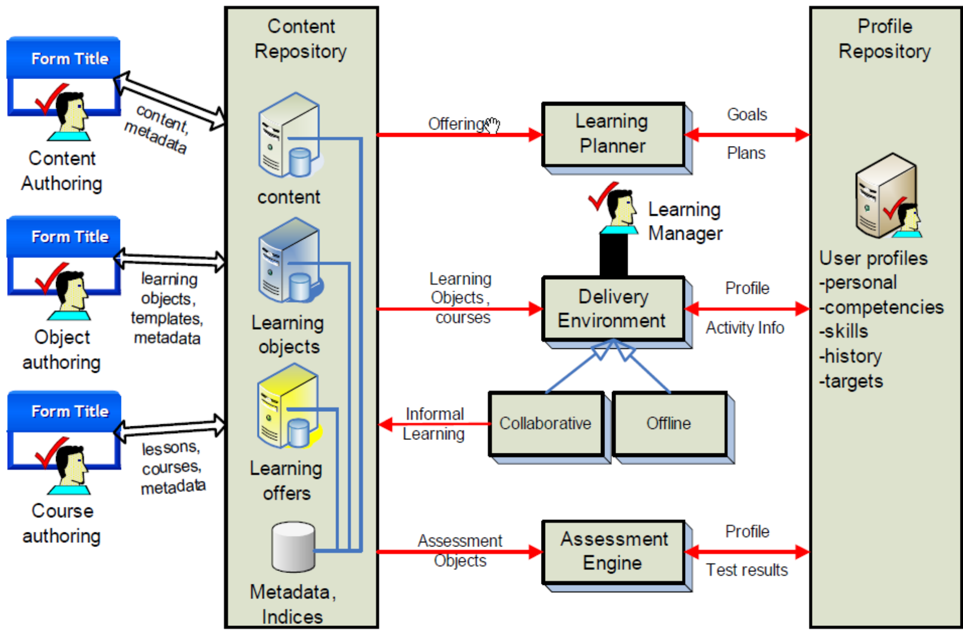
The e-learning functional model is summarized from "the present and future of standards for e-learning technologies." Based on Robson, (2003), the model is composed of production, dissemination phase, and management phase as shown below in Model 4.The main production phase components are:

1. Content Repositories (they index commercial and custom learning object that can be retrieved and served to people and systems)
2. Metadata (they are used for indexing and retrieval tasks, especially for non-textual content)
3. Content Authoring Tools and Services (allow education experts and instructional developers to create and modify fundamental learning entities)
4. Learning Objects Authoring (tools support the assembly of content entities into cohesive learning modules)
5. Package course authority tools (support the composition of learning objects into courses)
6. Learning Offerings (Package course products are indexed and priced based on the accounted market needs so as to become offerings.

The dissemination phase is composed of:

1. Learner Profile Repositories (information about the learners that use them)
2. Learning Planners such as teachers, advisors, career counsellors, human resource managers (assist learners in determining their targets to evaluate and improve their profiles based on a concrete plan)

3. Delivery Environment (comprises tools and activities such as chat, email, quizzes, multimedia applications, collaboration tools, application sharing, shared whiteboards, equation editors, etc. that can be offline or online and collaborative i.e. virtual classrooms). Delivery can also be done informally (informed learning) using live conversations, presentations, informal training, hands-on demonstrations, etc. The Learning Management Systems (LMS) are intended to manage the learning environment and synchronize production and dissemination tasks (Varlamis & Apostolakis, 2006, pp. 66 – 67).



Model 4: E-learning Functional Model (Varlamis & Apostolakis, 2006, p. 66)

2.4.3. E-learning Platforms and Evaluation Frameworks

2.4.3.1. Introduction and Definitions

The platform for modern e-learning is composed of three fundamental parts: a Learning Management System (LMS), a Learning Content Management System (LCMS) and a set of tools for distributing training contents and for providing interaction (Colace, De Santo & Vento, 2003). According to Ferl (2005), the term "e-learning platform" is a generic term that covers a variety of different products, all of which support learning in some way and use electronic media (Garcia & Jorge, 2006).

The LCMS manages the contents while paying attention to its creation, importation and exportation. The LCMS enables creation, description, importation or exportation of contents and their reuse and sharing. The contents are organized into independent containers, called Learning Objects that are used to satisfy one or more didactic goals.

2.4.3.2. E-learning Platforms Evaluation Frameworks

Many evaluation frameworks and models have been used for evaluation of e-learning platforms against specific criteria using different methods. For example, Brian proposed the "Framework for Pedagogical Evaluation of a Virtual Learning Environment" and Liber (2004) based into two models, the "Conversation Framework" and the Viable Systems Model (VSM) (Garcia & Jorge 2006). The first model addresses several ways of considering learning processes in an e-learning platform (e.g. discursive, adaptive, interactive or reflective). The second model is oriented towards collaborative learning. It provides several steps to organize the learning process (e.g. Resource negotiation, Coordination, Monitoring, Individualization, Self-organisation or

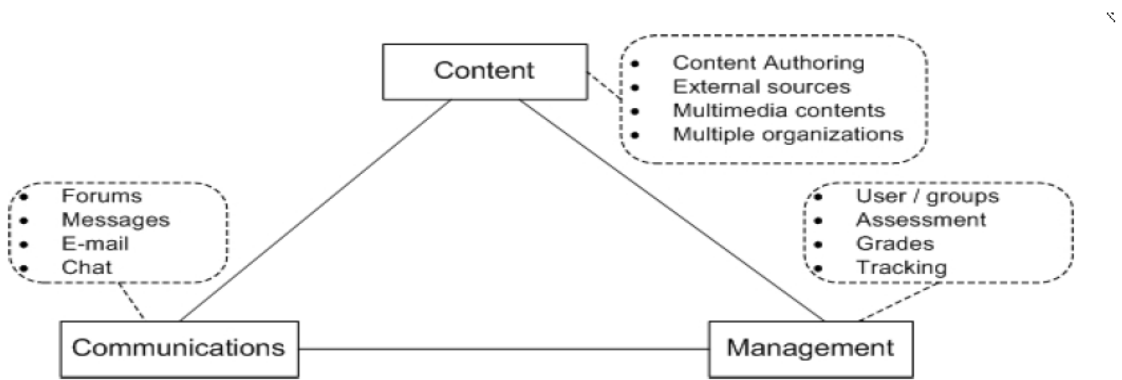
Adaptation). For each model, Brian and Liber proposed specific criteria for evaluation of e-learning platforms. Subjective methods such as completing questionnaires or elaborating on comparison grids are used for evaluation of the platform against the selected criteria.

Dyson and Barreto (2003) proposed another basic framework to distinguish between the many ways in which Virtual Learning Environments (VLEs) can be evaluated. In this framework, the types of methods used and the measures employed are considered (Gracia & Jorge, 2006):

The authors (Dyson and Barreto, 2003) describe the different roles for evaluation (e.g. formative, summative, integrative evaluations and quality assurance), the types of experiments to be performed (e.g. test or case studies) and criteria to evaluate the usability or the learning effectiveness. The proposed evaluation method range from interpreting results, identifying processes and outcomes, and detecting the type of data (e.g. qualitative vs. quantitative or subjective vs. objective) or participants (e.g. expert vs. novice user). Additionally, several measures (e.g. usability heuristics, frequency of interactions or learning outcomes) are included in the framework (Garcia, & Jorge, 2006).

Evaluation of e-learning platforms requires the consideration of different criteria, including function and usability of the overall learning system in the context of the human, social and cultural aspects of the organization within which the framework is to be used (Colace, De Santo & Pietrosanto, 2006). Model 5 shows how the e-learning system functions are modeled and the relation between the three components of the e-

learning platforms that need to be considered when an evaluation of e-learning is conducted.



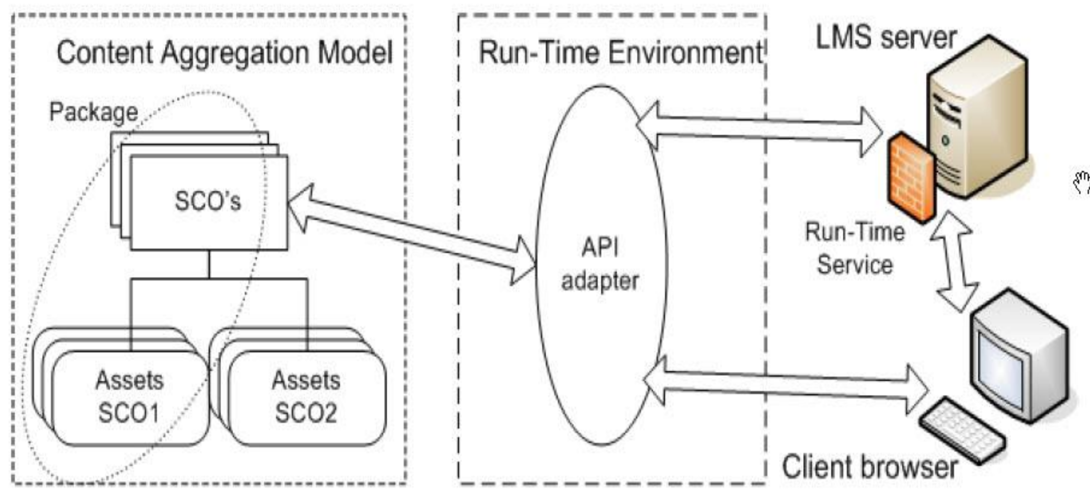
Model 5: E-learning Platform Evaluation Model (Garcia & Jorge, 2006)

In addition to the components, the evaluation of e-learning platforms requires evaluation of other things such as software package implementation, the supported teaching and delivering schema, etc. (Colace et al, 2006).

2.4.3.3. Benchmarks and SCORM Standards

Overall, any framework used should consider the benchmarks for evaluation that provide a formal reference in the analysis and comparison of e-learning platforms and Sharable Content Object Reference Model (SCORM) specifications (Garcia & Jorge, 2006). According to (Mackenzie, 2004), as cited in Garcia and Jorge (2006), the SCORM forms a “comprehensive picture of how a Learning Management System (LMS) might serve up Web-based learning content to learners in a standard way.” The main components of any SCORM include: the CAM (Content Aggregation Model) that defines a model for packaging learning content and the RTE (Run Time Environment) that

defines an interface for enabling communications between learning content and the system that launches it (e.g. LMS), as shown below in Model 6.



Model 6: SCORM Fundamentals (Garcia, & Jorge, 2006)

In fact, e-learning systems are multidisciplinary. Therefore, different researchers from computer science, information systems, psychology, education, educational technology, and health informatics have studied the evaluation of e-learning systems, depending on their fields of study and disciplines (Ozkan & Koseler, 2009).

According to Ozkan and Koseler (2009), the researchers from these fields have focused on different aspects when evaluating e-learning systems. For example, Islas et al, (2007) focused on the technology-based components of e-learning systems. Liaw, Haung and Chen (2007) studied the human factors of e-learning systems and user satisfaction. Still other researchers have focused on the assessment of effectiveness of e-learning course materials (Douglas & Van Der Vyver, 2004). Other researchers have studied and

investigated the importance of participant interaction in online environments (Gilbert, 2007) and the experience perspective of students only (Ozkan & Koseler, 2009).

A few studies have been found on health informatics where the researchers have evaluated the usability and usefulness of a e-learning module as used in WBT Manager for e-learning (Ruiz et al., 2006; Wilkinson, While & Roberts, 2008). Uniquely, this study was undertaken to evaluate the usability and usefulness of an e-learning module (as used in a WBT Manager for e-learning) for a patient clinical information system at a large Canadian healthcare organization. Thus, the research has practical implications in healthcare and contributes to health informatics. Based on this review, I proposed a framework for evaluation based on the usability and usefulness concepts that emerged as a user-centred evaluation method. These approach attempts to analyze and evaluate the way a user interacts with an information system with reference to two different, but at the same time related, aspects. The first aspect focuses on the interaction between user and content, while the second concentrates on the interaction between user and system features (Tsakonas & Papatheodorou, 2006).

I used a mixture of qualitative and quantitative methods for data collection and interpretation of the results from two distinct groups of participants, including experts and novice users. Specifically, this framework was used for evaluation of the MCEC-eLM, as used in the WBT Manager for e-Learning, for a patient clinical information system IT scheduling application at AHS. In the next section, the usability concept is reviewed.

2.5. Usability Concept

2.5.1. Introduction and Definitions

In health informatics, usability is broadly defined as the capacity a system to allow users to carry out their tasks safely, effectively, efficiently, and enjoyably (Kushniruk & Patel, 2004; Preece, Rogers & Sharp, 2002; Preece et al, 1994). In computer science and health informatics, usability is strongly related to quality (Kushniruk & Patel, 2004). Usability assesses how easy user interfaces are to use and it also refers to the methods for improving system ease-of-use during the design process (Debeve & Bele, 2008). Based on the term "utility", usability refers to the extent to which users can exploit the utility of the system (Dillon & Morris, 1996). In general, the de facto definition of usability is based on the "implicit assumption that users are rational agents, interacting with a system by using their knowledge and deriving information from the system's interactions to achieve their specific goals" (Arh & Blazic, 2008; Law & Blazic, 2004). Globally, the International Organization for Standardization, ISO 9241-11, has defined usability as the "extent to which a product (such as software) can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specific context of use" (Debeve & Bele, 2008). Relative to e-learning, from the user perspective, usability "relates to the development of interactive products that are easy to learn, effective to use, and enjoyable" (Adebesin et al., 2009).

2.5.2. Usability Measurement Criteria and Methods of Evaluation

2.5.2.1. Measurement Criteria

It has been shown that, based on the ISO standard definition, the evaluation of the usability of an application can be measured objectively in terms of effectiveness and

efficiency and subjectively in terms of satisfaction (Adebsen, De Villiers & Ssemugabi, 2009). Depending on the purpose and method of evaluation, researchers have assessed usability through different subjective quality components such as: learnability, efficiency of use, ease of recall, low error generation and subjective pleasure (Nielsen, 1993; Rogers, Patterson, Chapman & Render, 2005). According to Debeve & Bele (2008), Nielson's usability subjective quality criteria include:

1. Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the system?
2. Efficiency: Once users have learned the system, how quickly can they perform tasks?
3. Memorability: When users return to the system after a period of not using it, how easily can they re-establish proficiency?
4. Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
5. Satisfaction: To what extent is it a pleasure to use the system?

Debeve and Bele (2008) added "utility" to Nielson's list. They used the "utility" term to answer the following question: Does the system do what users need? Debeve and Bale (2008) described the word "utility" to mean effectiveness – producing a desired or intended result. In their presentation at the 43rd annual conference on Human Factors and Ergonomics, Dillon and Morris (1999) described "utility" as the technical capability of a tool to actually support tasks that the user wishes to perform.

2.5.2.2. Usability Evaluation Methods

Usability evaluation methods (UEMs) include various types, including analytical, expert heuristic evaluation, survey, observational, and experimental methods (Ssemugabi & De Villiers, 2007, p. 132). The UEMs are categorized into inspection and testing methods (Arh & Blazic, 2008; Kushniruk & Borycki, 2006).

Inspection methods are used for identifying usability problems and improving the usability of an interface design by checking it against established standards. Inspection methods include heuristic evaluation (HE), cognitive walkthrough (CW), and action analysis (Arh & Blazic, 2008).

Usability testing methods provide a direct way of observing how people use the system and their interaction with the interface. The most common usability testing methods involve video recording user interactions; think-aloud protocol analysis, field observation, and questionnaires (Arh & Blazic, 2008; Kushniruk & Patel, 2004). Unlike usability inspection methods, usability testing methods are conducted with end users (Arh & Blazic, 2008; Kushniruk & Borycki, 2006). The think-aloud usability testing method (THA) " involves having end users continuously thinking out loud while using the system, which makes it easier to identify the end users' major misconceptions" (Arh & Blazic, 2008). Usability testing methods can be used alone or in combination with usability inspection methods such as heuristic or cognitive walkthrough evaluation methods (Jaspers, 2008).

Kushniruk and Patel (2004) describe approaches to usability testing in more detail in "Cognitive and usability engineering methods for the evaluation of clinical information systems." According to Kushniruk and Patel (2004), usability testing refers to the

evaluation of information systems. It "involves testing of participants (i.e. subjects) who are representative of the target user population as they perform representative tasks using an information technology (e.g. physicians using a CPR system to record patient data) in a particular clinical context" (p. 59).

In addition to this, usability ensures patient safety. Usability testing "helps to reveal the organizational, design, and training adjustments necessary to make the system more useful, while reducing unintended side effects related to the change" (Rogers et al., 2005). Researchers have also used usability testing methods for improving "user satisfaction with health information systems in order to make user interactions with a computer system more efficient, effective and enjoyable in hopes that it would improve adoption and appropriation of the health information system" (Kushniruk, 2002; Borycki & Kushniruk, 2005).

More recently, researchers at University of Victoria have developed a cost-effective and rapid usability testing evaluation method. Researchers developed the "Low-Cost Rapid Usability Engineering" to "rapidly evaluate the usability and safety of healthcare information systems both in artificial mocked-up settings and in real clinical context (e.g. in hospital wards)" (Kushniruk & Borycki 2006).

In this study, I developed a framework for the evaluation of the usability and usefulness of an e-learning module as used in a WBT Manager for e-learning for a patient clinical information system IT scheduling application. In this framework, usability inspection and testing methods are combined. I adapted and used the Low-cost Rapid Usability Engineering (LCRUE) and Cognitive Task Analysis (CTA). I combined these approaches with a conventional usability subjective evaluation approach. I combined the

LCRUE and CTA with the Software Usability Measurement Inventory (SUMI) approach. The results of the analysis were inspected against custom-designed heuristics usability evaluation criteria, based on Nielsen's guidelines, developed by Ssemugabi and De Villiers (2007). Before reviewing the Low-cost Rapid Usability Engineering, CTA, and SUMI, conventional and modern or proactive usability evaluation methods are reviewed in the next section.

2.5.3. Conventional Reactive vs. Modern Proactive Usability Evaluation Methods

Many methods have been used for the evaluation of the usability of health information systems. Questionnaire-based survey methods have been identified as the most common conventional usability evaluation approach to evaluate health information system. This approach is based on survey methods and it has many advantages, including ease of distributing questionnaires to a large number of users and automated analysis of results and quick feedback. However, numerous disadvantages have limited its use to the evaluation of health information systems alone. For example, questionnaire results don't reveal how a technology fits into the context of actual system use, nor do they identify new or emergent issues in the use of a system that the investigators haven't thought of. In addition to this, the results are dependent on subjects' recall of their experience for using the system. More importantly, when compared with video-recorded proactive methods, the results of the questionnaire alone often don't reflect what the user actually did in practice for using a system, as it would be captured on video (Kushniruk & Patel, 2004; Kushniruk, Patel & Cimino, 1997). According to Kushniruk and Patel (2004), the use of interviews or questionnaires alone may be insufficient for revealing how health care

workers actually use a system to perform a complex task and may need to be complemented by using other methods (Kushniruk & Patel, 2004).

Unlike conventional usability methods, modern usability evaluation methods such as usability inspection and usability testing methods have emerged from theories and methods from cognitive science and the emerging field of usability engineering (Kushniruk & Patel, 2004). Modern usability evaluation methods can be used as, “a part of the formative evaluation of systems during their iterative development, and can also complement conventional methods used in summative system evaluation of completed systems” (Kushniruk & Patel, 2004). Modern usability evaluation methods for testing interactive health technologies include the heuristic evaluation, the cognitive walkthrough, and the think-aloud approach. They are all used to evaluate an interactive system’s design against user requirements and can be applied to identify usability problems early in a system’s design as part of system development (Jaspers, 2009).

For all these reasons, the author conceptualized a framework in which usability testing and think-aloud methods were used and combined with a conventional usability evaluation method. In this framework the Low-cost Rapid Usability Engineering and modern proactive Cognitive Task Analysis were adapted and combined with the Software Usability Measurement Inventory (SUMI) method for evaluation of the usability and usefulness of an e-learning module, as used in a WBT Manager, for a patient clinical information system IT scheduling application. The results obtained from the data collected by these methods were analyzed and interpreted against custom-designed heuristics usability evaluation criteria for e-learning, based on Nielsen’s heuristic evaluation criteria, adapted from Ssemugabi & De Villiers (2007).

In this study, we drew on the strengths of each method in one conceptualized framework to effectively evaluate the usability and usefulness of the system under study. The Low-cost Rapid Usability Engineering will be reviewed next.

2.5.4. Low-cost Rapid Usability Engineering

Rapid Low-Cost Usability Engineering testing method was developed to rapidly evaluate the usability of numerous health information technologies. According to Kushniruk and Borycki (2006), Kushniruk and Patel (2004) and Kushniruk, Patel and Cimino (1997), this method has been used to rapidly answer concerns such as: “How can we ensure the healthcare information systems that we develop are suitable, meet information and workflow needs, and are safe?” Usability testing involves observing representative end users of a specific system as they carry out representative tasks using the system. The observation of users interacting with the system involves video recording of all user’s interactions with the system, including recording of their physical behaviour and all computer screens. Users are asked to “think aloud” or verbalize their thoughts while being videotaped and audio recorded. A representative sample of about 10 to 15 participants is typically required to identify most surface level usability issues (although sample size may vary depending on the nature of the study). A small number of three to four participants may also be sufficient in some cases (Kushniruk, Patel & Cimino, 1997). Equipment for data collection during usability testing includes: a video camera, microphone, screen cam, and screenshot software. The equipment and setting costs associated with “Low-Cost Rapid Usability Engineering” methods are described in the paper entitled “Low-Cost Rapid Usability Engineering: Designing and customizing usable healthcare information systems” (Kushniruk & Borycki, 2006). This method is

used to identify problems related to user interface (UI) issues, such as a lack of interface consistency, problems in representing time sequences, and issues in matching user-specific terms to computer terms. Usability testing can also be used at different points within the systems development life cycle (SDLC) of the healthcare information systems, "ranging from selection of systems to design and later testing and/or customization of emerging IT solutions" (p. 102). The analysis of the data can involve both informal review and formal analysis. The analysis involves coding themes that emerge from the video annotation of the movie file using video editing software to facilitate the analysis process. Informal analysis involves playing back the movies of user interactions to identify specific usability problems in which users are unable to perform the requested tasks. The intent of this method is to provide feedback and useful information to improve system design, deployment or customization in an efficient and rapid manner. The method will be used to rapidly test the usability of an e-learning module as used in a WBT Manager for e-Learning for a patient clinical information system IT scheduling. This application is used to manage patient identification for waitlists and schedule appointments in outpatient clinics at Alberta Health Services (AHS).

Figure 1: Basic Equipment Needed for Conducting Portable Usability Tests
(Low-Cost Rapid Usability Engineering Technique (Kushniruk & Borycki 2006, p.100)

2.5.5. Software Usability Measurement Inventory (SUMI)

According to Arh and Blazic (2008), the SUMI method was mentioned in the ISO 9241 standard as a recognized way of testing user satisfaction. This questionnaire requires ten minutes to complete. However, users with no previous experience may require additional time. The data collected by the SUMI questionnaire is analyzed using a dedicated software program called SUMISCO, which comes with the SUMI evaluation package. SUMISCO is able to analyze and compare the results to a standardized database. The software calculates the mean score and the standard deviation of the scores and compares them to a standardized mean and standard deviation of 50 and 10 respectively in a central database for SUMI questionnaires hosted by the Human Factors Research Group (HFRG) at University College Cork in the UK. The system that scores in the range of 40 to 60 is comparable in terms of usability to the data in the standardized

database that does not include a score below and above this range. The SUMI method is a solution to the recurring problem of measuring users' perceptions of the usability of software. It provides a valid and reliable method for the comparison of competing products and differing versions of the same product, as well as providing diagnostics and information that can be used to improve the software in the future. SUMI provides an objective way of assessing user satisfaction with software. SUMI is considered to be a generic usability tool and is comprised of a validated 50-item paper-based questionnaire in which respondents score each item on a three-point scale (i.e. agree, undecided, disagree) (pp. 175 - 181).

> The SUMI method has been hailed as the de facto industry standard questionnaire for analyzing users' responses to software. It is a commercially available questionnaire for the assessment of the usability of software which has been developed, validated and standardized on an international basis. SUMI consists of 5 statements to which the user has to reply with "agree", "Don't Know", or "Disagree". SUMI gives reliable results with as few as 10 users (Kirakowski and Corbett, 1993p. 110).

In a recent study that evaluated the usability of e-learning content as used in a learning management system, Debeve and Bele (2008) found that "usability testing of e-learning content as used in two learning management systems" could be done using the SUMI. As described by Debeve and Bele (2008), there are several methods for studying usability, including: heuristic evaluation by Nielsen, SUMI (Software Usability Measurement Inventory), automatic evaluation with tools (e.g. Bobby/Webcast) and field

observation (Quick and Dirty Evaluation). Debeve and Bele (2008) used the SUMI method for testing e-learning systems because it is a fast way of testing and does not require a large number of end users. According to Kirakowski and Corbett (1993), a minimum number of ten users are required to be able to use the SUMI inventory. As described by Debeve and Bele (2008), the dimensions of the inventory include: (1) efficiency (the user's feeling that the software is quick and economical), (2) affect (the user's emotional feeling that the software is stimulating and pleasant), (3) helpfulness (the user's perception that the software communicates in a helpful way), (4) control (the user's feeling that the software is responding in a normal and consistent way and assists him in the event of errors), and (5) learnability (the ease with which the user becomes familiar with the software) (p. 5).

According to Wikinson, While and Robrts (2009), there are numerous instruments that can be used to measure learners' experience, attitude and satisfaction with e-learning in healthcare. Although the SUMI questionnaire has been used for many years, it can still be used as a quick and simple tool for the global and general evaluation of e-learning content where end users are concerned (Debeve & Bele, 2008). Researchers have argued that the SUMI questionnaire can be effectively used to assess usability of an e-learning software system in healthcare (Argentero, Mazzoleni, Presciutti & Giorgi, 2009). For this reason, the SUMI questionnaire, the Low-cost Rapid Usability Engineering method and Cognitive Task Analysis were used to evaluate the usability and user satisfaction with an e-learning module for a patient clinical information system IT scheduling application, as used in a WBT Manager for e-Learning. In the next section of this thesis a review of theory relevant to Cognitive Task Analysis will be presented.

2.5.6. Cognitive Task Analysis (CTA)

Cognitive Task Analysis (CTA) has emerged as a new approach to assessing the impact of system applications on human reasoning and decision-making processes. Cognitive Task Analysis will help identify the characteristics of the system that are concerns prior to implementation (Kushniruk & Patel, 2003). There are different approaches to CTA (Gorden & Grill, 1997).

According to Kushniruk and Patel (2004), CTA includes development of a task hierarchy for individual activities and observation of subjects with different levels of expertise while performing their tasks.

Researchers have identified three major CTA techniques: (1) observations and interviews technique that involves watching experts and talking with them, (2) process tracing technique that captures an expert's performance using a think-aloud protocol or subsequent recall, and (3) conceptual technique, in which structured and interrelated representations of relevant concepts within a domain are produced (Clark, Feldon, Van Merrienboer, Yates & Early, 2006). According to Clark et al. (2006), CTA is most often used to develop expert systems, clarify job or task competence, and attain performance goals.

Execution of CTA may involve video recording and includes a number of specific steps (Kushniruk, Patel & Cimino, 1997; Ping Li, 2005). The CTA can be used to provide the producers, developers, and the designers of an e-learning system with feedback and guidance to produce a usable system (Kushniruk & Patel, 2004; Clark et al., 2006). The review of literature and the theory relevant to heuristic evaluation are presented in the next section.

2.5.7. Usability Heuristic Evaluation

Heuristic evaluation (HE) is defined as "a usability inspection method in which the system is evaluated on the basis of well-tested design principles such as visibility of system status, user control and freedom, consistency and standards, flexibility, and efficiency of use" (Kushniruk & Patel, 2004).

Nielsen developed the HE method. According to Nielsen (1994), the evaluation is guided by a set of usability principles known as heuristics. Expert evaluators determine whether a system conforms to these usability principles and identify specific usability problems in the system. The method is fast, inexpensive, and easy to perform and can result in major improvements to user interfaces. Three to five evaluators are sufficient to identify 65 – 75% of the usability problems (Ssemugabi & De Villiers, 2007).

According to Kushniruk and Patel (2004), heuristic evaluation is conducted in a series of phases. The phases include: (1) A list of heuristics is given to the analysts who use them in evaluating the system or the interface, (2) Analysts "step through" or inspect the user interface or system for heuristic violations, (3) Each analyst independently evaluates the user interface and generates a list of heuristic violations which can be compiled into a single list and (4) The results of the evaluation are summarized and presented to the design team along with recommendations (p. 71). The severity of the usability problems that are evaluated are based on Nielsen's severity scale: 0 = Not a usability problem; 1 = Cosmetic problem only; 2 = Minor usability problem; 3 = Major usability problem, important to fix, so should be given a high priority; and 4 = usability catastrophe, imperative to fix this before product can be released. According to Kushniruk and Patel (2004), the purpose of rating each heuristic violation in terms

severity is to help designers in prioritizing aspects of the interface that need fixing (p. 73).

2.5.8. Usability Evaluation of E-learning

The goal of e-learning is to offer users the opportunity to become skilful and to acquire knowledge in a new domain (Costabile, et al. 2005). Costabile and colleagues argued that the evaluation of educational software must consider its pedagogic effectiveness and its usability. In addition, the interface design should: (1) consider the ways students learn and (2) provide good usability for natural and intuitive interactions of students with the software. In e-learning, users need interfaces that support learning to do their tasks rather than interfaces that support doing a single task alone (His & Soloway, 1998). Researchers have found that a poorly designed user interface will make users spend more time trying to understand software functionality instead of understanding the learning content (Costabile, et al. 2005). Therefore, researchers recognized and recommended the need for an effective evaluation method for e-learning software that takes into account both the usability and learning effectiveness of the technology. In other words, the two dimensions of e-learning, the platform and the didactic module, should be considered (Costabile et al. 2005). According to Costabile et al. (2005), the e-learning platform is a complex environment. It includes a number of integrated tools and services for teaching, learning, communicating and managing learning material. The didactic module includes the educational content provided through the platform (the container):

> Usability attributes for a platform generally differ from those of a specific didactic module (content), since different features must be considered. However, some characteristics of the content provided

> through a platform are bound to functionalities of the platform itself. As a consequence, evaluating an e-learning application involves such two components. (Costabile et al., 2005, p. 5)

From a user-centred perspective, the evaluation of the usability of e-learning applications should include three components: the interfaces, usability and interaction in terms of human-computer interaction (HCI), and pedagogy and learning in terms of education (Ssemugabi & De Villiers, 2007, p.132). In the next section, the researcher reviews the theory relevant to the usefulness concept and user acceptance testing.

2.6. Conventional vs. Proactive User Acceptance Testing

In this section of the thesis a short review and theory relative to conventional software testing and proactive user acceptance testing are reviewed. The difference between user acceptance testing from a technical point of view (system requirements) and a user's acceptance of technology from an organizational business point of view (owner and user requirements) are also discussed in this section. Perceived e-learning "usefulness" is viewed by the researcher as part of user acceptance testing which is originated from the technology acceptance model (TAM) (Holden & Karsh, 2010). Therefore, conventional software user testing is not a part of the researcher's focus. However, the level of e-learning module acceptance from end user perspectives is a part of the evaluation conducted in this study. In the next section, I will begin with a short review of conventional software testing.

2.6.1. Conventional User Acceptance Testing

There are four main types of conventional software testing: unit, integration, system, and acceptance testing. Based on the Institute of Electrical and Electronic

Engineers (IEEE) (2001) descriptions, user acceptance testing (UAT) "checks the system behaviour against the customer's requirements (the ''contract''); the customers undertake (or specify) typical tasks to check their requirements" (IEEE, 2001, p. 76 as cited by Klein, 2003, p. 92). According to Klein (2003), software system testing and user acceptance testing are sometimes performed and documented in the same test plan (p. 92).

There are three main documents included in UAT testing: Functional Requirements Specifications (FRS), traceability matrix, and test scripts (Klein, 2003). According to Klein, the FRS details the user and system requirements. The FRS describes what the system will do, not how it will do it (Muirhead, 2000, p.8, as cited in Klein, 2003, p. 93). According to Klein, the FRS document is to be submitted to the system development group after it is reviewed and approved by appropriate representatives of a user community. Based on the approved FRS document, a development group can re-design existing software, develop new software, or select vendor software that best meets functional requirements (p. 93). A traceability matrix is prepared based on a FRS document and includes a listing for each requirement, a reference to where the requirement is found in the FRS, and a reference to where the requirement is tested in the user acceptance testing plan (UATP). The UATP consists of the following components as listed by Klein (2003):

- Pre-Execution Signature page
- Post-Execution Signature page
- Document Revision page
- List identifying the people responsible for the various activities

- List identifying the software and hardware
- Security Precautions
- List of Assumptions, Exclusions, and Limitations
- Procedure for executing the UATP
- Traceability Matrix
- Test Scripts
- Description of the data that will be used in the testing
- Summary of the failures that were encountered during testing and how the errors were resolved.
- Acceptance criteria
- Acceptance memo with signature indicating acceptance of the system or upgrade
- Reference to related documents

According to Klein (2003), the test scripts are an ordered sequence of tests and should include:

- A unique identifier for each test
- A description of the test
- Prerequisites required for conducting the test including data
- The activity required to perform the test
- The expected result
- Objective evidence of actual results
- An indication of whether the test passed or failed (subjective assessment)

- An area for signing and dating by the tester

In addition to the three major parts of the user acceptance testing, three things must be in place before a system is put into production: (1) system user information, (2) standard operating procedures (SOPs), and (3) training needs to be provided for the users prior to implementation (Klein, 2003). In the following section, the review and the theory relevant to the usefulness concept is presented.

2.6.2. Usability and Usefulness of E-Learning Technology

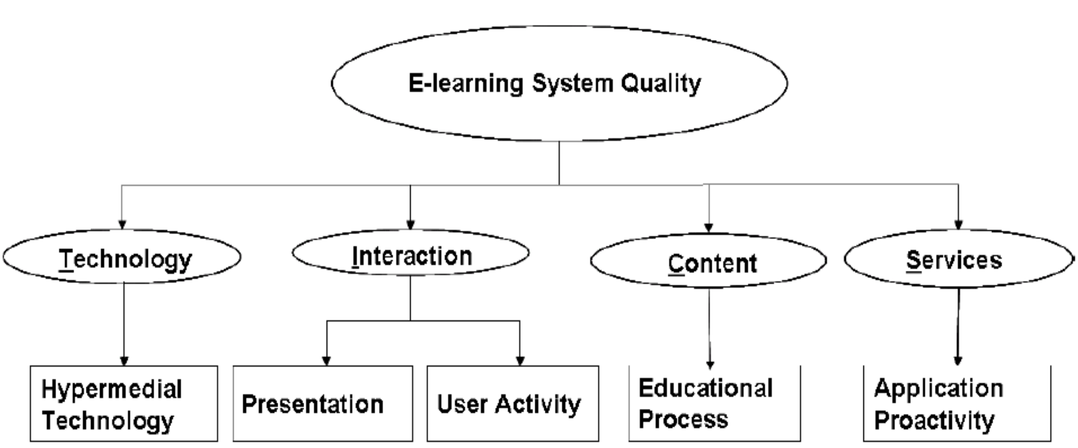
Usability is defined in ISO 9241-11 (ISO 1993c) as “the effectiveness, efficiency and satisfaction with which specific users achieve specified goals in particular environments” (Bevan & Macleod, 1994). Usability is a concept that can be used to examine interaction between a user, a computer, and a computer interface. As a construct, it has multiple components: learnability, efficiency of use, ease of recall, low error generation, and subjective pleasure (Rogers, Patterson, Chapman & Render, 2005). According to De Kock et al. (2009), effectiveness and efficiency are objective measurements of usability that are measured by “conducting tests to measure the time, number of errors and completion rate on specific task.” User satisfaction [User Acceptance] is a subjective measurement of the usability that is measured with post-test questionnaires (p. 124).

Part of an end user-centred usability testing plan includes user testing (Rogers et al., 2005). From an organizational perspective, user acceptance testing determines how end users react to a system that they will use to fulfill the business requirements of an organization. Hence, usability testing resolves problems around organizational issues (Holden & Karsh 2009). User acceptance satisfaction is defined broadly as an

"individual's psychological state with regard to his or her voluntary and intended use of technology" (Lin, Hu & Chen, 2011). User acceptance satisfaction measures individuals' perceived usefulness of "health IT use leading to enhancement or gains in job performance" (Holden & Karsh, 2010). In other words, usefulness is measured by the degree of user acceptance of information technology (subjective beliefs) in terms of satisfaction with "perceived usefulness (PU)" and "perceived ease of use (PEU)" that were originated as part of the Technology Acceptance Model (TAM) (Wen-Chin, Chyuan & Chin-Chao, 2009). Perceived usefulness (PU) and perceived ease of use (PEU) are the main predictors of system usage (Tsakonas & Papatheodorou, 2006). Usefulness is defined as "the degree to which a specific information item will serve the information needs of the user" and it is "an extension of the concept of relevance," which is determined subjectively by measuring the inherent attributes of usefulness criteria or resources (Tsakonas & Papatheodorou, 2006). According to Tsakonas and Papatheodorou (2006), p. 403, the usefulness criteria attributes, as listed and defined, include:

1. Relevance denotes how [topically] the content corresponds to the work task.
2. Format is a resource attribute that connects with the user's work practice and/or the available technological infrastructure.
3. Reliability investigates how credible the resource is and how well it satisfies present and future aspects of the work task.
4. Level refers to the various representations of information provided, such as abstracts, full text, etc.
5. Timeliness investigates how current the information resource is and how well it will satisfy the information need.

Relative to e-learning, evaluation of the usability of e-learning applications addresses interfaces, usability and interaction from a human-computer interaction (HCI), and pedagogical perspective (Ssemugabi & De Villiers, 2007). A successful system implementation depends on the quality of the system used and user perceptions (e.g. if the system is useful and beneficial to a user's practice). From this perspective, based on ISO 9126 (1991), quality is defined as "the totality of characteristics of an entity that hold on its ability to satisfy stated and implied user needs" (Lannzilotti et al., 2006). Lanzilotti, Ardito and Costabile (2006) construct a framework for an e-learning quality system. The framework, as illustrated in Model 7, is based on the "extent with which technology, interaction, content and offered services comply with expectations of learners and teachers by allowing them to learn/teach with satisfactions" (p. 46).



Model 7: Quality Aspects of E-learning System (Lanzilotti, Ardito & Constabile, 2006, p. 46)

It has been argued that a successful evaluation of e-learning cannot be performed based on a single proxy construct (e.g. user satisfaction) or a single-item scale (Wang et

al, 2007). In a recent study, Wang and colleagues (2007) constructed a multi-dimensional measure for assessing e-learning system success (ELSS). The 34-item ELSS instrument consists of six major factors for success at an organizational level. These factors include: System Quality, Information Quality, Service Use, User Satisfaction, and Net Benefit (p. 1803). Wang et al, (2007) argued that ELSS provides not only an overall assessment but also has the capability to investigate aspects of an e-learning system that are most problematic. According to Grutzner, Weibelzahl and Waterson (2004), several dimensions affected the quality of e-learning systems:

> The content of learning materials; the presentation of these materials; the pedagogic content, i.e., the way in which materials are taught; the overall functionality of courseware life-cycle to ensure high quality of the final product and thus to facilitate learning (Lanzilotti, Ardito & Costabile, 2006, p. 45)

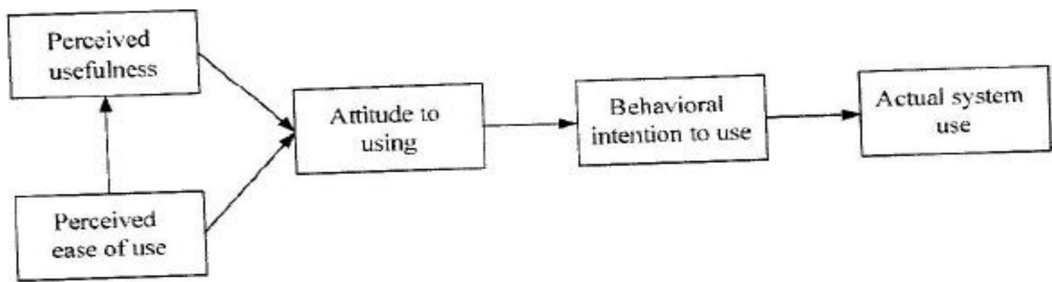
Thus, an effective e-learning system evaluation includes these dimensions. Despite the advancement of e-learning websites, "usability, educational effectiveness, practical efficiency, and general level of satisfaction with such websites on the Internet are still not yet well known or understood" (Arh, & Blazic, 2008; Badii, 2001). In the next section, theory relevant to the Technology Acceptance Model (TAM) is reviewed.

2.6.2.1. Technology Acceptance Model (TAM) and Usefulness Concept

User acceptance testing (UAT) or satisfaction is broadly referred to as "an individual's psychological state with regard to his or her voluntary and intended use of a technology" (Lin, Hu & Chen, 2004). System usefulness is predicted by perceived usefulness (PU) and perceived ease of use (PEU) originated from the Technology

Acceptance Model (TAM) and measured with a post-test questionnaire (De Kock et al., 2009; Tsakonas & Papatheodorou, 2006). The Technology Acceptance Model proposed by Davis is based on the theory of reasoned action (TRA), which has been used to predict and explain human behaviour (Wu et al., 2008). The TRA is a general social-psychological/behavioural theory that has been proven to be useful for understanding a variety of behaviours, such as voting, exercise, and condom use (Holden & Karsh, 2010). An illustration of TAM is shown below in Model 8. The original TAM was based in interrelated factors that included factors related to perceived usefulness (PU), perceived ease of use (PEU), attitude toward using a system, behaviour intentional to use, actual system use (Wu et al., 2008), and external factors which include user experience and skill (Wen-Chih et al., 2008). Wu et al, (2008) described the correlation between the different parts of the TAM as follows:

> Behavioural intention to use is defined as the individual's interest in using the system for future work. Perceived usefulness (PU) is defined as the degree to which a person believes that using a particular system would enhance his or her job performance, while perceived ease of use is defined as the degree to which a person believers that using a particular system would be free of effort. Perceived usefulness has a direct effect on behavioural intension to use. Perceived ease of use has a direct effect on perceived usefulness and behavioural intension to use (p. 124).



Model 8: The Original Technology Acceptance Model (Wu et al., 2008, p. 123)

Relative to healthcare, perceived usefulness (PU) is defined as “health IT use leading to enhancement or gains in job performance” (Holden & Karsh, 2010). Measures of key constructs that are part of TAM are summarized by Holden and Karsh (2010) in “The technology acceptance model: its past and its future in health care.” In this study, a conceptualized evaluation framework was proposed for evaluation of the usability and usefulness of an e-learning module for a patient clinical information system IT scheduling application, as used in a WBT Manager for e-Learning. In the next chapter, the research purpose, questions, and objectives will be discussed.

CHAPTER 3: RESEARCH PURPOSE, QUESTIONS AND OBJECTIVES

3.1. Research Purpose

The purpose of this study was to evaluate the usability and usefulness of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC–eLM) for a patient clinical information system IT scheduling application (as used in AHS's.WBT Manager for e-Learning). The goal of this module was to provide employees with core competencies for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments for outpatient clinics. The study also investigated the effectiveness of Low-Cost Rapid Usability Engineering (LRUE) Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE) criteria, combined with the Software Usability Measurement Inventory (SUMI) for evaluating the usability and usefulness of the MCEC-eLM.

3.2. Research Questions

To fulfill the purpose of this study, the following questions will be answered:

1. Does the MCER-eLM (as used in AHS's WBT Manager for e-Learning) effectively and efficiently provide learners with core competencies needed for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments?
2. Was the MCER-eLM acceptable, useful, and did it satisfy the real-world business requirements for obtaining usernames and passwords for accessing

the patient clinical information system IT scheduling application in a real production environment?

3. How effective were the modern Low-Cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE) criteria, combined with the Software Usability Measurement Inventory (SUMI) in evaluating the usability and usefulness of the MCEC-eLM (as used in AHS' WBT Manager for e-Learning)?
4. How did the different methods employed in this study compared in terms of results obtained by each and their effectiveness?

3.3. Research Objectives

The major objectives of this study include the following:

- To determine the effectiveness and efficiency of MCER-eLM (as used in AHS' WBT Manager for e-Learning) in providing its users with core competencies for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics.
- To determine whether the real-world business requirements for obtaining usernames and passwords for accessing the patient clinical information system IT scheduling application in a real production environment have been met.
- To investigate the effectiveness of LCRUE, CTA and HE when combined with the SUMI questionnaire for evaluation of the usability and usefulness of the MCEC-eLM as used in AHS' WBT Manager for e-Learning.

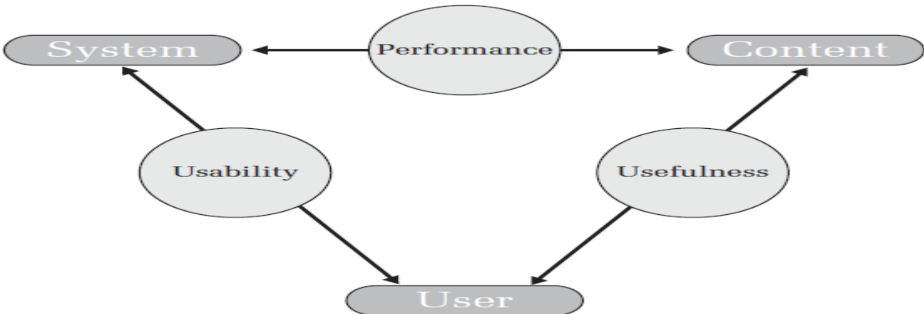
- To compare the differing methods of usability testing and inspection methods used in this study.
- To identify objective evidence about problematic usability issues.
- To provide beneficial feedback and recommendations based on objective and subjective evidence identified from the comments of experts, to developers, designers and strategic planners of e-learning solutions in AHS for improving the content and the general interface usability (GIU) before it will be released in a real production environment.
- To provide opportunities for understanding how the e-learning module, as interfaced in a WBT Manager, actually functioned, by demonstrating how the end users accommodated and adapted to it to perform their tasks.
- To provide feedback to a research-based process to offer further understanding as to how e-learning modules for a patient clinical information system as used in WBT Manager for e-Learning could facilitate learning and improve the proficiency and competencies of the end users for using patient clinical information system IT applications in a real work environment.
- To facilitate organizational change acceptance and successful implementation of high quality and “expert” e-learning modules for future initiatives of patient clinical information system IT applications.

CHAPTER 4: RESEARCH METHODOLOGY

4.1. Research Design and Evaluation Framework Conceptualization

The purpose of this study was to evaluate the usability and usefulness of the Millennium Clinibase Encounter Creation e-learning Module (MCEC–eLM) for a patient clinical information system IT scheduling application (as used in AHS's WBT Manager for e-Learning). The goal of this module is to provide employees with core competencies for using the patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics. To fulfill the purpose of this study, an evaluation framework was developed and conceptualized based on the usability and usefulness concepts reviewed from the literature.

The framework was built around the integration among three core components: users, system and content as modeled by Tsakonas and Papatheodorou (2006), as illustrated below in Model 9 constructed by Tsakonas and Paptheodorou, (2006).



Model 9: Association in the Interactions Triptych Framework (Tsakonas & Papatheodorou, 2006, p. 402)

Since this study was part of a quality improvement process for producing an effective e-learning system, a quality model for e-learning system (Lanzilotti et al, 2006) was adapted in an attempt to achieve a high quality e-learning module taking into consideration the four dimensions of the model: technology, interaction, content and services (see Model 7).

Usability is measured objectively in terms of effectiveness and efficiency (user performance) and subjectively in term of user satisfaction (system performance) (Bevan & Macleod, 1994; Tsakonas & Papatheodorou, 2006). Effectiveness answers the question of whether users perform their tasks. Efficiency answers what resources users must expend to achieve a given outcome, such as time, effort, etc. Satisfaction answers how well users like the application (Dillon & Morris, 1999). Satisfaction is measured with a post-test questionnaire (De Kock et al, 2009).

According to Tsakonas and Papatheodorou (2006), usefulness refers to, “the degree to which a specific information item will service the relevance of information needs of the user”. Usefulness is subjectively determined by: inherent attributes of the resource, and its applicability to specific information seeking contexts and work tasks and goals (Tsakonas & Papatheodorou, 2006). The quality attributes of usefulness include: relevance, format, reliability, level of response and timeliness (p. 403).

I adapted three proactive usability testing and inspection methods: Low-cost Rapid Usability Engineering (LCRUE) (Kushniruk & Borycki, 2006), Cognitive Task Analysis (CTA) (Clark, Feldon, van Merrienboer, Yates & Early, 2006; Kushniruk & Patel 2004; Ping Li, 2005) and Heuristic Evaluation (HE) criteria for e-learning

(Ssemugabi & De Villiers, 2007). The proactive usability testing and inspection methods are combined with a conventional usability evaluation method. I used the Software Usability Measurement Inventory (SUMI) questionnaire as a conventional method to subjectively evaluate the usability and usefulness of the e-learning system based on five quality criteria or attributes: efficiency, affect, helpfulness, control and learnability (Kirakowski, Proteous & Corbett, 1992; Kirakowski & Corbett, 1993; Bevan& Macleod, 1994; Anjaneyulu, Singer & Harding, 1998; Debeve, 2008; Arh & Blazic, 2008).

Based on the above assumptions reviewed from the literature, I developed a methodological framework to measure specific objectives listed in Chapter 3 in two groups: frontline users and informatics consultant users.

4.2. Participants

All of the participants who participated in this study met the following criteria:

- They were adults that needed to take part in Millennium Clinibase Encounter Creation e-Learning Module training for patient clinical information system as used in AHS' WBT Manager for e-Learning.
- They voluntarily agreed to participate in this study.
- They were 18 years of age or older.
- They fluently read, write and speak English.
- They were willing to sign a written consent (Appendix E).
- They possessed basic computer and Internet access skills.

4.3. Sampling and Stratification of Groups

A convenience sample was used. The method was used to identify "typical" users from a broad staff (Leedy and Ormrod, 2005). A total number of 19 individuals

participated. Fourteen frontline users and five informatics consultant users participated. The number of participants in each group was sufficient to fulfill sample size requirements of the SUMI questionnaire and for usability testing and evaluation to take place (Kushniruk & Patel, 2004; Kushniruk & Borycki, 2006; Lewis, 1994: Nielsen, 1993; Kirakowski & Corbett, 1993; Debeve & Bele, 2008: Kushniruk, Patel & Cimino, 1997). The “frontline” users group were included: secretaries, clerks, nurses, and laboratory technicians from different departments and hospitals at AHS. The informatics consultant users group were technology experts. The participants in this group were asked to participate as they are able to identify problematic issues using their skills, knowledge and expertise in the area of usability.

4.4. Participant Recruitment

Participants were recruited using the following method: Potential participants were recruited from adult employees who had taken part in an e-learning training course to learn the core features and functionalities of a patient clinical information system IT scheduling application. The e-learning module for this course was named “Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM).” The goal of this module was to provide employees with core competencies and to fulfill IT Access and Security requirements (Appendix: F) to obtain usernames and passwords for using the patient clinical information system IT scheduling application in managing patient identification and scheduling patient appointments in outpatient clinics at AHS in a real production environment (Kitchin, personal communication, 2011).

Then the Research Coordinator sent an invitation letter (Appendix: D) and consent form (Appendix E) to each potential participant. If participants were interested in the study, they came to book appointments.

4.5. Setting

The research took place in two staff training rooms in Foothills Medical Centre, South Tower, and Quarry Park. The rooms where the research took place had the following set up:

The first room (Figure 2) was set to accommodate a larger number of participants. Each participant was provided with a computer desk and chair. The room is equipped with a stationary storage unit, printer and overhead projector screen. This room was booked for the (frontline users) participants.

The second room (Figure 3) was set to accommodate a smaller number of participants. The researcher used this room to set up the equipment for rapid usability testing and observation of the informatics consultant users. The room was equipped with a desk, chair, projector, projector screen, telephone, Sony video camera, laptop with installed Hypercam software, and audio headphone set.

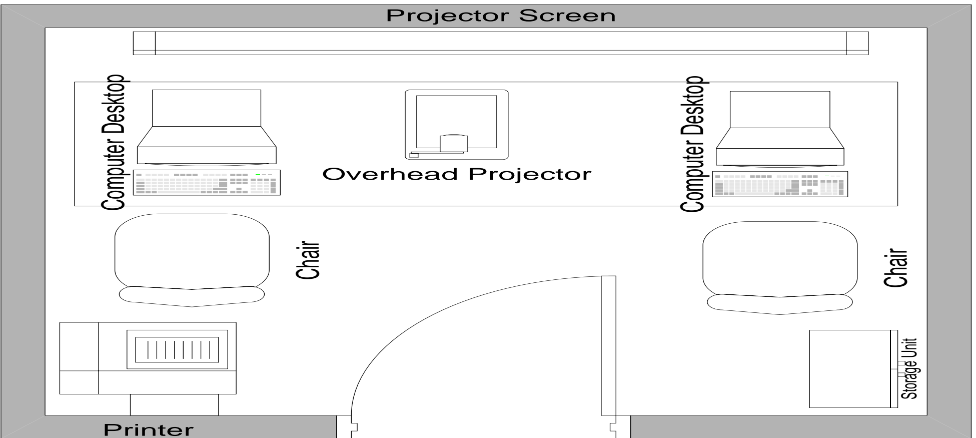


Figure 2: Room Setting for Frontline Users

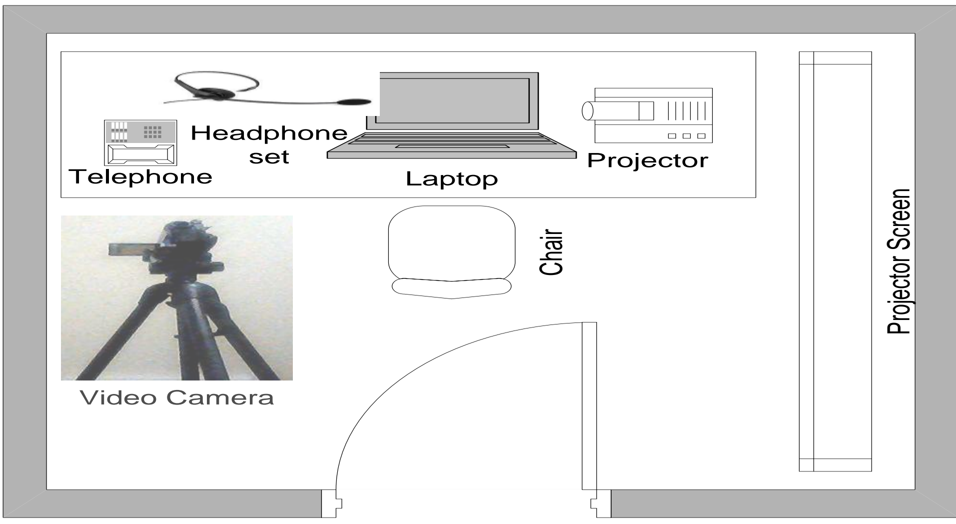


Figure 3: Room Setting for Informatics Consultant Users

4.6. Procedures

The study was conducted in the following manner. Both frontline users and informatics consultant users participated in steps 1-7 described below. As will be described, informatics consultant users additionally underwent usability testing upon completion of steps 1-7:

1. On the day of testing, frontline users and informatics consultant users came to their booked appointments.
2. Before started testing, all participants were asked to sign their invitation letters and consent forms, (Appendix D) and (Appendix E) respectively.
3. After the consent was signed, the participants were asked to log on to WBT Manager for e-Learning using usernames and passwords provided in the

testing rooms by the Research Coordinator. Participants were provided with an instruction sheet showing how to log on to WBT Manager for e-Learning (Appendix P) and to access the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) and the Millennium Clinibase Encounter Creation e-Learning Module Core Competency Assessment (MCEC-eLM/CCA) as used in AHS' WBT Manager for e-Learning.

4. After the participant logged on to the WBT Manager for e-Learning, the participant was asked to work with the MCEC-eLM and to complete the MCEC-eLM/CCA (see Appendix Q). After finishing the lessons in the module and the exercise workbook tasks (see Appendix G). The MCEC-eLM was divided into four topics: (1) Introduction to Clinibase (2) Clinibase Navigation (3) Clinibase Outpatient Functionality and (4) Case Management and Reports. The goal of the module was to provide employees with core competencies needed for using the patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments for outpatient clinics. The participants finished the module's lessons and workbook tasks within 60 minutes. The participants also finished a knowledge-based core competency assessment at the end of the module that took approximately 30 minutes. The MCEC-eLM/CCA was composed of 20 competency questions that included true and false questions, matching questions and scenarios. The respondents were expected to pass the assessment with a minimum average performance score of 80% to fulfill the IT Access and Security requirements (see Appendix F)

and to obtain usernames and passwords to use the patient clinical information system IT scheduling application in a production environment. The participants were also provided with a supportive placemat (Appendix H) to help them use the system if they needed the help.

5. After each participant finished the MCEC-eLM and completed the MCEC-eLM/CCA, their interaction data were aggregated and stored in the WBT Manager for e-Learning. The WBT Manager for e-Learning generated a detailed WBT report (see example in Appendix O. According to Thomson (personal communication, e-mail, August 12, 2011), the WBT report provides useful information that includes a participant's ID, department, job code, site, manager, course result, date, time, course completed (or attempted), time spent in the lesson or assessment (test), scores on the test and how many attempts it took to pass the test. In addition, the WBT Manager for e-Learning generates a specialized "Interaction Data" report for lessons within the e-learning module. The "Interaction Data" feature was used to gather more specific information about lessons, such as correct or incorrect responses to each question. This was to determine if there were specific questions that users were having difficulties with and also to evaluate e-learning and compare user responses question by question.
6. The participants were then asked to complete the user demographic questionnaire. As shown in Appendix I, the demographic questionnaire is composed of six short questions. It was used to gather information about the participants' age, sex, professional status, professional location, Internet and

computer use and the purpose of completing an e-learning module. Some of the questions in the questionnaire were adapted from "Analysing and evaluating usefulness and usability in electronic information services" (Tsakonas & Papptheodoru, 2006, p 416). Some other questions were added by the investigator to assist in understanding the demographic characteristics of the participants in each group and to be used as a basis for data classification in this study.

7. The participants were then asked to complete the SUMI questionnaire. The participants received an instructional sheet (Appendix J) about how to complete the SUMI questionnaire. As shown in Appendix K, the SUMI questionnaire was developed from the Human Factors Research Group (HFRG) at University College Cork in the United Kingdom (UK). The SUMI questionnaire is composed of 50 questions and it comes in two formats: paper-based and electronic. The last three questions are open-ended. The SUMI method was mentioned in the ISO 9241 standard as a recognized way of testing user satisfaction. The questionnaire takes approximately ten minutes to complete. The tool is comprised of a validated 50-item paper-based questionnaire in which respondents score each item on a three-point scale (i.e. agree, undecided, disagree) (Arh & Blazic, 2008, p. 177). It has been shown that the SUMI has given reliable results with as few as ten users (Kirakowski & Corbett, 1993, p. 110). According to Kirakowski and Cobbett (1993), a minimum number of ten users are required to fulfill the sample size based on the SUMI methodology. However, a smaller number of users can be used for

diagnostic purposes. As described by Debeve and Bele (2008, p. 5), the dimensions of the scale assessed by the SUMI method include: (1) efficiency - the user's feeling that the software is quick and economical, (2) affect - the user's emotional feeling that the software is stimulating and pleasant, (3) helpfulness - the user's perception that the software communicates in a helpful way, (4) control- the user's feeling that the software is responding in a normal and consistent way and assists him in the event of errors, and (5) learnability - the ease with which the user becomes familiar with the software, whether there are tutorial, handbooks, etc., or not. The SUMI questionnaire is a quick and simple tool that can be used for global and general evaluation of the content of e-Learning software (Debeve & Bele, 2008). For this reason, the SUMI questionnaire was used in this study for measuring the subjective usability of the MCEC-eLM for patient information system IT scheduling application as used in AHS' WBT Manager for e-Learning.

8. Usability Testing with Informatics Consultant Users

   The stages described above for the procedure for both groups of participants (i.e. frontline users and informatics consultants) was the same – i.e. all participants underwent the 7 stages described above. However, for the 5 informatics consultant users, during step 4, when they were asked to work with the MCEC-eLM and to complete the MCEC-eLM/CCA, they were also instructed to "think aloud", or verbalize their thoughts while working with the MCEC-eLM. In addition, by applying low-cost usability testing methods, the interactions of the informatics consultant users with the MCED-eLM were

recorded in their entirety using Hypercam screen recording software. Also, their verbalizations were also audio-recorded as they worked with the MCEC-eLM.

Traditional usability testing has been known to be a labour-intensive, time-consuming and expensive method. It is typically conducted in a usability laboratory that consists of testing rooms containing computer systems that participants interact with and observation rooms with one-way mirrors for the experimenters to watch the participants (Wiklund, 1994 as cited in Kushniruk, Patel and Cimino, 1997). A promising cost-effective and rapid usability testing method has emerged to overcome this limitation: the Low-cost Rapid Usability Engineering approach developed by Kushniruk and Borycki (2006) at the School of Health Information Science at the University of Victoria. This approach involves video recording user's behaviours and computer screenshots of their interactions with the system. The approach modified and used in this study to observe users walking through the module while "thinking aloud". A portable usability laboratory was set-up as shown in Figure 3. The laboratory includes a Sony mini-DVD camera on a tripod for recording the physical actions and verbalizations of the users. It was also used for individual interviews. Hypercam© software was used for recording the actual computer screens in a digital movie file (AVI) accompanied with an audio portion of the movie corresponding to the subjects' verbalizations with "thinking-aloud" audio input that was captured using a headphone set. A computer was used for running the Internet and software applications and

tools. The participants were frequently reminded to "think aloud" and verbalize their thoughts. A total number of five informatics consultant users were observed for up to 2 hours for each participant. The number of participants in this group was selected based on the size of the sample (5 to 10) recommended for the Low-cost Rapid Usability Engineering (Kushniruk & Borycki, 2006).

Finally, a short open-ended individually audio-taped interview was conducted with the informatics consultant users after they finished the module, the assessment, and the SUMI paper-based questionnaire. Qualitative open-ended interviewing is typically guided by a simple straightforward set of predetermined questions. Many researchers, such as ethnographers, use these questions with each interviewee to ensure that certain topics will be covered with everyone (Hoffmann, 2007). According to Hoffmann, limitations of interviewing can be overcome through triangulation and collection of data from more than one method, such as combining interview data with operational data and archival data. In this study, the open-ended interview data were triangulated with different methods of data collection as discussed above. All interviews were conducted individually, using a set of two open-ended questions (Appendix N) adopted from the last three open-ended questions of the SUMI questionnaire (Appendix K). The individual interview was used to identify from the different informatics consultant perspectives the best aspects of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM). Each individual interview ended within 5 to 10

minutes. All individual interviews were audio-taped using the audio system of the Sony mini DVD camera.

4.7. Data Collection

Data were collected using the following methods:

Table 1: Summary of Data Collection Materials and Formats

Data Format			**Participants**	
			Frontline Users	**Informatics Consultant Users**
Aggregated data: WBT Manager for e-Learning Reports			✓	✓
Questionnaires	Paper	Demographic	✓	✓
		SUMI	X	✓
	Electronic	e-SUMI	✓	X
Observations (video, audio, computer screenshot, etc.)			X	✓
Interviews – short open-ended			X	✓

4.8. Data Analysis

In this study, the researcher used mixes of qualitative and quantitative methods for analysis, depending on the methods of data collection. Objective data were quantitatively analyzed by counting various attributes contained in the data while subjective data were qualitatively analyzed by finding patterns and themes (Kaplan, 2011). An integrated mixed method approach was used in this study for a number of reasons as highlighted by Kaplan:

> Use of a rich variety of evaluation research methods provides several advantages. A combination of methods to evaluate medical information systems has been recommended for two reasons. The first is the diverse and diffuse nature of information systems' effects. The second reason is to combine results in a way that maximizes understanding of causal links, collecting a variety of data, each set of which might provide partial information needed for a complete evaluation. Combining qualitative with quantitative methods allows for a focus on the complex web of technological, economic, organizational, and behavioural issues. Putting together data collected by a variety of methods from a variety of sources strengthens the robustness of research through a process known as "triangulation." Lastly, a multiplicity of methods can help ensure that issues and concerns that were not included in the preliminary design can be integrated into a future evaluation (Kaplan, 2011, p. 97).

The users' responses to the SUMI questionnaire were analyzed by using a dedicated software program called SUMISCO, which comes with the SUMI evaluation package. SUMISCO was used to analyze and compare the study data to a standardized

database of responses. The software calculated the mean score and the standard deviation of the scores and compared them to a standardized mean and standard deviation in the database. The participant scores were compared in terms of usability global scale and subscales to the standardized database of responses (Arh & Blazic, 2008).

Users' observations and think aloud comments that were collected using the Low-cost Rapid Usability Engineering testing method were thematically analyzed using an approach from Cognitive Task Analysis (CTA). Data were coded for identification of user problems and cognitive processes. The coding categories provided insights into problematic usability areas in the content of the information, comprehensiveness of graphics and text, navigation, and overall website understandability (Kushniruk &Patel, 2004, p. 65). Kushniruk identified the types of qualitative and other research methodologies that can be used at different points in the system life cycle development process including cognitive task analysis, focus groups, and usability testing (Currie, 2005, p. 914). Video and audio data were informally transcribed and analyzed as outlined in Kushniruk and Patel (2004). Themes emerging from the analysis were classified and categorized using Ssesmugabi and De Villiers's (2009) approach.

CHAPTER 5: STUDY FINDINGS

5.1. Introduction

The purpose of this study was to evaluate the usability and the usefulness of the Millennium Clinibase Encounter Creation e-learning Module (MCEC–eLM) for a patient clinical information system IT scheduling application (as used in AHS's WBT Manager for e-Learning). The goal of this module was to develop core competencies for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics. The study also investigated the effectiveness of LCRUE, CTA and HE criteria, combined with the Software Usability Measurement Inventory (SUMI) for evaluation of the usability and usefulness of the MCEC-eLM. To achieve this purpose, mixes of qualitative and quantitative methods were used in the analysis. The results of our study are presented in this chapter under the following headings.

5.2. Demographic Characteristics of the Participants

In this section, the demographic characteristics of "frontline" users and informatics consultant users are summarized (Table 2).

5.2.1. Users' Participation and Questionnaire Return Rates

As shown in Table 2, the response and return rate for questionnaires were calculated for each group. The response rate showed the percentage of users who agreed to participate in the study (Leedy and Ormrod, 2005). Likewise, the return rate showed the percentage of the users who completed and returned the questionnaire. In general, the

results for both groups have shown that the response and return rates were high (see Table 2).

Table 2: Response and Return Rates

Users	Participants (#)	Response rate	DQ return rate	SUMI return rate
Front Line Users	14	14 (100%)	13 (93%)	14 (100%)
Informatics Consultant Users	5	5 (100%)	5 (100%)	5 (100%)
Total	19	19 (100%)	18 (95%)	19 (100%)

DQ: Demographic Questionnaire

5.2.1.1. Frontline User Response and Return Rates

As shown above in Table 2, two groups of users participated in this study: frontline users and informatics consultant users. A total number of 14 frontline users were selected for participation. A total of five informatics consultant users were selected for participation. All participants (100%) agreed to participate in this study. All participants (100%) completed and returned the electronic SUMI questionnaire. Thirteen of 14 participants (93%) completed and returned the Demographic questionnaire

5.2.1.2. Informatics Consultant Response and Return Rates

As shown above in Table 2, a total number of five informatics consultant users were selected for participation in this study. All of them (100%) were agreed to participate and completed and returned both the demographic and the paper-based SUMI questionnaires.

5.2.2. Demographic Characteristic of Frontline Users

The frequency and percentage distributions of the demographic characteristics of the frontline users group are summarized below in Table 3.

Table 3: Demographic Characteristics of Frontline Users

	Frequencies		**Total**	**Percentages % (N=13)**		**Total**
	Male	Female		Male	female	
Age						
25 - 35 Years	1	3	4	8%	23%	31%
35 - 45 Years	0	3	3	0%	23%	23%
Over 45 Years	0	6	6	0%	46%	46%
Total	1	12	13	8%	92%	100%
Professional Status						
MRT	1	1	2	8%	8%	16%
Clerks	0	8	8	0%	61%	61%
PLN	0	1	1	0%	8%	8%
Secretaries	0	2	2	0%	15%	15%
Total	1	12	**13**	8%	92%	100%
Location						
CV Lab	1	4	5	8%	30%	38%
Endoscopy	0	1	1	0%	8%	8%
Colon Cancer	0	1	1	0%	8%	8%
GI Clinic	0	1	1	0%	8%	8%
Speciality Clinic	0	1	1	0%	8%	8%
Others	0	4	4	0%	30%	30%
Total	1	12	**13**	8%	92%	100%
Purpose for Completing e-Learning						
Education	1	8	9	8%	62%	70%
Research	0	4	4	0%	30%	30%
Total	1	12	**13**	8%	92%	100%
Internet and Computer Use						
Frequently	1	12	13	8%	92%	100%
Regularly	0	0	0	0%	0%	0%
Sparingly	0	0	0	0%	0%	0%
Rarely	0	0	0	0%	0%	0%
Total	1	12	**13**	8%	92%	100%

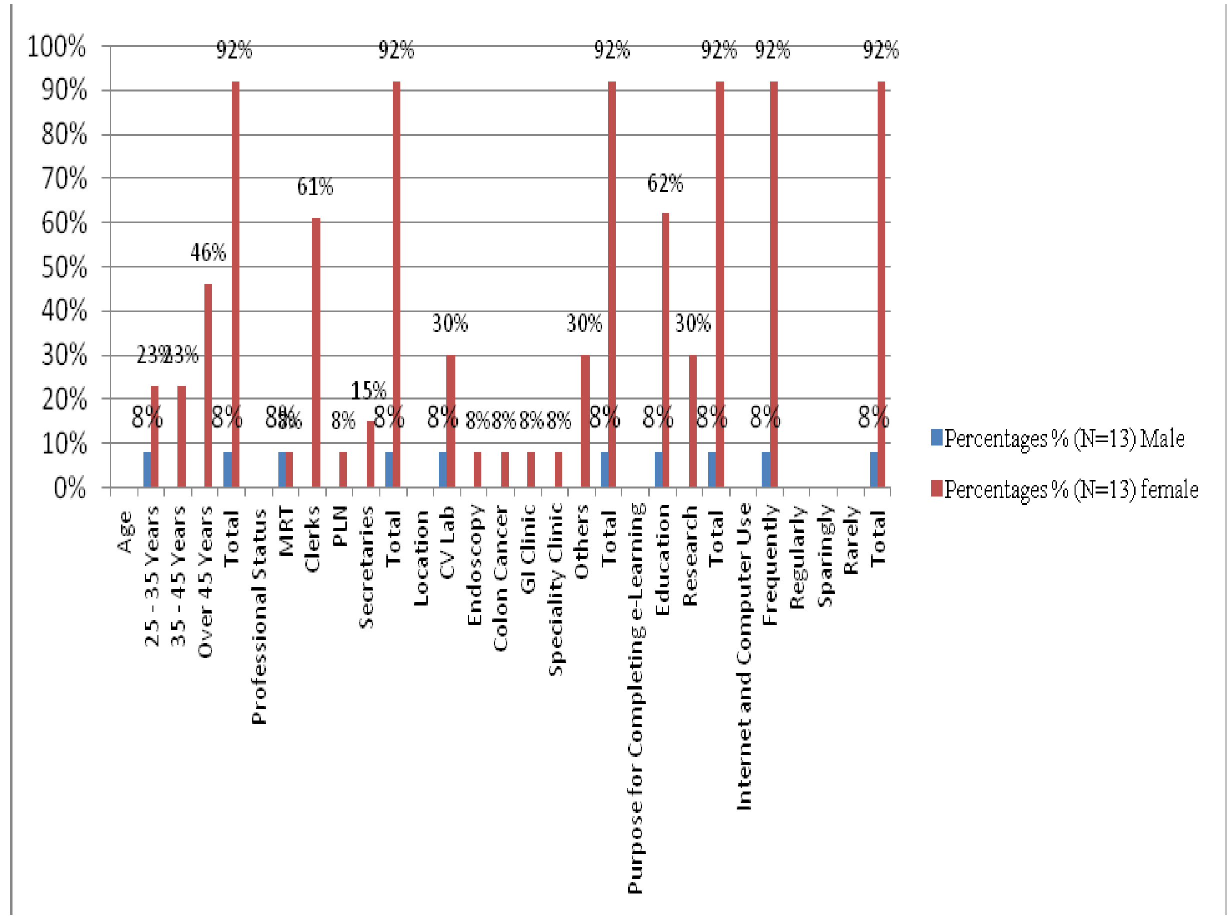


Figure 4: Demographic Characteristics of Frontline Users

5.2.2.1. Age

As illustrated in Figure 4, the majority of the frontline users were female (92%), of which forty-six percent (46%) were over 45 years of age. Twenty-three percent (23%) were between 35 and 45 years and twenty-three percent (23%) were between 25 and 35 years of age. Compared to the female participants, only one was male. These findings indicated that the number of older female frontline users was higher than the number of the male frontline users in this study.

5.2.2.2. Professional Background of Participants

As illustrated above in Figure 4, most of the female frontline users were clerks (61%), followed by secretaries (15%), a nurse (8%) and a medical radiology technician (8%). All except for one were female, a male medical radiology technician. These results indicated that the majority of the frontline end users were clerks and secretaries (76%), the rest of the users were came from the clinicians' staff (nurses, laboratory technicians, etc.)

5.2.2.3. Locations Where the Participants Worked

In general, as illustrated in Figure 4, most of the frontline users came from the cardiovascular (CV) laboratory and related locations (68%); the rest came from different locations in AHS. Of all the frontline female users, thirty percent (30%) came from the cardiovascular (CV) laboratory, eight percent (8%) came from the endoscopy, colon cancer, gastrointestinal (GI) and specialty clinics, and thirty percent (30%) from other locations,.

5.2.2.4. Reasons for Completing the e-Learning Module

As illustrated in Figure 4, seventy percent (70%) of the frontline users used the MCEC-eLM for educational purposes and thirty percent (30%) used it for research purposes. Sixty-two percent (62%) of the female frontline users intended to use it for educational purposes compared to thirty percent (30%) who intended to use it for research purposes. Compared to the female frontline users' responses, eight percentages (8%) of the frontline male users intended to use it for educational purposes. These results indicated that the number of frontline users who intended to use the MCEC-eLM for

training and educational purposes is higher than those who intended to use it for research purposes.

5.2.2.5. Internet and Computer Use

As illustrated in Figure 4, all of the frontline users (92% female and 8% male), had the minimum skills for accessing the Internet and using computers frequently in a daily basis.

5.2.3. Demographic Characteristics of Informatics Consultant Users

The frequency and percentage distribution of the demographic characteristics of the informatics consultant users are summarized in Table 4 below.

Table 4: Demographic Characteristics of Informatics Consultant Users

	Frequencies		**Total**	**Percentages % (N=5)**		**Total**
	Male	Female		Male	Female	
Age						
25 - 35 Years	1	0	1	20%	0%	20%
35 - 45 Years	1	1	2	20%	20%	40%
Over 45 Years	0	2	2	0%	40%	40%
Total	2	3	5	40%	60%	100%
Professional Status						
Informatics Consultant	2	3	5	40%	60%	100%
Total	2	3	5	40%	60%	100%
Location						
QP	1	1	2	20%	20%	40%
Midnapore	0	2	2	0%	40%	40%
AC	1	0	1	20%	0%	20%
Total	2	3	5	40%	60%	100%
Purpose for Completing e-Learning						
Education	0	0	0	0%	0%	0%
Research	2	3	5	40%	60%	100%
Total	2	3	**5**	40%	60%	100%
Internet and Computer Use						
Frequently	2	3	5	40%	60%	100%
Regularly	0	0	0	0%	0%	0%
Sparingly	0	0	0	0%	0%	0%
Rarely	0	0	0	0%	0%	0%
Total	2	3	**5**	40%	60%	100%

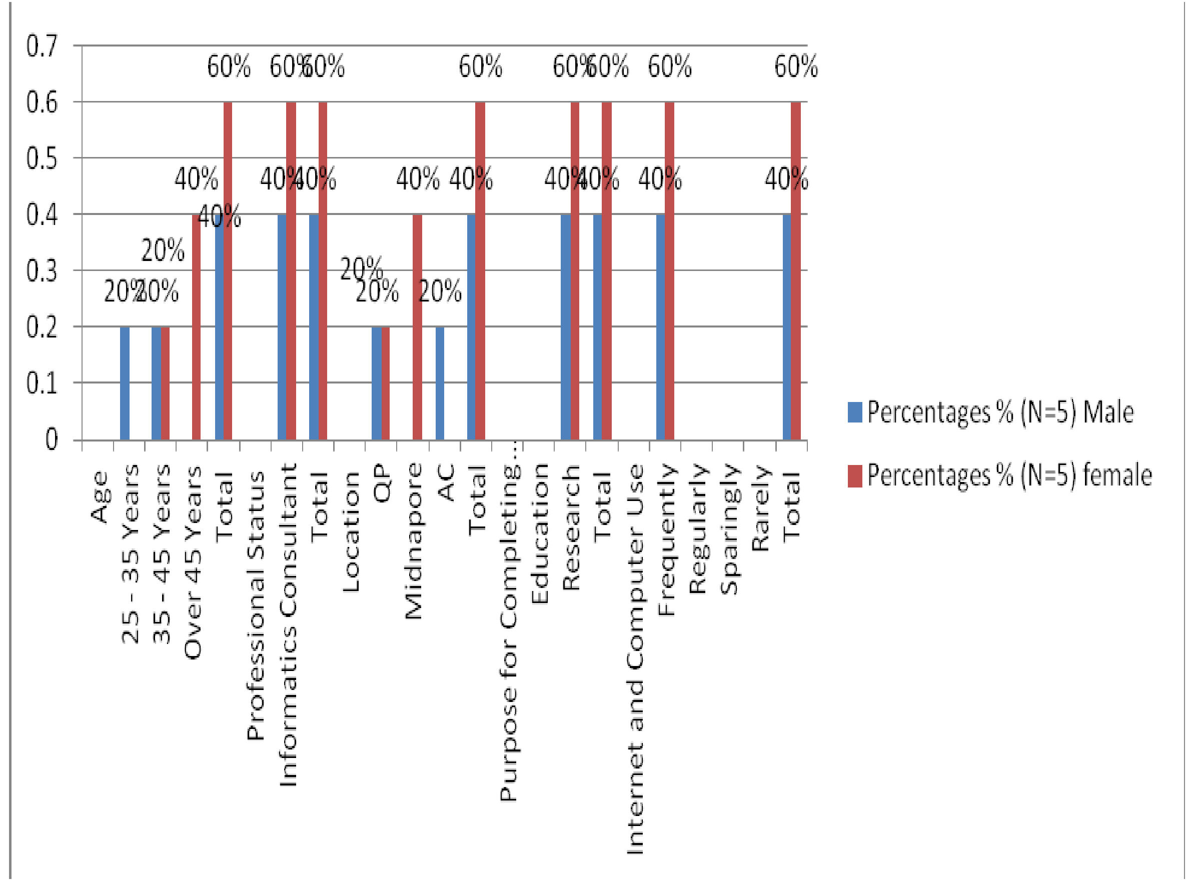


Figure 5: Demographic Characteristics of Informatics Consultant Users

5.2.3.1. Age

As illustrated above in Figure 5, forty percent (40%) of informatics consultant users were over 45 years in age, forty percent (40%) were between 35 and 45 years of age, and twenty percent (20%) were between 25 and 35 years of age. Forty percent (40%) of the informatics consultant female users were over 45 years of age and twenty percent (20%) were between 35 to 45 years of age. None were less than 35 years old. Compared to female users, twenty percent (20%) of the users were male between 25 to 35 years of age and twenty percent (20%) between 35 to 45 years of age. None of them were more than 45 years old.

5.2.3.2. Professional Background of Participants

All participants in the informatics consultant group were working as informatics consultants. Sixty percent (60%) were female informatics consultant users and forty percent (40%) were male informatics consultant users (see Figure 5).

5.2.3.3. Locations Where the Participants Worked

As illustrated above in Figure 5, forty percent (40%) of the informatics consultant users came from Quarry Park (QP), forty percent (40%) came from Midnapore, and twenty percent (20%) came from the Airport Centre (AC). Of all female informatics consultant users, forty percent (40%) came from Midnapore and twenty percent (20%) came from QP. Twenty percent (20%) of male informatics consultant users came from QP and twenty percent (20%) from AC.

5.2.3.4. Reasons for Completing e-Learning Module

As illustrated in Figure 5, the majority of informatics consultant users indicated their enthusiasm for using the MCEC-eLM for research purposes. These results are consistence with the purpose of the subject recruitment for this group.

5.2.3.5. Internet and Computer Use

All of informatics consultant users (60% female and 40% male) showed the minimum requirements for accessing the Internet and using computers frequently on a daily basis as illustrated in Figure 5.

5.2.4 Measuring Participant Performance – Frontline Users

The results of the users' interactions with the MCEC-eLM and with the MCEC-eLM/CCA were obtained from the WBT Manager for e-Learning. The report obtained from the WBT Manager contained aggregated data in which user login ID, course name,

time spent on the module lesson, time spent on the core competency assessment and the average performance score of each participate was recorded. The report was prepared in Microsoft Excel spreadsheets as in the example in Appendix O.

The performance of the frontline users is given in Table 5 for the following: the total time spent on the module's lessons, the total time spent on the MCEC-eLM/CCA, and the average performance scores.

Table 5: User Performance Testing Results for Frontline Users

Subject ID	Total time user spent in module's lessons	Total Time user spent in assessment (minutes)	Average score on assessment (%)	Number of times enter lesson	Number of attempts to pass
1	24.3	21.1	94	1	2
2	26.1	10.5	92	1	1
3	19.9	17.1	83	1	1
4	21.8	18.7	94	1	1
5	31.7	11.2	89	2	1
6	24.4	12.1	86	1	1
7	23.6	24.5	81	1	1
8	16.8	34	89	1	3
9	24.4	20.5	83	1	1
10	20.1	44.8	92	1	2
11	29.8	46.5	81	2	1
12	18.0	25.6	86	2	1
13	46.5	44.0	81	3	1
Average	25.2	25.4	87	1.4	1.3

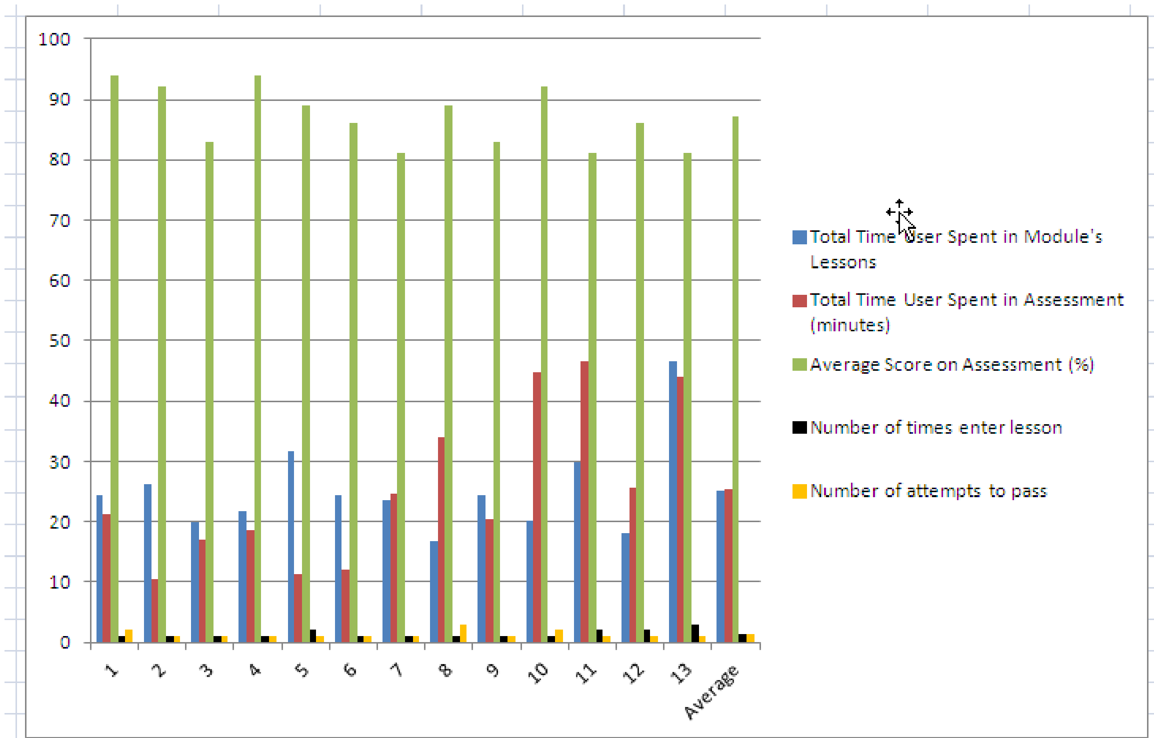


Figure 6: User Performance Testing Results for Frontline Users

5.2.4.1. Total Time Frontline Users Spent in Module Lessons

As illustrated above in Figure 6, the frontline users spent an average time of 25.2 minutes, less than half the average expected time of 60 minutes to complete their tasks. All except two frontline users completed their task in less than 30 minutes; two users finished it in more than 30 minutes but less than 60 minutes. These results indicated that the MCEC-eLM as used in AHS's WBT Manager was enabling users to efficiently complete their learning tasks in less time than expected.

5.2.4.2. Total Time Frontline Users Spent in Core Competency Assessment

As illustrated in Figure 6, the frontline users spent an average time of 25.4 minutes, less than half the average expected time of 60 minutes to finish the MCEC-eLM/CCA. All except four frontline users finished their assessment in less than 30 minutes; four users finished it in more than 30 minutes but less than 60 minutes. These

results indicated that the MCEC-eLM as used in the WBT Manager was enabling the users to efficiently finish their assessment in a less-than-expected average time.

5.3.4.3. Average Score on Assessment

As shown in Figure 6, all the frontline users achieved their goals and passed the MCEC-eLM/CCA with an average performance score which was higher (87%) than the expected average score (80%) that was required to fulfill the IT Privacy and Security requirements to obtain usernames and passwords for accessing the patient clinical information system IT scheduling application in the production environment. These results indicated that the MCEC-eLM was providing the users with the core competencies to effectively achieve a higher-than-expected average performance score required to fulfill the IT Privacy and Security requirements to obtain usernames and passwords needed to use the patient clinical information system IT scheduling application in the production environment.

5.2.5 Measuring Participant Performance - Informatics Consultant Users

The performances of informatics consultant users are summarized below in Table 6, including: the total time spent on the module's lessons, total time spent on the MCEC-eLM/CCA, and the average performance scores.

Table 6: User Performance Testing Results for Informatics Consultant Users

Respondent ID	Total time User spent in module's lessons	Total time user spent in assessment (minutes)	Average score on assessment	Number of attempts to pass the assessment	Number of times enter lesson
1	65.9	14.9	89	1	1
2	45.7	11.4	81	1	1
3	48.0	15.9	89	1	1
4	20.9	11.7	86	1	1
5	80.6	23.9	86	1	1
Mean	**52.22**	**15.56**	**86.2**	**1**	**1**

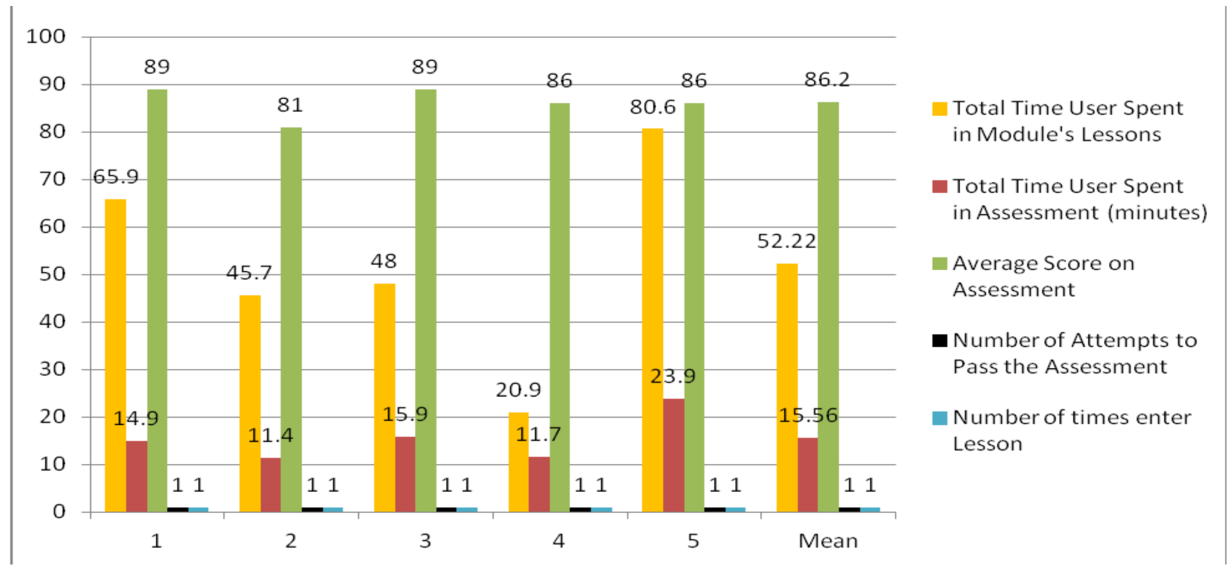


Figure 7: User Performance Testing Results for Informatics Consultant Users

5.2.5.1. Total Time Users Spent in e-Learning Module Lessons

As illustrated above in Figure 7, the informatics consultant users spent an average total time of 52.22 minutes, less than the expected average time of 60 minutes, but longer than the frontline users. This result indicated that the MCEC-eLM allowed the

informatics consultant users to efficiently finish all their tasks in a less-than-expected average time. The longer time completion time can be explained by the fact that this group was intentionally selected as “experts” to walk through the MCEC-eLM to identify any problematic issues in the general interface usability (GIU), educational website, and the learner-centred instructional design. The time they spent in the usability observation would account for taking more time than the frontline users to finish the module lessons (topics).

5.2.5.2. Total Time Users Spent in Core Competency Assessment

As shown in Figure 7, the informatics consultant users spent an average total time of 15.56 minutes, less than the expected average total time of 60 minutes, to finish the core competency assessment. This result indicated that the MCEC-eLM allowed the users to efficiently finish their assessment in a less-than-expected average time.

5.2.5.3. Average Assessment Scores

As illustrated in Figure 7, the informatics consultant users achieved an average performance score of 86.2, which was higher than the expected average performance score of 80%. This result also indicated that the module enabled the users to effectively achieve their goals and fulfil the IT Privacy and Security business requirement in order to obtain usernames and passwords to use the patient clinical information system IT scheduling application in the production environment.

5.3. Subjective Usability Measurement: Usability Satisfaction

The SUMI questionnaire presented an objective way for measuring subjective user satisfaction with the usability of the e-learning module. Therefore, the final results of SUMI analysis presented in this study did not deal with the usability problem issues that

were identified from the comments of the group observed in usability testing. These issues will be looked after in the usability testing results section.

Based on SUMI guidelines, subjective usability satisfaction for the MCEC-eLM was measured through a global quality scale and five subscales that included: effectiveness, affect, helpfulness, control and learnability (Anjaneyulu, Singer, Harding, 1998; Debeve & Bele, 2008, p. 5). These measures are defined as follows:

1. Efficiency (the user's feeling that the software is quick and economical)
2. Affect (the user's emotional feeling that the software is stimulating and pleasant)
3. Helpfulness (the user's perception that the software communicates in helpful way)
4. Control (the user's feeling that the software is responding in a normal and consistent way and assists him in the event of errors)
5. Learnability (the ease with which the user become familiar with the software; whether there are tutorials, handbook, etc. or not)

The analysis of the SUMI data is performed using a dedicated software analysis package called SUMICO (Debeve, 2008). In this study, all of the questionnaires from all the frontline users and the informatics consultant users were completed correctly and were included in the final results.

5.3.1. Final Result of SUMI Analysis for Frontline Users

The results shown below in Table 7 are presented in terms of median, standard deviation, upper and lower fences, and upper and lower confidence levels for the global usability scale and each of the five usability sub-scales. These results were obtained from

the testing of the MCEC-eLM Fourteen frontline users completed the electronic SUMI questionnaire correctly and their results are discussed in this section.

Table 7: Summary of SUMI Analysis for Frontline Users

Case #	Global	Eff	Aff	Helpf	Contr	Learna
1	71	71	71	65	71	59
2	67	62	62	60	62	54
3	57	52	54	49	66	59
4	71	68	71	69	67	66
5	48	44	54	57	42	46
6	62	55	56	62	63	44
7	66	66	69	66	56	68
8	61	52	62	58	57	68
9	61	52	62	58	57	68
10	67	71	66	58	52	71
11	35	35	38	40	39	40
12	40	30	49	51	49	35
13	44	49	51	49	44	38
14	52	57	47	52	56	43
Mean (M)	57.30	54.53	57.88	56.62	55.63	54.18
Standard Dev.	11.64	12.52	9.84	8.00	9.72	12.88
Upper Fence (UF)	80.12	79.07	77.16	72.30	74.69	79.42
Lower Fence (LF)	34.47	29.99	38.60	40.93	36.58	28.94
Standard Error of Mean	3.11	3.35	2.63	2.14	2.60	3.44
Upper 95% CL	63.39	61.09	63.03	60.81	60.72	60.93
Lower 95% CL	51.20	47.97	52.72	52.42	50.54	47.44

5.3.1.1. Global Score

As shown above in Table 7, the overall score achieved by the MCEC– eLM (as used in AHS's WBT Manager for e-Learning) on the global scale was 57.30, which indicated a good overall rating of usability satisfaction. The Upper Confidence Level (Ucl) and the Lower Confidence Level (Lcl) were 63.39 and 51.20 respectively. The Ucl and Lcl represented the limits within which the theoretical score falls 95% of the time for this sample (N = 14). The Upper and Lower Fences (UF and LF) represented the values beyond which it was credibly suspected that a user was not responding with the rest of the group and the user was responding as an outlier (Anjaneyulu et al., 1998).

5.3.1.2. Efficiency

The score achieved on this subscale was 54.53, which indicated that the interface of the MCEC-eLM did not present serious problems to the frontline users when carrying out their tasks within the MCEC- eLM, indicating the software quickly enabled the tasks to be performed in an effective manner. These results were supported by the quantitative findings from user performance measurement in Table 5 and illustrated in Figure 6.

5.3.1.3. Affect

The score achieved on the affect subscale was 57.88, which indicated that the attitudes of the frontline users were very positive towards the usability of the MCEC–eLM. The users believed that the MCEC-eLM (as used in AHS's WBT Manager for eLearning) is stimulating and pleasant

5.3.1.4. Control.

The overall score achieved on this subscale was 55.63, indicating a good sense of user control over the user interface. It indicated a positive feeling about the e-learning

module and the way the MCEC-eLM, as used in the WBT Manager for e-Learning, was responding to and assisting them in their learning. Overall, the users believed that the MCEC-eLM responds in a normal and consistent way.

5.3.1.5. Learnability

The overall score achieved on this subscale was 54.18, indicating that the MCEC-eLM was positively viewed by the frontline users as easy to learn (from the commands and functions of the user interface). The users believed that the MCEC-eLM (as interfaced in AHS's WBT Manager for e-Learning) is easy to use even there are tutorials, handbooks, etc., to assist them or not.

5.3.1.6. Helpfulness

The overall score achieved on this subscale was 56.62, which indicated that the frontline users found the Help system to be useful when difficulties were encountered and that the MCEC-eLM responded to them in a helpful way.

5.3.2. Final Result of SUMI Analysis for Informatics Consultant Users

The results from the SUMI for the five informatics consultant participants are shown below in Table 8 and are presented in terms of median, standard deviation, upper and lower fences, and upper and lower confidence levels for the global usability scale and for each of the five usability sub-scales. These results were obtained from the interactions of the informatics consultant users with the MCEC-eLM (as interfaced in AHS's WBT Manager for e-Learning). The five of informatics consultant users completed the paper-based SUMI questionnaires correctly and their results are discussed in this section.

Table 8: Summary of SUMI Analysis for Informatics Consultant Users

Case #	Global	Eff	Aff	Helpf	Contr	Learna
1	55	44	60	59	45	71
2	47	38	53	52	47	53
3	45	38	50	41	37	55
4	62	51	44	64	51	63
5	65	62	68	64	58	69
Mean (M)	54.78	46.47	54.92	56.16	47.62	62.16
Standard Dev.	9.02	10.16	9.34	9.82	7.86	7.85
Upper Fence (UF)	72.46	66.39	73.23	75.41	63.03	77.54
Lower Fence (LF)	37.09	26.56	36.60	36.92	32.21	46.79
Standard Error of Mean	4.04	4.54	4.18	4.39	3.52	3.51
Upper 95% CL	62.69	55.38	63.11	64.77	54.51	69.04
Lower 95% CL	46.87	37.57	46.73	47.56	40.73	55.29

5.3.2.1. Global Score

As shown above in Table 8, the overall score achieved by the MCEC-eLM (as interfaced in AHS's WBT Manager for eLearning) for the global scale was 54.78, indicating a good overall rating of usability satisfaction. The Upper Confidence Level (Ucl) and the Lower Confidence Level (Lcl) were 62.69 and 46.87 respectively. The Ucl (62.69) and Lcl (46.87) represented the limits within which the theoretical score falls 95% of the time for this sample of users (N = 5). The Upper Fence (UF) of 72.46 and lower fence (LF) of 37.09 represented the values beyond which it may be credibly suspected that a user was not responding with the rest of the group and that the user may be responding as an outlier (Anjaneyulu et al., 1998).

5.3.2.2. Efficiency and Control

The score attained on this subscale was lower at 46.47, followed by the “Control” subscale score of 47.62, which indicated that the user interface in this case might have presented a problem to the informatics consultant users while they were carrying out tasks within the MCEC-eLM.

Factors that may have influenced “efficiency”, according to the definition of efficiency by Anjananeyulu et al. 1998, include the user’s feeling that the software was enabling the task(s) to be performed in a quick, effective, and economical manner or, at the other extreme that the software was getting in the way of performance. The study quantitatively measured informatics consultant user performance as shown in Table 6 and Figure 7. In carrying out their tasks, the results indicated the informatics consultant users were able to achieve a higher-than-expected average performance score, so the lower ratings for efficiency and control (as compared to the frontline user group) might have been due to the fact that the informatics consultant users were being asked to think aloud while using the MCEC-eLM to carry out their tasks, which may have focused their attention on usability issues related to efficiency and control.

5.3.2.3. Affect

The score achieved on the affect subscale was 54.92, which is indicated that the attitudes of the informatics consultant users were very positive toward the usability of the MCEC-eLM. The users believed that the MCEC-eLM (as interfaced in AHS’s WBT Manager for e-Learning) is pleasant and stimulating.

5.3.2.4. Learnability

The overall score attained on this subscale was 62.16, indicating that the informatics consultant users found that it was easy to learn the commands and functions of the MCEC – eLM even there are tutorials, handbook etc., to assist them or not.

5.3.2.5. Helpfulness

The overall score attained on this subscale was 56.16, which reflects the perception that the informatics consultant users found the Help function and system responses were useful in solving difficulties they encountered when walking through the module's lessons.

5.3.3. Results of SUMI Item Consensual Analysis.

The results of the SUMI items consensual analysis for the frontline users and the informatics consultant users were described similar to the results reported by Anjaneyulu et al. (1998) and are presented and described in this section. The results of all SUMI items consensual analysis for all frontline and informatics consultant users are included in Appendix L and Appendix M respectively.

For the purpose of this study, the SUMI items that significantly different from the standardization SUMI database are presented in this section. Therefore, three items for frontline users and five items for informatics consultant users emerged from the results of the SUMI items consensual analysis. Items for the frontline users are shown in Tables 9, 10, and 11. Items for the informatics consultant users are shown in Tables 12, 13, 14, 15 and 16.

5.3.3.1. Results of SUMI Items Consensual Analysis for Frontline Users

The results of all SUMI items consensual analysis for the frontline users are shown in Appendix L. In this section, the results of the SUMI items consensual analysis that significantly different from the standardization SUMI database are presented and summarized in Tables 9, 10 and 11 below.

Table 9: Item 15 Consensual Analysis for Frontline Users

Item 15	The software documentation is very informative.			
	Agree	Undecided	Disagree	
Observed	11	3	0	
Expected	4.9	7.0	2.1	
Chi Square	7.47	2.27	2.08	11.83^{**}

As shown in Table 9, the majority of the frontline users, 11 of 14 (78.6%), had a 35.6% greater-than-expected positive view of the documentation (content) of the MCEC-eLM. Only 3 of 14 respondents (21.4%) were undecided about this. The users believed that the MCEC-eLM is very informative.

Table 10: Item 24 Consensual Analysis for Frontline Users

Item 24	This software is awkward when I want to do something which is not standard.			
	Agree	Undecided	Disagree	
Observed	0	5	9	
Expected	4.2	5.7	4.2	
Chi Square	4.17	0.08	5.60	9.85^{**}

Although five of 14 (35.5%) frontline users were undecided about the statement shown in Table 10, most of the frontline users, 9 of 14 (64.3%), had a 34.3% greater-

than-expected belief that it was not awkward to use this module to do something which is not standard.

Table 11: Item 28 Consensual Analysis for Frontline Users

Item 28	The software has helped me overcome any problems I have had in using it.			
	Agree	Undecided	Disagree	
Observed	10	4	0	
Expected	4.0	7.1	2.9	
Chi Square	9.05	1.35	2.91	13.32**

Table 11 showed that the majority of the frontline users, 10 of 14 (71.4%), had a 42.8% greater than expected, belief that the MCEC-eLM helped them to overcome problems they had experienced while using it (compared to only four of 14 respondents (28.6%) who were undecided about this statement).

5.3.3.1.1. Results Summary of SUMI Items Consensual Analysis for Frontline Users

In the global scale, all frontline users expressed positive attitudes towards the usability of the MCEC-eLM (as used in AHS's WBT Manager for e-Learning). They were satisfied that the module had helped them to do their tasks effectively and efficiently. This result is supported with findings from the SUMI items consensual analysis as listed below.

1. The majority of the users believed that the documentation of the MCEC-eLM was informative.
2. The majority of the users believed that the MCEC-eLM wasn't awkward to use to do something non-standard.
3. The majority of the users agreed that the MCEC-eLM had helped them to overcome problems they had experienced when using it.

Overall, the frontline users were satisfied with the usability of the MCEC-eLM. In their view, efficiency, affect, learnability, helpfulness, and control were not problematic. Based on the scores, the module was perceived as allowing them to do their tasks to obtain usernames and passwords to access the patient clinical information system IT scheduling application in the real production environment.

5.3.3.2. Results of SUMI Item Consensual Analysis for Informatics Consultant Users

The results of all SUMI items consensual analysis for informatics consultant users are shown in Appendix M. In this section, the results of the SUMI items consensual analysis that significantly different from the standardization SUMI database are presented below in Tables 12, 13, 14, 15 and 16.

Table 12: Item 4 Consensual Analysis for Informatics Consultants

Item 4	The software stops unexpectedly sometimes.			
	Agree	Undecided	Disagree	
Observed	0	0	5	
Expected	2.4	0.5	2.1	
Chi Square	2.43	0.48	4.04	6.95

As shown above in Table 12, all informatics consultant users believed the MCEC-eLM (as used in AHS's WBT Manager for e-Learning) didn't sometimes stop unexpectedly while they used it.

Table 13: Item 6 Consensual Analysis for Informatics Consultants

Item 6	I sometimes don't know what to do next with this software.			
	Agree	Undecided	Disagree	
Observed	3	2	0	
Expected	1.5	0.8	2.7	
Chi Square	1.45	1.66	2.66	5.77

Although 40% of informatics consultant users were undecided about the statement in Table 13, the majority of them, 3 of 5 or 60% (30% greater than expected), believed that sometimes they did not know what to do next with the MCEC-eLM (as interfaced in AHS's WBT Manager for e-Learning). In other words, the users had found some difficulties. The result of user performance analysis in Figure 7 showed that informatics consultants spent more time to finish their tasks compared to the frontline users. This finding could be explained in two ways: 1) the informatics consultants group identified some difficulties while working with the module or 2) they spent more time to rectify these difficulties. Table 33 provides evidence about the usability difficulties they experienced, specifically difficulties related to navigation and use of the system. These identified problems might be responsible for both the longer time the informatics consultants took to finish their tasks and their perceptions as shown in Table 13 above.

Table 14: Item 22 Consensual Analysis for Informatics Consultants

Item 22	I would not like to use this software every day.			
	Agree	Undecided	Disagree	
Observed	4	0	1	
Expected	1.1	0.8	3.1	
Chi Square	7.78	0.83	1.41	10.01

As shown in Table 14, the majority of informatics consultants, 4 of 5 (80%), indicated a 58 % greater-than-expected belief that they would not like to use the MCEC-eLM every day. The reason that informatics consultant users indicated they would use the module (as indicated in Figure 7) was for research and not as part of their daily job, which might account for the result in Table 14.

Table 15: Item 47 Consensual Analysis for Informatics Consultants

Item 47	This software is very awkward to use.			
	Agree	Undecided	Disagree	
Observed	0	3	2	
Expected	0.3	0.9	3.8	
Chi Square	0.32	4.85	0.83	6.01

As shown in Table 15 above, only two of the five of informatics consultant users believed that the MCEC-eLM is awkward to use.

Table 16: Item 49 Consensual Analysis for Informatics Consultants

Item 49	Getting data files in and out of the system is not easy.			
	Agree	Undecided	Disagree	
Observed	0	5	0	
Expected	0.7	1.9	2.4	
Chi Square	0.71	5.19	2.42	8.32

Sixty-two percentages (62 %) of all informatics consultants, greater than expected, were undecided about this statement in Table 16. This result is explained by the fact that users did not try to get data files in and out of the system.

5.3.3.2.1. Summary of Results for SUMI Item Consensual Analysis for Informatics Consultant Users

Overall, the informatics consultant users were satisfied with the usability of the MCEC-eLM. However, their attitudes toward “efficiency” and “control” and their user performance might have been impacted by their expectations as an expert group and by the problematic areas identified from their feedback and recommendations when they walked through the module. The problems related to the general interface usability (GIU), educational website, and learner-centred instructional design provided objective evidence of their impacted performance as indicated in Figure 7 and their lower ratings of the “efficiency” and “control” over the system.

5.3.4. Open-ended Question: What Do You in General Use this Software for?

In this section the responses of the frontline users and the informatics consultant users to the last three open-ended SUMI questions are presented. The responses of the

users were qualitatively analyzed and presented using a thematic approach in which they were analyzed for themes emerging from the line-by-line analysis of the responses. The themes were coded and evaluated in the context of the definition of the "usefulness" concept adapted from Tsakonas and Papatheodorou, 2006, p. 420 – 403, as shown below in Table 17. Participants discussed the MCEC-eLM in terms of its relevance for carrying out four tasks: patient identification and registration, learning and training, research, and general use, as shown in Table 18 and described in the next sections.

Table 17: Usefulness Concepts Used for the Thematic Analysis of Software Use

Concept/Definition	Resource Attributes/Definition
Usefulness: the degree to which a specific information item will serve the information needs of the user and determined by: Inherent attributes of the resource as a semantic entity and as an object Its applicability to specific information seeking contexts and work tasks	**Relevance:** denotes how (topically) the content corresponds to the work task
	Format: is a resource attribute that connects with the user work practice and/or the available technological infrastructure
	Reliability: investigates how credible the resource is and how well it satisfies present and future aspects of the work task
	Level: refers to the various representations of information provided, such as abstracts, full text, etc.
	Timeliness: investigates how current the information resource is and how it will satisfy the information need

Adapted from Tsakonas and Papatheodorou, 2006, p. 402 – 403

Table 18: What in General Do You Use This Software for?

Sub-themes emerged from "RELEVANCE"	% Frontline Users/N=14	Informatics Consultants/ N=
Patient identification and registration		
Patient registration	14%	
Observing patient encounters	7%	
Patient Information	14%	
Neurology	7%	
Mostly in relation to core data	7%	
Learning, training, and research		
Education guidance	7%	
learn to use a system from it		50%
Training	14%	
E-Learning for applications		50%
Research	7%	
General Use		
Printing labels	7%	
Every day use	7%	
Work	7%	

*Informatics Consultants/N=5

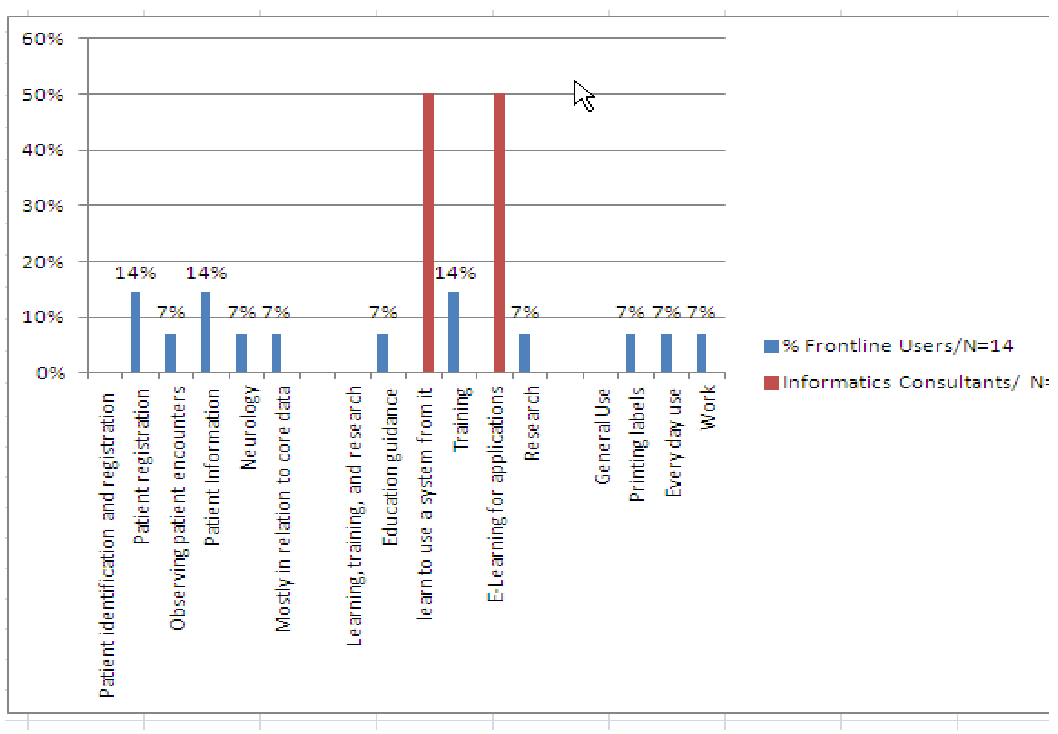


Figure 8: What in General Do You Use This Software for?

5.3.4.1. Patient Identification and Registration

The frontline users thought that the MCEC-eLM was useful and relevant to their work. Based on their responses as shown in Figure 8, they indicated they could use this software to learn the core functionalities and features of the patient clinical information system IT scheduling application for patient identification and registration related-tasks such as registration of patient in the system, observing patient encounters, recording patient information, recording patient demographics, such as core data, and for care-related information, such as patient encounters across the continuum of care. These findings are supported by the following examples from the responses of the users.

Seven percent (7%) of the frontline users believed that, based on one user's response, they could use it to learn about tasks "mostly in relation to demographic core data" collection. Core data in this module includes: the patient name, date of birth, etc. Fourteen percent (14%) of the frontline users reported that they could use it to learn, "patient registration" tasks that involve, according to another user's response, "registering of patients" in the system. Fourteen percent (14%) of the frontline users said they could use it to learn how to collect "patient information." Seven percent of the frontline users (7%) were more specific and said they could use it for "observing patient encounters" across the continuum of health care. Additionally, seven percent (7%) of the frontline users said they could use it for clinically related tasks in areas such as "neurology."

5.3.4.2. Learning, Training, and Research

The frontline user thought they could use the e-learning module for a range of purposes, including "training," "education guidance," and "research," according to the opinions of 14%, 7%, and 7% frontline user's responses respectively as illustrated in

Figure 8. Half (50%) of the informatics consultant users said they could use the e-learning module for e-learning applications.

5.3.4.3. General Use

Based on user responses as illustrated in Figure 8, twenty-one percent (21%) of the frontline users reported that they could use it for general use in supporting their work. Seven percent (7%) of the respondents said they could use the e-learning module for training related to general "work," "everyday use," and "printing labels."

5.3.5. Closed Question: How Important for You is the Kind of Software...?

In Table 19, the final results of the respondents are given in response to the SUMI closed question: How important for you is the kind of software you have just been rating?

Table 19: How Important for You is the Kind of Software You Have Just been Rating?

SUMI Statements	Frontline Users (N=13)	Informatics Consultants (N=5)
Extremely important	46%	40%
Important	46%	40%
Not important	8%	20%
Not Important at All	0%	0%
Total	**100%**	**100%**

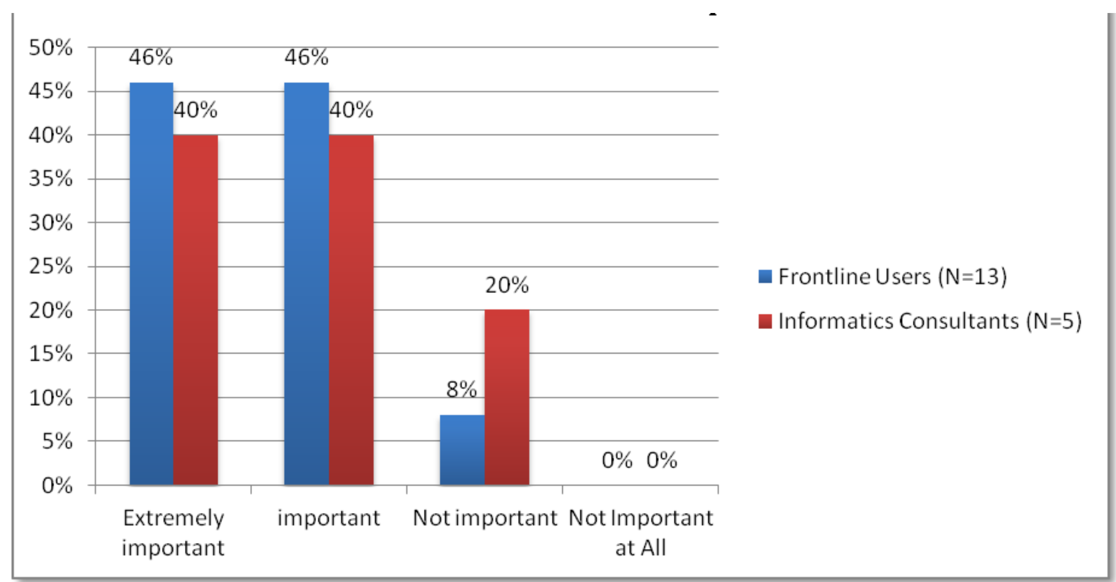


Figure 9: How Important for You is the Kind of Software You Have Just been Rating?

As illustrated in Figure 9, the majority of the frontline users (92%) recognized the importance of the MCEC-eLM. Forty-six percent (46%) of the frontline users indicated the e-learning module was "important," or "extremely important." Only eight percent of the frontline users said "not important." These findings indicated the perceived importance of this module and at the same time reflected the high level of enthusiasm of potential frontline users.

Compared to the frontline users, the majority of informatics consultant users, eighty percent (80%), indicated the e-learning module was "important" or "extremely important." Only twenty percent (20%) responded with "not important." Despite the fact that this group is not going to use the application in their daily work activities, the informatics consultant users recognized the importance of this module and indicated their enthusiasms for e-learning.

5.3.6. Closed Question: How Would You Rate Your Software Skills and Knowledge?

In Table 20 the results of the frontline user and informatics consultant user responses are given for the SUMI closed question: How would you rate your software skills and knowledge?

Table 20: How Would You Rate Your Software Skills and Knowledge?

SUMI Statements	Frontline Users (N=13)	Informatics Consultants (N=5)
Very experienced and technical	31%	40%
I'm good but not very technical	31%	40%
I can cope with most software	38%	20%
I find most software difficult to use	0%	0%
Total	**100%**	**100%**

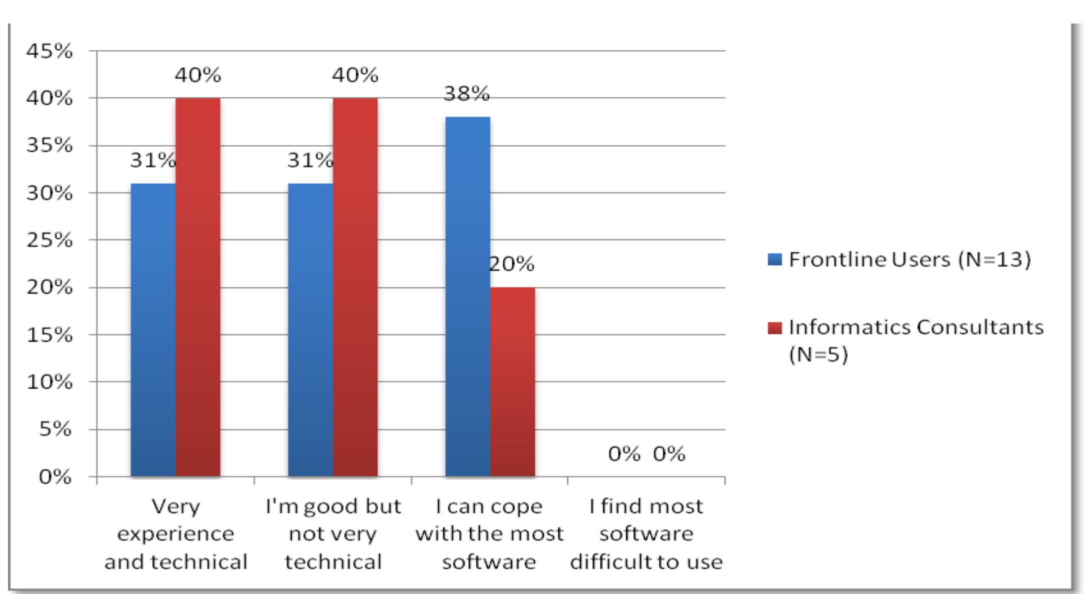


Figure 10: How Would You Rate Your Software Skills and Knowledge?

As illustrated in Figure 10, the frontline users believed that they could cope with the MCEC-eLM. Some of them (31%) thought themselves very experienced and technical and some of them (31%) believed they were good but not very technical.

Compared to the frontline users, the majority of the informatics consultant users either believed they were very experienced and technical (40%) or good but not very technical (40%). The rest (20%) believed they could cope with most of the MCEC-eLM. These results are consistent with the purpose for which the group were recruited. They were recruited as an "expert" group with different knowledge and skills to identify problems related to the interface usability and learner-centred instructional design. Thus, they may have focused more on problems they had than the frontline users did.

5.3.7. Open-ended Question: Best Aspect of This Software?

In this section, the final results of the users' responses are coded and categorized based on the definition of usefulness (as shown in Table 17) and usability (as shown below in Table 21) as concepts adapted from Tsakonas and Pappatheodorou (2006).

Table 21: Usability Concepts Used for Thematic Analysis of User Comments

<table>
<tr><th>Concept/Definition</th><th>Resource Attributes/Definition</th></tr>
<tr><td rowspan="5">Usability: concerns with the ease of use of a given system in an efficient, effective and satisfactory way. User friendliness is considered a determinant of system acceptance and perceived quality.</td><td>Ease of use refers to how easy it is to use all functions provided by the system</td></tr>
<tr><td>Aesthetic appearance of the system may influence the users affectively.</td></tr>
<tr><td>Navigation is the ease of navigation through the system.</td></tr>
<tr><td>Terminology refers to the comprehensibility of terms and phrases used to describe functions or content.</td></tr>
<tr><td>Learnability is an intrinsic property of usable systems that deliver users from the process of self-instruction or attending structured courses.</td></tr>
<tr><td>Performance: is a determinant factor for user acceptance of a system, especially a web-based information system</td><td>Precision and recall remain the principle evaluation criteria, but with the employment technologies other criteria have been developed e.g. response time.</td></tr>
</table>

Adapted from Tsakonas and Papatheodorou, 2006, p. 402 – 403

The responses of the frontline users and the informatics consultant users were qualitatively analyzed and the final results of the thematic analysis are summarized in Table 22 and Table 23 respectively.

Table 22: Themes That Emerged from Comments of Frontline Users

Coding Themes Concepts	Emerged themes	User Comments
Usability	Ease of use	"I think it is very user friendly"
		"easy to use and understand"
	Ease of use and aesthetics	"Layout and user friendliness"
		"Tabs on side"
	Ease of use and response time	"user friendly prompt when necessary"
		"Responds quickly"
	learnability	"Movable user"
Usefulness	Relevance	"learning module before assessment which has given me detailed information of this module"
		"New skills and new learning experience"
		"Learning opportunity"
		"Versatility"
		"Searching patients"

Table 23: Themes That Emerged from Comments of Informatics Consultant Users

Coding Theme Concepts	Emerged Themes	User Comments
Usability	Aesthetics	"It allows for customizability for a set response i.e. it will show only the response identified by the programmer even if there are many ways to perform a function"
	Ease of use and navigation	"It is friendly and offers option to move back for refresh"
	Learnability	"Training on a large scale, can be done independently for economic and design reasons"
Usefulness	Reliability	"I appreciate that, as a user, I could return and review when additional learning was needed"

The percentage of coded themes from user comments (related to the e-learning module features) that focused on the usability and usefulness of the MCEC-eLM for frontline users and for informatics consultant users is given in Tables 24 and 25 (also see

Figure 11 and 12). For the frontline users, 58% of the coded themes were related to usability and 41% were related to usefulness concepts. By comparison, for the informatics consultant users, 75% of the coded themes were related to usability and 25% were related to usefulness.

Table 24: Percentage of Usability and Usefulness Themes - Frontline Users

Concept	Emerged Theme Percentages %
Usability	58.30%
Usefulness	41.70%

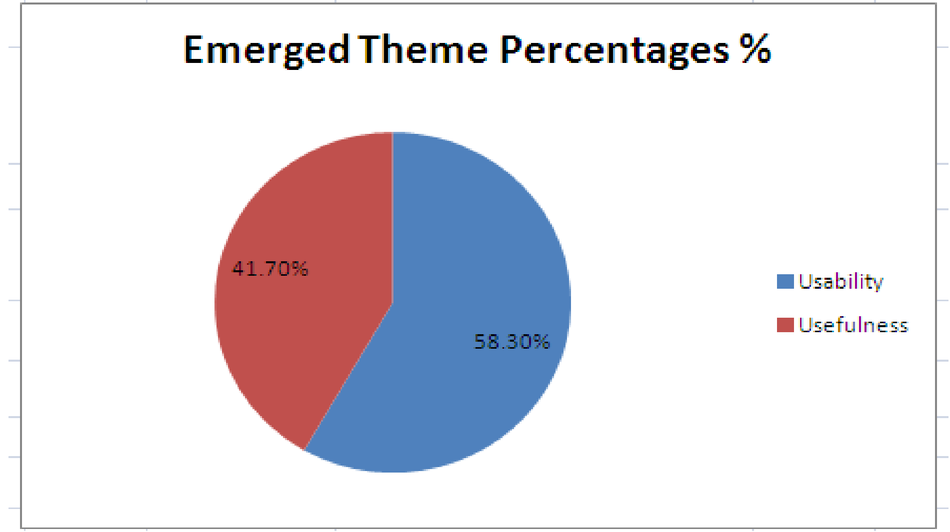


Figure 11: Rates of Usability and Usefulness-related Themes - Frontline Users

Table 25: Percentage of Usability and Usefulness Themes - Informatics Consultant Users

Concept	Emerged Theme Percentages %
Usability	75%
Usefulness	25%

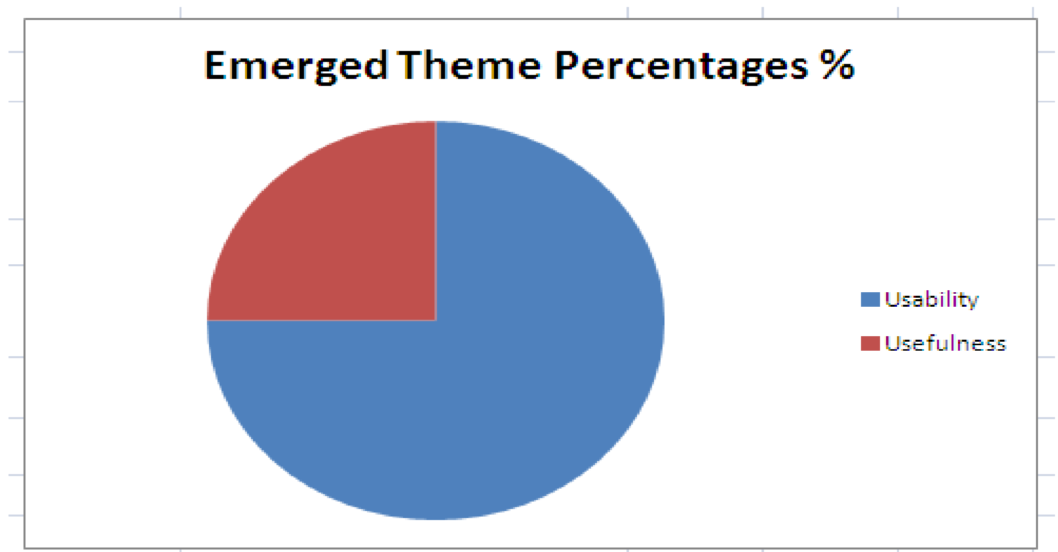


Figure 12: Rates of Usability and Usefulness-related Themes - Informatics Consultants

5.3.7.1. Themes Related to Usability of the Interface

As shown above in Figure 11, fifty eight percent (58%) of the themes identified (related to the e-learning module features) focused on the concept of usability, as identified from the comments of the frontline users. The majority of these users believed that the MCEC-eLM was easy to use. This finding was supported by the following frontline users' comments. For example, one frontline user said, "I think it is very user

friendly." Another frontline user stated that the application was "easy to use and understand".

In addition, the frontline users believed that the layout and the appearance of the module was one of the best aspects of the application. This finding was supported by users' comments indicating that they liked the "layout and user friendliness" aspect of the module and the way the" tabs on side were arranged." Overall, the frontline users liked the way the MCEC-eLM interacted with the users. For example, one frontline user mentioned that it "responds quickly."

Compared to the frontline users, of all the themes related to the e-learning module features identified from the comments of the informatics consultants, seventy five percent (75%) were related to usability (Figure 12). The informatics consultant users believed that the MCEC-eLM (as used in AHS's WBT Manager for e-Learning) was easy to use, with good layout and appearance. Overall, it was perceived as supporting the learning process of the users. These findings were supported by other comments from the users, such as, "it allows for customizability for a set response i.e. it will show only the response identified by the programmer even if there are many ways to perform a function." Another, user commented, "It is friendly and offers an option to move back for refresh." Finally, another informatics consultant user stated that" training on a large scale can be done independently for economic and design reasons."

5.3.7. 2. Themes Related to Usefulness of the Content

As shown in Figure 11, forty one percent (41%) of the themes of frontline users were related to the concept of usefulness. Based in their comments, the frontline users believed that the MCEC-eLM is useful and provides core competencies relevant to their

work. The frontline users thought it was useful in providing detailed information about the course they had taken. As an example of this perspective, one user stated it was useful in providing “new skills and new learning experience.” Overall, the frontline users believed that the MCEC-eLM could provide good “learning opportunity.”

Compared to the frontline users, 25% of the themes of the informatics consultant users were related to usability. Based on their comments, informatics consultant users believed that the MCEC-eLM could provide learning flexibility. This finding was supported by the following quote: “I appreciate that, as a user, I could return and review when additional learning was needed.”

5.3.8. Open-ended Question: What Needs Most Improvement? Why?

In this section, the results of the analysis of user comments analysis for the frontline users and the informatics consultant users in response to the question about what needs most improvement are presented in Table 26 and 27 respectively. Comments were analyzed and categorized qualitatively. The themes emerging from the users’ comments are categorized based on the concepts of usability and usefulness.

Table 26: Improvement-related Themes from Comments of Frontline Users

Coding Theme Concepts	Emerged Themes	User Comments
Usability	Aesthetics	"Icons are unclear"
		"Identification of patient should be
		"Error messages"
	Ease of use	"More average user friendly"
Usefulness	Format	"More test situations"
	Relevance	"Checking patient information is important"
	Format	"More hands on exercises"

Table 27: Improvement-related Themes from Comments of Informatics Consultant Users

Coded Themes	Emerged Themes	User Comments
Usability	Aesthetic	"At times, I was confused as to whether or not the software was demonstrating or whether I was expected to be interactive"
	Learnability	"Access remotely, so user can train on their own time. When forgot more information if required"
Usefulness	Reliability	"The instructions on how to view the video, it doesn't indicate you can pause if the screens are changing faster than you can read"
		"Some instructions might be specific about the source of the information comes from"

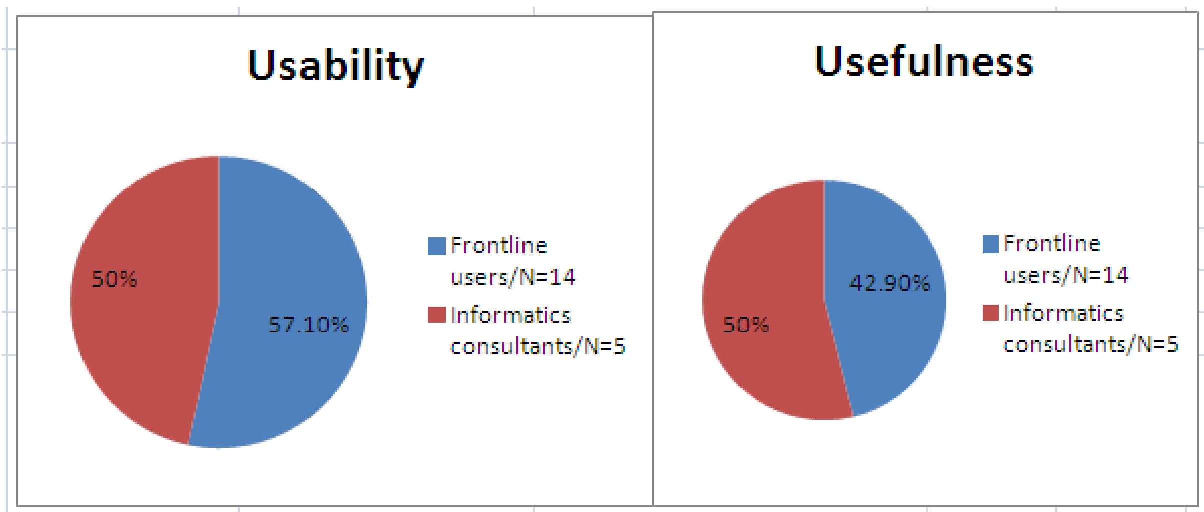


Figure 13: What Needs Most Improvement Related to Usability and Usefulness?

5.3.8.1. What Needs Most Improvement Related to Interface Usability?

As shown in Figure 13, from the comments of the frontline users there is opportunity for improvements related to the usability of the module. These were apparent from the comments of the frontline users and the informatics consultant users.

According to many frontline users, the layout and appearance of the content in the WBT Manager interface needs attention. For example, one participant mentioned that the "icons are unclear." In another example, the users suggested, "identification of patient should be bolder." Some frontline users believed "error messages" needed the most improvement. Other users stated they did not have "enough experience using the software to comment."

Compared to the frontline users, the informatics consultant users presented more opportunities for improvement. Some suggested that the appearance of the content in the interface should be more interactive; specifically, one stated, "At times I was confused as to whether or not the software was demonstrating or whether I was expected to be

interactive." The informatics consultant users suggested addition of other features so that users can "access remotely, so users can train in their own time."

5.3.8.2. What Needs the Most Improvement Related to Usefulness of the Content

The frontline users suggested a number of ideas for improvement that were related to the usefulness of the content, including adding, "more test situations." Other comments were related to more training about identification of patient information. For example, one user said, "Identification of patient information is important." Another frontline user suggested "more hands-on exercises" for the users.

The informatics consultant users suggested additional opportunities for improvement. For example, one informatics consultant user suggested, "some instructions might be specific about the source the information comes from." Others suggested that there should be further instruction, saying, "The instructions on how to view the video, it doesn't indicate you can pause if the screens are changing faster than you can read."

5.4. Results of Cognitive Task Analysis of the Video-based Data

As mentioned earlier, usability can be considered in terms of effectiveness, efficiency and user satisfaction (Guidance on Usability, 1998 as cited by Koch et al., 2009, p. 123). In the above sections, we discussed the usability subjective satisfaction measurement using the SUMI questionnaire, which was used as part of user acceptance testing (UAT). In this section, the results of the analysis of the video-based data analysis conducted with the informatics consultant users are presented. This involved using

cognitive task analysis (CTA) and the results will be compared with the subjective usability satisfaction measurements obtained using the SUMI questionnaire.

CTA emerged as a way of characterizing decision-making and reasoning skills and information processing needs of subjects as they perform activities and tasks involving the processing of complex information (Kushniruk and Patel, 2004). CTA typically includes:

> Development of a task hierarchy describing and cataloguing the individual work activities or tasks that might consist of activities or tasks that take place in an organization; observation of subjects with varying levels of expertise as they perform selected tasks of interest. (Kushniruk & Patel, 2004)

The CTA approach was used for the analysis of the video data. The application of this approach requires development of coding categories before analyzing the video data for identifying user problems and aspects of cognitive processes from the transcripts of the subjects who are observed while walking through tasks and “thinking aloud.” The coding categories can provide insight into identifying problematic usability areas regarding the content of the information, the comprehensiveness of graphics and text, navigation, and overall understandability (Kushniruk and Patel, 2004). In this thesis, categories used for coding video data were taken from a list of heuristic criteria customized specifically for evaluating web-based learning by Ssesmugabi and De Villiers, 2009, p. 134 – 135, as shown below in Table 28.

Table 28: Heuristic Evaluation Criteria for Web-based Learning Framework

	Category 1: General interface usability criteria (based on Nielsen's heuristics, modified for e-learning context)
I	**Visibility of system status** • The website keeps the user informed about what is going on through constructive, appropriate and timely feedback. • The system responds to user-initiated actions. There are no surprise actions by the site or tedious data entry sequences.
2	**Match between the system and the real world i.e. match between designer model and user model** • Language usage such as terms, phrases, symbols, and concepts is similar to that of users in their day-to-day environment. • Metaphor usage corresponds to real-world objects/concepts e.g. understandable and meaningful symbolic representations are used to ensure that the symbols, icons and names used are intuitive within the context of the Performed task. • Information is arranged in a natural and logical order.
3	**Learner control and freedom** • Users control the system. • Users can exit the system at any time, even when they have made mistakes. • There are facilities for Undo and Redo.
4	**Consistency and adherence to standards** • The same concepts, words, symbols, situations, or actions refer to the same thing. • Common platform standards are followed.
5	**Error prevention; in particular, prevention of peripheral usability-related errors [36]** • The system is designed such that the users cannot easily make serious errors. • When a user makes an error, the application gives an appropriate error message.
6	**Recognition rather than recall** • Objects to be manipulated, options for selection, and actions to be taken are visible. • The user does not need to recall information from one part of a dialogue to another. • Instructions on how to use the system are visible or easily retrievable whenever appropriate. • Displays are simple and multiple page displays are [minimized].
7	**Flexibility and efficiency of use** • The site caters to different levels of users, from novice to expert. • Shortcuts or accelerators, unseen by novice users, are provided to speed up interaction and task completion by frequent users • The system is flexible to enable users to adjust settings to suit themselves, i.e. to customise the system.
8	**Aesthetics and minimalism in design** • Site dialogues do not contain irrelevant or rarely needed information which could distract users as they perform tasks.

9	**Recognition, diagnosis, and recovery from errors** • Error messages are expressed in plain language. • Error messages define problems precisely and give quick, simple, constructive, specific instructions for recovery. • If a typed command results in an error, users need not retype the entire command, but repair only the faulty part.
10	**Help and documentation** • The site has a help facility and other documentation to support users' needs. • Information in these facilities is easy to search, task-focused, and lists concrete steps to accomplish a task.

	Category 2: Website-specific criteria for educational websites
11	**Simplicity of site navigation, [organization] and structure** • The site has a simple navigational structure. • Users should know where they are and have options [as to] where to go next, e.g. via a site map or breadcrumbs. • The navigational options are limited so as not to overwhelm the user. • Related information is placed together. • Information is organised hierarchically, moving from the general to the specific. • Common browser standards are followed. • Each page has all the required navigation buttons or hyperlinks (links), such as previous (back) next and home.
12	**Relevance of site content to the learner and the learning process** • Content is engaging, relevant, appropriate and clear to learners using the WBL site. • The material has no biases such as racial and gender biases, which may be deemed offensive. • It is clear which materials are copyrighted and which are not. • The authors of the content are of reputable authority.

Category 3: Learner-centred instructional design, grounded in learning theory, aiming for effective learning	
13	**Clarity of goals, objectives and outcomes** • There are clear goals, objectives and outcomes for learning encounters. • The reason for inclusion of each page or document on the site is clear.
14	**Effectiveness of collaborative learning (where such is available)** • Facilities and activities are available that encourage leamer-Ieamer and learner-teacher interactions. • Facilities for both asynchronous and synchronous communication, such as e-mail, discussion forums and chat rooms.
15	**Level of learner control** • Apart from controlling the interactions with the site, learners have some freedom to direct their learning, either individually or through collaborative experiences, and to have a sense of ownership of their learning. • Learners are given some control of the content they learn, how it is learned, and the sequence of units. • Individual learners can customize the site to suit their personal learning strategies. • Educators can [customize] learning artefacts to the individual learner; for example, tests and performance evaluations can be customized to the learner's ability. • Where appropriate, learners take the initiative regarding the methods, time, place, content, and sequence of learning
16	**Support for personally significant approaches to learning** • There are multiple representations and varying views of learning artefacts and tasks. • The site supports different strategies for learning and indicates clearly which styles it supports. • The site is used in combination with other media of instruction to support learning. • Metacognition (the ability of a learner to plan, monitor and evaluate his/her own cognitive skills) is encouraged. • Learning activities are scaffolded by learner support and by optional additional information.
17	**Cognitive error recognition, diagnosis and recovery** • Cognitive conflict, bridging and problem-based learning strategies are used in the recognition-diagnosis-recovery cycle. • Learners have access to a rich and complex environment where they can explore different solutions to problems. • Learners are permitted to learn by their mistakes and are provided with help to recover from cognitive errors. • Learners are given opportunities to develop personal problem-solving strategies.
18	**Feedback, guidance and assessment** • Apart from the system's interface-feedback by the system, considered under Criterion I, learners give and receive prompt and frequent feedback about their activities and the knowledge being constructed. • Learners are guided as they perform tasks. • Quantitative feedback (e.g. grading of learners' activities) is given, so that learners are aware of their level of performance.

19	**Context meaningful to domain and learner** • Knowledge is presented within a meaningful and authentic context that supports effective learning. • Authentic, [contextualized] tasks are undertaken rather than abstract instruction. • The application enables context- and content-dependent knowledge construction. • Learning occurs in a context of use so that knowledge and skills learned will be transferable to similar contexts. • The representations are understandable and meaningful, ensuring that symbols, icons and names used are intuitive within the context of the learning task.
20	**Learner motivation, creativity and active learning** • The site has content and interactive features that attract motivate and retain learners, and that promote creativity on the part of learners; e.g. the online activities are situated in real-world practice and interest and engage the learners. • To promote active learning and critical thinking, tasks require learners to compare, analyse and classify information, and to make deductions

Adapted from Evaluation criteria for web-based learning – a framework, Ssemugabi and De Villiers, 2007, pp. 134-135.

The transcripts of the five informatics consultant user interactions with the MCEC – e-LM were coded using the coding categories from Table 28. The coded transcripts are shown in Tables 29, 30, 31, 32 and 33. Each table includes the time sequence of the task, transcript of user interactions, coding themes, and computer screenshot reference (actual screenshots are included in Appendix R). Themes were coded using the heuristic categories, as shown above in Table 28, for web-based learning applications and were adapted from Ssemugabi and De Villiers (2007).

Table 29: Cognitive Task Analysis: Informatics Consultant User 1

Time Sequences'	Transcripts of user interactions	Coding themes	Screenshot
00:00:30	(User login WBT Manager for e-Learning using username and password provided in testing room)		
00:01:28	(User started Millennium Clinibase Encounter Creation e-Learning Module, Main Menu)		
00:01:30	(User started Topic 1: Introduction to Clinibase)		
00:05:23	(User started Topic 2: Clinibase Navigation)		
00:05:43	(User Walked through Topic 2: Clinibase Navigation, Access and Layout) (User started to think aloud and said,) "Not take a lot of thinking"	FLEXIBILITY AND EFFICIENCY OF USE	
00:09:00	(User started Topic 3: Clinibase Outpatient Functionality)		
00:14:50	"This basic walkthrough"	FLEXIBILITY AND EFFICIENCY OF USE	
00:17:14	(User started Topic 4: Caseload Management and Reports)		
00:21:10	(User started Core Competency Assessment)		
00:32:48	(User finished and passed the core competency assessment)		

Table 30: Cognitive Task Analysis: Informatics Consultant User 2

Time sequences'	Transcript of user interactions	Coding themes	Screenshot
00:00:00	(User starts session)		
00:00:02	(User Logs into WBT Manager using user username and password provided in training room)		
00:00:51	(User starts MS/CEC-eLM)		
00:01:51	(User goes to module Main Menu)		
00:01:58	(User starts Topic 1: Introduction to Clinibase)		
00:02:30 – 00:03:20	"For introduction piece here, I think will be helpful to users when it says 'consists of clinibase and … etc.,' may be mention that is the one way communication. So that Clinibase beats SCM. You know, because, I think, that one issues we having right now. They understand how they interact. They know the interactivity, but they don't know how. May be by having a little bit information…etc., kind of, to say, the communication goes from Clinibase to SCM"	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	1.1
00:06:49 – 00:07:27	"What we thought when we watching sort of the view video, in this type of these things, will be nice to see along the bottom, like, how fast is moving. So, as a user, you know if you reading very quickly, you wondering, well, I have click something? How long do I have to wait to go on? But, if at the bottom, there is a pause and move forward and go back, but, there sort of a little bar like watching a movie saying okay here is going, so okay, allows you to better judge how much time is going forward"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	1.2
00:08:45 – 00:09:11	"I think this the way the screen is set up here. It asks me to continue, but, there is no button that says Next, I am assuming the arrow pointing right but it doesn't fit the screen, I am assuming that Next, but, may stuck some people."	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	1.3
00:10:23 to 00:10:41	" The only thing I will add to use Verify Validate Window, there quite few places says 'followed approved processes' if somebody is new coming in they don't know what those are so may add additional comment of 'will be provided to you once you get your clinic" otherwise they may be looking here where are these processes"	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	1.4

Case 2 continued…

00:11:48 – 00:12:09	" Been a part of many issues around overlays, I would almost suggest, the last sentence on the screen be enforced either in red flashing lights, whatever we can make that as clear as possible, and all user can understand how important to make sure they close all of the windows before doing something else."	RECOGNITION RATHER THAN RECALL	1.5
00:13:15 – 00:13:31	"Getting access is always a concern to users, and here, it said, you will receive your own user ID and password. Honestly, nothing wrong with that, but again, I don't know, if would be a value of adding from managers or by email, so that everyone knows exactly how to get it"	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	1.6
00:14:50 – 00:15:34	"I want to come to requesting how many letters to enter when searching for a name? I think, it said concrete, here saying; only enter the first two letters of the last name and first two letters of the first name. Do not enter any other information. Not be aware the system can be valid reason for that, but may be consider the idea of putting, only enter up to this amount at least three letters for the Cerner at least two for that, you know, telling a person can only use three or two letters, sometimes you know limiting your scope; what if you have names start with the same three letters or two letters, that kind of things."	CONSISTENCY AND ADHERE TO STANDARDS	1.7
00:20:29 – 00:21:16	"So, based on my first comment that I have actually made, I think this screen is very important towards explain how Millennium and Clinibase work together." So, the more I think the users that are exposed to different systems we used and how they talked to each others, I think will be great understanding how, where information flows and why it doesn't show up, why is not there or how I get something somewhere. I think this one of the challenges right now is not their job to know how the technology works that the better understanding of how the tools interact together will help them do the job efficiency. I like the screen words bring those two applications together."	FLEXIBILITY AND EFFICIENCY OF USE	1.8

Case 2 continued…

00:22:53 – 00:23:36	"So, on this screen, I clicked Referrals because it asked me to start a Referral process change screens but I am not sure if it's suppose to do anything else or if that all is doing, so, may be just mentioned that I am not expecting something new to happen here or when I click Referrals it doesn't change the screen it just this is the red start. It changes the screen and I am not sure if I quit something or if a video is going to show up, moving on."	FLEXIBILITY AND EFFICIENCY OF USE	1.9
00:24:35 – 00:25:09	"So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I never seen the checkmark as a symbol used to save anything, so, more than user interface things. I have assumed will be trying to be similar to other programs, may be click save to save. I don't think the checkmark until have used for a while that an obvious choice of button, I know it is a configuration thing."	MATCH BETWEEN THE SYSTEM AND THE REAL WOLD	1.10
00:25:52 – 00:26:00	"Here, I might make mention somewhere do you have to search by last name or first name or something just a quick note for the users."	CONSISTENCY AND ADHERENCE TO STANDARDS	1.11
00:27:10 – 00:27:28	"I am assuming this trail piece is over but is not indicating anything more except to wait anything happened or might be done. Might have some kind of close the screen or show the video is over."	RECOGNITION RATHER THAN RECALL	1.12
00:29:57 – 00:30:10	"So again, this is sort of configuration piece …etc., very bottom is a checkmark for close which I don't know it means save and close, etc."	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	1.13
00:31:50 – 00:32:00	"Same thing on this screen, checkmark with close at the bottom …etc. it seems like irrelevant button. It may confuse people at this point."	AESTHETICS AND MINIMALISM IN DESIGN	1.14
00:33:57 – 00:34:17	"In this window, here, now said enter the first four letters of the physician surname. Before, it said just enter the first three for the surname and the two for the other name. So, I think, you know, these are minor details obviously, but I still… to say at a minimum enter these values and then users can make up their mind."	CONSISTENCY AND ADHERE TO STANDARDS	1.15

Case 2 end of analysis

00:35:03 – 00:35:26	"I guess as a user, I am just used of everything starting at the top and I am working my way be down and in this program everything you action on it goes back to the top. I guess, again the choice to the people who configure it, but it seems we flow left to right top bottom. This goes left to right but bottom to top almost"	MATCH BETWEEN THE SYSTEM AND THE REAL WORLD	1.16
00:38:02 – 00:38:37	"So for this transferring attending physician, the examples are used are perfectly fine but one for which probably will be more likely to do it will be transferring physician from one service to the next, so physician comes on attending physician for the next week and they go away a new physician comes on that will be the example that I would use. They will do that every week." Using like physician retires and that leaves hardly ever happened."	MATCH BETWEEN THE SYSTEM AND THE REAL WORLD	1.17
00:39:12 – 00:39:35	"Again, this is an example of transfer individual physician to individual user. I think the best transfer might be a better example because that goes back to the physician comes on and off service. They more likely be doing that more often than this. I still stand be corrected, but, it seems to me, I know living in the SCM world that happens a lot."	MATCH BETWEEN THE SYSTEM AND THE REAL WORLD	
00:43:29 – 00:43:44	"I think in this window, Then click plus sign to add a new diagnosis, I can't distinctively want to go to click that and nothing happened… So, just the screen flowed to me."	COGNITIVE ERROR RECOGNITION, DIAGNOSIS AND RECOVERY	
00:45:35	(User goes to Scheduler/Clinbase Encounter Creation Performance Assessment)		
00:45:43	(User starts the Assessment)		
00:57:00	(User finish the Performance Assessment)		

Table 31: Cognitive Task Analysis: Informatics Consultant User 3

Time sequences'	Transcripts of user interactions	Coding themes	Screenshots
00:00:46	(User login using username and password provided in the room)		
00:00:44	(Started Millennium/Clinibase Encounter Creation module, Main Menu)		
00:00:48	(Started Topic 1: Introduction to Clinibase)		
00:04:32	"You have to remember all little icons and what they mean as you are going through, so, remembering to click view to identify the core mandatory data"	RECOGNITION RATHER THAN RECALL	2.1
00:04:57	"If you are slow reader, these actually goes by too fast, so, is remembering to find a pause at the bottom to slow it down, so, you can read it"	RECOGNITION RATHER THAN RECALL	2.2
00:07:29	"In the mandatory data, should it say provincial health card, in case they recently moved here"	RELEVANCE OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	2.3
00:10:28 – 00:10:39	"When it returned to main menu, it does tell you to click on topic to proceed, the original instruction is click Next to the bottom right hand corner" (Start Topic 2: Clinibase Navigation)	CONSISTENCY AND ADHERENCE TO STANDARDS	2.4
00:13:34	"The Millennium Scheduler OPPI Form, just changed today, so, I don't know if that be updated here, is not in the link that is embedded"	LEARNER CONTROL AND FREEDOM	2.5
00:17:08	(Started Topic 3: Clinibase Outpatient Functionality)		
00:20:34	"One cyclic Referrals and the screen changes, I am not sure I am supposed to click Next or something else is going to appear, so, I will click Next"	RECOGNITION RATHER THAN RECALL	2.6
00:27:32	"Is it better to click the X on the corner or the Close button, the instruction said, click X on the corner"	RECOGNITION RATHER THAN RECALL	2.7

Case 3 Continued…

Time sequences'	Transcripts of user interactions	Coding themes	Screenshots
00:34:41 – 00:35:27	"When I go to look for the Appointments tab, I don't see it in the screen, but when I click to the link, it takes me to a different view, so, I am confused this to going from moment tab on left side showing OP Registration and Patient History to the actual tab view that shows the appointments… Also, when I clicked on the Service Events is that changing my tab from Appointments to Service Events, it looks like it does, but it doesn't show that transition, so that I can follow it"	RECOGNITION RATHER THAN RECALL	2.8 & 2.9
00:36:24	"When I start Transfer Attending Physician, I am making the assumption that I get to the screen by the tabs that on the left hand side, is not very well defined is how to get to Transfer screen"	MATCH BETWEEN THE SYSTEM AND THE REAL WOLD	2.10
00:37:48	(Started Topic 4: Caseload Management and Reports)		
00:43:08	"This is the first Tip I have noticed, I am not sure if they appear before. They kind of hidden behind the main focal point of the screen"	RECOGNITION RATHER THAN RECALL	2.11
00:45:23	"In this screen, it doesn't show the exit button. I am going to click the X. it works."	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	2.12

Case 3 continued…end

00:46:16	(Started the Core Competency Assessment)		
00:52:06	"As I am working on the Assessment, it would be nice to have the number of questions remaining for people that need to know how many questions they are"	LEVEL OF LEARNER CONTROL	2.13
00:53:53	"In transitioning from question 13 to 14 it said click here to continue and it automatically change the screen"	VISIBILITY OF SYSTEM STATUS	2.14
00:55:17	"Is not recalled in the module where is actual it shows where, which tab to click on it to check your checked appointments"	RECOGNITION RATHER THAN RECALL	2.15
00:58:36	(Finished and passed the assessment).		

Table 32: Cognitive Task Analysis: Informatics Consultant User 4

Time sequences'	Transcript of user interaction	Coding themes	Screenshots
00:00:00	(User logged into the WBT Manager using username and password provided in the room)		
00:00:57	(User started the Millennium Scheduler/Clinibase Encounter Creation Module)		
00:03:57 – 00:07:18	"So, I was here, so I was clicking, there is referrals, but, I can't see the where is the second Referrals… can I move back, ooh no, it says click to create a new referral to select Referrals to the right, it should be Referrals to the left, I think so, it says, the first step… I can't find the Referrals on the right, I only see the Referrals on the left, so, I clicked the Referrals on… it can't find the Referrals on the right. Anyway, I will say that here, will say Referrals to the left…etc., I am lost. Sorry, I can't start this Referrals process. I need a hand here…. this means Referrals to the left, but can't understand to start Referral process, I am missing this…"	RECOGNITION RATHER THAN RECALL	3.1
00:09:22	"I will say here when the above fields have been completed click checkmark to save, to see checkmark at the top or at the head line. because I am looking for the checkmark"	RECOGNITION RATHER THAN RECALL	
00:20:38	"That nice to receive all these warnings when changing the address… I like it because sometime you change the address and you don't know what other information is impacted, so, is good to know that from the user perspective"	ERROR PREVENTION, IN PARTICULAR, PREVENTION OF PERIPHERAL USABILITY-RELATED ERRORS	
00:27:43	"Probably on this screen, when it says OP Registration/Service Events there is a kind of gap between Appointment tab and Service Events because is saying an appointment or existing registration become a Service Event once the appointment is checked-in and is not clear when it checked-in, probably will be good to say the time of the date or once the patient showed up for the appointment"	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	.3.2

Case 4 continued…end

00:31:39	(Started topic 4: Caseload Management)		
00:34:31	"It says that patient's should be discharge in a timely manner, and it shows the date of discharge in 2011 and we are talking about the pre-registration of this year, so, probable this date be changed to avoid confusion, this date should be 2012"	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	3.3
00:40:39 – 00:41:18	"I will say that here, Topic 4: Adding a diagnosis, all the steps are clear, but we need to point if is the clerk or administrative side who is adding the diagnosis they do the diagnosis from the physician report or whatever, because is not clear…so one can think, Okay, I can add my diagnosis… Should be taken from a source of truth"	CONSISTENCY AND ADHERENCE TO STANDARDS	
00:46:00	(Started Core Competency Assessment)		
01:07:28	(Finished and passed the Core Competency Assessment)		

Table 33: Cognitive Task Analysis: Informatics Consultant User 5

Time sequences'	Transcripts of user interactions	Coding themes	Screenshots
00:00:00	(User Logged into WBT Manager using username and password provided in the room)		
00:01:10	(Started Millennium/Clinibase Encounter Creation Module)		
00:02:05	(User started Millennium/Encounter Creation E-Learning Module Main Menu – lessons)		
00:02:23	" Is a good thing that the little hand comes up, I like that because people that may not be used using the computer might expect to use a different colour of text like a blue or something for a link"	RECOGNITION RATHER THAN RECALL	4.1
00:03:21	(User starts Topic 1: Introduction to Clinibase		
00:03:41	" So, I know Next would mean the arrows here, but when it said click Next to continue, it may not obvious to some people"	RECOGNITION RATHER THAN RECALL	4.2
00:06:38	"I am clicking on the arrows wasn't sure whether just screen shots or whether linked to something. They just button. They don't link to anything"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	4.3
00:08:41 – 00:09:21	"With this view screen, I wasn't sure initially, I wasn't sure whether or not it was interactive or whether I suppose to view it and first I got the changes were too slow then I started reading all the information then at one point it took me a little bit longer to read it and it flipped by itself and then at the end it was a long time before changing and I wasn't sure if I was suppose be exiting out or whether something else was to come"	VISIBILITY OF THE SYSTEM STATUS	4.4
00:11:12	"I like the fact you can click down the tree rather than exiting out it just save one click for the user"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	4.5
00:12:07	"Errors with validating PIEM information can impact patient care and have significant negative effects. You certainly can't say that enough. It's very important."	RELEVANCE OF SITE CONTENT TO THE LEARNER AND HE LEARNING PROCESS	4.6
00:14:22	"When selecting the list, it slightly out of view and I don't know if the alignment in your computer screen or not but the menu is barred below here your tabs here"	VISIBILITY OF SITE STATUS	4.7

Case 5 continues…

00:14:41	(Started Topic 2: Clinibase Navigation)		
00:16:25	"Again, this is another spot where I wasn't sure whether or not the. I am not sure what to call it, but the action is showing me whether is done or not so I was waiting to continue because I wasn't sure this Click to quit is showing me different menu option or is actually asking me to quit"	RECOGNITION RATHER THAN CALL	4.8
00:18:58	"I am still not a hundred percent sure I know what to do when I am doing eLearning project but I am not hundred percent sure where to click on the name so that I can search and bring up the screen"	HELP AND DOCUMENTATION	4.9
00:23:59	"I was expecting to have a little quiz at the end of each topic just to review the knowledge, but may be that is coming at a later time, I am not sure, but something similar to Introduction to Clinibase and I didn't see that in Clinibase Navigation at all"	FEEDBACK, GUIDANCE AND ASSESSMENT	4.10
00:24:26	(Started Topic 3: Clinibase Outpatient Functionality)		
00:27:41	"The first step to create a new referral is to select Referrals to the right which I did. Click Referrals to start referral process, I am just not sure that another step that I need to do or whether is just referring to the first step. I am thinking you just repeating the first step, but I am not sure as this page opened and I am find myself looking for another button that said Referrals although it said step 2 in the process"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	4.11
00:29:07	"That is a good description for the Site/Program category/Program/Care Unit, is very good"	RELEVANCE OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	4.12
00:29:58	"I am just wondering if the Attending Physician, if that list can be added to by the user as Referring Physician can and also wondering, it makes me wonder whether or not, the, when you add to referring list it does that physician stay on the list for everybody to see and how is that controlled"	CONSISTENCY AND ADHERE TO STANDARDS	4.13

Case 5 continued…

00:30:58	"In the screen shot the checkmark you are asking me to check once I have completed it is greyed out so I am assuming that in the real world when I add to this and start adding will become active it is not right now so I had to sort of look around for it and it is greyed out, but it is there"	MATCH BETWEEN THE SYSTEM AND THE REAL WOLD	4.14
00:33:27	"I am a hands on learner, so, I enjoyed that a little try Create a Referrals, so, it is a good exercise to go through"	LEARNER MOTIVATION, CREATIVITY AND ACTIVE LEARNING	4.15
00:34:40 – 00:35:47	"So, because I am used to, in a teacher in a class room because I did training in the long time as well as being taught in the class room where you have a free range of doing everything on alive screen what I find really difficult with eLearning and is something that everybody will have to learn I am always unsure as I mentioned before click each step to learn more click decision I am so not a hundred percent sure whether or not it was telling me to click decision on screen or whether is going to do it itself I am just learn by errors by clicking it didn't happened and just waiting too more seconds and then it did it. So, I think that just frost older folks that they have to learn how just to be patient in things don't respond, you know, is going to do for us, so that things have to learn about eLearning myself"	COGNITIVE ERROR RECOGNITION, DIAGNOSIS AND RECOVERY	4.16
00:37:11	"Clinic Labels, actually wondering what is difference between Generic and Emergency labels, I am still not sure"	RELEVANCE TO SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	4.17
00:37:52	"Oops, as I click forward from print facesheet and labels page and I click Next there is an instant flash of different screen called page name with some information there"	VISIBILITY OF SYSTEM STATUS	4.18.A & 4.18.B

Case 5 continued…end

00:39:51 – 00:40:44	"So for the Identification Window, click Names or Addresses and that displayed the buttons surrounded by orange ridge is a super. The next step is to click a little icon to display all names/addresses. I wasn't immediately sure whether or not that little icon was beneath the buttons the Names and Addresses or whether I should be looking at the main screen to find another button I am not sure what it looks like but a little list but or something like that so I clicked view and I am assuming said the address is up here and I am assuming is underneath the Addresses button but it wasn't obvious to me at first"	RECOGNITION RATHER THAN RECALL	4.19
00:43:27	"I am just wondering, It said to close the window instruct me to do an X in the corner, I am wondering if I will be able to do the button at the bottom as well, I am not sure"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	4.20
00:46:58	"I know what probable unnecessary evil, I just find all pop ups a little bit annoying about changing address warnings I know that system issue rather than eLearning issue"	VISIBILITY OF SYSTEM STATUS	4.21
00:47:21	"In the case of modifying the address now it tells me to close in the bottom where I was changing the name it tells me to exit out from the top so it possible to be, may be eLearning demonstrating two ways of closing out, but is just some of inconsistency there, so maybe it could be stated as an either or options"	CONSISTENCY AND ADHERENCE TO STANDARDS	4.22
00:55:38	"That page name screen I think it pops almost every time screen refresher from tab to tab that something in the back but hopefully I caught it"	VISIBILITY OF SYSTEM STATUS	4.18.B
00:57:49	"At this moment doing the topic for Caseload Management I find myself trying to remember from the very first module what the colour means so I am not sure why one discharge is red and the other discharge is blue because I can't remember what I was told at the very beginning. So, It might be nice to have another little reminder when we actually working with the Caseload"	RECOGNITION RATHER THAN RECALL	4.23
01:01:19	"I just noticed on the Close a Preregistration eLearning page at the bottom you have option to rewind back and forward I like that feature because I can go back and forward over the point that you want to learn, that is a great feature"	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	4.24
01:05:50	(Started the Core Competence Assessment)		
01:19:23	(Finished and passed the Core Competency Test)		

The coded categories and themes that emerged from the analysis are summarized in Table 34. Both positive and negative aspects of the e-learning module emerged from the coding of the transcripts. Of all the coded themes, 58 of 66 themes (90%) were for areas indicating problematic issues as compared to 8 themes (12%), which referred to strengths of the application (i.e. strongly positive features).

As shown below in Figure 14, each identified issue, based on the heuristics usability criteria used for coding, were then categorized under one of three main categories including the following: general interface usability, website-specific criteria for educational websites, and learner-centred instructional design aspects. Sub-categories emerged from both the negative (i.e. problematic issues and features) and positive (i.e. strengths of the design) areas as discussed below.

Of all areas with problematic issues related to general interface usability, four major problems emerged from the comments of the informatics consultant users, including the following: problems related to recognition rather than recall (22.7%), consistency and adherence to standards (10.6%), match between the system and the real world (9.1%), and visibility of system status (9.1%). Some minor areas were identified, including flexibility and efficiency of use (3%), aesthetics and minimalism in design (1.5%), learner control and freedom (1.5%), and help and documentation (1.5%).

Of all areas with problematic issues related to website-specific criteria for educational websites, two major problems, which were identified, related to simplicity of navigation, organization, and structure (10.6%) and relevance of site contents to the learner (12.1%).

Table 34: Areas with Problematic Issues and with Features of Strength

Coding themes		Areas with problematic issues/N (58)	Areas with strength features/N (8)	Total/N (66)
General Interface Usability Criteria	VISIBILITY OF SYSTEM STATUS	9.1%		**9.1%**
	MATCH BETWEEN THE SYSTEM AND THE REAL WOLD	9.1%		**9.1%**
	LEARNER CONTROL AND FREEDOM	1.5%		**1.5%**
	CONSISTENCY AND ADHERE TO STANDARDS	10.6%		**10.6%**
	ERROR PREVENTION, IN PARTICULAR, PREVENTION OF PERIPHERAL USABILITY-RELATED ERRORS		1.5%	**1.5%**
	RECOGNITION RATHER THAN RECALL	22.7%	1.5%	**24.3%**
	FLEXIBILITY AND EFFICIENCY OF USE	3.0%	3.0%	**6.0%**
	AESTHETICS AND MINIMALISM IN DESIGN	1.5%		**1.5%**
	HELP AND DOCUMENTATION	1.5%		**1.5%**

Website Specific Criteria for Educational Website	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	10.6%	3.0%	**13.6%**
	RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	12.1%	1.5%	**13.6%**
Learner-Centred Instructional Design, Grounded in Learning Theory, Aiming for Effective Learning	LEVEL OF LEARNER CONTROL	1.5%		**1.5%**
	COGNITIVE ERROR RECOGNITION, DIAGNOSIS AND RECOVERY	3.0%		**3.0%**
	FEEDBACK, GUIDANCE AND ASSESSMENT	1.5%		**1.5%**
	LEARNER MOTIVATION, CREATIVITY AND ACTIVE LEARNING		1.5%	**1.5%**
TOTAL		**88.0%**	**12.0%**	**100.0%**

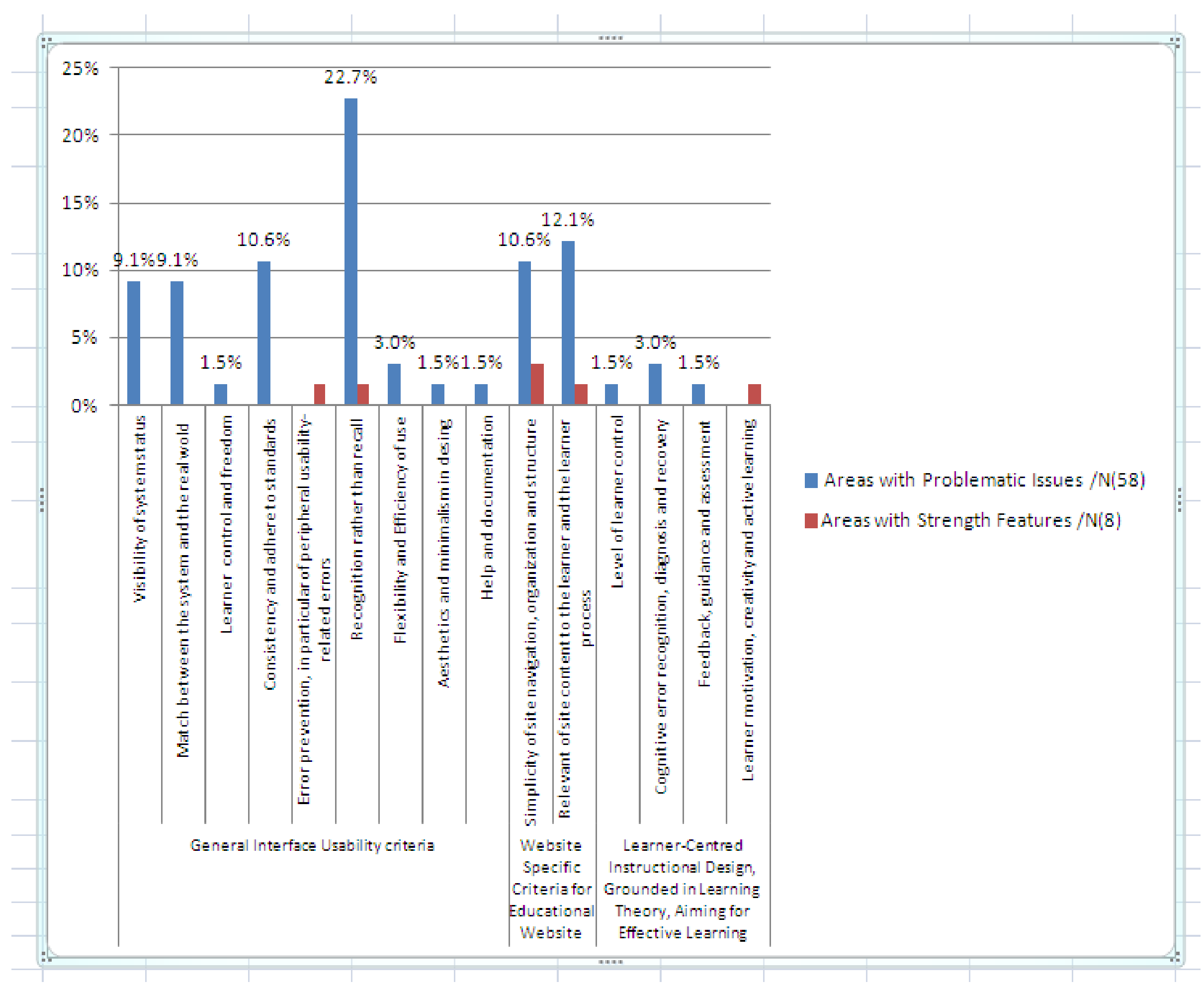


Figure 14: Areas with Problematic Issues and Strength Features

Minor problems were identified from the users' comments, including problems with cognitive recognition, diagnosis and recovery (3%), level of learner control (1.5%), and feedback, guidance and assessment (1.5). The cognitive task analysis (CTA) was also effective in identifying some positive ("strength") features of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) from the users' perspective. As shown above in Figure 14, two areas with strength-features-related general interface usability were identified from the users' comments, including flexibility and efficiency of use (3%) and recognition rather than recall (1.5%). In addition, two areas with strength

features related to website-specific criteria for educational websites including simplicity of navigation, organization and structure (3%); and relevance of site content to the learner and to the learner process (1.5%). Some informatics consultant users identified positive features related to learner instructional design, grounded in learning theory and aimed at effective learning. The features identified were related to learner motivation, creativity and active learning (1.5%). In the next section, problematic issues identified from the users' comments and supported by computer screenshots will be presented.

The comments of informatics consultant users with regard to major and minor problems are summarized below in Table 35. The problems are discussed based of their order of appearance in Table 35.

Table 35: Problems Related to General Interface Usability

Emerged themes	User's Comments
VISIBILITY OF SYSTEM STATUS	"In transitioning from question 13 to 14 it said click here to continue and it automatically change the screen"
	"With this view screen, I wasn't sure initially, I wasn't sure whether or not it was interactive or whether I suppose to view it and first I got the changes were too slow then I started reading all the information then at one point it took me a little bit longer to read it and it flipped by itself and then at the end it was a long time before changing and I wasn't sure if I was suppose be exiting out or whether something else was to come"
	"When selecting the list, it slightly out of view and I don't know if the alignment in your computer screen or not but the menu is barred below here your tabs here"
	"Oops, as I click forward from print facesheet and labels page and I click Next there is an instant flash of different screen called page name with some information there"
	"I know what probable unnecessary evil, I just find all pop ups a little bit annoying about changing address warnings I know that system issue rather than eLearning issue"
	"That page name screen I think it pops almost every time screen refresher from tab to tab that something in the back but hopefully I caught it"
MATCH BETWEEN THE SYSTEM AND THE REAL WORLD	"So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I never seen the checkmark as a symbol used to save anything, so, more than user interface things. I have assumed will be trying to be similar to other programs, maybe click save to save. I don't think the checkmark until have used for a while that an obvious choice of button, I know it is a configuration thing."
	"I guess as a user, I am just used of everything starting at the top and I am working my way be down and in this program everything you action on it goes back to the top. I guess, again the choice to the people who configure it, but it seems we flow left to right top bottom. This goes left to right but bottom to top almost"
	"So for this transferring attending physician, the examples are used are perfectly fine but one for which probably will be more likely to do it will be transferring physician from one service to the next, so physician comes on attending physician for the next week and they go away a new physician comes on that will be the example that I would use. They will do that every week." Using like physician retires and that leaves hardly ever happened"
	"Again, this is an example of transfer individual physician to individual user. I think the best transfer might be a better example because that goes back to the physician comes on and off service. They more likely be doing that more often than this. I still stand be corrected, but, it seems to me, I know living in the SCM world that happens a lot."
	"When I start Transfer Attending Physician, I am making the assumption that I get to the screen by the tabs that on the left hand side, is not very well defined is how to get to Transfer screen"
	"In the screen shot the checkmark you are asking me to check once I have completed it is greyed out so I am assuming that in the real world when I add to this and start adding will become active it is not right now so I had to sort of look around for it and it is greyed out, but it is there"

Problematic issues related to general interface usability continued…

LEARNER CONTROL AND FREEDOM	Scheduler OPPI Form, just changed today, so, I don't know if that be updated here, is not in the link that is embedded"
CONSISTENCY AND ADHERE TO STANDARD	"I want to come to requesting how many letters to enter when searching for a name? I think, it said concrete, here saying; only enter the first two letters of the last name and first two letters of the first name. Do not enter any other information. Not be aware the system can be valid reason for that, but may be consider the idea of putting, only enter up to this amount at least three letters for the Cerner at least two for that, you know, telling a person can only use three or two letters, sometimes you know limiting your scope; what if you have names start with the same three letters or two letters, that kind of things."
	"So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I never seen the checkmark as a symbol used to save anything, so, more than user interface things. I have assumed will be trying to be similar to other programs, may be click save to save. I don't think the checkmark until have used for a while that an obvious choice of button, I know it is a configuration thing."
	"Here, I might make mention somewhere do you have to search by last name or first name or something just a quick note for the users."
	"In this window, here, now said enter the first four letters of the physician surname. Before, it said just enter the first three for the surname and the two for the other name. So, I think, you know, these are minor details obviously, but I still… to say at a minimum enter these values and then users can make up their mind."
	"When it returned to main menu, it does tell you to click on topic to proceed, the original instruction is click Next to the bottom right hand corner" (Start Topic 2: Clinibase Navigation)
	"I will say that here, Topic 4: Adding a diagnosis, all the steps are clear, but we need to point if is the clerk or administrative side who is adding the diagnosis they do the diagnosis from the physician report or whatever, because is not clear…so one can think, Okay, I can add my diagnosis… Should be taken from a source of truth"
	"I am just wondering if the Attending Physician, if that list can be added to by the user as Referring Physician can and also wondering, it makes me wonder whether or not, the, when you add to referring list it does that physician stay on the list for everybody to see and how is that controlled"
	"In the case of modifying the address now it tells me to close in the bottom where I was changing the name it tells me to exit out from the top so it possible to be, may be eLearning demonstrating two ways of closing out, but is just some of inconsistency there, so maybe it could be stated as an either or options"

Problematic issues related to general interface usability continued…

RECOGNITION RATHER THAN RECALL	" Been a part of many issues around overlays, I would almost suggest, the last sentence on the screen be enforced either in red flashing lights, whatever we can make that as clear as possible, and all user can understand how important to make sure they close all of the windows before doing something else."
	I am assuming this trail piece is over but is not indicating anything more except to wait anything happened or might be done. Might have some kind of close the screen or show the video is over."
	"You have to remember all little icons and what they mean as you are going through, so, remembering to click view to identify the core mandatory data"
	"If you are slow reader, these actually goes by too fast, so, is remembering to find a pause at the bottom to slow it down, so, you can read it"
	"One cyclic Referrals and the screen changes, I am not sure I am supposed to click Next or something else is going to appear, so, I will click Next"
	"Is it better to click the X on the corner or the Close button, the instruction said, click X on the corner"
	"When I go to look for the Appointments tab, I don't see it in the screen, but when I click to the link, it takes me to a different view, so, I am confused this to going from moment tab on left side showing OP Registration and Patient History to the actual tab view that shows the appointments… Also, when I clicked on the Service Events is that changing my tab from Appointments to Service Events, it looks like it does, but it doesn't show that transition, so that I can follow it"
	"This is the first Tip I have noticed, I am not sure if they appear before. They kind of hidden behind the main focal point of the screen"
	"Is not recalled in the module where is actual it shows where, which tab to click on it to check your checked appointments'
	"So, I was here, so I was clicking, there is referrals, but, I can't see the where is the second Referrals... can I move back, ooh no, it says click to create a new referral to select Referrals to the right, it should be Referrals to the left, I think so, it says, the first step… I can't find the Referrals on the right, I only see the Referrals on the left, so, I clicked the Referrals on… it can't find the Referrals on the right. Anyway, I will say that here, will say Referrals to the left…etc., I am lost. Sorry, I can't start this Referrals process. I need a hand here…. this means Referrals to the left, but can't understand to start Referral process, I am missing this…"

Problematic issues related to general interface usability continued…..end

	"I will say here when the above fields have been completed click checkmark to save, to see checkmark at the top or at the head line. because I am looking for the checkmark"
	" So, I know Next would mean the arrows here, but when it said click Next to continue, it may not obvious to some people"
	"Again, this is another spot where I wasn't sure whether or not the. I am not sure what to call it, but the action is showing me whether is done or not so I was waiting to continue because I wasn't sure this Click to quit is showing me different menu option or is actually asking me to quit"
	"So for the Identification Window, click Names or Addresses and that displayed the buttons surrounded by orange ridge is a super. The next step is to click a little icon to display all names/addresses. I wasn't immediately sure whether or not that little icon was beneath the buttons the Names and Addresses or whether I should be looking at the main screen to find another button I am not sure what it looks like but a little list but or something like that so I clicked view and I am assuming said the address is up here and I am assuming is underneath the Addresses button but it wasn't obvious to me at first"
	"At this moment doing the topic for Caseload Management I find myself trying to remember from the very first module what the colour means so I am not sure why one discharge is red and the other discharge is blue because I can't remember what I was told at the very beginning. So, It might be nice to have another little reminder when we actually working with the Caseload"
FLEXIBILITY AND EFFICIENCY OF USER	"So, based on my first comment that I have actually made, I think this screen is very important towards explain how Millennium and Clinibase work together." So, the more I think the users that are exposed to different systems we used and how they talked to each others, I think will be great understanding how, where information flows and why it doesn't show up, why is not there or how I get something somewhere. I think this one of the challenges right now is not their job to know how the technology works that the better understanding of how the tools interact together will help them do the job efficiency. I like the screen words bring those two applications together."
	"So, on this screen, I clicked Referrals because it asked me to start a Referral process change screens but I am not sure if it's suppose to do anything else or if that all is doing, so, may be just mentioned that I am not expecting something new to happen here or when I click Referrals it doesn't change the screen it just this is the red start. It changes the screen and I am not sure if I quit something or if a video is going to show up, moving on."
AESTHETICS AND MINIMALISM IN DESIGN	"Same thing on this screen, checkmark with close at the bottom …etc. it seems like irrelevant button. It may confuse people at this point."
HELP AND DOCUMENTATION	"I am still not a hundred percent sure I know what to do when I am doing eLearning project but I am not hundred percent sure where to click on the name so that I can search and bring up the screen"

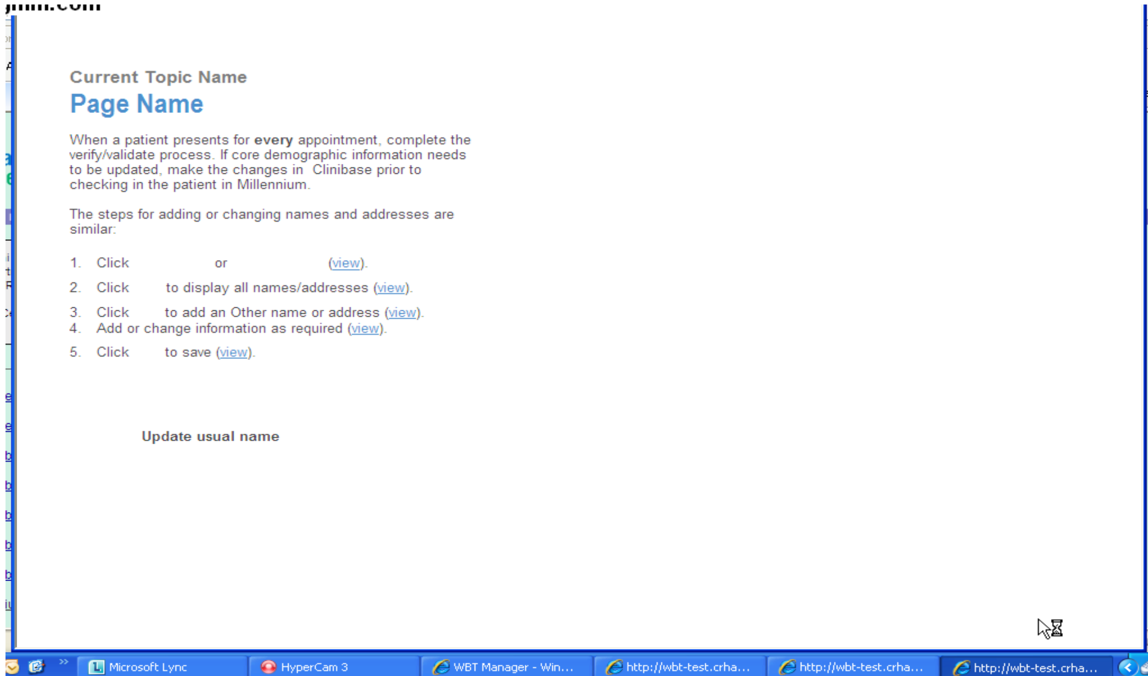
5.4.1. Problems Related to General Interface Usability

From the users' comments, as shown above in Table 35, many problematic issues related to general interface usability (GIU) were identified. In this section, we will present the problems, the users' comments about the problems, and the corresponding computer screenshots to use as evidence regarding the problems.

5.4.1.1. Problems Related to Visibility of System Status

As shown in Table 35, many frontline users pointed out problems related to visibility of the system status in their comments. These problems represented 9.1% of all the problems related to GIU as shown in Figure 14. Below were some of the users' comments, supported by corresponding computer screenshots to illustrate these problems.

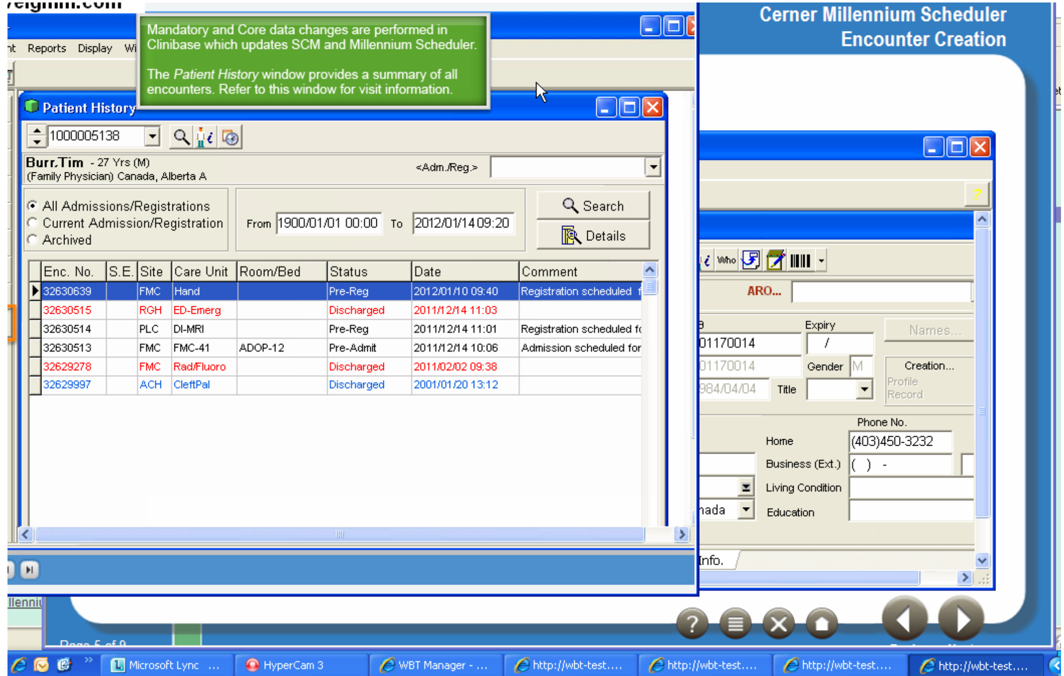
In one of the problems related to system visibility status the frontline users pointed out that there was a flash screen that was showing frequently while they were walking through the tasks. This finding was described by one of the informatics consultant user as "Oops, as I click forward from print factsheets and labels page and I click 'Next' there is an instant flash of a different screen called page name with some information there." The same user continued to comment by saying, "that page name screen, I think it pops almost every time screen refreshes from tab to tab that is something in the back but hopefully I caught it." This problem is illustrated below by Screenshot 4.18B captured from the computer of the user while interacting with the e-learning module and "thinking aloud."



Screenshot: 4.18B. Error, Page Name

In addition, some informatics consultant users commented that they expected the system to be more interactive in a way that would facilitate learning. This was identified from comments such as the following and is supported by Screenshot 4.4 below:

> With this view screen, I wasn't sure initially, I wasn't sure whether or not it was interactive or whether I am supposed to view it and first I got the changes were too slow then I started reading all the information then at one point it took me a little bit longer to read it and it flipped by itself and then at the end it was a long time before changing and I wasn't sure if I was supposed to be exiting out or whether something else was to come.



Screenshot 4.4: Topic 1, Patient History

In summary, the problems related to visibility of the system status, as illustrated above, indicated that the website failed to keep the user informed about what is going on through constructive, appropriate and timely feedback, and to respond to user-initiated actions at the same times. Fixing these problems could have a positive impact on the general interface usability (GIU), specifically for user's actions and interactions with the site or during the sequences required for data entry.

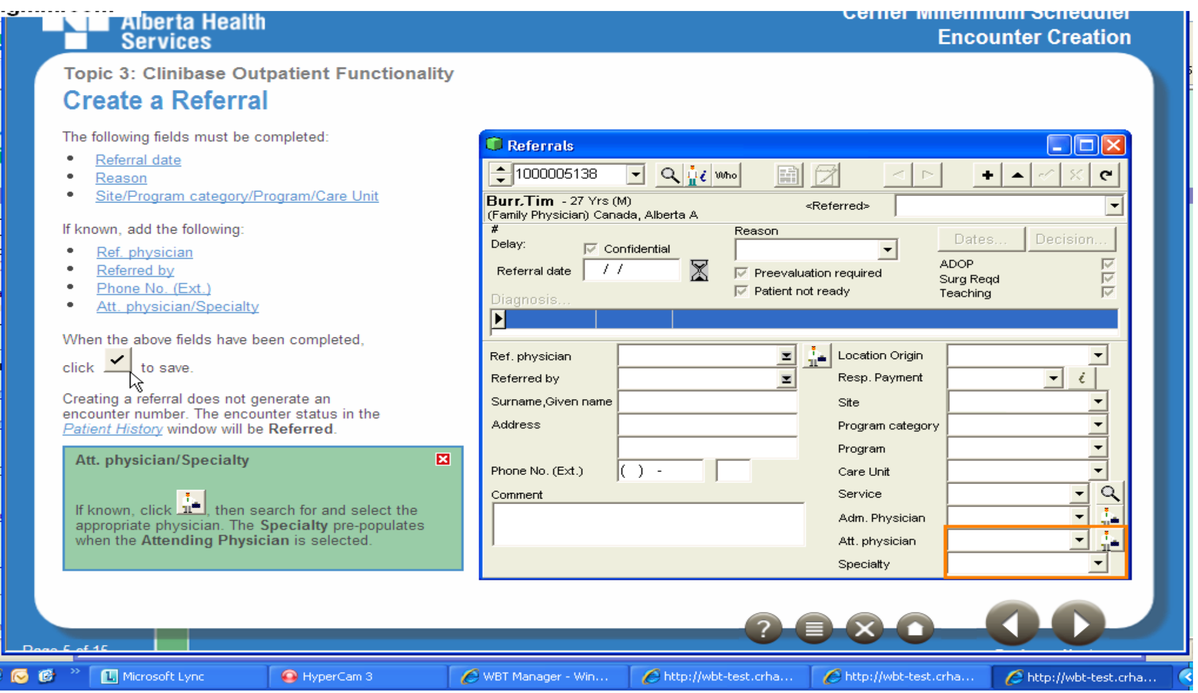
5.4.1.2. Problems Related to Match Between the System and the Real World

As shown above in Figure 14, a number of problems (9.1%) were issues related to match between the system and the real world. The users' comments on these issues are summarized above in Table 35. Below are some examples of these issues, supported by

screenshots from the users' computer while interacting with the module and "thinking aloud."

In this example, the user was confused about whether he/she could use the checkmark or press the "save" button, as is usually required in the real world environment. The user's comment is given below and is supported by Screenshot 1.10:

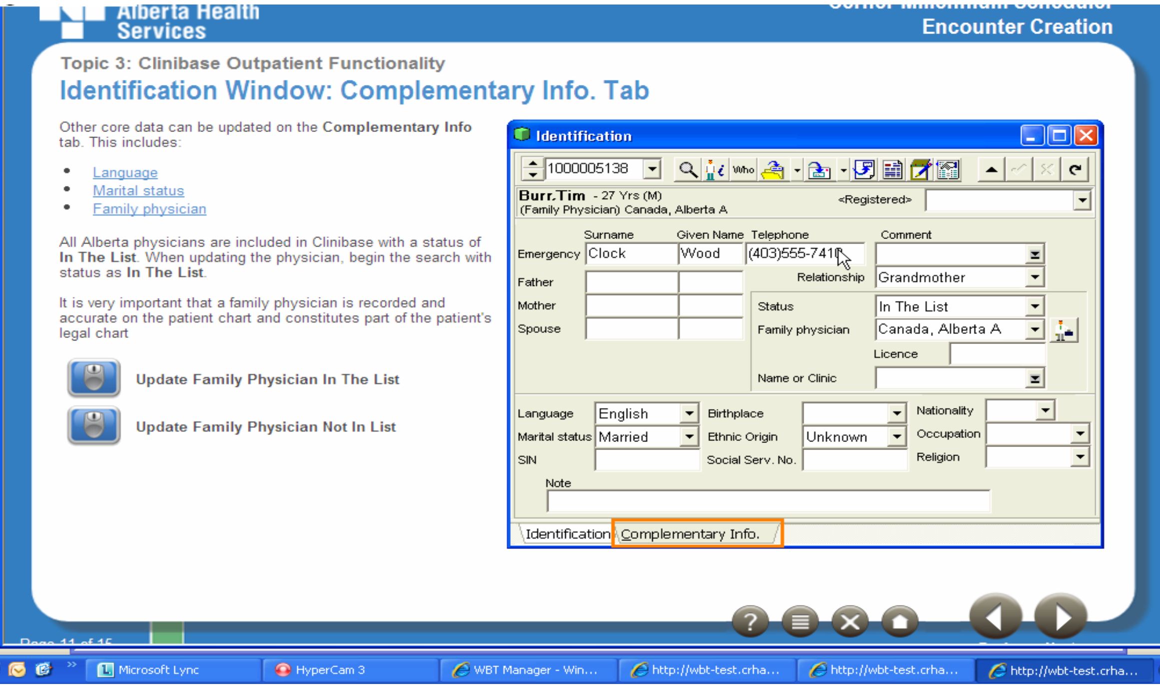
> So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I never seen the checkmark as a symbol used to save anything, so, more than user interface things. I have assumed will be trying to be similar to other programs, may be click save to save. I don't think of the checkmark until have used for a while that an obvious choice of button, I know it is a configuration thing.



Screenshot 1.10: Topic 3, Create a Referral, 1

In this example, the informatics consultant user believed that users are usually expecting to view data in websites flowing from left to right and from top to bottom. A user pointed out this problem in the quote below, supported below by Screenshot 1.16:

> I guess as a user, I am just used of everything starting at the top and I am working my way down and in this program everything you action on it goes back to the top. I guess, again the choice to the people who configure it, but it seems we flow left to right top bottom. This goes left to right but bottom to top almost.

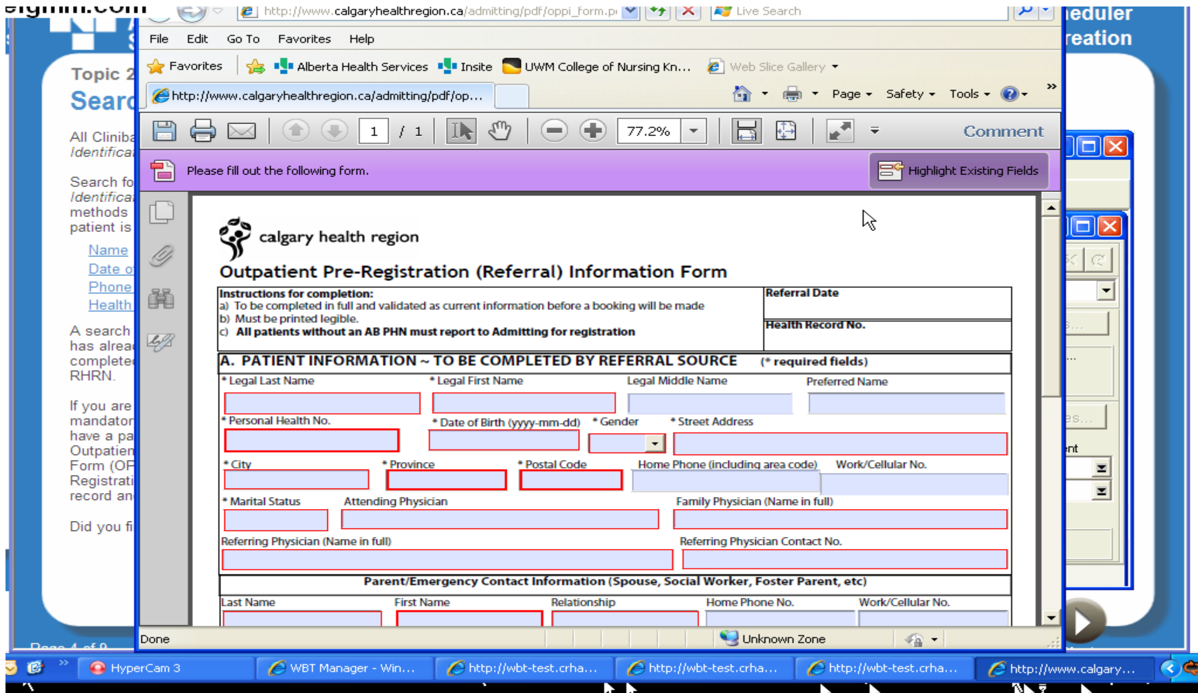


Screenshot 1.16: Topic 3, Identification Window, Complementary Info Tab

In summary, many problems identified from the comments of the users were related to the match between the system and the real world category. Fixing these problems could help users view the information in a natural and logical order.

5.4.1.3. Problems Related to Learner Control and Freedom

As shown in Figure 14, the informatics consultant users pointed to some issues related to learner control and freedom. It was found to be difficult to control the module in some circumstances. As an example, some informatics consultant users found it was difficult to have control over the e-learning system to update some recently changed information. As one user said, supported below by Screenshot 2.5, “Scheduler OPPI [outpatient pre-registration (Referral) information form] just changed today, so I don’t know if that be updated here, it is not in the link that is embedded.”



calgary health region

Outpatient Pre-Registration (Referral) Information Form

Instructions for completion:
a) To be completed in full and validated as current information before a booking will be made
b) Must be printed legible.
c) All patients without an AB PHN must report to Admitting for registration

Referral Date

Health Record No.

A. PATIENT INFORMATION ~ TO BE COMPLETED BY REFERRAL SOURCE (* required fields)

* Legal Last Name | * Legal First Name | Legal Middle Name | Preferred Name

* Personal Health No. | * Date of Birth (yyyy-mm-dd) | * Gender | * Street Address

* City | * Province | * Postal Code | Home Phone (including area code) | Work/Cellular No.

* Marital Status | Attending Physician | Family Physician (Name in full)

Referring Physician (Name in full) | Referring Physician Contact No.

Parent/Emergency Contact Information (Spouse, Social Worker, Foster Parent, etc)

Last Name | First Name | Relationship | Home Phone No. | Work/Cellular No.

Screenshot 2.5: Topic 2, Outpatient Pre-registration (Referral) Information Form

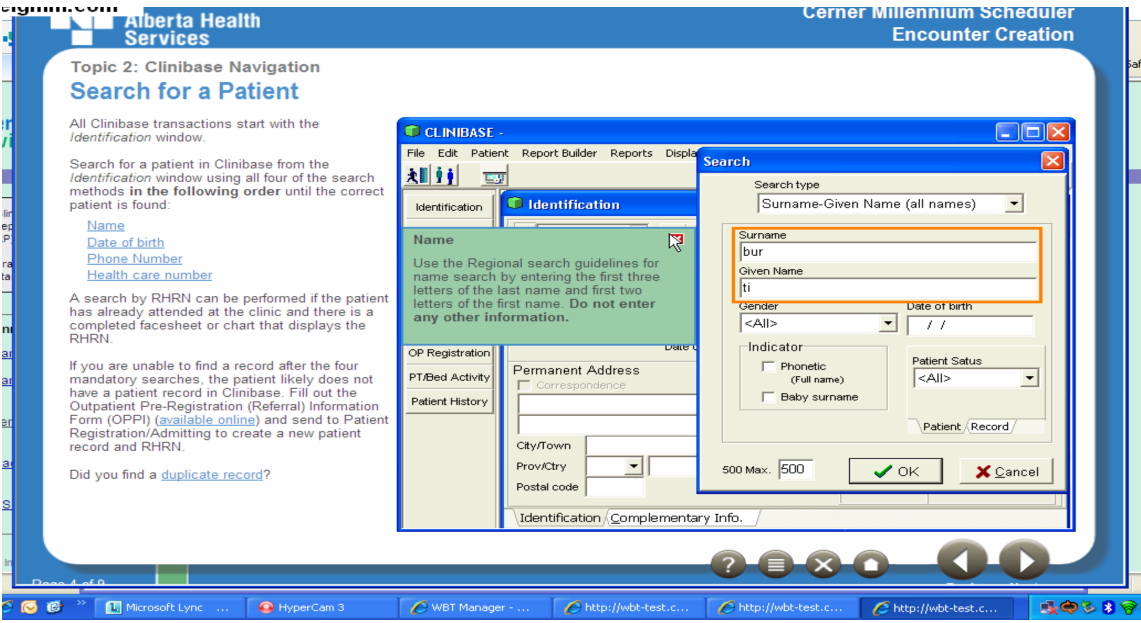
In summary, many problems related to learner control and freedom emerged from the comments of the informatics consultant users. Based on heuristics for web-based learning as shown in Table 28, fixing these problems can lead to a high quality e-learning system that can enable its users to have control, be able to undo and redo actions, and exit at any time, even when they have made mistakes.

5.4.1.4. Problems Related to Consistency and Adherence to Standards

As shown in Figure 14, the problems related to consistency and adherence to standards identified from the comments of informatics consultant users represented 10.6% of all issues. Based on the coding scheme concepts in Table 28, a high quality e-learning system should use consistent concepts, words, situations, or actions. In addition, the interface should follow common platform standards. In this regard, informatics consultant users identified many issues that didn’t comply with this heuristic. In the following example, the module didn’t allow a consistent way of searching for a name across the system. This finding was supported by the following user quote, supported by Screenshot 1.7.

> I want to come to requesting how many letters to enter when searching for a name? I think, it said concretely, here saying; only enter the first two letters of the last name and first two letters of the first name. Do not enter any other information. Not aware the system can five valid reason for that, but may consider the idea of putting, only enter up to this amount at least three letters for the Cerner at least two for that, you know, telling a person they can only use three or two

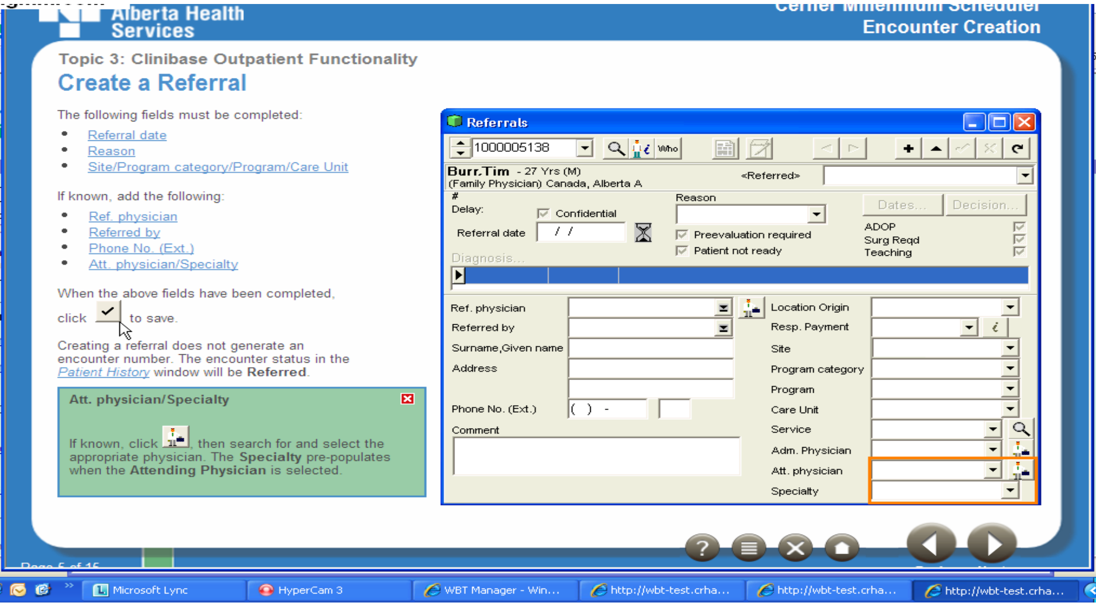
letters, sometimes you know limiting your scope; what if you have names starting with the same three letters or two letters, that kind of things.



Screenshot 1.7: Topic 2, Search for a Patient

In the following example, another example of not matching the real world, the module didn't allow for a standard way for saving, since saving could be done by using the "Checkmark" or "Save" button. This finding was shown in the following quote, supported below by Screenshot 1.10:

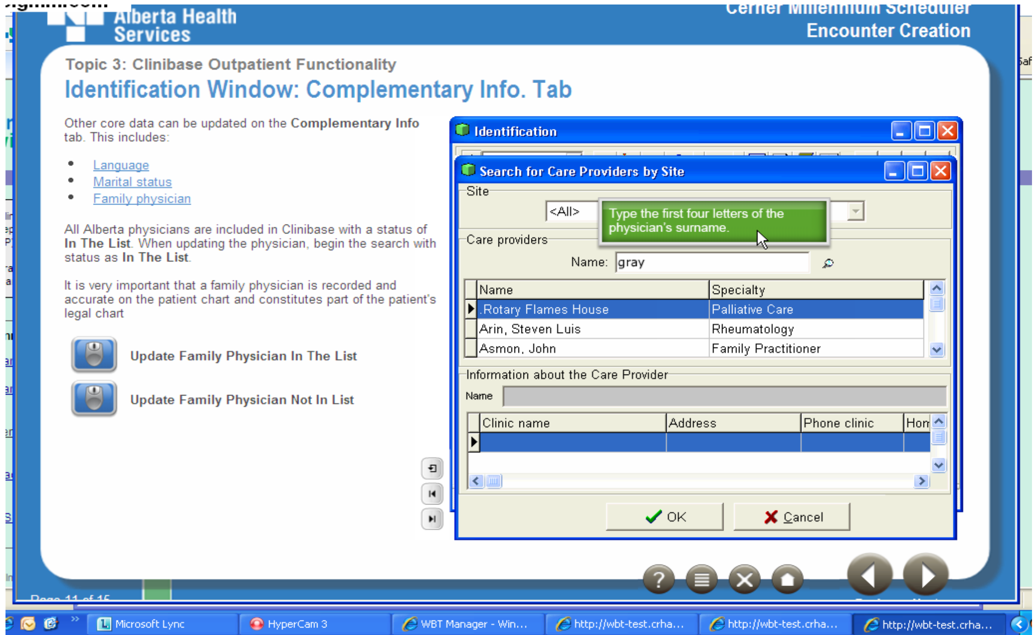
> So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I've never seen the checkmark as a symbol used to save anything, so, more than user interface things. I have assumed it will be trying to be similar to other programs, maybe click save to save. I don't think of the checkmark until have used it for a while that it's an obvious choice of buttons; I know it is a configuration thing.



Screenshot 1.10: Topic 3, Creating a Referral, I

Another user confirmed and pointed out more problems related to consistency and adherence to standards in the following quote, supported by Screenshot 1.15:

> Here, now it said enter the first four letters of the physician surname. Before, it said just enter the first three for the surname and the two for the other name. So, I think, you know, these are minor details obviously, but I still… to say at a minimum enter these values and then users can make up their mind.



Screenshot 1.15: Topic 3, Identification Window, Complementary Info Tab

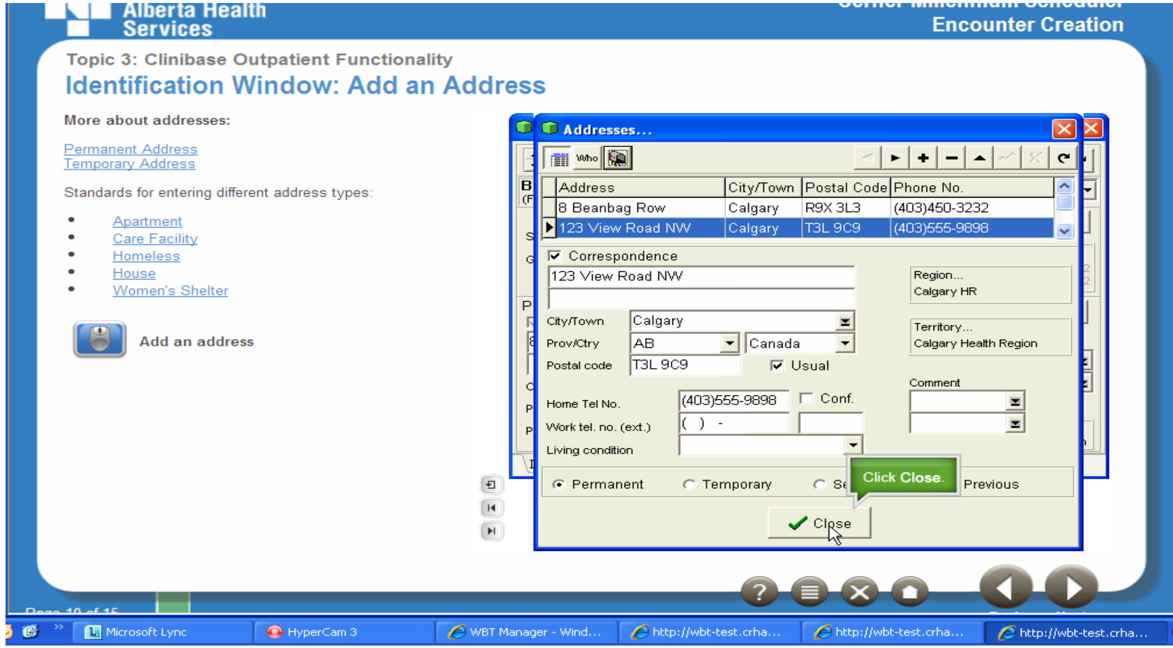
Some other informatics consultant users pointed out that there was a standard for who was responsible for adding the diagnosis in the system, as shown in this example with a quote from the user below:

> I will say that here, Topic 4: Adding a diagnosis, all the steps are clear, but we need to point if it is the clerk or administrative side who is adding the diagnosis they do the diagnosis from the physician report or whatever, because it is not clear…so one can think, Okay, I can add my diagnosis… Should be taken from a source of truth.

Another informatics consultant user found some difficulties in finding a consistent way to close the windows. The user said the following, supported by Screenshot 4.22:

> In the case of modifying the address now it tells me to close in the bottom where I was changing the name it tells me to exit out from the top so it is possible to be,

may be e-learning demonstrating two ways of closing out, but is just some of inconsistency there, so maybe it could be stated as an either or options.



Screenshot 4.22: Topic 3, Identification Window, Add an Address

In summary, many problematic issues were related to consistency and adherence to standards identified from the comments of informatics consultant users. For better usability outcomes, consistency and adherence to specific standards are required for the concepts, words, symbols, situations, or actions referring to the same thing, and for common platform standards, too.

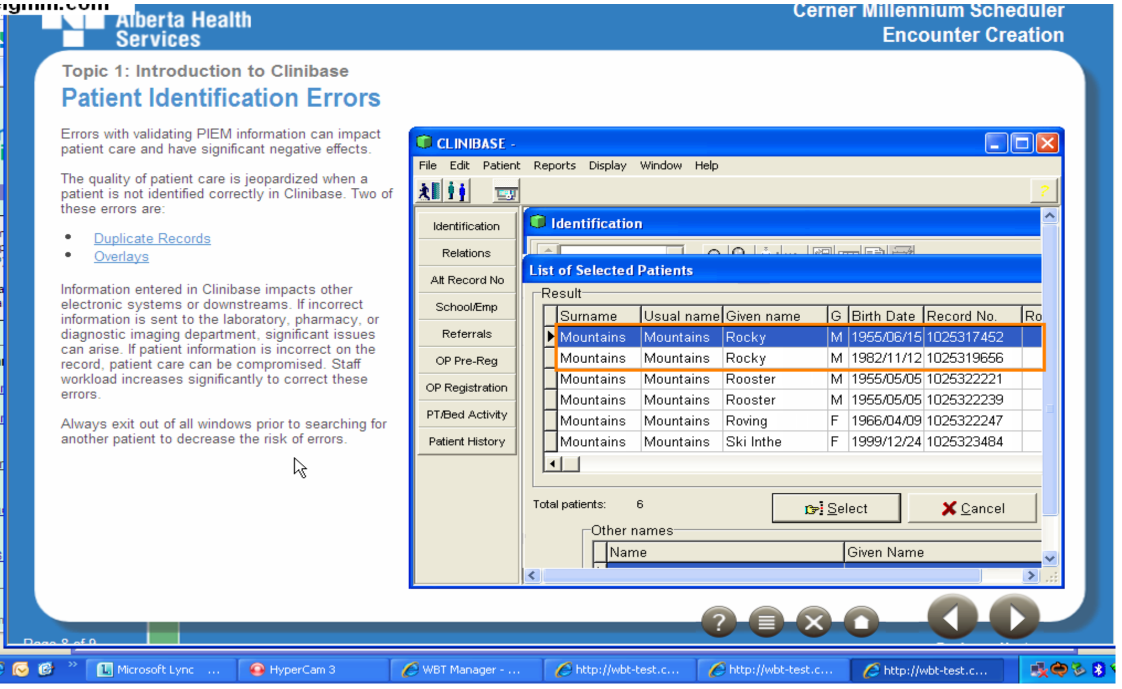
5.4.1.5. Problems Related to Recognition rather than Recall

As shown in Figure 14, areas with problematic issues related to recognition rather than recall represented the largest number of problems (22.7%). Based on the usability heuristic for web-based learning guidance, objects to be manipulated, options for

selection, and actions should be visible; instructions on how to use the system should also be visible or easily retrievable whenever appropriate; and the displays should be simple. We identified many issues regarding lack of compliance with this. These findings were identified from the comments of the informatics consultant users, supported by screenshots relevant to each example given.

In the following example, informatics consultant users suggested that there should be red flashing lights on the last sentence of the instructions before proceeding to the next task to facilitate recognition rather than recalling what to do. This was supported by the following quote, supported below by Screenshot 1.5:

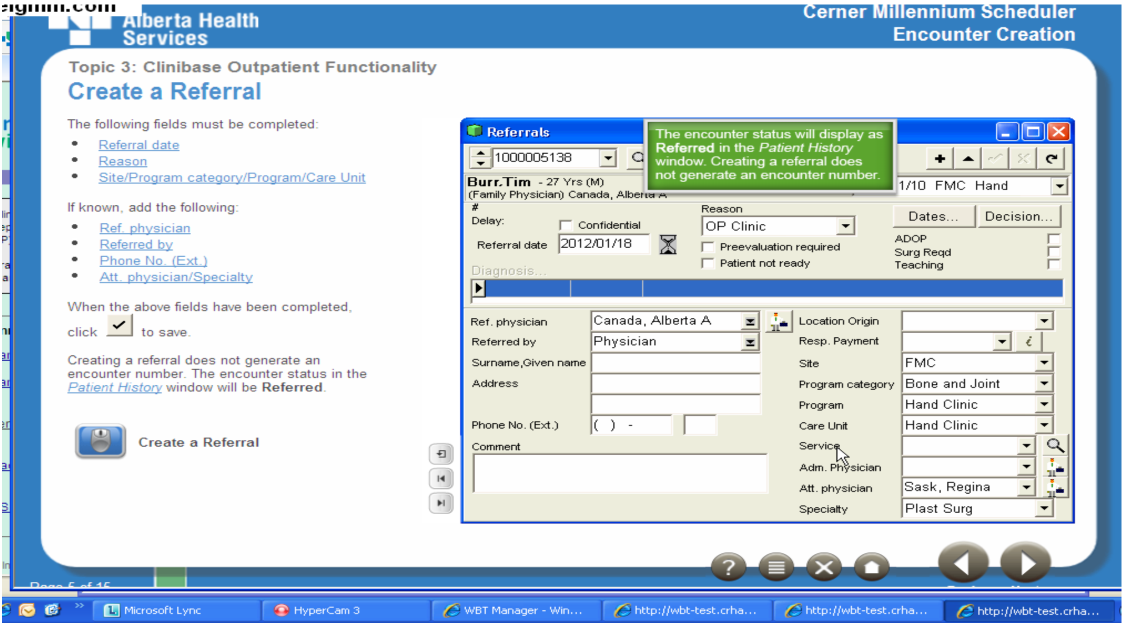
> Been a part of many issues around overlays, I would almost suggest, the last sentence on the screen be enforced either in red flashing lights, whatever we can make that as clear as possible, and all users can understand how important it is to make sure they close all of the windows before doing something else.



Screenshot 1.5: Topic 1, Patient Identification Errors

In this example, the informatics consultant user didn't recognize whether the video was over or not, as shown below in this quote, which is supported by Screenshot 1.12:

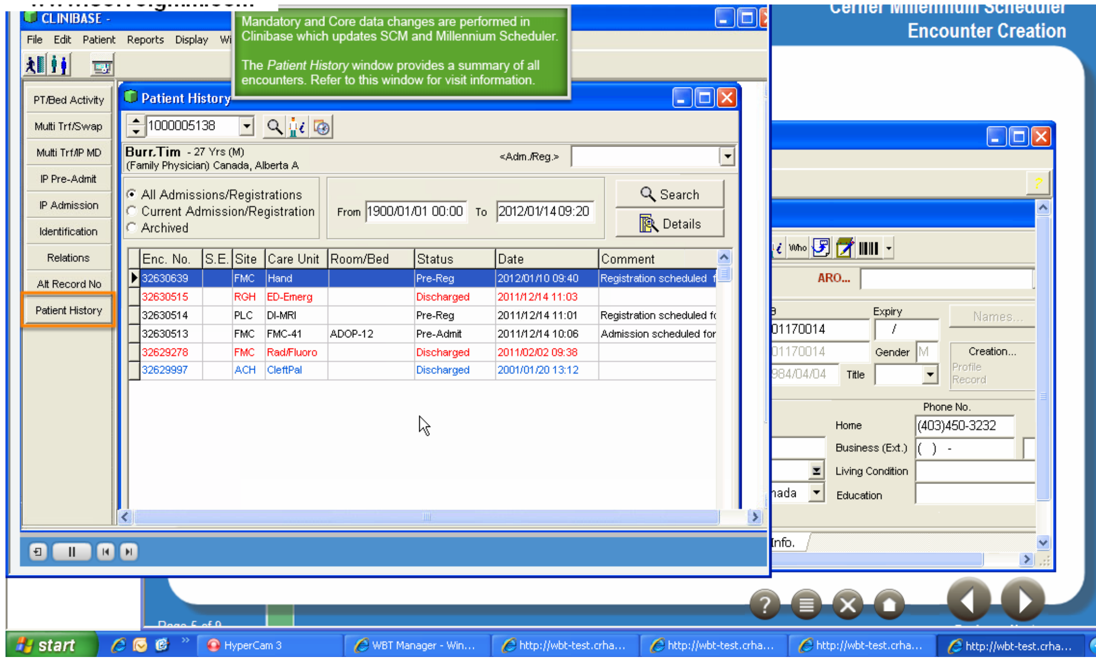
> I am assuming this trail piece is over but is not indicating anything more except to wait if anything happened or might be done. Might have some kind of way to close the screen or show the video is over."



Screenshot 1.12: Topic 3, Create a Referral, 2

In the following example, some informatics consultant users found that it was difficult to recognize the entire set of icons and colours in the "Patient History" window, as shown below in Screenshot 14.2.1. This finding is illustrated by the following

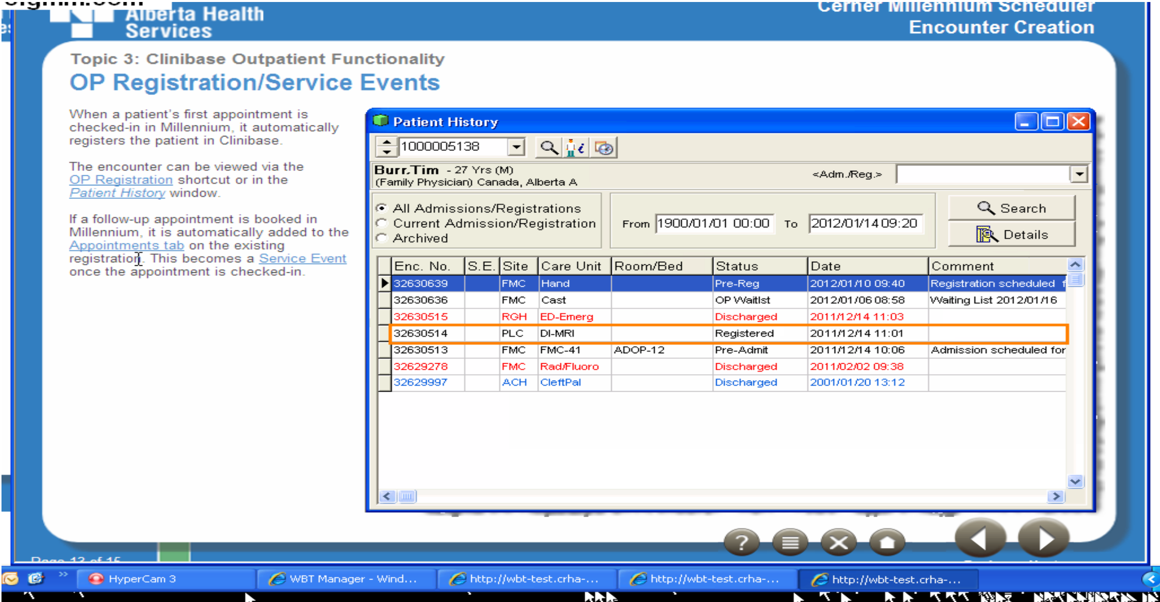
consultant user quote: “You have to remember all little icons and what they mean as you are going through, so, remembering to click view to identify the core mandatory data.”



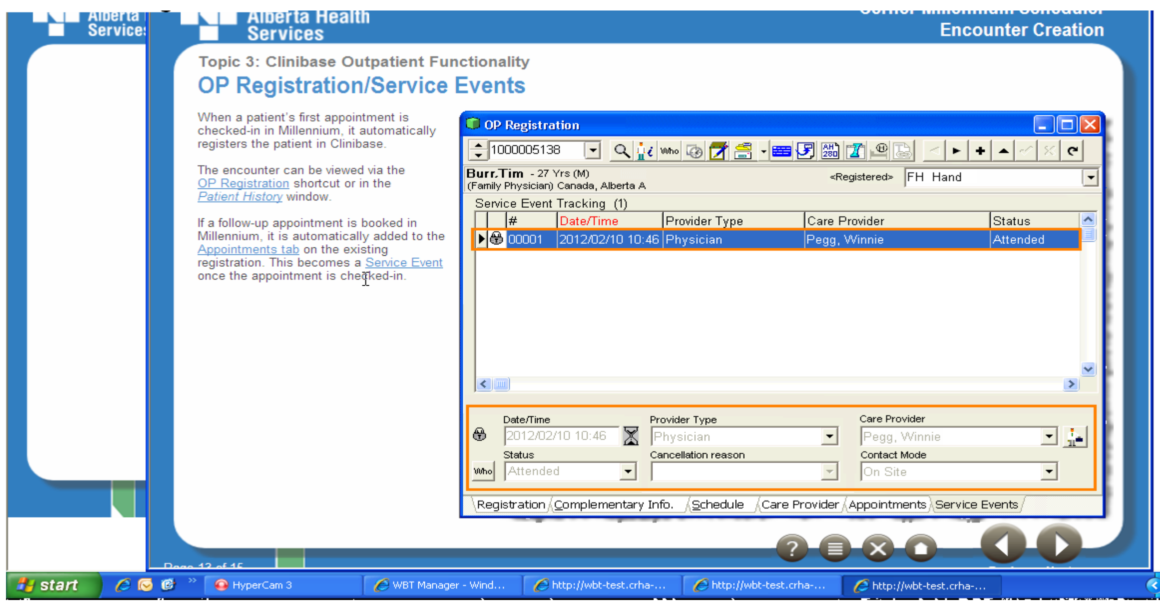
Screenshot 14.2.1: Patient History

In the next example, the user faced some difficulties to recognize the tabs and the computer windows corresponding to them. Here, what is the expert commented on and supported by Screenshots 2.8 and 2.9:

> When I go to look for the Appointments tab, I don’t see it in the screen, but when I click to the link, it takes me to a different view, so, I am confused this to going from moment tab on left side showing OP Registration and Patient History to the actual tab view that shows the appointments… Also, when I clicked on the Service Events is that changing my tab from Appointments to Service Events, it looks like it does, but it doesn’t show that transition, so that I can follow it.



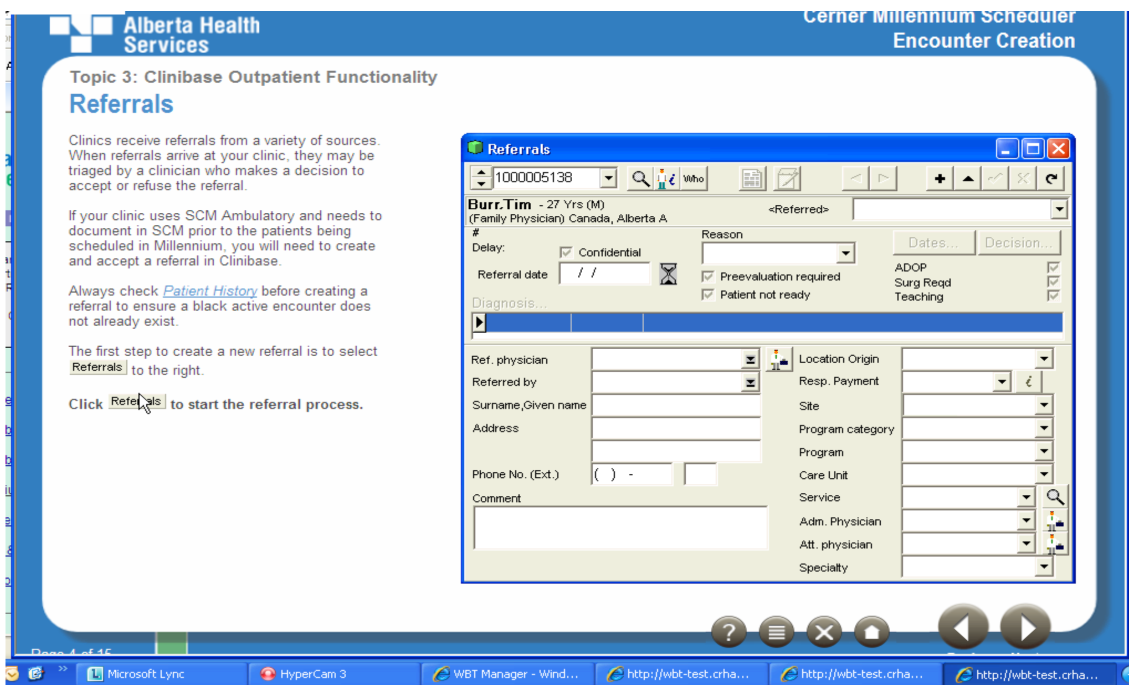
Screenshot 2.8: Topic 3, OP Registration/Service Events, 1



Screenshot 2.9: Topic 3, OP Registration/Service Events, 2

In this example, the informatics consultant user was confused and didn't recognize the correct "Referral" button, as in the following quote, supported by Screenshot 3.1:

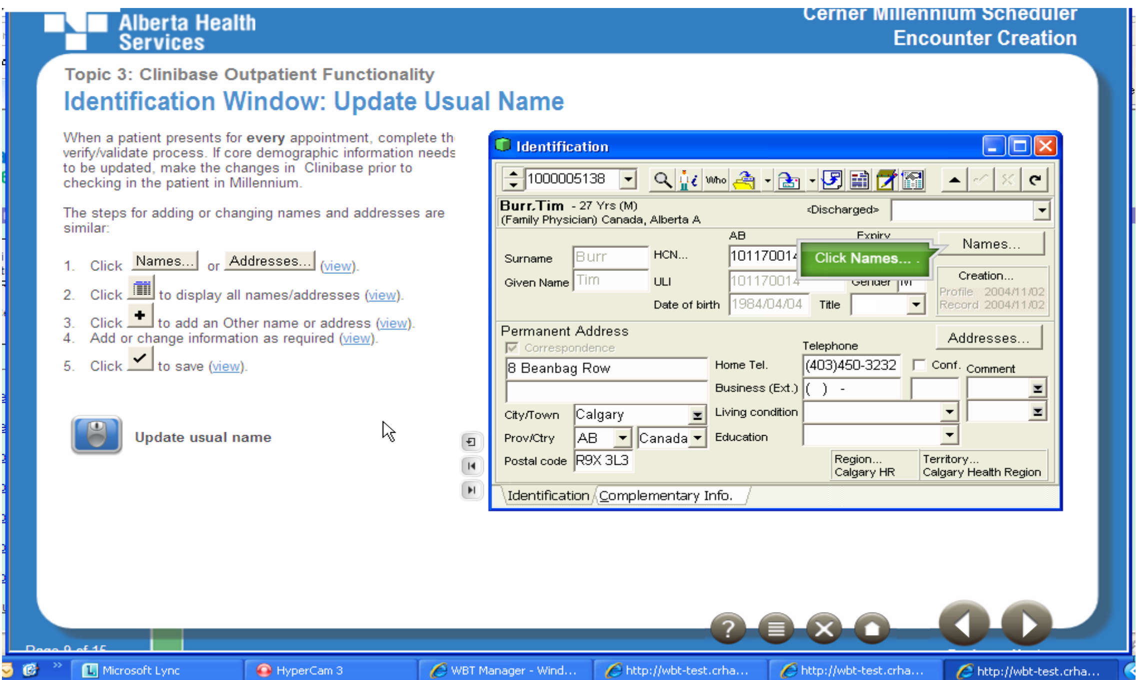
> So, I was here, so I was clicking, there is referrals, but, I can't see where is the second Referrals... can I move back, ooh no, it says click to create a new referral to select Referrals to the right, it should be Referrals to the left, I think so, it says, the first step… I can't find the Referrals on the right, I only see the Referrals on the left, so, I clicked the Referrals on… it can't find the Referrals on the right. Anyway, I will say that here, will say Referrals to the left…etc., I am lost. Sorry, I can't start this Referrals process. I need a hand here…. this means Referrals to the left, but can't understand to start Referral process, I am missing this…



Screenshot 3.1: Topic 3, Referrals

In another example, the informatics consultant user was confused about the position of the “List Icon.” The user’s comment is given below, supported by Screenshot 4.19:

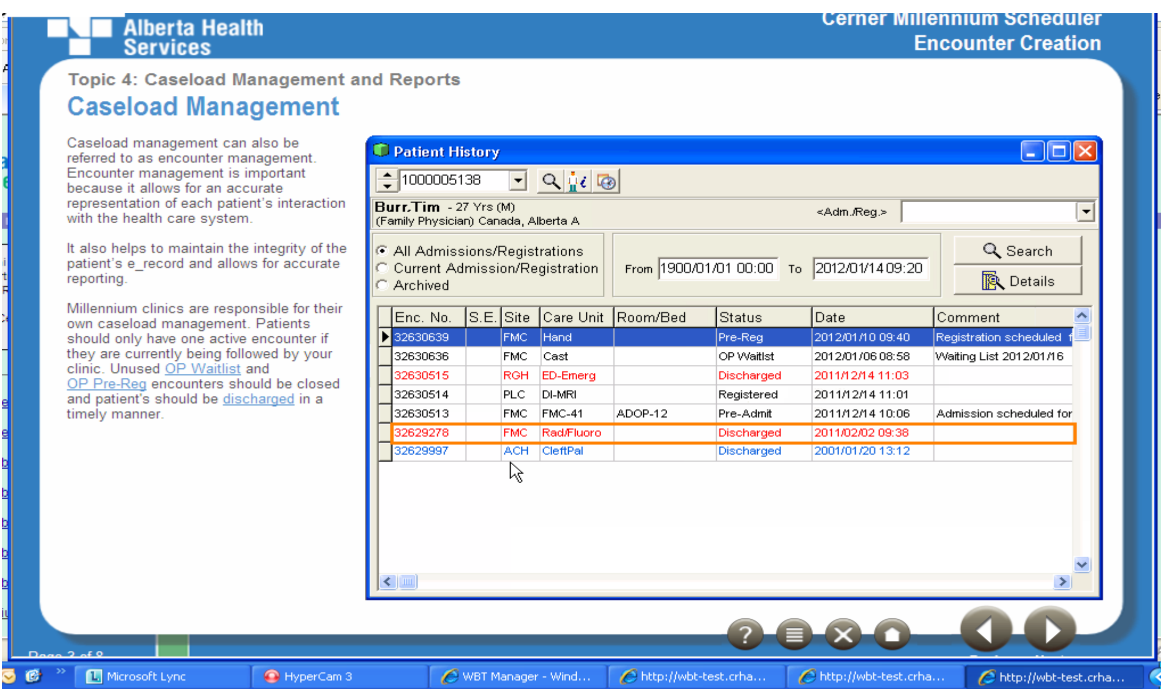
> So for the Identification Window, click Names or Addresses and that displayed the buttons surrounded by the orange ridge is super. The next step is to click a little icon to display all names/addresses. I wasn’t immediately sure whether or not that little icon was beneath the buttons with the Names and Addresses or whether I should be looking at the main screen to find another button. I am not sure what it looks like but a little list but or something like that so I clicked view and I am assuming it said the address is up here and I am assuming it is underneath the Addresses button but it wasn’t obvious to me at first.



Screenshot 4.19: Topic 3, Identification Window: Update Usual Name

Finally, in this example, the informatics consultant user suggested a reminder be put into place for assisting in recognizing the colours and what they mean in the discharge process. The quote below and Screenshot 4.23 support this finding:

> At this moment doing the topic for Caseload Management I find myself trying to remember from the very first module what the colour means so I am not sure why one discharge is red and the other discharge is blue because I can't remember what I was told at the very beginning. So, It might be nice to have another little reminder when we actually working with the Caseload.



Screenshot 14.4.23: Topic 4, Caseload Management

In summary, many problems identified from the comments of the informatics consultant users were related to recognition rather than recall category. These problems represented the most frequent of all the issues identified from the comments of the users. Recognition rather than recall is an essential criterion for understanding and completing any task effectively and efficiently. Fixing these problems will eventually lead to a system that can effectively and efficiently be used for completing any relevant task.

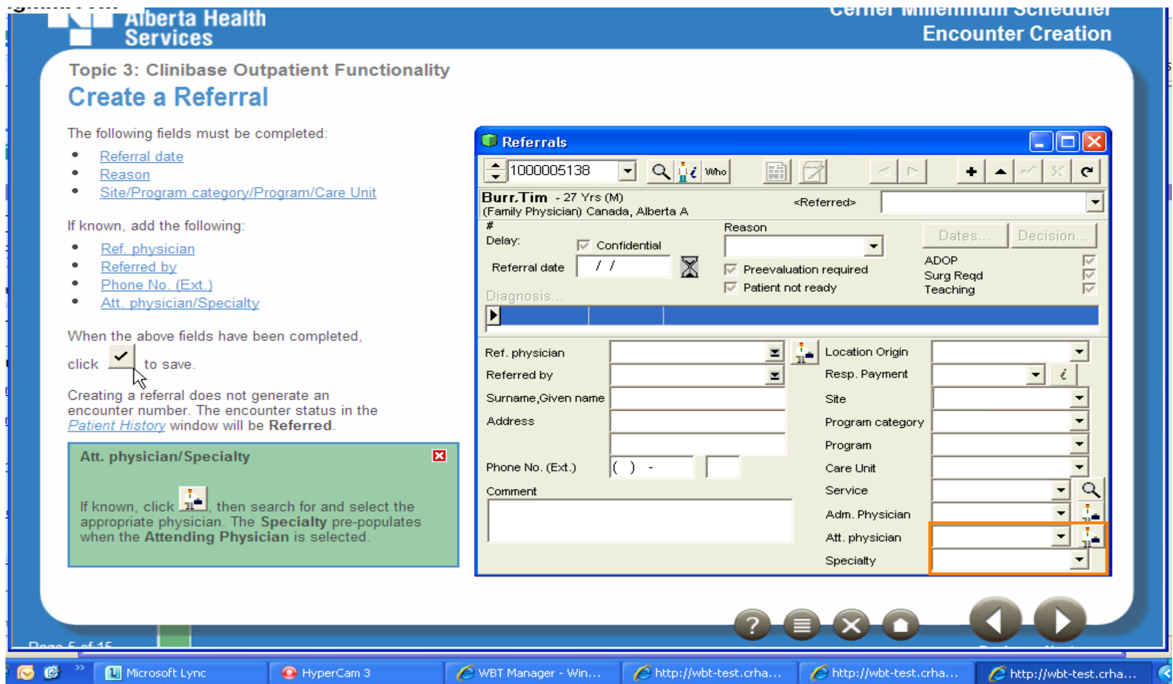
5.4.1.6. Problems Related to Flexibility and Efficiency of Use

As illustrated in Figure 14, approximately six percent (6.1%) of all issues were problems related to flexibility and efficiency of use. Based on heuristics for web-based learning, as shown in Table 28, areas with problematic issues related to user interface flexibility and efficiency of use included the following: (1) The site didn't support different levels of users, from novice to experts, (2) Shortcuts or accelerators were not provided to speed up interaction and task completion by frequent users, and (3) The system was not flexible enough to enable users to adjust settings to suit themselves, i.e. to customize the system.

The researcher identified from the comments of the users that many of the interface's shortcuts and accelerators were problematic. In this example, the expert found it difficult to complete tasks using the "Referral" tab on the left side of the window, as shown in Screenshot 1.9 and in this quote:

> So, on this screen, I clicked "Referrals" because it asked me to start a referral process change screen but I am not sure if it's supposed to do anything else or if that all is doing, so, may be just mentioned that I am not expecting something new to happen here or when I click "Referrals" it doesn't change the screen if it just

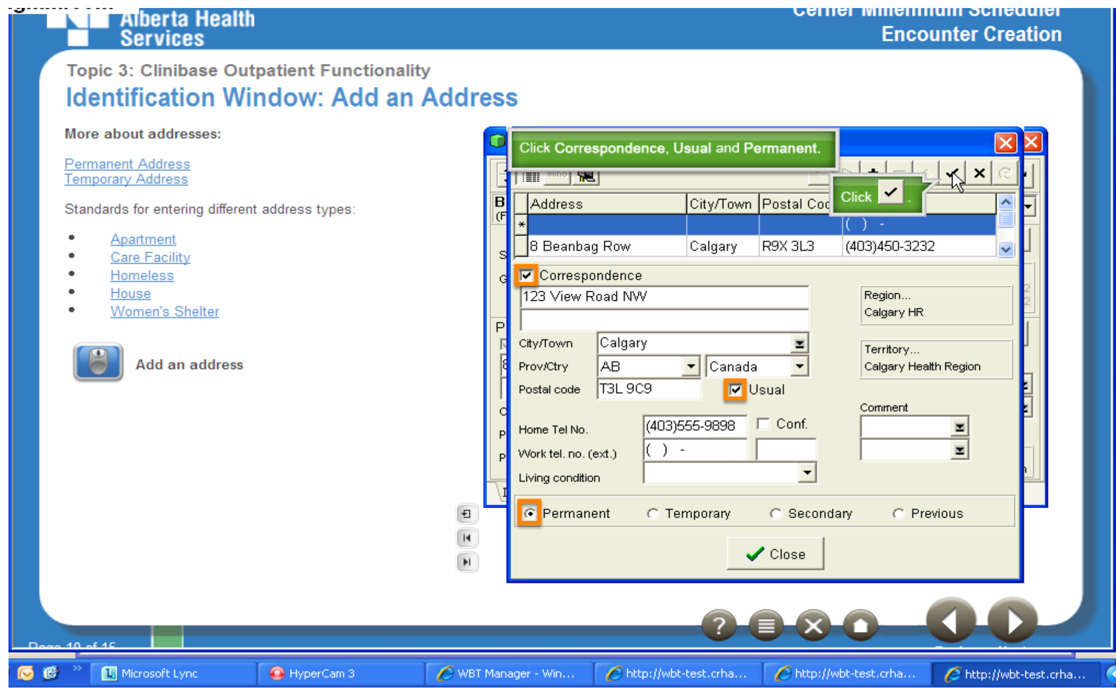
this is the red start. It changes the screen and I am not sure if I quit something or if a video is going to show up, moving on.



Screenshot 1.9: Topic 3, Create a Referral, 1

5.4.1.7. Problems Related to Aesthetics and Minimalism in Design

The aesthetics and minimalism in design criteria mean that site dialogues do not contain irrelevant information, which could distract users as they perform tasks (see Table 28). Below, an example of an irrelevant button, as shown in Screenshot 1.14, was identified from the user's comment when he said, "same thing on this screen, checkmark with close at the bottom …etc. it seems like an irrelevant button. It may confuse people at this point."

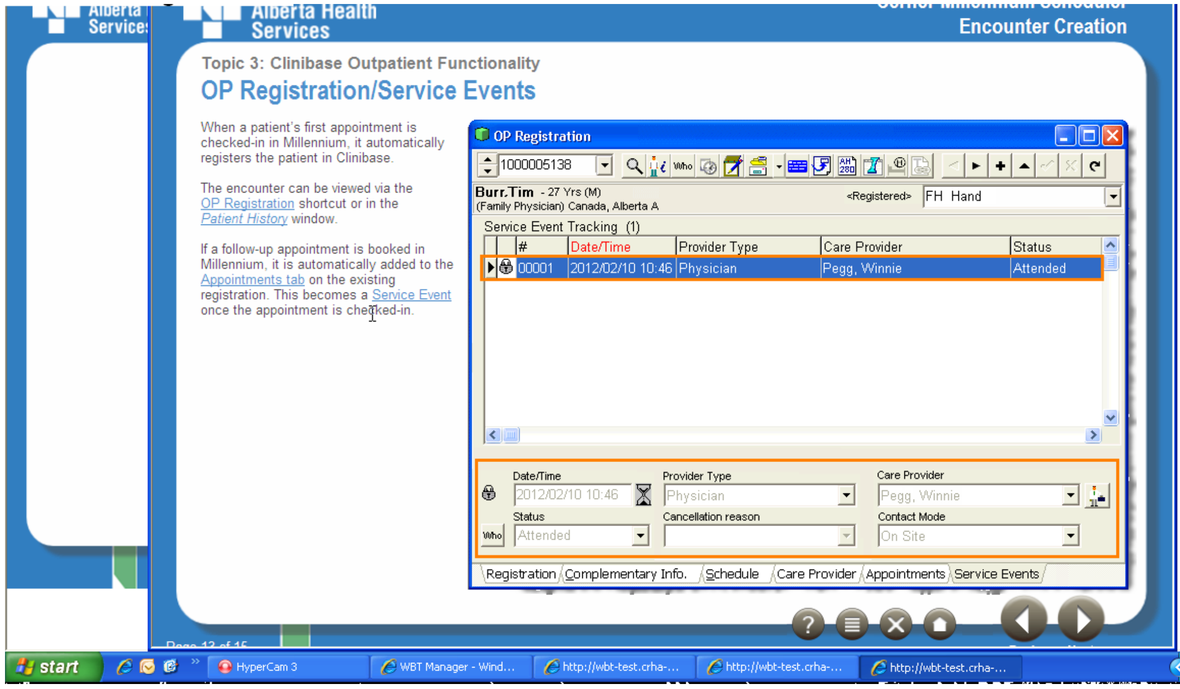


Screenshot 1.14: Topic 3, Identification Window, Add an Address

5.4.1.8. Problems Related to Help and Documentation

A high quality site should have a help facility and other documentation to support user needs. In addition, the information in these facilities should be easy to search, task-focused, and should list concrete steps to accomplish a task (see Table 28). In the following example, the informatics consultant user found it was very difficult to find help information for searching names, as shown in Screenshot 2.9 and in this comment:

> I am still not a hundred percent sure I know what to do when I am doing an e-learning project but I am not hundred percent sure where to click on the name so that I can search and bring up the screen.



Screenshot 2.9: Topic 3, OP Registration/Service Events

In summary, many problems related to general usability were identified from the comments of informatics consultant users in this section. Four majors problems were identified and related to recognition rather than recall, consistency and adherence to standards, match between the system and the real world, and visibility status. In addition, four minor problematic issues were identified and were related to flexibility and efficiency of use, learner control and freedom, aesthetics and minimalism in design, and help and documentation. The findings from these areas highlighted many opportunities for improvements in the general interface usability (GIU).

5.4.2. Problems Related to Website-specific Criteria for Educational Websites

As shown in Figure 14, two major problematic issues related to the educational website were identified from the comments of the informatics consultant users. The problematic issues related to the educational website included problems to do with

relevancy of site content to the learner and the learning process (12.1%) and simplicity of the site navigation, organization and structure (10.6%). Problematic areas identified from the comments of the informatics consultant users are summarized below in Table 36.

Table 36: Problems Related to Website-specific Criteria for Educational Website

SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	"What we thought when we watching sort of the view video, in this type of these things, will be nice to see along the bottom, like, how fast is moving. So, as a user, you know if you reading very quickly, you wondering, well, I have click something? How long do I have to wait to go on? But, if at the bottom, there is a pause and move forward and go back, but, there sort of a little bar like watching a movie saying okay here is going, so okay, allows you to better judge how much time is going forward"
	"I think this the way the screen is set up here. It asks me to continue, but, there is no button that says Next, I am assuming the arrow pointing right but it doesn't fit the screen, I am assuming that Next, but, may stuck some people."
	"So again, this is sort of configuration piece …etc., very bottom is a checkmark for close which I don't know it means save and close, etc."
	"In this screen, it doesn't show the exit button. I am going to click the X. it works."
	"I am clicking on the arrows wasn't sure whether just screen shots or whether linked to something. They just button. They don't link to anything"
	"The first step to create a new referral is to select Referrals to the right which I did. Click Referrals to start referral process, I am just not sure that another step that I need to do or whether is just referring to the first step. I am thinking you just repeating the first step, but I am not sure as this page opened and I am find myself looking for another button that said Referrals although it said step 2 in the process"
	"I am just wondering, It said to close the window instruct me to do an X in the corner, I am wondering if I will be able to do the button at the bottom as well, I am not sure"

Problematic issues related to educational website continued….end

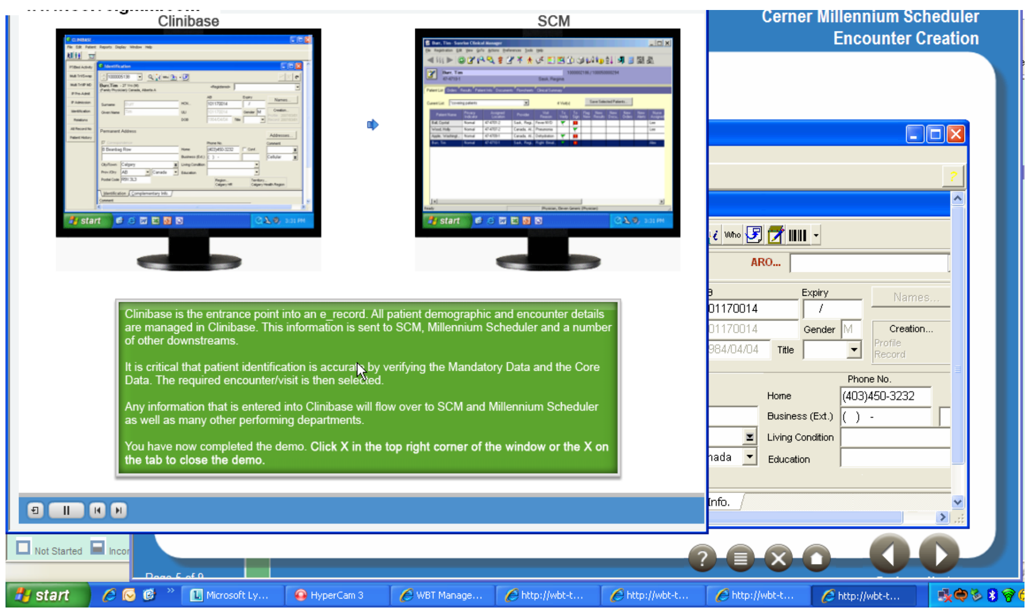
RELEVANT OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	"For introduction piece here, I think will be helpful to users when it says 'consists of clinibase and … etc.,' may be mention that is the one way communication. So that Clinibase beats SCM. You know, because, I think, that one issues we having right now. They understand how they interact. They know the interactivity, but they don't know how. May be by having a little bit information…etc., kind of, to say, the communication goes from Clinibase to SCM"
	" The only thing I will add to use Verify Validate Window, there quite few places says 'followed approved processes' if somebody is new coming in they don't know what those are so may add additional comment of 'will be provided to you once you get your clinic" otherwise they may be looking here where are these processes"
	"Getting access is always a concern to users, and here, it said, you will receive your own user ID and password. Honestly, nothing wrong with that, but again, I don't know, if would be a value of adding from managers or by email, so that everyone knows exactly how to get it"
	"In the mandatory data, should it say provincial health card, in case they recently moved here
	"Probably on this screen, when it says OP Registration/Service Events there is a kind of gap between Appointment tab and Service Events because is saying an appointment or existing registration become a Service Event once the appointment is checked-in and is not clear when it checked-in, probably will be good to say the time of the date or once the patient showed up for the appointment"
	"It says that patient's should be discharge in a timely manner, and it shows the date of discharge in 2011 and we are talking about the pre-registration of this year, so, probable this date be changed to avoid confusion, this date should be 2012"
	"Errors with validating PIEM information can impact patient care and have significant negative effects. You certainly can't say that enough. It's very important."
	"Clinic Labels, actually wondering what is difference between Generic and Emergency labels, I am still not sure"

5.4.2.1. Problems Related to Simplicity of Navigation, Organization and Structure

As shown above in Table 36, the informatics consultant users pointed out many areas with problematic issues related to simplicity of site navigation, organization and structure. Informatics consultant users experienced some difficulties navigating backward or forward and were sometimes confused about what to do next with the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM). These findings were supported by the following comments in Table 36.

In the first example, the user found that it was difficult to move forward, backward or to pause while watching a video, as shown below in Screenshot 1.2 and supported by this quote:

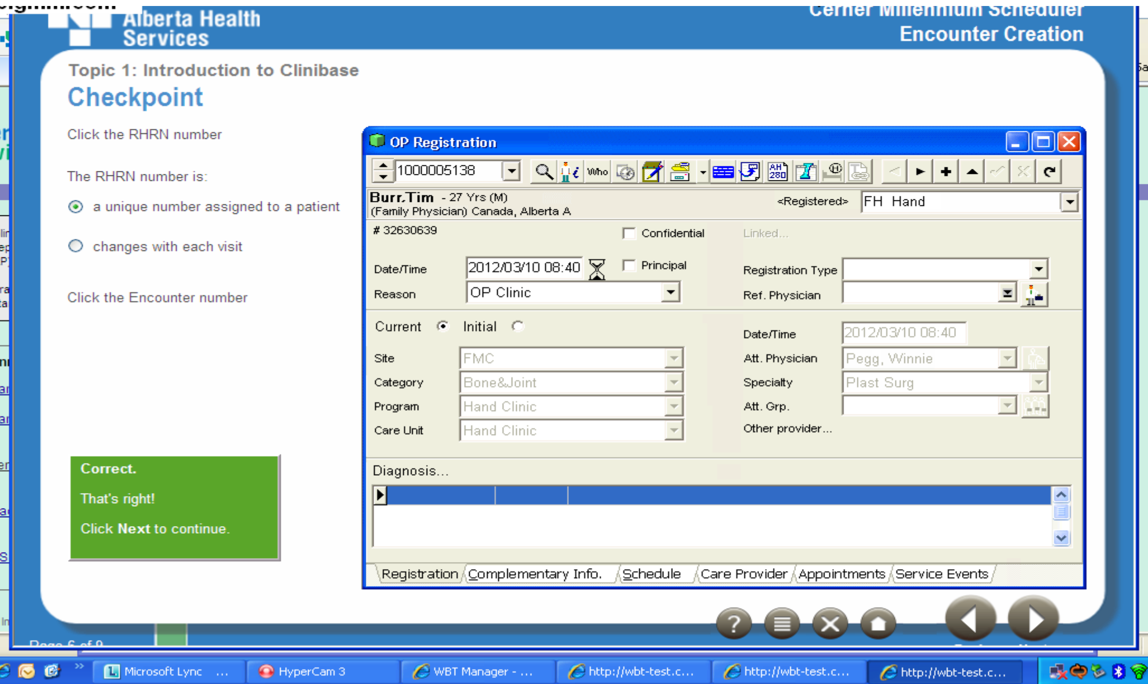
> What we thought when we watching, sort of viewing the video, in this type of things, will be nice to see along the bottom, like, how fast it is moving. So, as a user, you know if you reading very quickly, you are wondering, well, I have clicked something? How long do I have to wait to go on? But, if at the bottom, there is a pause and move forward and go back, but, there sort of a little bar like watching a movie saying okay here is going, so okay, allows you to better judge how much time is going forward.



Screenshot 1.2: Clinibase and Sunrise Care Manager (SCM)

In another example, the user found that it was difficult to navigate to the next page using the “Next” button as instructed. Instead of the “Next” button, the user found two arrows pointing to the left and to the right at the right bottom corner of the screen, as shown in Screenshot 1.3. This finding was supported by the comment of the user in this quote:

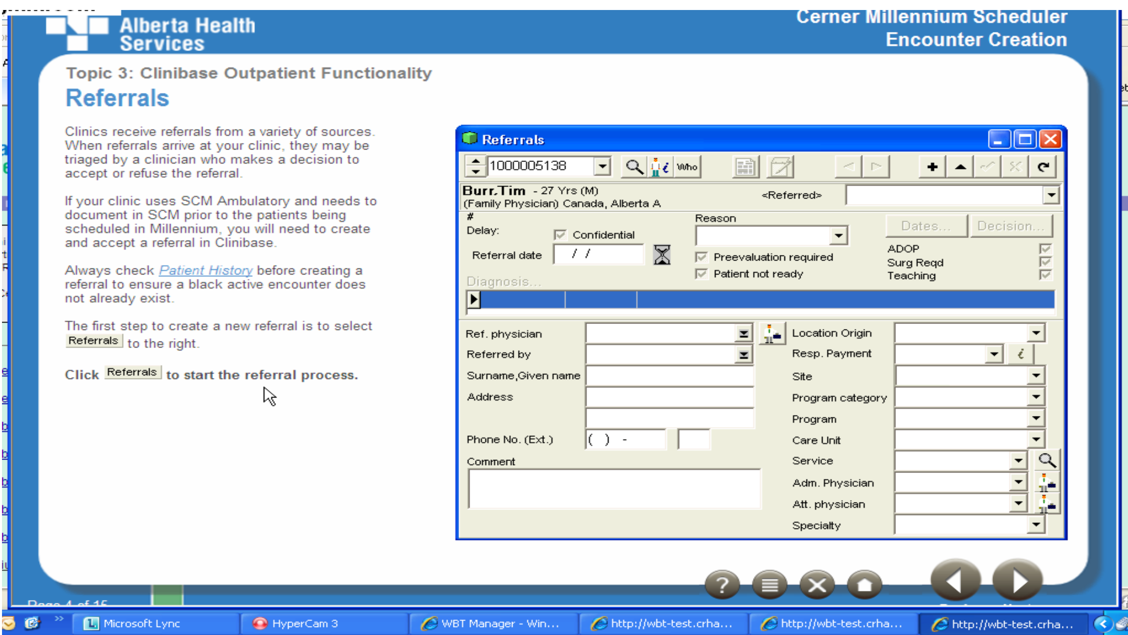
> I think this the way the screen is set up here. It asks me to continue, but, there is no button that says Next, I am assuming the arrow pointing right but it doesn’t fit the screen, I am assuming that Next, but, may stuck for some people.



Screenshot: 13, Topic 1, Checkpoint

In a different example, one user found that it was difficult to navigate forward by clicking the “Referrals” button, as shown below in Screenshot 4.11. This finding was supported by the following quote:

> The first step to create a new referral is to select Referrals to the right, which I did. Click Referrals to start referral process, I am just not sure that another step that I need to do or whether it is just referring to the first step. I am thinking you are just repeating the first step, but I am not sure as this page opened and I am finding myself looking for another button that said Referrals although it said step 2 in the process.



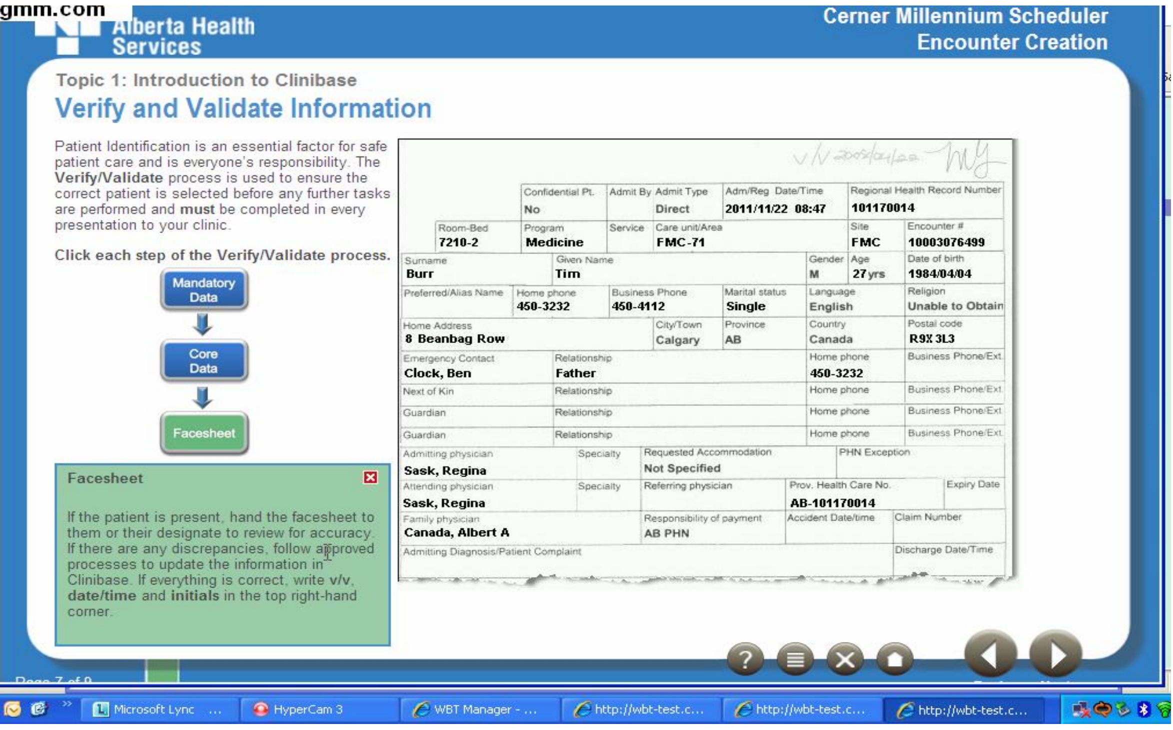
Screenshot 4.11: Topic 3, Referrals

5.4.2.2. Problems Related to Relevance of Site Content to the Learner and the Learning Process

As shown in Table 35, many problems were identified from the comments of informatics consultant users related to relevance of site content to the learner and the learning process. Based on the usability evaluation criteria in Table 28, a high quality e-learning system should have engaging, relevant, appropriate and clear content to present to learners who use the WBL site. In addition, its materials should not have any kind of biases, such as racial and gender biases, which may be deemed offensive. Moreover, it should have a clear mandated copyright and the authors of the content should be of reputable authority. From these perspectives, informatics consultant users commented on many issues that didn't comply with these criteria. For example, one expert recommended more precise and clear content in many circumstances, such as for the

"Verify and Validate Information" window in this example, as shown below in Screenshot 1.4. This finding is supported by the user's comment in this quote:

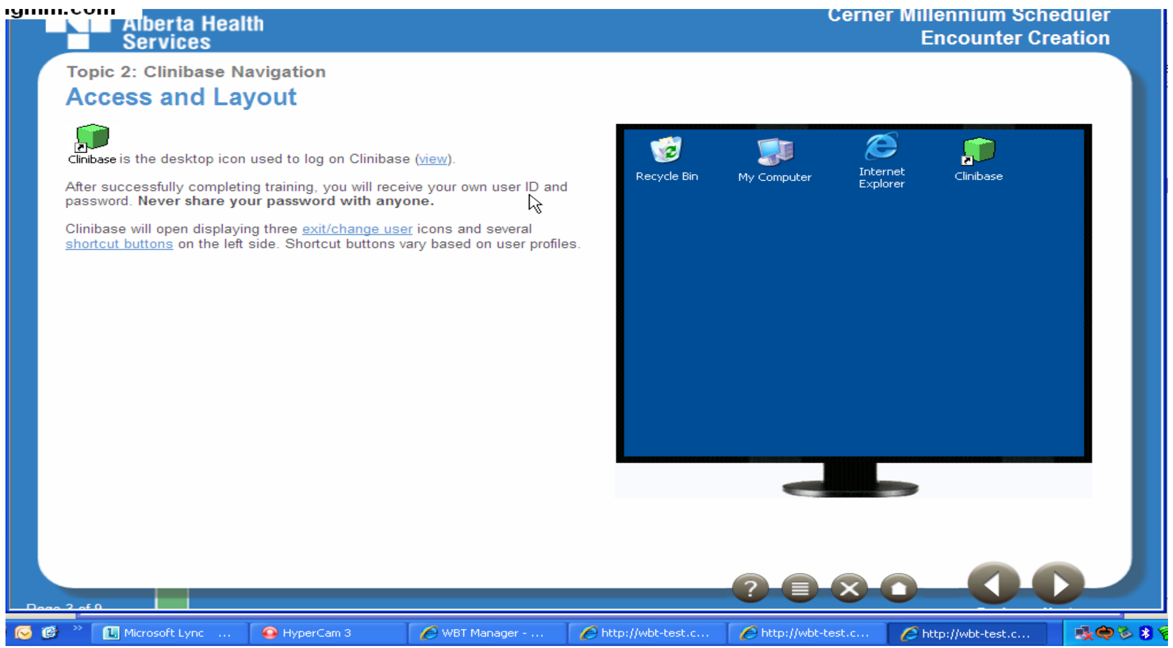
> "The only thing I will add to use the Verify Validate Window, there were quite a few places that say 'followed approved processes' if somebody is new coming in they don't know that those are so many additional comments of 'will be provided to you once you get your clinic" otherwise they may be looking here where are these processes."



Screenshot 1.4: Topic 1, Verify and Validate Information

In the next example, the informatics consultant user asked for more clarification to make the task understandable and clear, as illustrated in this quote, supported by Screenshot 1.6:

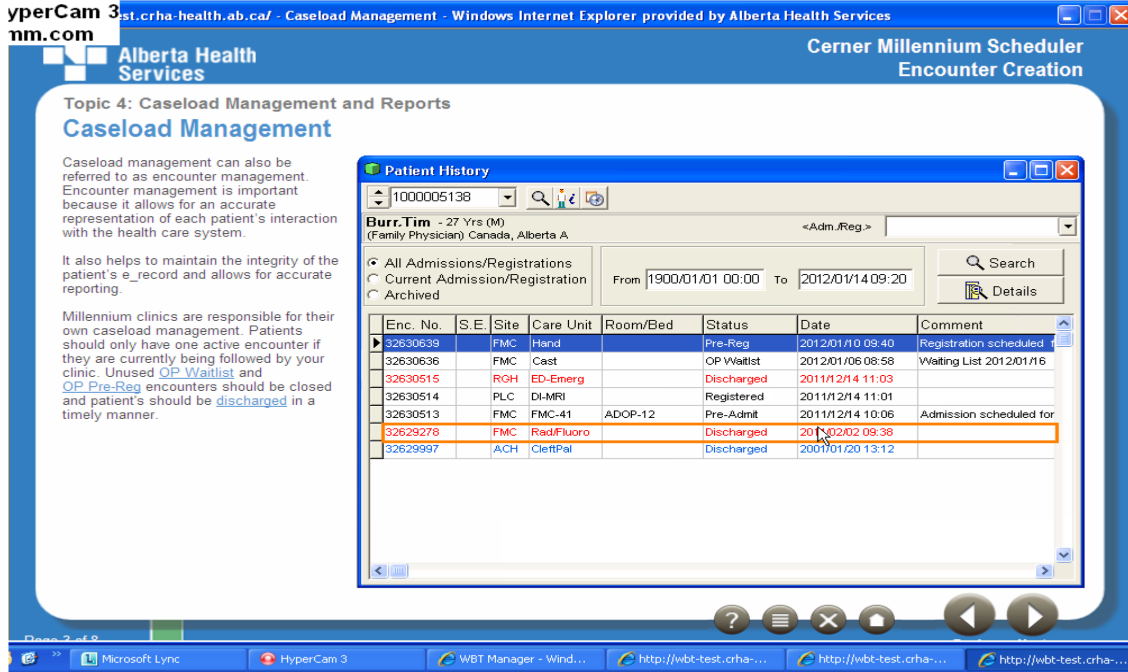
Getting access is always a concern to users, and here, it said, you will receive your own user ID and password. Honestly, nothing wrong with that, but again, I don't know, if would be a value of adding from managers or by email, so that everyone knows exactly how to get it.



Screenshot 1.6: Topic 2, Access and Layout

In this example, the user pointed out invalid information on the screen, as illustrated in this quote, supported below by Screenshot 3.3:

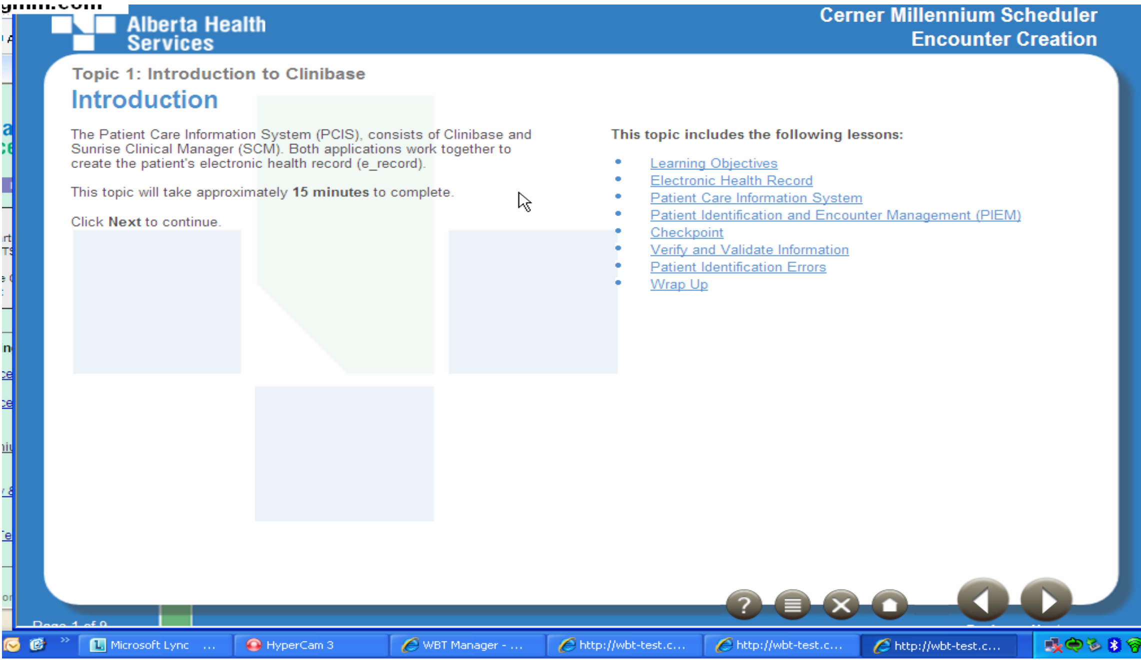
It says that patients should be discharged in a timely manner, and it shows the date of discharge in 2011 and we are talking about the pre-registration of this year, so, it is probable this date be changed to avoid confusion, this date should be 2012.



Screenshot 3.3: Topic 4, Caseload Management

Finally, in the following example one user recommended that precise and clear content for clarification of how two applications work together is needed. This finding is illustrated in Screenshot 1.1 and supported by the user comment in this quote:

> For an introduction piece here, I think it will be helpful to users when it says 'consists of Clinibase and … etc.,' may be mentioned that is the one way communication. So that Clinibase beats SCM. You know, because, I think, that one issues we having right now. They understand how they interact. They know the interactivity, but they don't know how. Maybe by having a little bit information…etc., kind of, to say, the communication goes from Clinibase to SCM.



Screenshot 1.1: Topic 1, Introduction to Clinibase

In summary, two major problematic issues related to educational websites were identified from the comments of the informatics consultant users, including problems related to relevance of site content to the learner and the learning process and the simplicity of site navigation, organization and structure. Fixing these problems could lead to a higher quality educational website.

5.4.3. Problems Related to Learner-centred Instructional Design

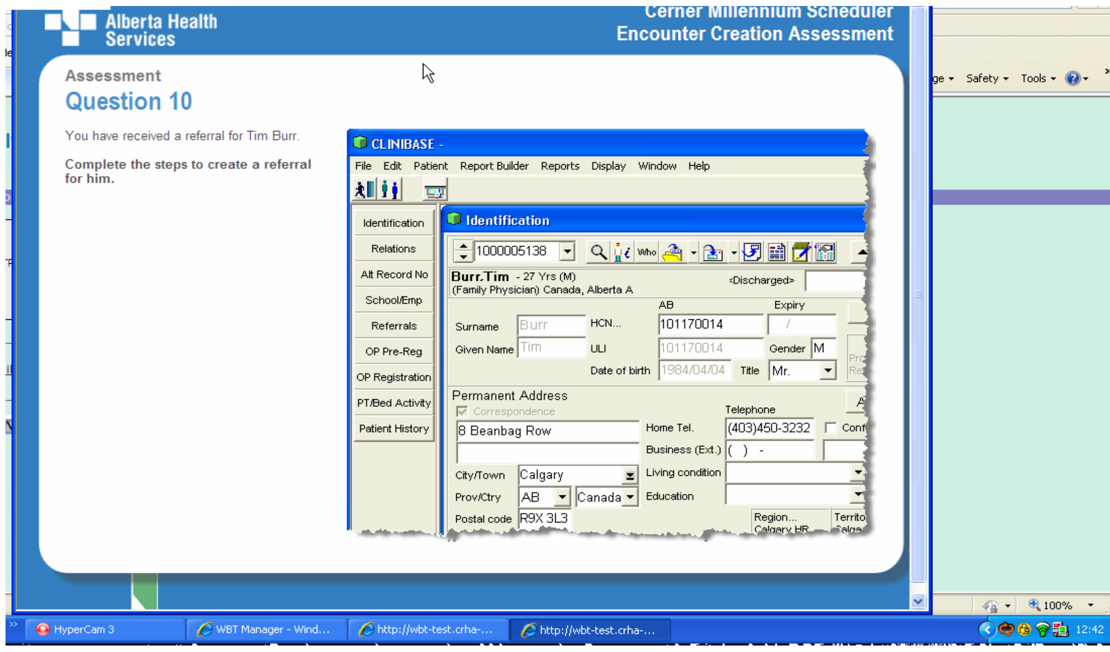
As shown in Figure 14, three problematic areas related to learner-centred instructional design were identified form the comments of the informatics consultant users, including level of learner control (1.5%); cognitive error recognition, diagnosis and recovery (3%); and feedback, guidance and assessment (1.5%). The findings identified from the users' comments as shown in Table 37 are summarized in the sections below.

Table 37: Problems Related to Learner-centred Instructional Design

LEVEL OF LEARNER CONTROL	"As I am working on the Assessment, it would be nice to have the number of questions remaining for people that need to know how many questions they are"
COGNITIVE ERROR RECOGNITION, DIAGNOSIS AND RECOVERY	"I think in this window…then click plus sign to add a new diagnosis, I can't distinctively want to go to click that and nothing happened… So, just the screen flowed to me."
	"So, because I am used to, in a teacher in a class room because I did training in the long time as well as being taught in the class room where you have a free range of doing everything on alive screen what I find really difficult with eLearning and is something that everybody will have to learn I am always unsure as I mentioned before click each step to learn more click decision I am so not a hundred percent sure whether or not it was telling me to click decision on screen or whether is going to do it itself I am just learn by errors by clicking it didn't happened and just waiting too more seconds and then it did it. So, I think that just frost older folks that they have to learn how just to be patient in things don't respond, you know, is going to do for us, so that things have to learn about eLearning myself"
FEEDBACK, GUIDANCE AND ASSESSMENT	"I was expecting to have a little quiz at the end of each topic just to review the knowledge, but may be that is coming at a later time, I am not sure, but something similar to Introduction to Clinibase and I didn't see that in Clinibase Navigation at all"

5.4.3.1. Problems Related to Level of Learner Control

Based on heuristics for web-based learning in Table 28, a high quality e-learning system should allow learners to have some freedom to direct their learning, either individually or through collaborative experiences, and to have a sense of ownership of their learning. In addition, learners, where appropriate, should take initiative regarding method, time, place, content, and sequence of learning. From these perspectives, informatics consultant users pointed out some issues that didn't comply with this heuristic. This finding is supported by Screenshot 2.13 and the comments of the user in this quote: "As I am working on the assessment, it would be nice to have the number of questions remaining for people that need to know how many questions there are."



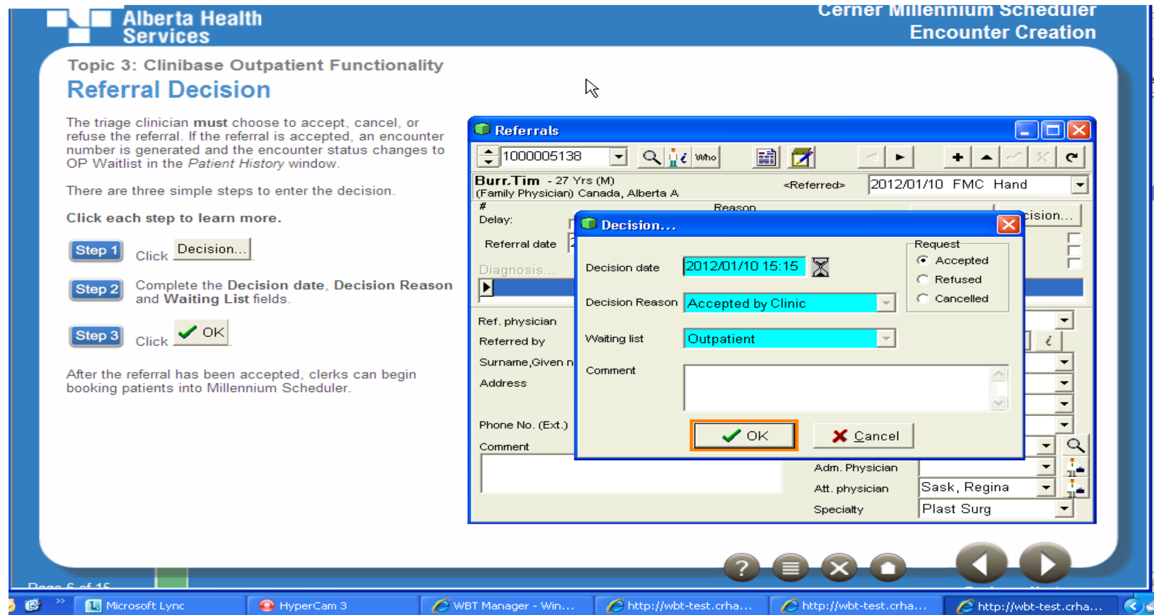
Screenshot 2.13: Assessment, Question 10

5.4.3.2. Problems Related to Cognitive Error Recovery, Diagnosis and Recovery

According to the usability evaluation criteria for web-based learning, learners should be permitted to learn from their mistakes and be provided with help to recover from cognitive errors. in this example; the learner was trying to recover from errors by learning from their mistakes. However, nothing was happening to help them. The e-learning system should help its users to recover from errors by learning from mistakes. As supported by the user computer screenshot in Figure 15.4.16, the user commented:

> So, because I am used to, in a teacher in a class room because I did training for long time as well as being taught in the class room where you have a free range of doing everything on a live screen what I find really difficult with e-learning and is something that everybody will have to learn I am always unsure as I mentioned before click each step to learn more. Click decision I am so not a hundred percent sure whether or not it was telling me to click decision on screen or whether is

going to do it itself. I just learn by errors by clicking it didn't happen and just waiting too more seconds and then it did it. So, I think that just for older folks that they have to learn how just to be patient in things don't respond, you know, is going to do for us, things I have to learn about e-learning myself.



Screenshot 14.4.16: Topic 3, Clinibase Outpatient Functionality, Referral Decision

5.4.3.3. Problems Related to Feedback, Guidance and Assessment

Based on Heuristic 18 in Table 28, learners should have the option to give and receive prompts and frequent feedback about their activities and the knowledge being constructed. From this perspective, in one case the software didn't comply with this heuristic related to feedback, guidance and assessment. This was identified from the comments of the informatics consultant users, as shown in Screenshot 4.10. The user

pointed out the need for little quizzes at the end of each topic, as a feedback tool from which they could receive feedback from the e-learning system. Here, what the user said:

> I was expecting to have a little quiz at the end of each topic just to review the knowledge, but may be that is coming at a later time, I am not sure, but something similar to Introduction to Clinibase and I didn't see that in Clinibase Navigation at all

Screenshot 4.10: Topic 1, Main Menu, 3

Some problems related to cognitive error recognition, diagnosis and recovery were the following: feedback, guidance and assessment and level of learner control. These were identified from the comments of the informatics consultant users. Fixing these problems will eventually lead to a high quality e-learning module in terms of learner-centred instructional design.

In summary, it was found that the cognitive task analysis (using heuristics to aid in coding the data) was not only effective in identifying problematic areas but also in pointing out areas of strength related to general interface usability (GIU), educational websites, and learner-centred instructional design, as presented in Table 38.

Table 38: Summary of Areas with Strength Features

Strength features		User comments
General Interface usability	RECOGNITION RATHER THAN RECALL	“ Is a good thing that the little hand comes up, I like that because people that may not be used using the computer might expect to use a different colour of text like a blue or something for a link"
	FLEXIBILITY AND EFFICIENCY OF USE	“Not take a lot of thinking”
		“This basic walkthrough”
Website Specific Criteria for Educational Website	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	“I like the fact you can click down the tree rather than exiting out it just save one click for the user”
		I just noticed on the Close a Preregistration e-learning page at the bottom you have option to rewind back and forward I like that feature because I can go back and forward over the point that you want to learn, that is a great feature”
	RELEVANCE OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	“That is a good description for the Site/Program category/Program/Care Unit, is very good”
Learner-centred Instructional	LEARNER MOTIVATION, CREATIVITY AND ACTIVE LEARNING	“I am a hands on learner, so, I enjoyed that a little try Create a Referrals, so, it is a good exercise to go through”

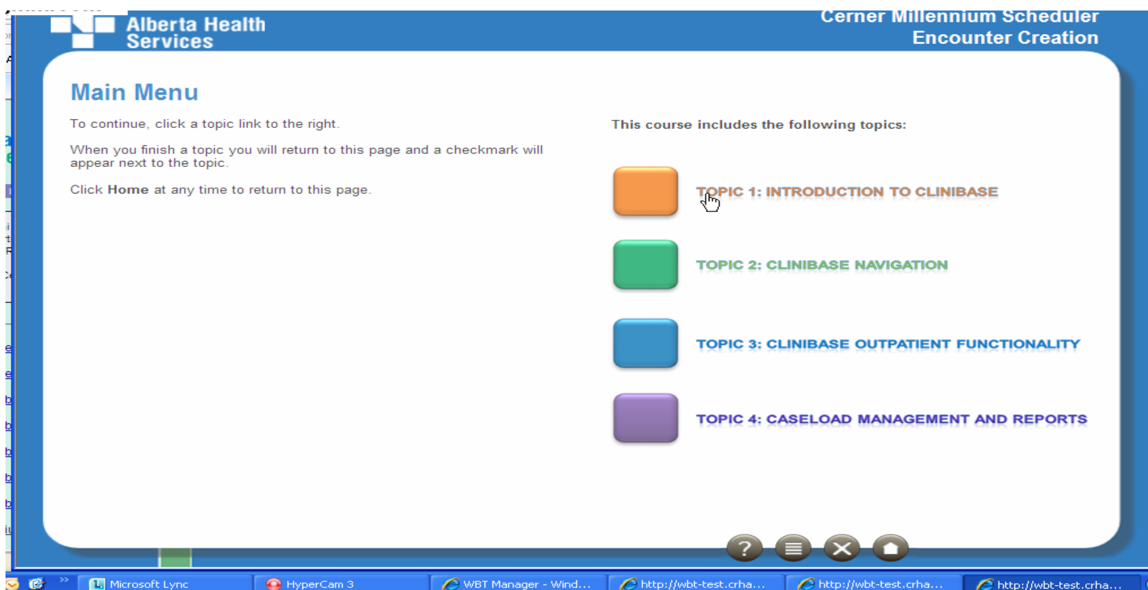
5.4.4. Areas with Strong Features Related to General Interface Usability

In general, two areas of strength are related to general interface usability (GIU), including recognition rather than recall and flexibility and effectiveness of the user.

5.4.4.1. Areas with Strong Features Related to Recognition Rather than Recall

As shown above in Table 38, some informatics consultant users pointed out to some areas with strong features (i.e. positive features) related to general interface usability. They liked the little hand icon feature that made it easy to recognize what it tells them to do instead of memorizing what to do. This finding was supported below by Screenshot 4.1 and by the comment of the user in this quote:

> Is a good thing that the little hand comes up, I like that because people that may not be used using the computer might expect to use a different colour of text like a blue or something for a link.



Screenshot: 4.1: Topic 1, Introduction to Clinibase, Main Menu 1

5.4.4.2. Areas with Strong Features Related to Flexibility and Efficiency of Use

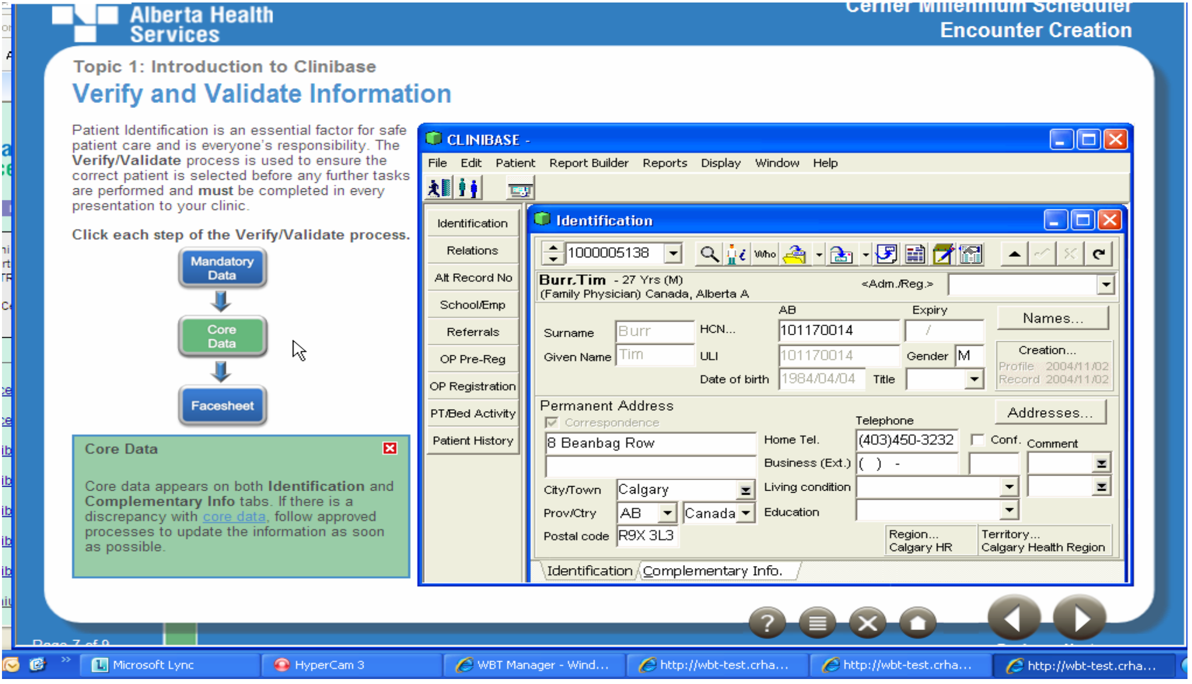
One informatics consultant user believed that the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) was flexible and efficient. The user stated: “Not take a lot of thinking” in doing “this basic walkthrough.”

5.4.5. Areas with Strong Features Related to e-Learning Educational Websites

In general, two areas related to the educational website were identified, including simplicity of site navigation, organization and structure; and relevance of site content to the learner and the learning process.

5.4.5.1. Areas with Simplicity of Site Navigation, Organization and Structure

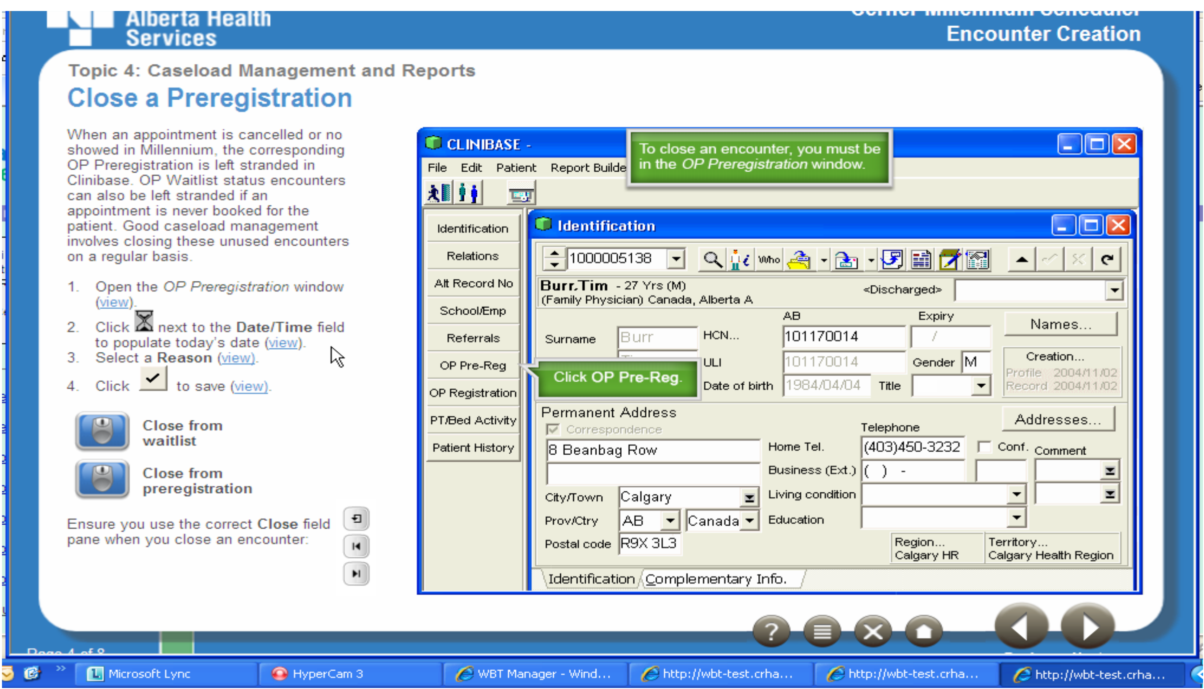
In this example, the user pointed out a good usability feature from which the user can navigate through the tree, as shown in Screenshot 4.5. The user said, “I like the fact you can click down the tree rather than exiting out, it just save one click for the user”



Screenshot 4.5: Topic 1, Verify and Validate Information

In this case, as illustrated in Screenshot 4.24, users can move back and forth easily. This finding was supported by the comment of the user in this quote:

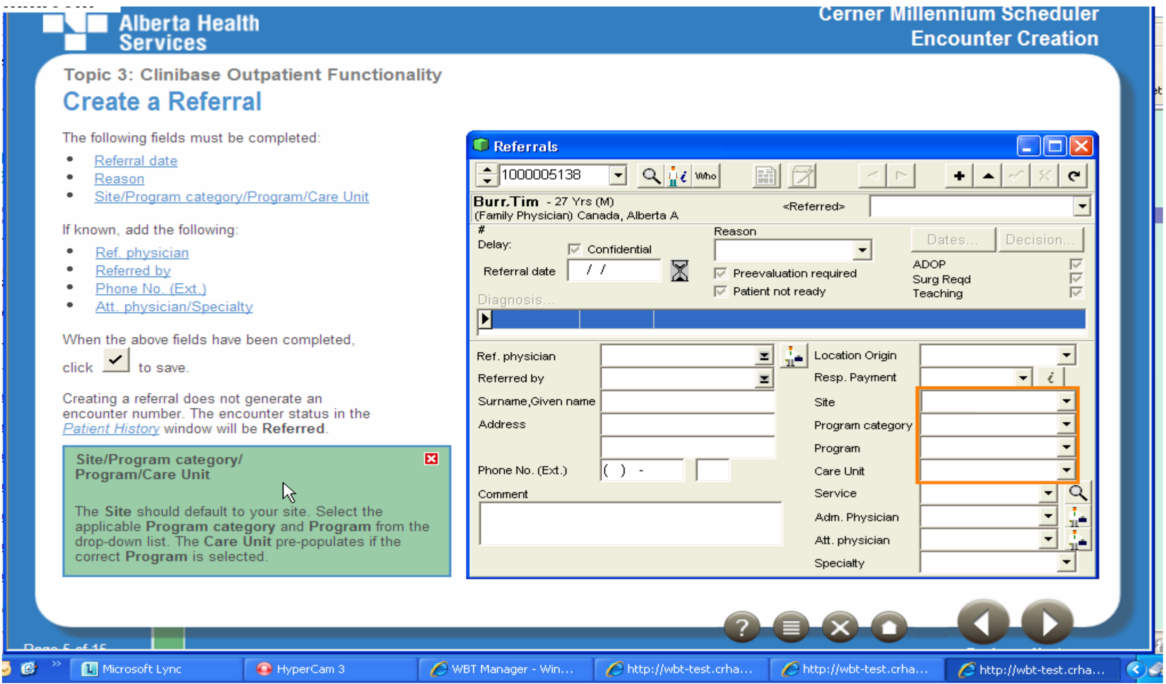
> I just noticed on the close a Preregistration e-learning page at the bottom. You have an option to rewind back and forward. I like that feature because I can go back and forward over the point that you want to learn, that is a great feature.



Screenshot 4.24: Topic 4, Close a Preregistration

5.4.5.2. Relevance of Site Content to the Learner and the Learning Process

In this example, the user believed that the information, descriptions and definitions of the concepts in the green boxes were very good. As an example, supported by Screenshot 4.12, one informatics consultant user said," that is a good description for the Site/Program category/Program/Care Unit, is very good."



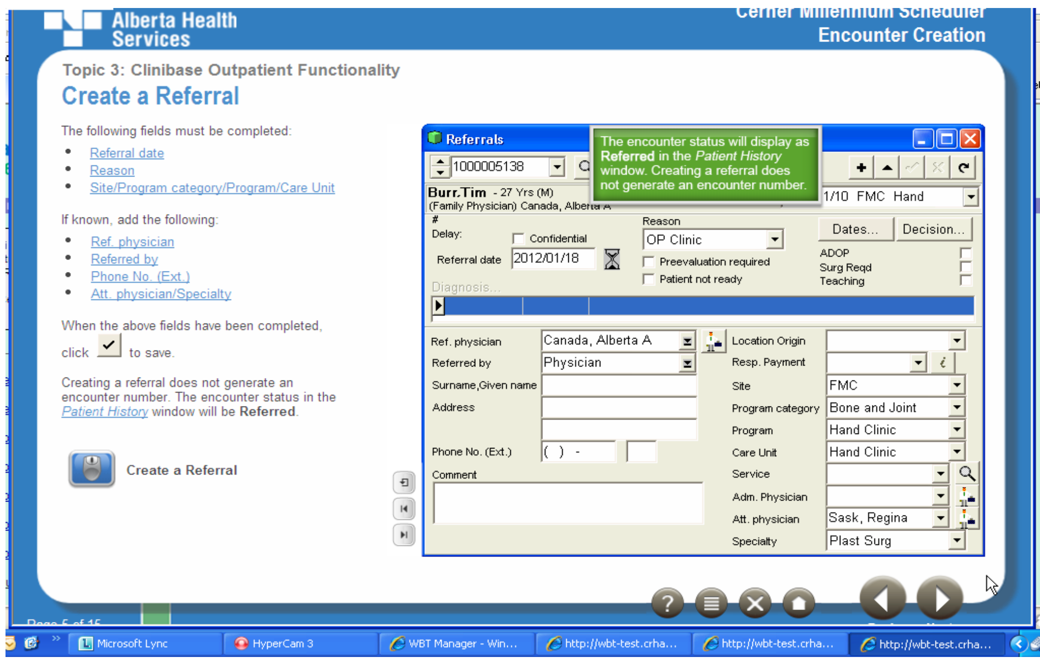
Screenshot 4.12: Topic 3, Create a Referral, 2

5.4.6. Areas with Strong Features Related to Learner-centred Instructional Design

One area with strong features related to leaner-centred instructional design was focussed around learner motivation, creativity and active learning.

5.4.6.1. Learner Motivation, Creativity and Active Learning

One area that was positive was identified from the comments of the informatics consultant users related to the learner instructional design. This finding was supported by Screenshot 4.15 and the user comment in this quote: “I am a hands on learner, so, I enjoyed that a little try “Create a Referrals”, so, it is a good exercise to go through”



Screenshot 4.15: Topic 3, Create a Referral, 4

5.4.7. Results of Short Open-ended Individual Interviews

We conducted the open-ended interviews to get a better understanding of the best aspects and areas that need improvement from the informatics consultant user perspective. Because this was a short interview that was guided by two questions, individual responses were transcribed word-for-word directly from the audio recordings. Then the transcripts were qualitatively analyzed line-by-line using Microsoft Word (LaPelle, 2007). Themes that emerged from the analyses were categorized, based on the usability evaluation criteria in Table 28. Three of five users (60%) answered the questions. From their comments, a theme related to general interface usability emerged. The informatics consultant users believed that the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) was flexible and efficient (Table 39). In contrast, the informatics consultant users believed that two aspects needed more improvement and these areas were related to website-specific criteria of educational

websites. These two aspects include the need for simplicity of site navigation and better organization and structure (Table 40).

Table 39: Best Aspects Related to General Interface Usability (GIU)

Emerged themes	Comments of informatics consultants
FLEXIBILITY AND EFFICIENCY OF USE	"I think the best aspects users can complete it independently within region… train a lot of people on it, go back and forth… their benefits in that regards."
	"I will say the best is the options for the users to enter many times and move back for… the module the e-learning module."
	"The best, I think, probably, what I would like about the eLearning, the most will be to do it on my time and also went back over and having manual type learning tool that I can go back if I want to refresh my memory"

5.4.7.1. Aspects Related to Flexibility and Efficiency of Use

From the interviews (as shown above in Table 39) the informatics consultant users believed that flexibility and efficiency of use are the best aspects of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) as used in the WBT Manager for e-Learning. They believed that it offers a flexible and independent learning and refreshment tool that can be used remotely at any time within the region. For example, in their comments, one said, "I think the best aspect is that users can complete it independently within a region… train a lot of people on it, go back and forth… there are benefits in that regards." Another user who said, "I will say the best is the options for the

users to enter many times and move back for the module the e-learning module", also supported this. In summary about this, one user said:

> The best, I think, probably, what I would like about the e-learning, the most will be to do it on my time and also went back over and having manual type learning tool that I can go back if I want to refresh my memory.

In summary, informatics consultant users believed that the MCEC-eLM offers a flexible learning option and refreshment tool that can be accessed independently and remotely at any time within the region. On the other hand, the users pointed out two aspects related to the e-learning educational site that need more improvement. These aspects are discussed below under the following headings.

Table 40: What Needs Most Improvement Related to Educational Websites?

Emerged themes	Comments of informatics consultants
SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	"If I recall some of the two things actually: the Try when you actually going through and doing, making your own click etc. I don't know what will all of the Tries had a back rewind forward buttons if they don't then that will be handy I only noticed it closer to the end of the module, and also, and I know it is difficult to get a perfect sometimes the automatic scripts will pop up sometimes will be a long wait so I was unsure as to whether I was finish or not and then I will clicking around and a last pop up will come up so the timing might be a little bit off, but I know some people read faster another ones are click around"
RELEVANCE OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	"Probably some directions specially for the discharge process and the changes indicating that those where the information should come from because depend on who is looking at the things they could understand that they can't make changes by their own or just because those words verbally communicated sometimes can be but sometimes not, for example for the discharge"

5.4.7.2. Aspects Needing Improvement Related to Educational Websites, Simplicity of Site Navigation, Organization and Structure

Based on their interviews, the informatics consultant users believed that some aspects related to simplicity of site navigation, organization and structure (such as "Try Me" buttons) need the most improvement. This finding was supported by the comment of this user:

If I recall some of the two things actually: the Try Me when you actually going through and doing, making your own click etc. I don't know what will all of the Tries … had a back rewind forward buttons if they don't then that will be handy. I only noticed it closer to the end of the module, and also, and I know it is difficult to get it perfect sometimes the automatic scripts will pop up sometimes. Will be a long wait so I was unsure as to whether I was finished or not and then I will be clicking around and a last pop up will come up so the timing might be a little bit off, but I know some people read faster another ones are click around

5.4.7.3. Aspects Needing Most Improvement Related to Educational Websites, Relevance of Site Content to the Learner, and the Learning Process

In addition to navigation, organization and structural aspects, the informatics consultant users believed that some information content related to the discharge process needs to be improved. This finding was supported by this user's comment when asked about what needs improvement:

> Probably some directions, especially for the discharge process and the changes indicating that those where the information should come from, because this depends on who is looking at the things they could understand, that they can't make changes by their own or just because those words verbally communicated, sometimes can be but sometimes not, for example for the discharge.

Chapter 6: Discussion, Implications for Practice, Recommendations for Future Research, and Conclusions

6.1. Background Discussion

6.1.1. Evaluation Conceptual Framework and Study Design

Alberta Health Services (AHS) has adapted an e-learning option to offer flexible web-based learning opportunities to individual employees in order to reduce training time and cost and to extend the available methodologies for learning. An effective evaluation was recognized as being an essential process for wide adoption and successful implementation of e-learning at the individual, organizational, and technical levels. In response to this, a conceptual framework for evaluation of the usability and usefulness of the Millennium Clinibase Encounter Creation e-Learning Module (MCEC-eLM) was proposed. The goal of the MCEC-eLM was to provide employees with core competencies and skills for using a patient clinical information system IT scheduling application used for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics in AHS.

The framework for evaluation was proposed based on usability and usefulness concepts that emerged from user-centred evaluation methods for evaluation of user interactions with the content as well as with the system features. The Software Usability Measurement Inventory (SUMI) was used for evaluating one group of users and was also combined with the Low-cost Rapid Usability Engineering testing method for another group of users. For this reason, two groups of users were involved: frontline users and

informatics consultant users. For analysis, a mixture of qualitative and quantitative methods was used. For analyzing video-based usability data, we used Cognitive Task Analysis (CTA) and usability heuristics to aid in analyzing the video data (Kushniruk, Patel & Cimino, 1997). This involved judging whether each dialogue or other iterative element from the video data followed established usability principles (Arh & Blazic, 2008, p. 176). We used custom-designed heuristics for web-based learning, based on Nielsen's heuristics, adapted from Ssemugabi and De Villiers (2007) for the analysis. This is a unique application of usability heuristics to drive the analysis of video-based usability testing.

The study described in this thesis was designed to answer these questions:

1. Does the MCER-eLM (as used in AHS' WBT Manager for e-Learning) effectively and efficiently provide learners with core competencies needed for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics at AHS?
2. Was the MCEC-eLM acceptable, useful, and did it satisfy the real-world business requirements for obtaining usernames and passwords for accessing a patient clinical information system IT scheduling application in a real production environment?
3. How effective were the Low-cost Rapid Usability Engineering (LRUE), Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE) criteria combined with Software Usability Measurement Inventory (SUMI) in

evaluating the usability and usefulness of the MCEC – eLM (as used in WBT Manager for e-Learning)?

4. How did the different methods employed in this study compared in terms of results obtained by each and in terms of their effectiveness?

The framework for evaluation developed and conceptualized in this study was used to answer the above-mentioned questions to fulfill a specific purpose, which was to evaluate the usability and usefulness of the MCEC-eLM (as used in a WBT Manager for e-learning). In addition, the study investigated how effective LCRUE, CTA, and HE criteria were when combined with SUMI for evaluating the usability and usefulness of MCEC-eLM. Finally, one objective was to explore how the different methods employed in this study compared in terms of results obtained by each and in terms of their effectiveness. The results obtained from the analysis are discussed in the sections below.

6.1.2. User Demographics: Individual Assessment toward e-Learning

User demographics impact adoption of e-learning options and organizational readiness to cope with e learning and training plans. In this section, the demographic characteristics results of the frontline and informatics consultant users are discussed. Overall results regarding each individual's age, professional status, location, purpose for completing e-learning, and Internet and computer use for each group are summarized and compared below in Table 41.

Table 41: Overall Demographic Characteristics of Users

	Percentages % (N=18)			
	Male		female	
	Frontline Users/N=13	Informatics Consultant Users/N=5	Frontline Users/N=13	Informatics Consultant Users/N=5
Age				
25 - 35 Years	8%	20%	23%	
35 - 45 Years		20%	23%	20%
Over 45 Years			46%	40%
Total	8%	40%	92%	60%
Professional Status				
MRT	8%		8%	
Clerks			61%	
PLN			8%	
Secretaries			15%	
Informatics Consultants		40%		60%
Total	8%	40%	92%	60%
Location				
CV Lab	8%		30%	
Endoscopy			8%	
Colon Cancer			8%	
GI Clinic			8%	
Speciality Clinic			8%	
Others			30%	
QP		20%		20%
Midnapore				40%
AC		20%		
Total	8%	40%	92%	60%
Purpose for Completing e-Learning				
Education	8%		62%	
Research		40%	30%	60%
Total	8%	40%	92%	60%
Internet and Computer Use				
Frequently	8%	40%	92%	60%
Regularly				
Sparingly				
Rarely				
Total	8%	40%	92%	60%

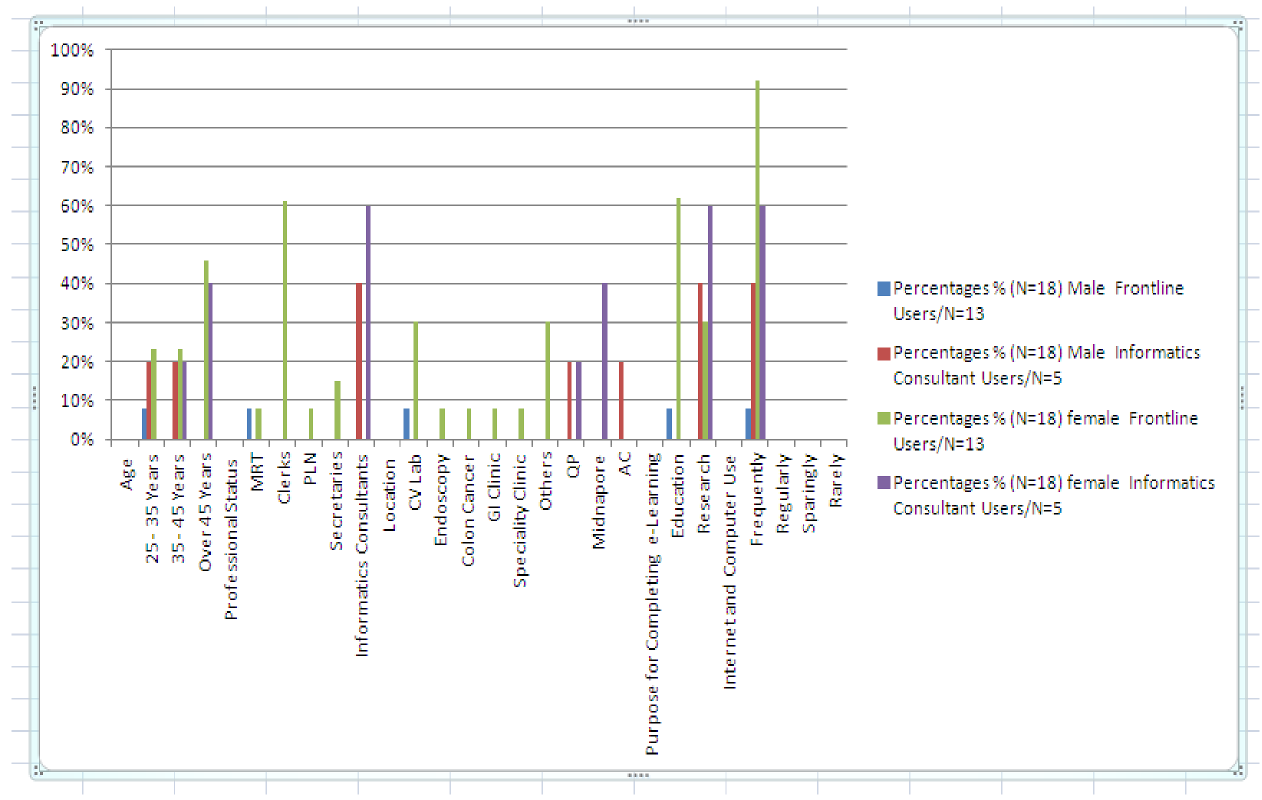


Figure 15: Overall User Demographics

6.2.1.1. Similarities

In general, the number of female participants in both groups was higher than the number of male participants, 92% of frontline users and 60% of informatics consultant users, as illustrated in Figure 15. The number of female participants over 45 years old was higher than any other age group. All of the male and female frontline users and informatics consultant users used the Internet and computer frequently in their daily job activities. These results indicated that both the frontline and informatics consultant users were mostly experienced, skilled, and knowledgeable female employees. In addition, all users had the skills and experience to cope with the module and with the future initiatives for e-learning.

6.2.1.2. Differences

As illustrated in Figure 15, the frontline users had varied professional status, including clerks, secretaries, nurses, and laboratory technicians. Participants in the other group were all informatics consultants and each participant in this group specialized as either an organization change management specialist (OCM) or business analyst (BA). They were chosen from a multi-disciplinary Transformation Support Services (TSS) team with different skills and knowledge ranging from computer science, clinical science, engineering, business, etc. For the purpose of this study, they had been chosen due to their expertise and knowledge to identify any problems in the content or in the interface of the MCEC-eLM (as used in a WBT Manager for e-Learning) before the final release of the module for use in the real production environment.

Most of the frontline users (61%) were clerks, followed by secretaries (15%). This reflected the trend that the end users of the MCEC-eLM mostly come from clerk and secretary professional roles. Other users come from different professional roles, depending on their professional status and the locations they came from. Locations of the users were varied; including the cardiovascular laboratory (CV Lab), colon cancer, gastrointestinal (GI), endoscopy, speciality clinics, and others undisclosed locations.

6.1.3. Knowledge-based User Acceptance Performance Testing

User performance testing is part of user acceptance testing. It measures learning outcome and usability quantitatively in terms of effectiveness and efficiency. In knowledge-based performance testing, knowledge is evaluated to see whether it meets the domain expert's expectations and the system requirements (Hartung and Hakansson, 2007). In this study, the knowledge gains and competencies provided for using e-learning

were determined by the users' performance in the core competency assessment at the end of the MCEC-eLM, including the time has taken to complete the module and the assessment.

According to Kitchin, the goal of the MCEC-eLM is to provide employees with core competencies for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics (personal communication, email, 2011). Based on this goal, the e-learning strategic planners and experts were expecting the users in AHS to pass the core competency assessment with a minimum average score of 80% to fulfil the requirements of AHS IT Security and Privacy to obtain usernames and passwords to use a patient clinical information system IT scheduling application in a real production environment.

The overall results of the frontline users and informatics consultant users are discussed below. Table 42 shows the overall results of the user performance testing for the frontline users as compared to the informatics consultant users.

Table 42: Overall Results of Knowledge-based User Performance

Group	**Total time user spent in module's Lessons (minutes)**	**Total time user spent in assessment (minutes)**	**Average score on assessment (%)**	**Number of times enter lesson**	**Number of attempts to pass**
Frontline Users (N=13)	25.2	25.4	87	1.4	1.3
Informatics Consultants (N=5)	52.2	15.56	86.2	1	1
Mean	**38.7**	**20.48**	**86.6**	**1.2**	**1.2**

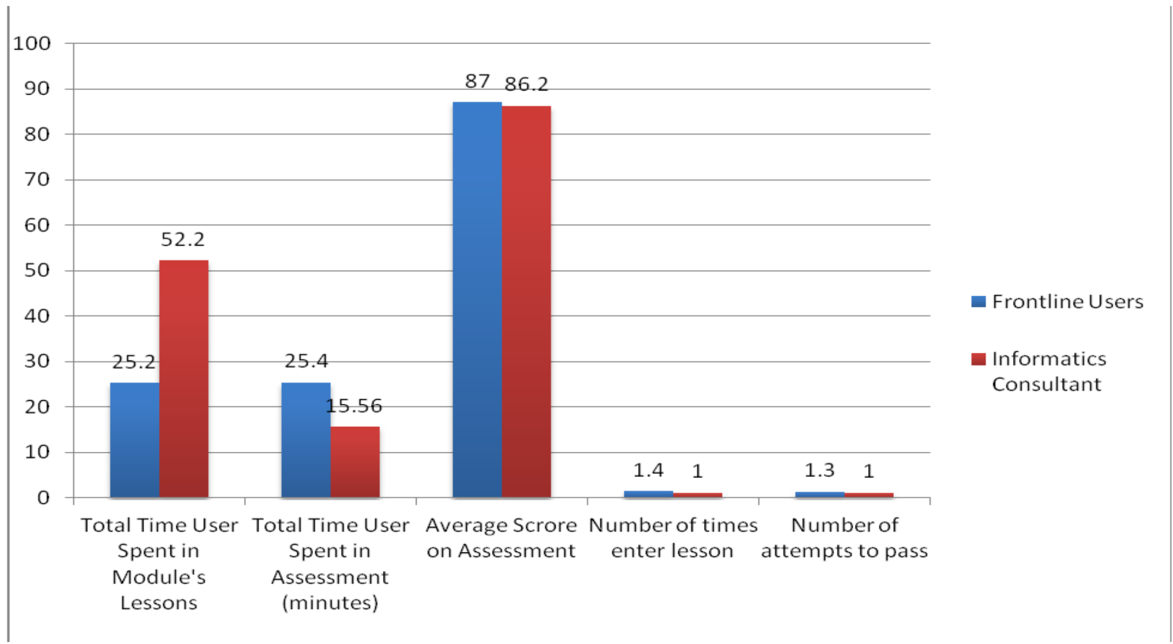


Figure 16: Overall Objective Knowledge-based User Performance

6.1.3.1. Similarities: Answer to Research Questions 1 & 2

As shown above in Table 42, the average performance score in the core competency assessment was approximately the same in both groups (i.e. frontline and informatics consultant users). These results indicated that the knowledge gains and competencies provided from using the MCEC-eLM enabled both groups of users to achieve higher than expected average performance scores in the Millennium Clinibase Encounter Creation e-Learning Core Competency Assessment (MCEC-eLM/CCA). Hence, all users fulfilled the business requirement to obtain usernames and passwords in order to use the clinical information system IT scheduling application in the real production environment. Overall, this finding alone answered our first and second research questions:

1. Does the MCER-eLM (as used in a WBT Manager for e-Learning) effectively and efficiently provide learners with core competencies needed for using a patient clinical information system IT scheduling application for managing patient identification for waitlists and scheduling patient appointments?
2. Was the MCEC-eLM acceptable, useful, and did it satisfy the real-world business requirements for obtaining usernames and passwords for accessing the patient clinical information system IT scheduling application in a real production environment?

In summary, the MCEC-eLM effectively and efficiently provided its users with core competencies for using a patient clinical information system IT application that is used for managing patient identification for waitlists and scheduling patient appointments in outpatient clinics at AHS. Hence, it was acceptable, useful, and satisfied the real-world business requirements for obtaining usernames and passwords for accessing a patient clinical information system.

6.1.3.2. Differences

As illustrated above in Figure 16, the informatics consultant users spent more time on the module's lessons. This result was explained by the fact that all informatics consultants intentionally spent more time in identifying any problems while they were working through the module and "thinking aloud." The time spent in usability testing to identify these problematic areas might account for the longer time they spent to finish the module's lessons.

Also, the informatics consultant users spent less time than the frontline users to pass the core competency assessment. This result can be explained by several factors.

The two groups had different skills and knowledge. The informatics consultant users were recruited from a multi-discipline team with different skills and expertise ranging from engineering, computer science, clinical science, etc. The members of this team are either organizational change management specialists (OCM) or business analysts (BAs). They use their broad knowledge to facilitate change and support IT applications at AHS. For these reasons, they were intentionally recruited to participate in this research (Figure 15) as experts to identify problematic areas for improvement.

6.1.3.3. Discussion and Conclusions

The overall results of the user acceptance performance testing for the frontline users correspond closely with the results of the informatics consultant users. Regardless of their levels, possessing minimum skills required for accessing the Internet and using the computer, the frontline users and informatics consultant users achieved acceptable results in the MCEC-eLM/CEC and satisfied the real-world business requirement in obtaining usernames and passwords for accessing a patient clinical information system IT scheduling application in a real production environment.

6.1.4. Subjective Usability Evaluation Using SUMI

According to Dillon and Morris (1999), satisfaction measures how well users like the application. Based on Theory of Reasoned Action from social psychology (Fishbein & Ajzen, 1975) the Technology Acceptance Model (TAM), according to Davis et al. (1999), predicts use based on the influence of two factors: perceived usefulness (the degree to which a user believes that using the system will enhance his/her performance) and perceived ease of use (the degree to which the user believes that using the system will be free from effort) (Dillon & Morris, 1999).

As cited in Dillon and Morris (1999), Davis argued that usefulness is the most important predicator of use. From this perspective, Dillon and Morris (1999) also argued that the final driver of use must be the users' perceptions and attitudes toward the technology. Many tools have been used for measuring a user's perceptions toward the technology, such as TAM, TAM P3 Module, etc. In this study, I used SUMI measurement for measuring subjective user perceptions and attitudes toward using the MCEC-eLM.

According to Porteous, Kirakowski and Corbett (1993), the SUMI questionnaire measures how usable a software product is according to the subjective satisfaction of their users:

> The Software Usability Measurement Inventory (SUMI) measures how usable a software product is according to the perceptions and attitudes of its users. It produces a set of valid and reliable numbers which are indicators of the usability of the software being rated. SUMI focuses on the perceptions or feelings that the typical user has when using a piece of software. This important consideration is not evaluated by some software engineering approaches to usability (Anjaneyulu et al., 1998).

The results of the users' subjective usability satisfaction with the MCEC-eLM, as used in AHS' WBT Manager for e-Learning, are summarized below in Table 43.

Table 43: Overall Results of Subjective Usability Satisfaction

SUMI Measurement	Frontline Users (N=14)	Informatics Consultant Users (N=5
Global	57.3	54.78
Efficiency	54.53	46.47
Affect	57.88	54.92
Helpfulness	56.62	56.16
Control	55.62	47.62
Learnability	55.63	62.16

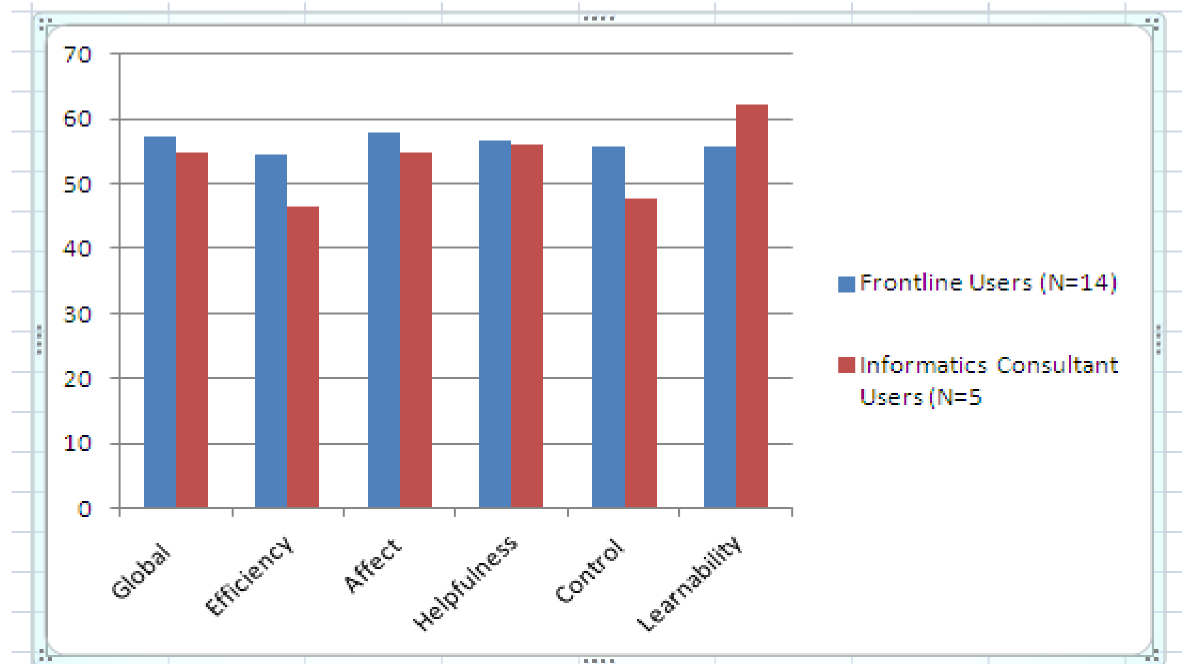


Figure 17 : Overall Subjective Usability Satisfaction

6.1.4.1. Similarities

As shown above in Figure 17, the average scores attained on the global scale – known as user perceived software quality (Anjaneyulu, et al. 1998) – and subscales: affect, helpfulness, and learnability – were higher than the average score expected (50%). However, except for learnability, frontline users were more satisfied with the usability

global scale and subscales mentioned above than informatics consultant users. The level of education and expertise as well as the time they spent on the module's lessons for identifying any usability problems might account for this result. These results indicated that none of the subscales (affect, helpfulness, and learnability) were problematic in the view of both the frontline and informatics consultant users, since all were above the score of 50, as illustrated in Figure 17.

The high ratings attained on the global scale affect and learnability subscales were explained by the following reasons:

1. The MCEC-eLM was used in and already tried and tested within the WBT Manager for e-Learning.
2. The frontline users and the informatics consultant users were enthusiastic about participating in this study, which could have led to higher ratings.
3. This evaluation was a part of an e-learning development process. Prior to the evaluation the content of the module and the user interface design were checked many times for errors. Thus, many potential problems related to content or interface were fixed. This also might account for higher usability ratings.

In conclusion, regardless of their skill levels, both the frontline users and informatics consultant users were satisfied with the MCEC-eLM. They believed the Help system, including the tutorial interface, handbooks, and so forth were useful, readable and instructive. Moreover, they thought it was easy to start and learn new features when using this module for learning core competencies and functionalities related to the clinical information system IT scheduling application. This application is used for managing

patient waitlists and scheduling patient appointments in outpatient clinics in AHS. Moreover, they believed this module was mentally stimulating and pleasant to use. These results were supported by some examples from the major findings in the consensual analysis of SUMI items:

1. The majority of frontline users believed that the documentation of the MCEC-eLM was very informative.
2. The majority of frontline users believed that the MCEC-eLM wasn't awkward to use to do something not standard. In other words, it was pleasant to use it even if it was used for something not standard.
3. The majority of frontline users agreed that the MCEC-eLM had helped them to overcome any problem they had experienced when using it.

6.1.4.2. Differences

As shown above in Figure 17, the average scores attained on efficiency and control subscales by informatics consultant users were lower than those for frontline users. The informatics consultant users attained lower ratings on these subscales, lower than the expected average of 50%. These results indicated that efficiency and control were problematic in the view of the informatics consultant users.

Factors that influence perception of "efficiency", according to its definition, include users' feeling that the software is enabling the task(s) to be performed in a quick, effective, and economical manner or the opposite extreme that the software is getting in the way of performance (Anjananeyulu et al. 1998). Therefore, poorly rated efficiency was an indication of user interaction-related problems and that the interface presented a barrier for the consultants to finish their tasks rapidly. The fact that the problems identified by the informatics consultant users, as shown in Figure 18, and the time they

spent on the module lessons, as shown in Figure 16, might account for the lower efficiency ratings.

Likewise, factors that influence control, according to its definition, include users' feelings that the software was not responding in a normal and consistent way to input and commands or the opposite extreme, that the software was difficult to operate and not easily internalized by the users due to lack of prior computing experience (Anjaneyulu et al. 1998). Lack of computer experience would not account for the lack of control the users experienced. This fact was supported by findings in Figure 5 and Figure 10 from the demographic and SUMI questionnaires. All informatics consultant users had the minimum skills for accessing the Internet and using the computer. In addition, they had very good experience with technical aspects. However, their responses may have been due to their role in examining the e-learning application more thoroughly from a usability perspective in their participation in low-cost usability testing.

The results of the usability testing that were gathered from the comments of informatics consultant users are described in Figure 18 and provide objective evidence for the poorly rated SUMI subscales – efficiency and control. This will be discussed in the next section.

6.1.5. Usability Evaluation Using Cognitive Task Analysis

From the comments of the informatics consultant users, a total number of fifty-eight (58) problematic areas were identified, related to general interface usability, educational website, and aspects of instructional design (33). As shown below in Table 44, sixty-seven percent (67%) of the issues were related to general interface usability,

twenty-six percent (26%) to educational website, and seven percent (7%) to learner-centred instructional design.

Some of these findings provided objective usability evidence about some poorly rated subjective usability measurements measured by SUMI. Thus, the two methods, namely the SUMI questionnaire and the low-cost usability testing, were found to be complementary (i.e. results from the usability testing could be looked at to help explain SUMI questionnaire ratings). This application of usability testing also provided objective evidence for more problems than using SUMI alone would have provided. Altogether, the study explored how effective CTA is when combined with SUMI to evaluate usability.

Table 44: Overall Usability Problems

	Coding Themes	Areas with Problematic Issues/N(58)
General Interface Usability Criteria	VISIBILITY OF SYSTEM STATUS	10%
	MATCH BETWEEN THE SYSTEM AND THE REAL WOLD	10%
	LEARNER CONTROL AND FREEDOM	2%
	CONSISTENCY AND ADHERENCE TO STANDARDS	12%
	RECOGNITION RATHER THAN RECALL	26%
	FLEXIBILITY AND EFFICIENCY OF USE	3%
	AESTHETICS AND MINIMALISM IN DESIGN	2%
	HELP AND DOCUMENTATION	2%
	SUB-TOTAL	**67%**
Educational Website	SIMPLICITY OF SITE NAVIGATION, ORGANIZATION AND STRUCTURE	12%
	RELEVANCE OF SITE CONTENT TO THE LEARNER AND THE LEARNING PROCESS	14%
	SUB-TOTAL	**26%**
Learner-Centred Instructional Design, Grounded in Learning Theory, Aiming for Effective Learning	LEVEL OF LEARNER CONTROL	2%
	COGNITIVE ERROR RECOGNITION, DIAGNOSIS AND RECOVERY	3%
	FEEDBACK, GUIDANCE AND ASSESSMENT	2%
	SUB-TOTAL	**7%**
	TOTAL	**100%**

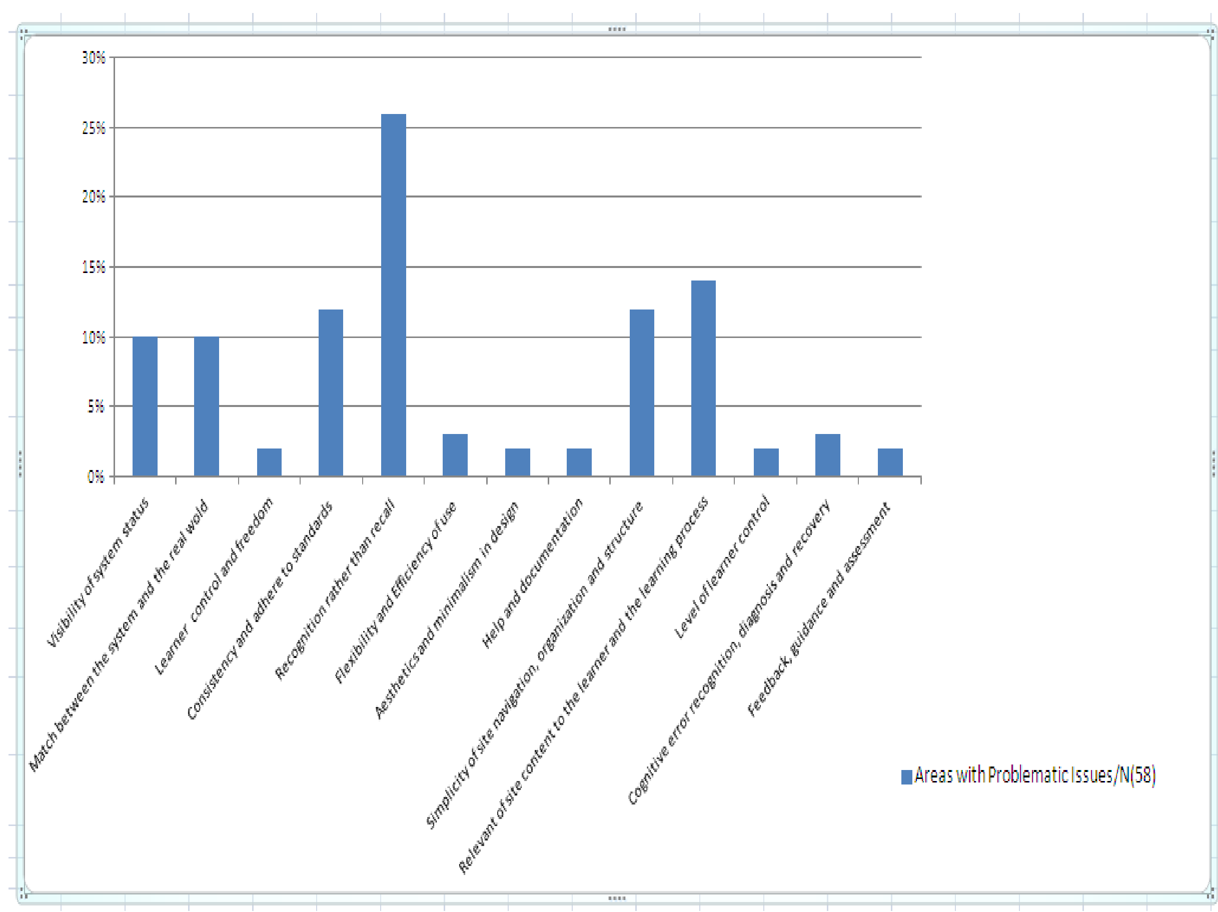


Figure 18: Overall Usability Problematic Issues

6.1.5.1. Overall Problems Related to General Interface Usability

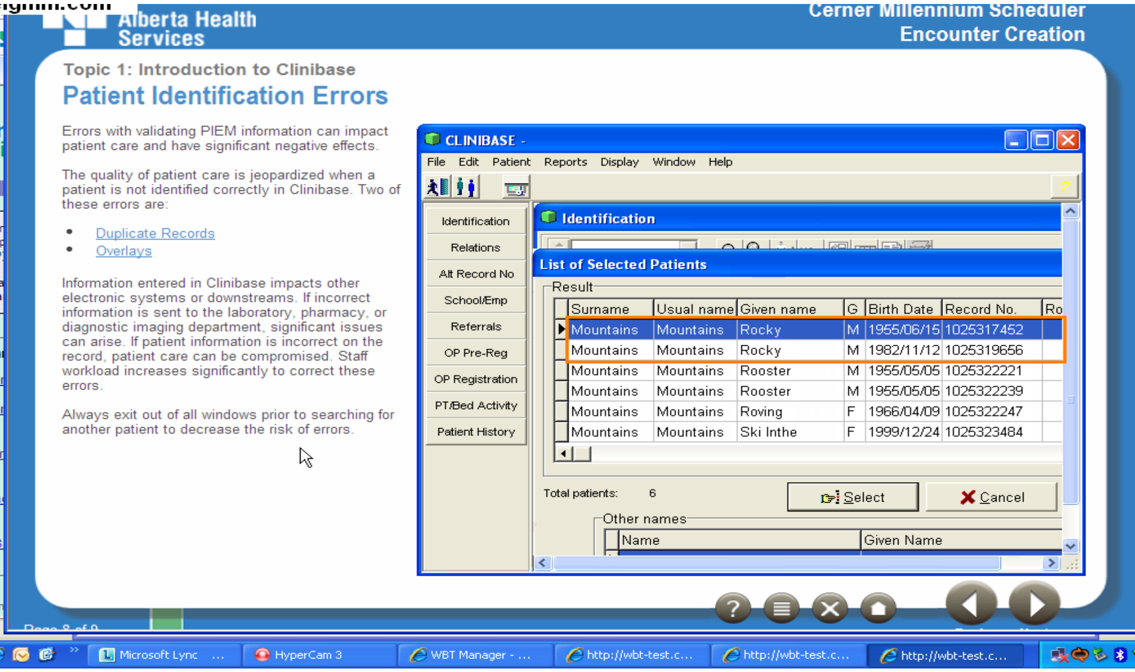
As illustrated in Figure 18, sixty-seven percent (67%) of the informatics consultant users identified problems related to general interface usability (GIU): recognition rather than recall (26%), consistency and adherence to standards (12%), match between the system and the real world (10%), and visibility of system status (10%). Some of these problems identified objective evidence for the poorly rated measurement subscale – efficiency – as measured by the SUMI questionnaire.

6.1.5.1.1. Problems Related to Recognition Rather than Recall

Recognition rather recalls had the highest percentage of comments (26%) as identified from the comments of the informatics consultant users. These were related to general interface usability (Figure 18), based on usability heuristics guidance in Table 28, and can be explained by these criteria: (1) objects to be manipulated, options for selection and actions to be taken need to be visible, (2) the user does not need to recall information from one part of a dialogue to another, (3) instructions on how to use the system are visible or easily retrievable whenever appropriate, and (4) displays are simple and multiple page displays are minimized. We identified from the comments of the informatics consultant users many examples of aspects that didn't comply with the recognition rather than recall heuristic criteria.

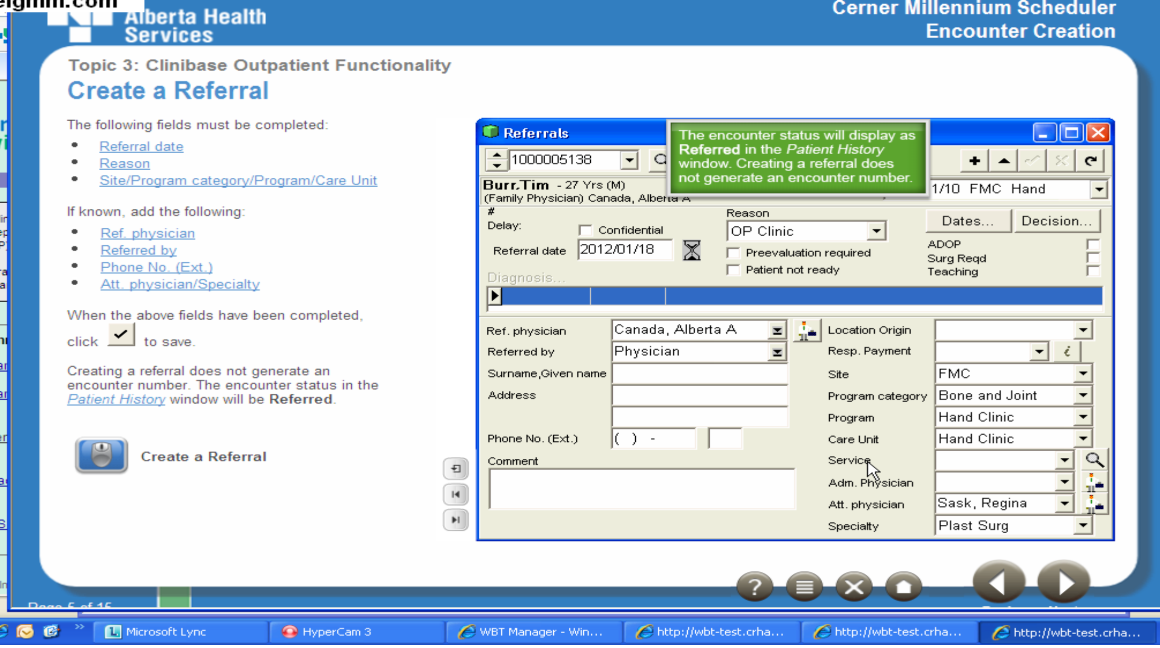
In the first example, the user suggested use of a red flashing light for users to understand and recognize rather than recall how to close windows before proceeding to the next task, as shown in Screenshot 1.5 and supported by the expert comment in this quote:

> Been a part of many issues around overlays, I would almost suggest, the last sentence on the screen be enforced either in red flashing lights, whatever we can make that as clear as possible, and all user can understand how important to make sure they close all of the windows before doing something else



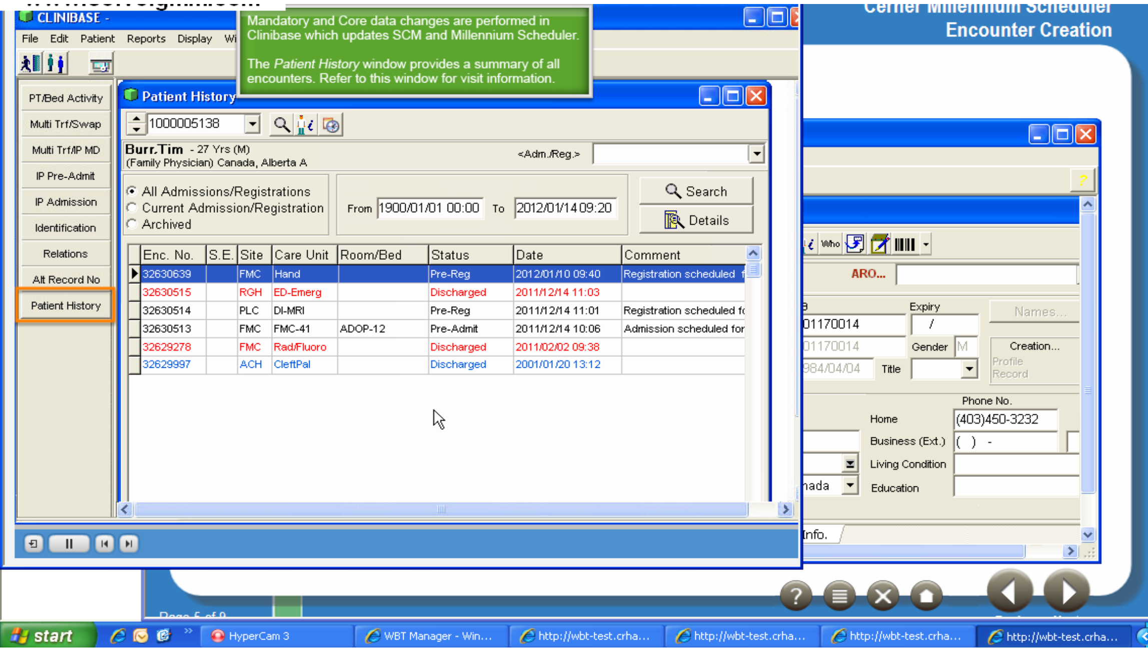
Screenshot 1.5: Topic 1, Patient Identification Errors

In the next example, supported below by Screenshot 1.12, the user didn't recognize whether the video was over or not. They kept waiting and then responded to this problem by saying, "I am assuming this trailer piece is over but is not indicating anything more except to wait anything happened or might be done. Might have some kind of close the screen or show the video is over."



Screenshot 1.12: Topic 3, Create a Referral, 2

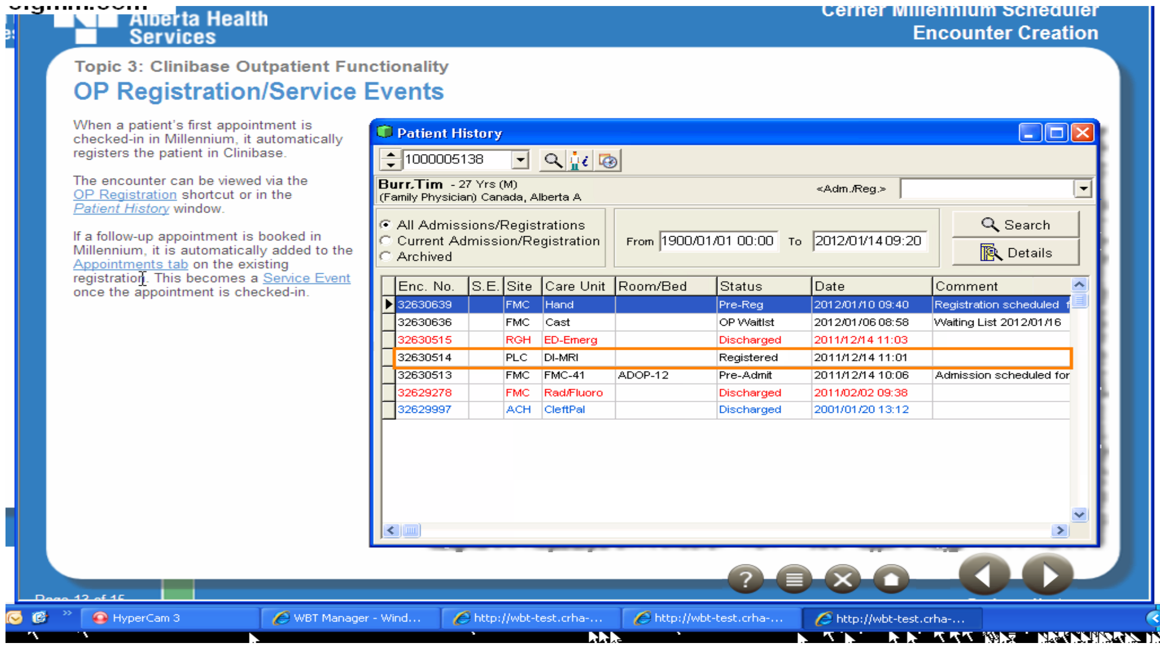
In the following example, the informatics consultant users found it was difficult to recall the entire colour in the Patient History window, as shown in Screenshot 2.1, and one user said: “You have to remember all the little icons and what they mean as you are going through, so, remembering to click view to identify the core mandatory data.”



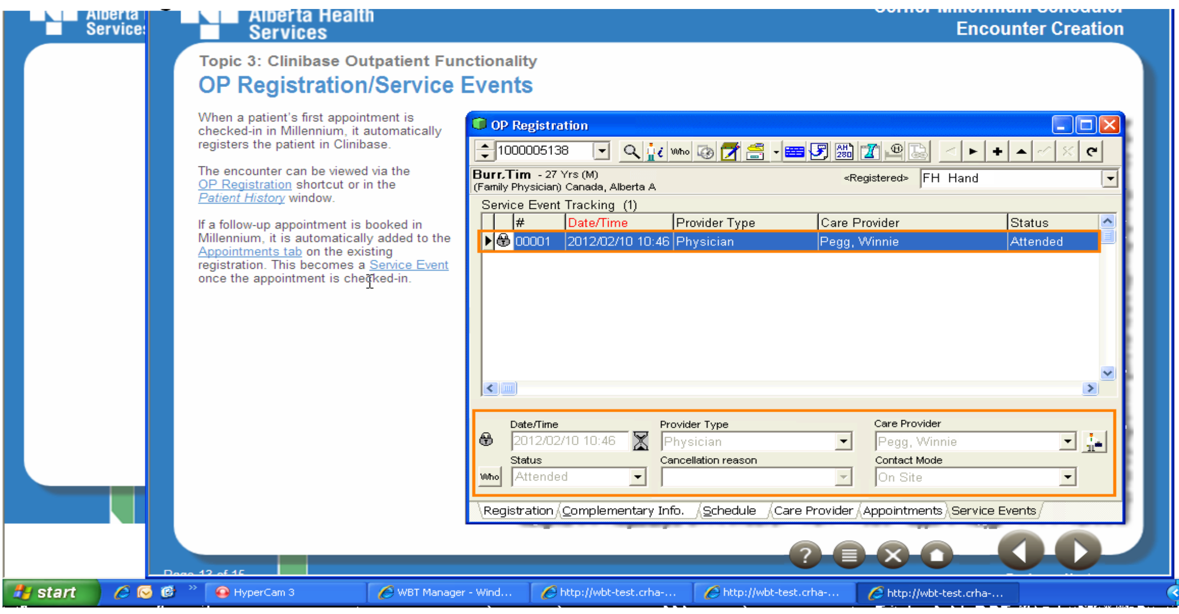
Screenshot 2.1: Patient History

In this example, the user was faced with some difficulties in recognizing the tabs and their corresponding computer windows. Below is a quote from the user, supported by Screenshots 2.8 and 2.9:

> When I go to look for the Appointments tab, I don't see it in the screen, but when I click to the link, it takes me to a different view, so, I am confused this to going from moment tab on left side showing OP Registration and Patient History to the actual tab view that shows the appointments… Also, when I clicked on the Service Events is that changing my tab from Appointments to Service Events, it looks like it does, but it doesn't show that transition, so that I can follow it.



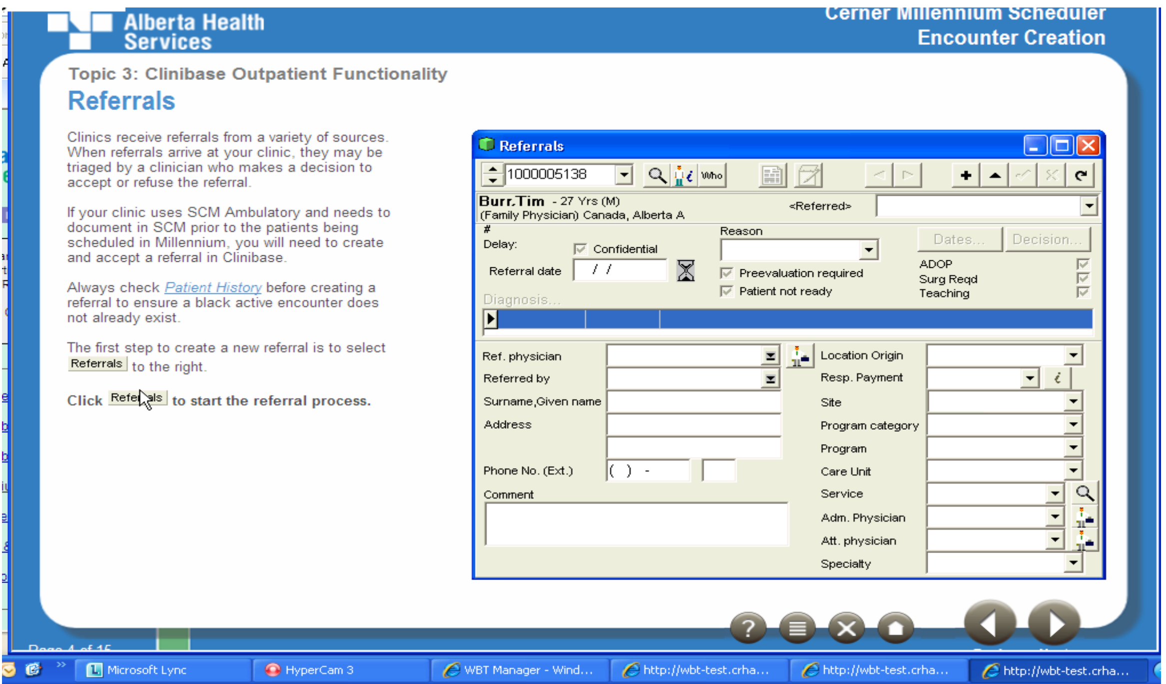
Screenshot 2.8: Topic 3, OP Registration/Service Events 1



Screenshot 2.9: Topic 3, OP Registration/Service Events 2

In this example, the user was confused about recognizing the “Referral” button, as shown in Screenshot 3.1, and the user commented:

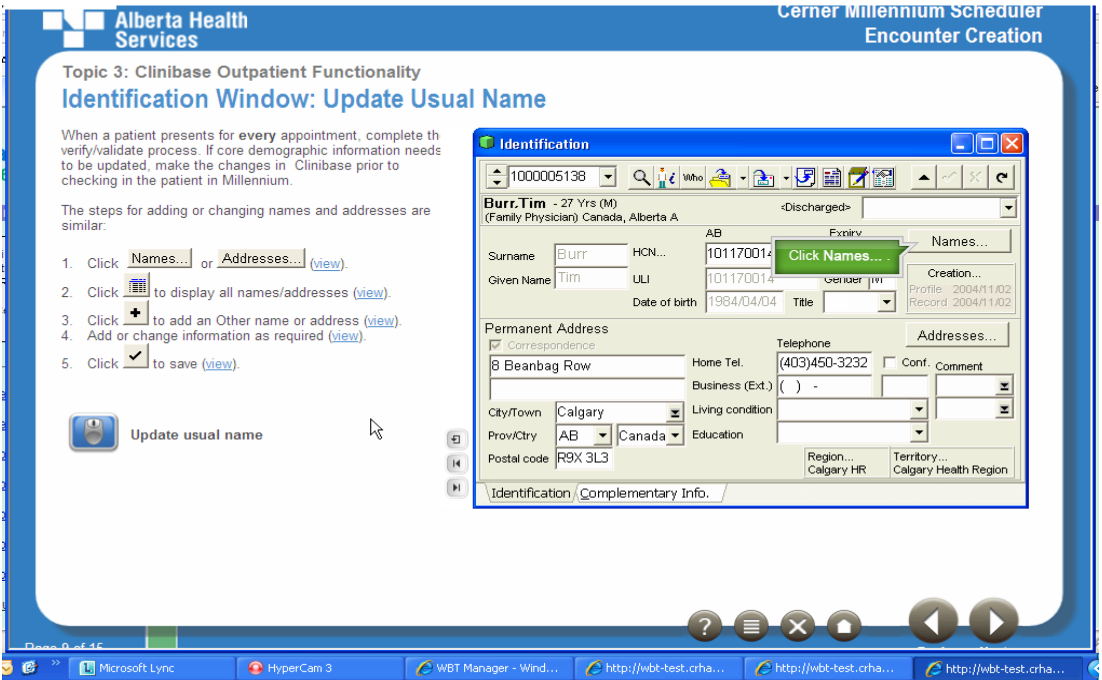
> So, I was here, so I was clicking, there is referrals, but, I can’t see the where is the second Referrals... can I move back, ooh no, it says click to create a new referral to select Referrals to the right, it should be Referrals to the left, I think so, it says, the first step… I can’t find the Referrals on the right, I only see the Referrals on the left, so, I clicked the Referrals on… it can’t find the Referrals on the right. Anyway, I will say that here, will say Referrals to the left…etc., I am lost. Sorry, I can’t start this Referrals process. I need a hand here…. this means Referrals to the left, but can’t understand to start Referral process, I am missing this…



Screenshot 3.1: Topic 3, Referrals

In one more example, the user was confused about the “List” icon position, as shown below in Screenshot 4.19 and mentioned in this quote:

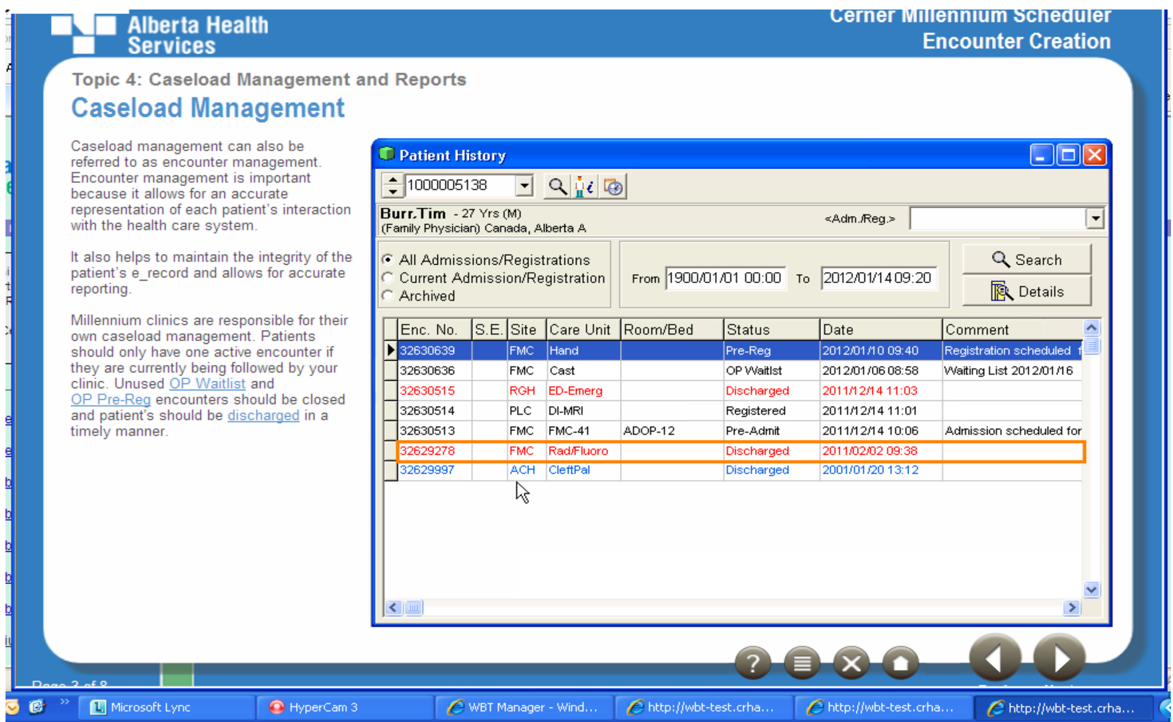
> So for the Identification Window, click Names or Addresses and that displayed the buttons surrounded by orange ridge is a super. The next step is to click a little icon to display all names/addresses. I wasn’t immediately sure whether or not that little icon was beneath the buttons the Names and Addresses or whether I should be looking at the main screen to find another button I am not sure what it looks like but a little list but or something like that so I clicked view and I am assuming said the address is up here and I am assuming is underneath the Addresses button but it wasn’t obvious to me at first.



Screenshot 4.19: Topic 3: Clinibase Outpatient Functionality, Update Usual Name

Finally, in this example the expert spent a longer time to recognize rather than to recall the colour associated with text in the Patient History window and how it was related to each activity in the discharge process. Screenshot 4.23 and the comment of the user in this quote support this finding:

> At this moment doing the topic for Caseload Management I find myself trying to remember from the very first module what the colour means so I am not sure why one discharge is red and the other discharge is blue because I can't remember what I was told at the very beginning. So, It might be nice to have another little reminder when we actually working with the Caseload.



Screenshot 4.23: Topic 4, Caseload Management

In conclusion, we identified evidence of many usability issues from the comments of the informatics consultant users related to recognition rather recall. Trying to recall how to solve these problems while working in the module is time consuming and might account for longer time spent finishing the tasks efficiently or lowering the users' perceptions towards completing these tasks efficiently. Fixing these problems could lead to improvement in both user satisfaction for efficiency and general interface usability in terms of heuristic criteria related to recognition rather than recall as shown in Table 28.

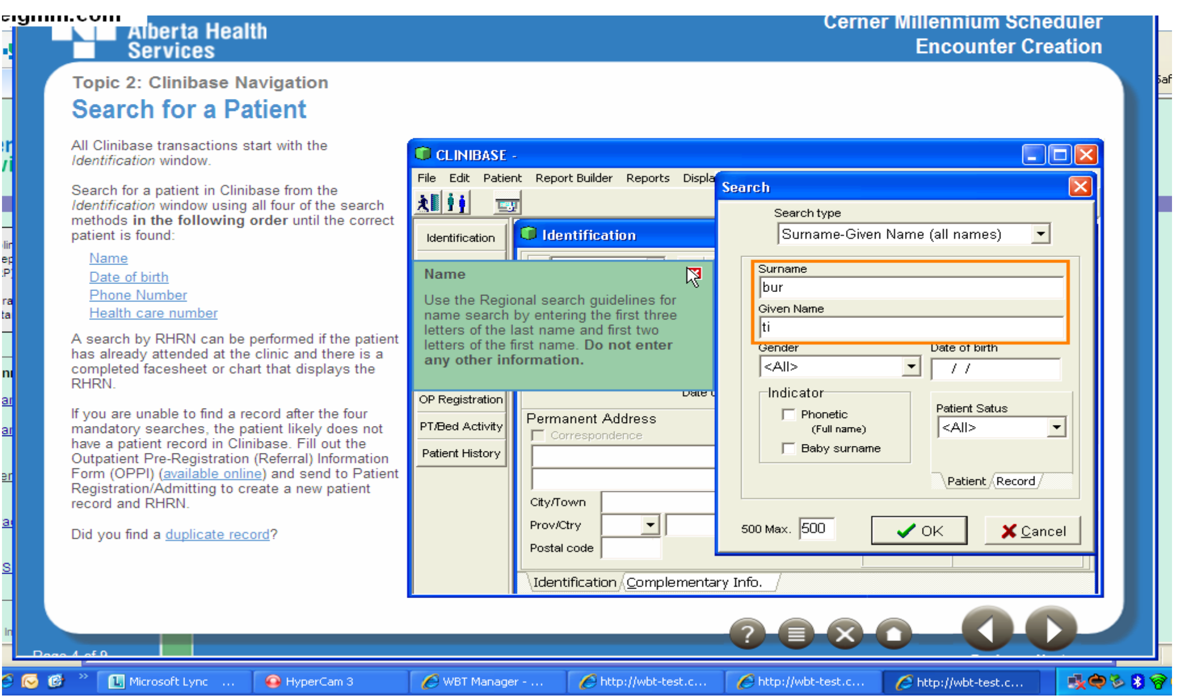
6.1.5.1.2. Problems Related to Consistency and Adherence to Standards: Evidence for "Efficiency" and "Control"

Based on the usability heuristic criteria for web-based learning (Table 28), a high quality e-learning system should have a high degree of consistency and adherence to standards in terms of concepts, words, symbols, situations, or actions referring to the same thing. When considering this heuristic, we identified objective evidence of many problems (12%) related to consistency and adherence to standards from the comments of the informatics consultant users, as shown in Figure 18. These problems could explain the longer time spent by the consultants to go forward, backward, complete their tasks and exit the system. The following examples provide evidence for the lower usability ratings regarding both "control" over the system and "efficiency" of the system measured by the SUMI questionnaire, as shown in Figure 17.

In the first example, the informatics consultant user encountered some difficulties when searching for names. There was no consistent way of searching for names, as shown in Screenshot 1.7 and supported by these comments of the user:

> I want to come to requesting how many letters to enter when searching for a name. I think, it said concretely, here saying; only enter the first two letters of the last name

and first two letters of the first name. Do not enter any other information. Not be aware the system can be valid reason for that, but may be consider the idea of putting, only enter up to this amount at least three letters for the Cerner at least two for that, you know, telling a person can only use three or two letters, sometimes you know limiting your scope; what if you have names start with the same three letters or two letters, that kind of things.

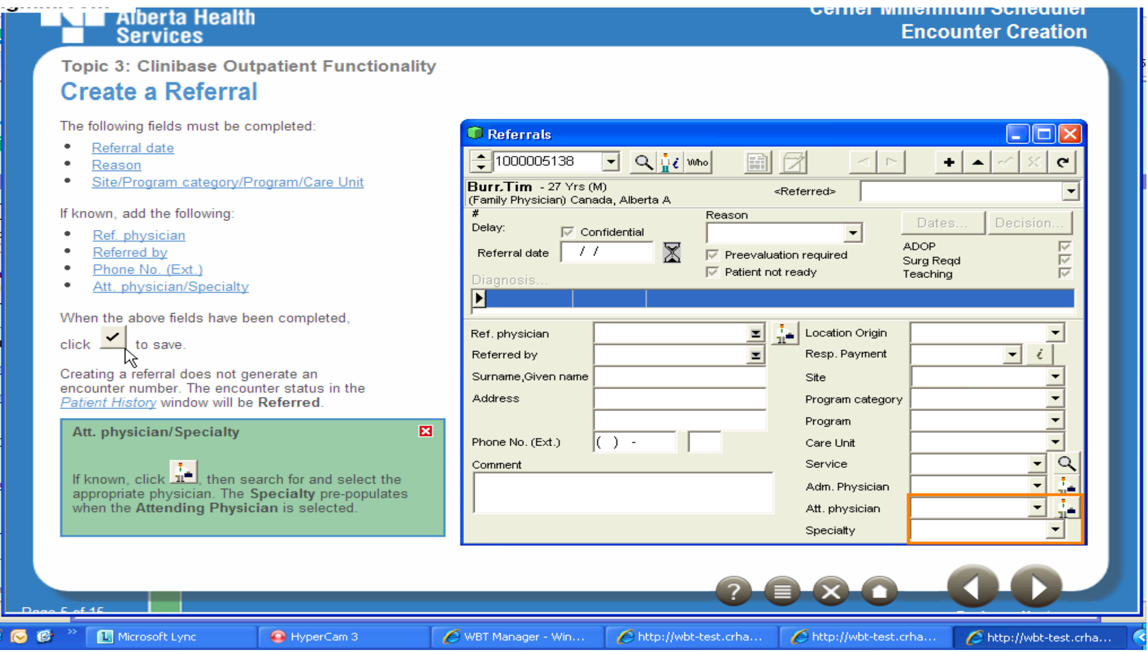


Screenshot 1.7: Topic 2, Search for a Patient

In this next example, the user found it difficult to find a consistent way of saving documents, as supported by Screenshot 1.10 and these comments:

So, when the above fields have been completed, click the checkmark to save. I know in my computer days, I never seen the checkmark as a symbol used to save

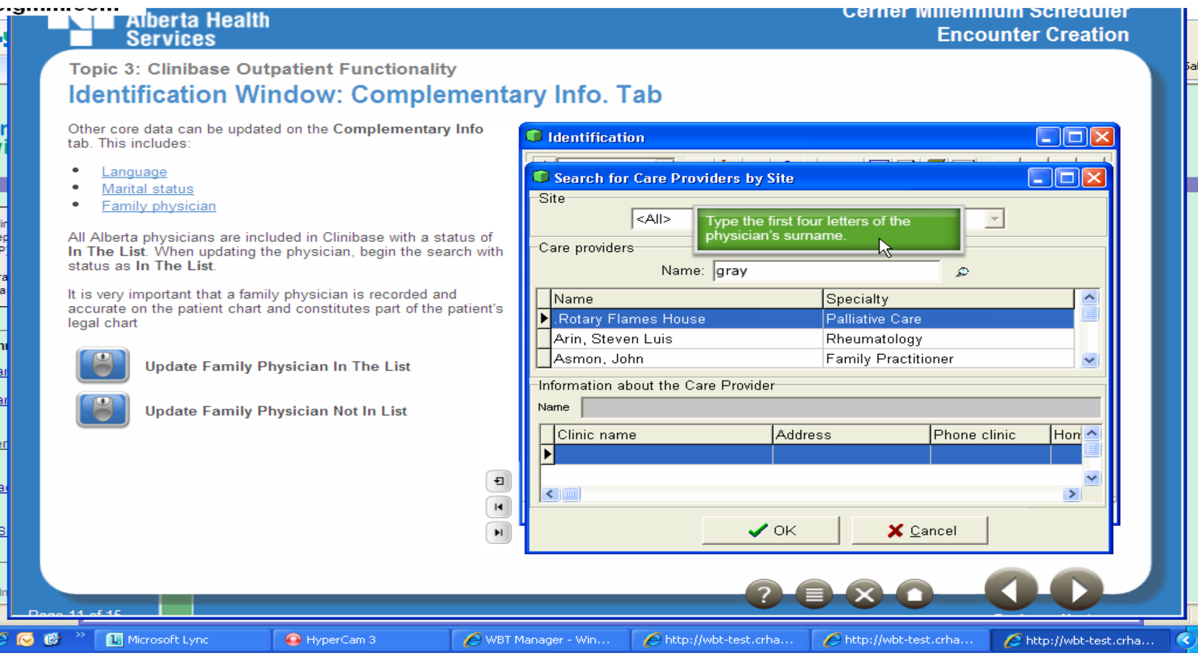
anything, so, more than user interface things. I have assumed it will be trying to be similar to other programs, may be click save to save. I didn't think of the checkmark until I have used it for a while that an obvious choice of button, I know it is a configuration thing.



Screenshot 1.10: Topic 3, Creating a Referral, 1

In this example, a user pointed out the following (as shown in Screenshot 1.15):

> In this window, here, now said enter the first four letters of the physician surname. Before, it said just enter the first three for the surname and the two for the other name. So, I think, you know, these are minor details obviously, but I still… to say at a minimum enter these values and then users can make up their mind.



Screenshot 1.15: Topic 3, Complementary Info Tab

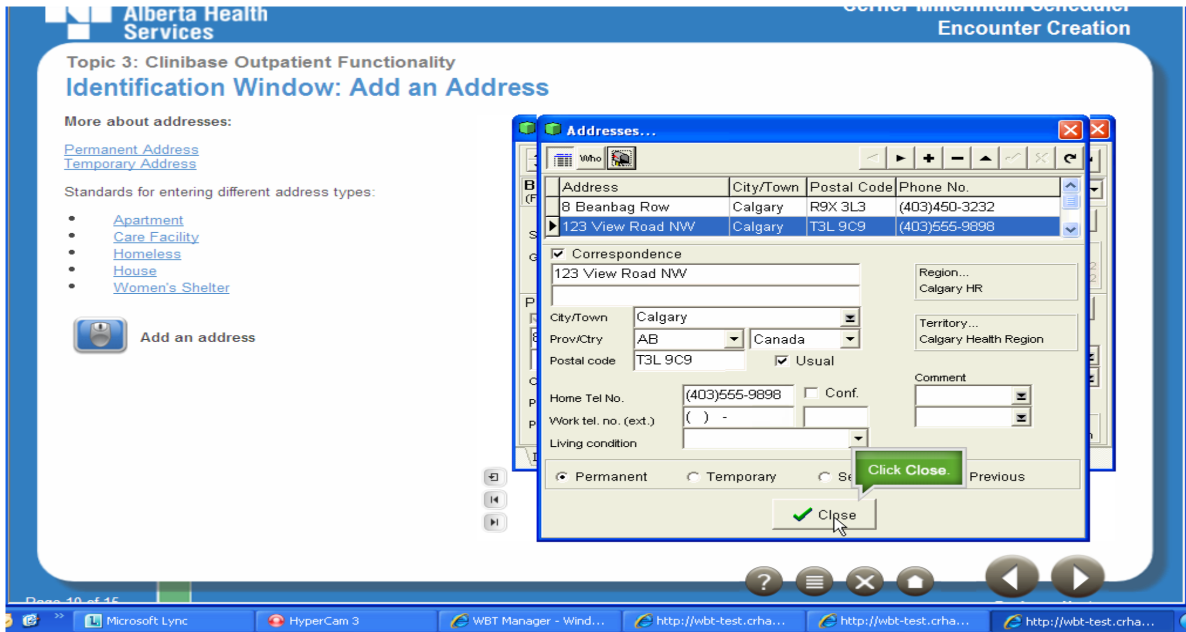
In the next example, the expert pointed out issues relevant to who will add the diagnosis, as shown in Screenshot 4.22 and commented on by the user:

> I will say that here, Topic 4: Adding a diagnosis, all the steps are clear, but we need to point if is the clerk or administrative side who is adding the diagnosis they do the diagnosis from the physician report or whatever, because is not clear…so one can think, Okay, I can add my diagnosis… Should be taken from a source of truth

One more example relevant to adding the address in a consistent and standard is shown below in Screenshot 4.22 and supported by the user comment in this quote:

> In the case of modifying the address now it tells me to close in the bottom where I was changing the name it tells me to exit out from the top so it possible to be, may

be e-learning demonstrating two ways of closing out, but is just some of inconsistency there, so maybe it could be stated as an either or options.



Screenshot 4.22: Topic 3, Add an Address

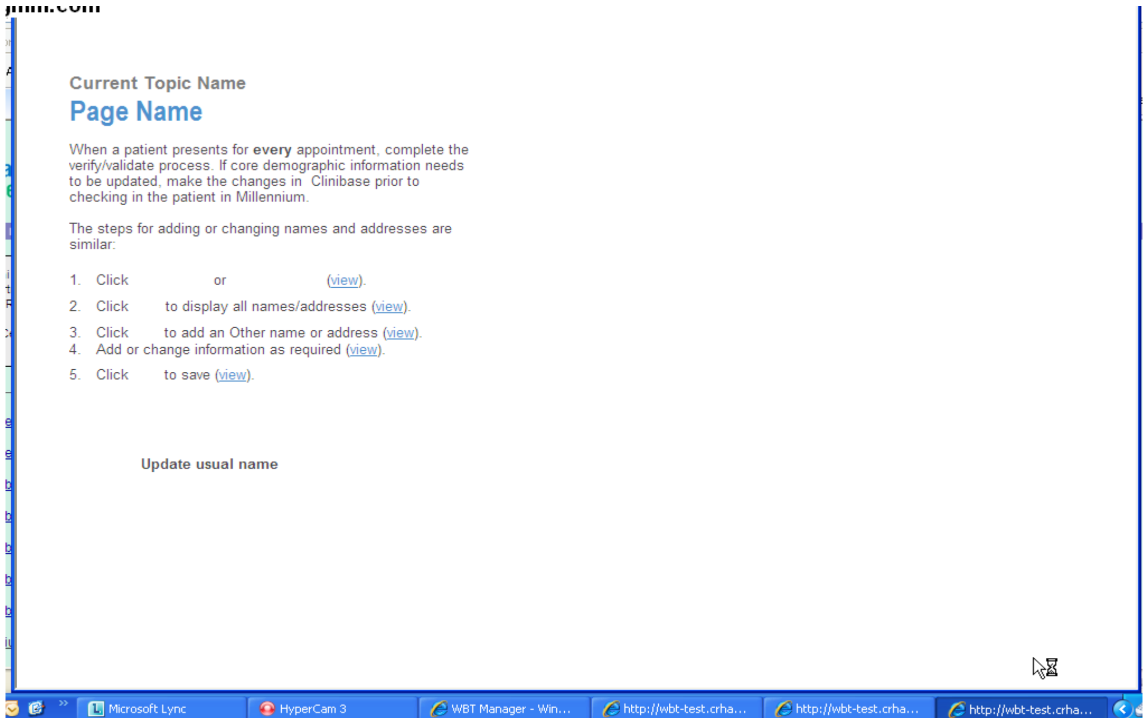
In conclusion, many problems identified from the comments of the informatics consultant users were related to consistency and adherence to standards. Fixing these problems could lead to significant improvement in general interface usability for consistency and standards.

6.1.5.1.3. Problems Related to Visibility of System Status

As shown in Figure 18, ten percent (10%) of all problems were related to visibility of system status as identified from the comments of the informatics consultant users. Based on the usability heuristic criteria for visibility and system status as shown in Table 28, the general interface usability (GIU) of the e-learning platform did not comply

with this heuristic when the website did not keep the user informed about what was going on through constructive, appropriate and timely feedback and when the system did not respond to user-initiated actions or when there were surprise actions initiated by the site. Problems related to consistency and adherence to standards could have negative impact on both general interface usability and usability satisfaction toward the efficiency of the system for completing the tasks rapidly. Therefore, as shown below in the following examples, these problems might explain and provide objective evidence for the lower rating of usability satisfaction toward efficiency of the system as measured by the SUMI questionnaire. From these perspectives, we identified many problems related to visibility of system status from the comments of the informatics consultant users as presented in the following examples.

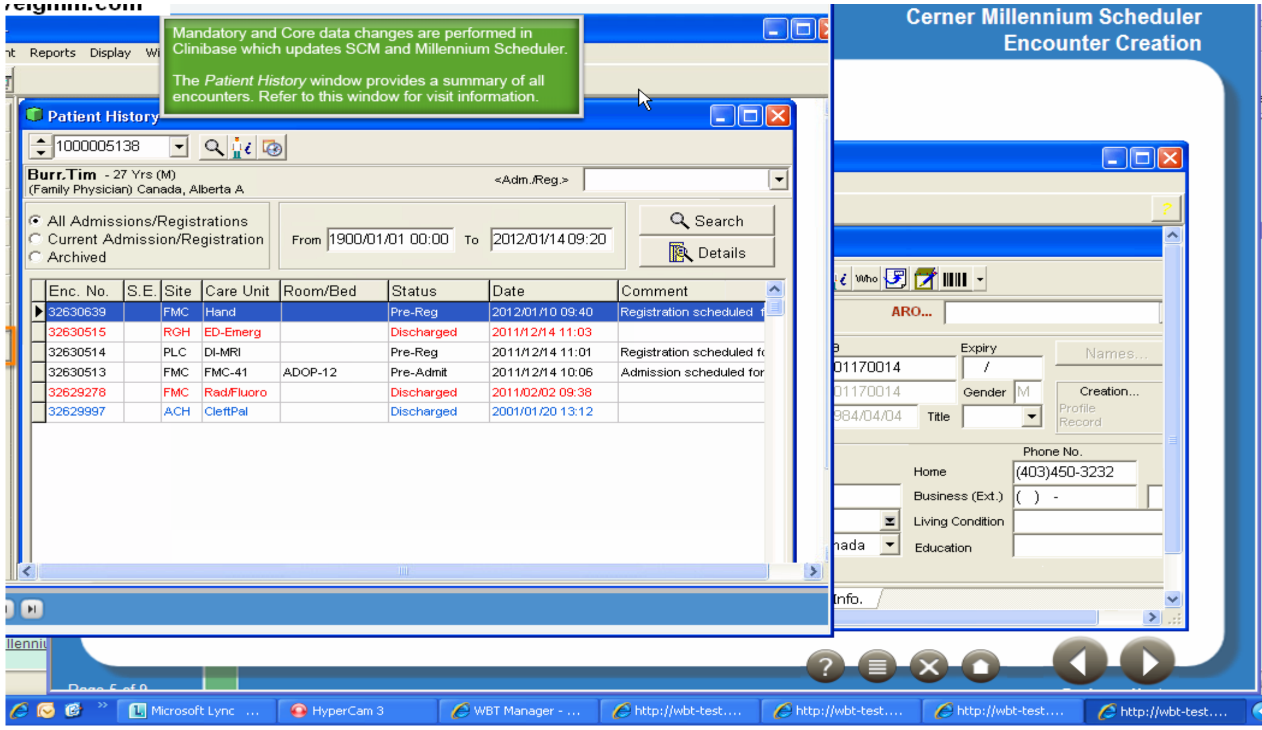
In the first example, the informatics consultant users were distracted by the action of a flash screen error that frequently showed up on the screen while the user was working through the site, as shown in Screenshot 4.18B. The user commented on this problem in this quote: “Oops, as I click forward from print factsheets and labels page and I click ‘Next’ there is an instant flash of a different screen called page name with some information there.” The user was still distracted every time the flash screen error “Page Name” showed up on their computer screens. The user responded to this problem by saying, “That page name screen I think it pops almost every time screen refresher from tab to tab that something in the back but hopefully I caught it.”



Screenshot 4.18B: Error, Page Name

In the following example, the user was confused by whether the e-learning interface was interactive and consistent enough or not. The user kept waiting to review specific information or instructions. This is shown in Screenshot 4.4 and supported by this comment:

> With this view screen, I wasn't sure initially, I wasn't sure whether or not it was interactive or whether I suppose to view it and first I got the changes were too slow then I started reading all the information then at one point it took me a little bit longer to read it and it flipped by itself and then at the end it was a long time before changing and I wasn't sure if I was suppose be exiting out or whether something else was to come.



Screenshot 4.4: Topic 1, Patient History

In conclusion, the researcher presented in this section many usability issues identified from the comments of informatics consultant users as a result of violations of usability heuristic criteria related to recognition rather than recall, consistency and adherence to standards, and visibility of system status. The problems identified in this section were originated as result of many issues. Relative to recognition rather than recall, these problems originated as results of invisible or not easily retrievable objects, options, selections, actions and instructions; users needed to recall information from one part of a dialogue to another; and the displays aren't simple and multiple page displays are not minimized. Relative to consistency and adherence to standards, the site is not presenting the same concepts, words, symbols, situations, and actions in the same way and the platform standards are not consistent. Relative to visibility of system status, the website either failed to keep the user informed through constructive, appropriate and

timely feedback about what was going on, or it failed to respond to actions initiated by the user. Combining cognitive task analysis (CTA) with SUMI was effective in identifying and explaining these usability issues and the lower rating of subjective usability satisfaction toward efficiency and control as measured by the SUMI questionnaire.

6.1.5.2. Problems Related to Educational Websites

As illustrated in Figure 18, two problematic areas with frequency rates of 14% and 12% were identified from the comments of the consultants relative to the educational website, including relevance of site contents to the learner and the learning process and simplicity of site navigation, structure and organization.

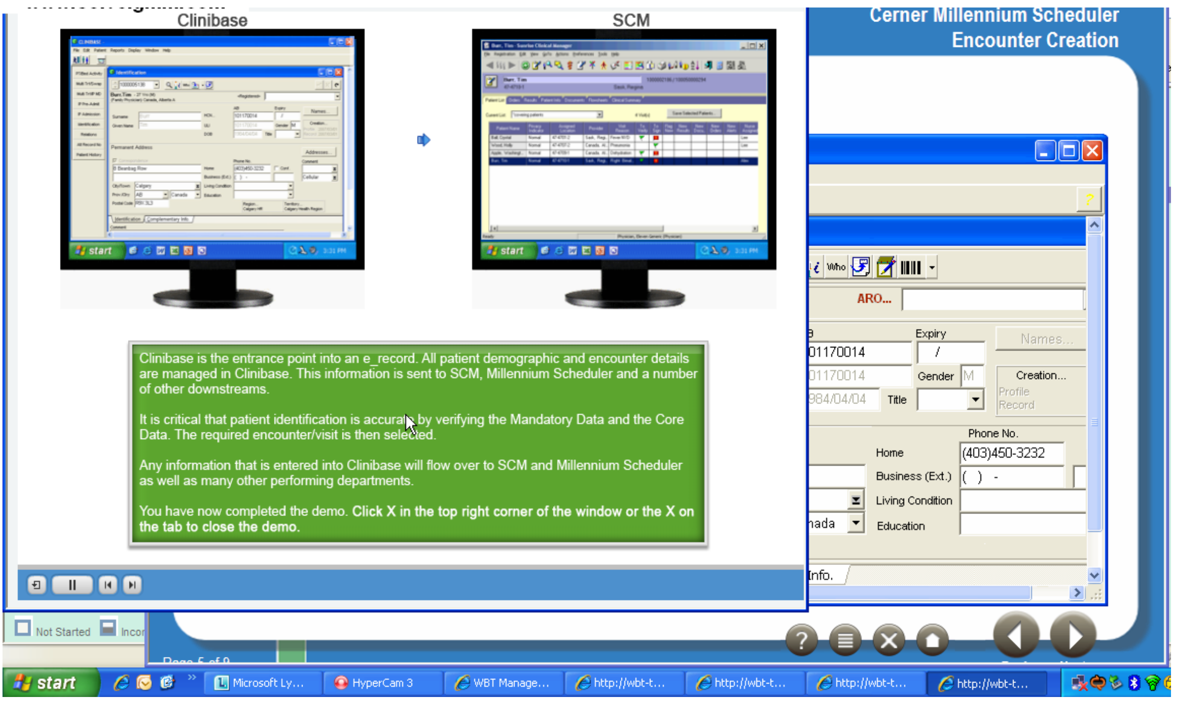
6.1.5.2.1. Simplicity of Site Navigation, Organization and Structure

Based on the concepts of simplicity of site navigation, organization and structure usability heuristic criteria as shown in Table 28, in a high quality site: (1) the site should have a simple navigation structure, (2) uses should know where they are and have options as to where to go next, e.g. via a site map or breadcrumbs, (3) navigational options should be limited so as not to overwhelm the user, (4) related information should be placed together, (5) information should be organized hierarchically, moving from general to specific, (6) common browser standards should be followed, and (7) each page should have all the required navigation buttons and/or hyperlinks (links), such as “Previous,” “Back,” “Next,” and “Home.”

From these perspectives, as illustrated in Figure 18, the informatics consultant users pointed out many problems related to the need for simplicity and better site navigation, organization and structure, as we can see in the following examples.

In the first example, the user found it was difficult to move forward, backward or to pause while watching a video, as shown below in Screenshot 1.2, and supported by this comment:

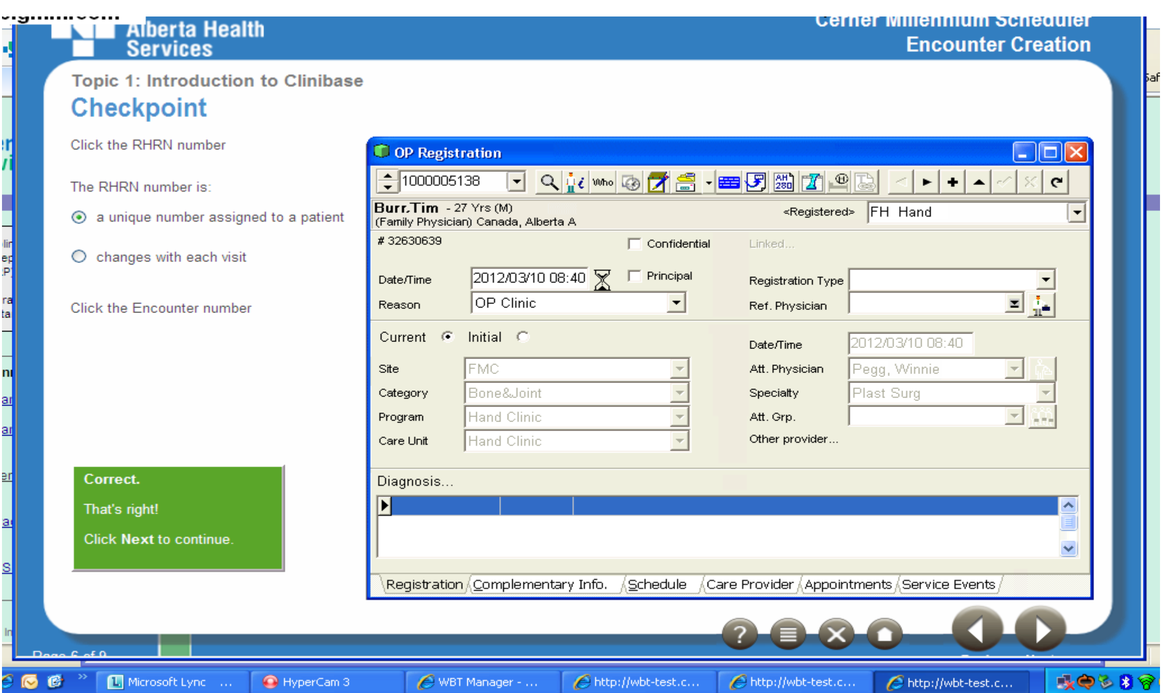
> What we thought when we watching sort of the view video, in this type of these things, will be nice to see along the bottom, like, how fast is moving. So, as a user, you know if you reading very quickly, you wondering, well, I have click something? How long do I have to wait to go on? But, if at the bottom, there is a pause and move forward and go back, but, there sort of a little bar like watching a movie saying okay here is going, so okay, allows you to better judge how much time is going forward.



Screenshot 1.2: Clinibase and Sunrise Care Manager (SCM)

In the following example, the user found it was difficult to navigate to the next page using the “Next” button as instructed. Instead of the “Next” button, the user found two arrows pointing to the left and to the right at the right bottom corner of the screen, as shown in Screenshot 1.3. This is supported by this comment from the informatics consultant:

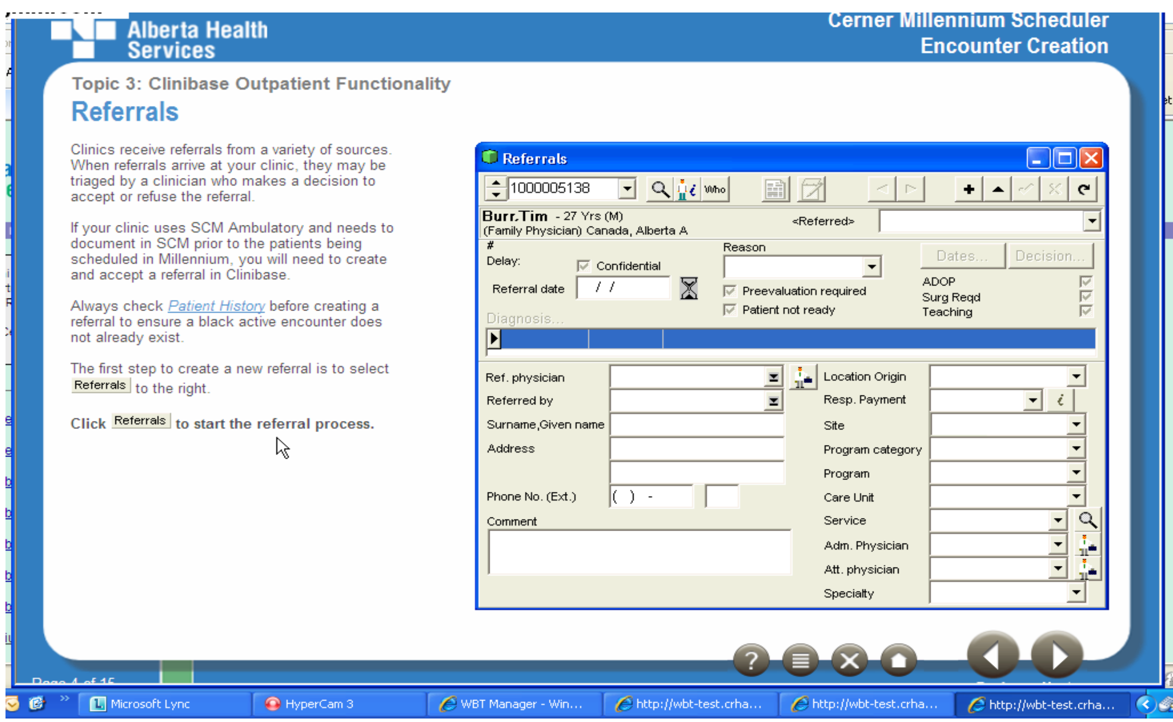
> I think this the way the screen is set up here. It asks me to continue, but, there is no button that says Next, I am assuming the arrow pointing right but it doesn’t fit the screen, I am assuming that Next, but, may stuck some people.



Screenshot 1.3: Topic 1, Checkpoint

In the following example, the expert found it was difficult to navigate forward by clicking the “Referral” shortcut or button, as shown below in Screenshot 4.11. This is supported by this expert comment:

The first step to create a new referral is to select Referrals to the right which I did. Click Referrals to start referral process, I am just not sure that another step that I need to do or whether is just referring to the first step. I am thinking you just repeating the first step, but I am not sure as this page opened and I am finding myself looking for another button that said Referrals although it said step 2 in the process.



Screenshot 4.11: Topic 3, Referrals

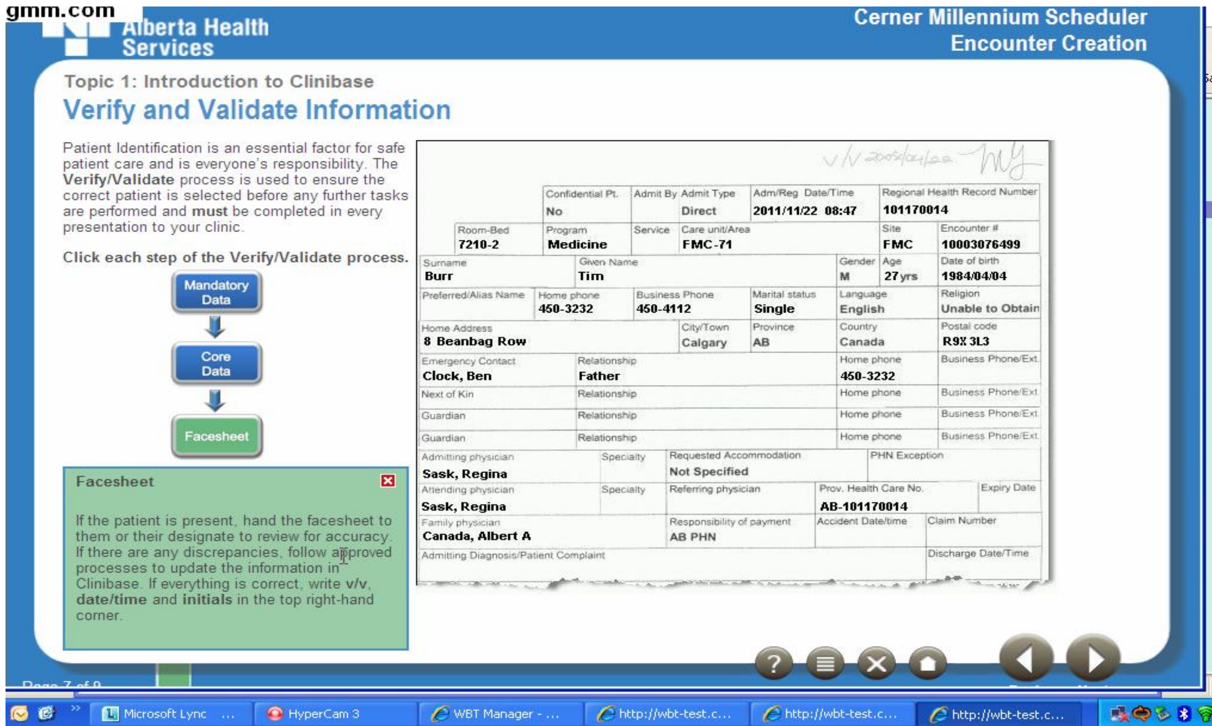
6.1.5.2.2. Relevance of Site Contents to the Learner and the Learning Process

Based on the usability heuristic criteria for relevance of site content to the learner and to the learning process in Table 28, the problems related to this arose if any one of the following conditions were met: (1) the content is not engaging, relevant, appropriate and clear to learners, (2) the material has biases such as racial and gender biases, which

may be deemed offensive, (3) it is not clear which materials are copyrighted and which are not, and (4) the author of the content is not of reputable authority. From these perspectives, many problems as shown in Figure 18 were identified from the comments of informatics consultant users as presented in the following examples.

In the first example, the informatics consultant user suggested some changes to the content of the "Verify and Validate Window" as in following quote, supported by Screenshot 1.4.

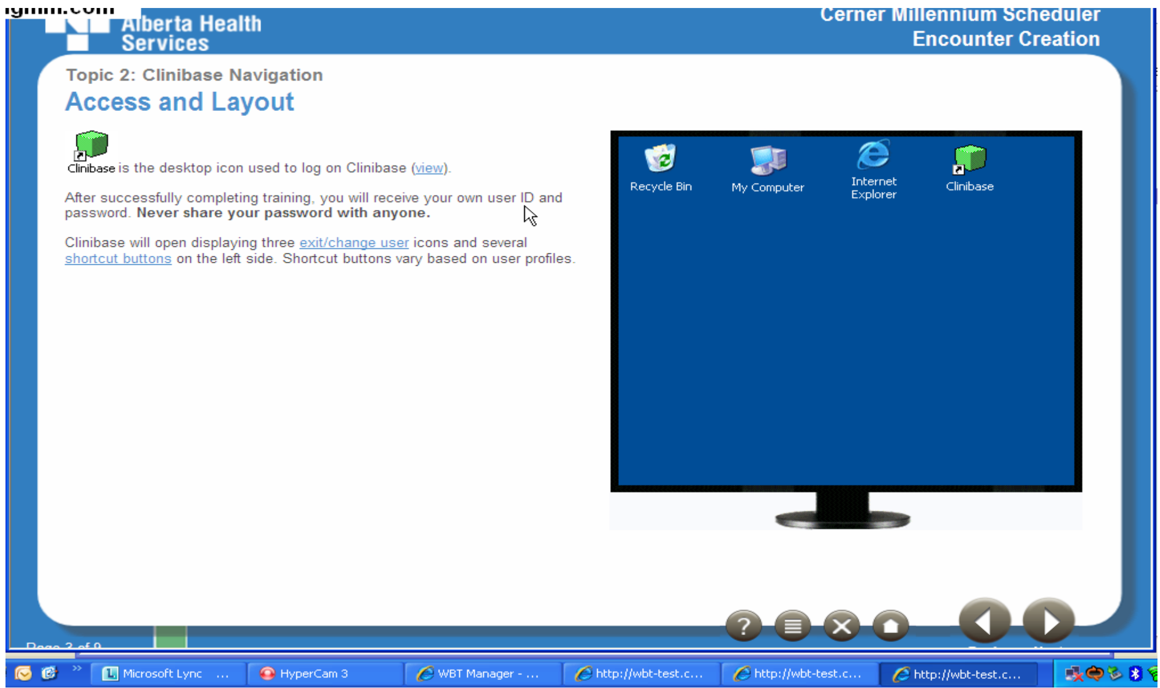
> The only thing I will add to use Verify Validate Window, there quite few places it says followed approved processes' if somebody is new coming in they don't know what those are so may add additional comment of 'will be provided to you once you get your clinic" otherwise they may be looking here where are these processes.



Screenshot 1.4: Topic 1, Verify and Validate Information

In the next example, the user suggested some changes to the content of the window showed below in Screenshot 1.6 to clarify from which the users should receive the user ID and password. This is identified from the user comment in this quote:

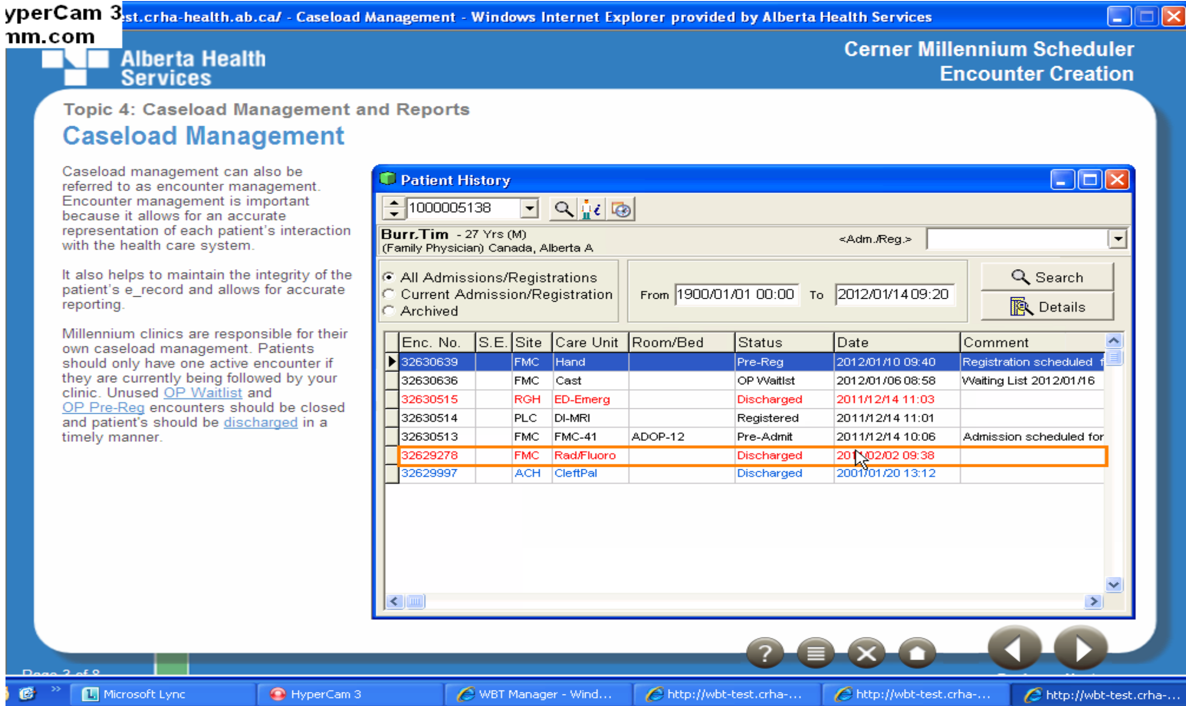
> Getting access is always a concern to users, and here, it said, you will receive your own user ID and password. Honestly, nothing wrong with that, but again, I don't know, if would be a value of adding from managers or by email, so that everyone knows exactly how to get it.



Screenshot 1.6: Topic 2, Access and Layout

In the following example, the users suggested some changes to make the information on the screen as relevant as possible, as shown in Screenshot 3.3 and this user comment:

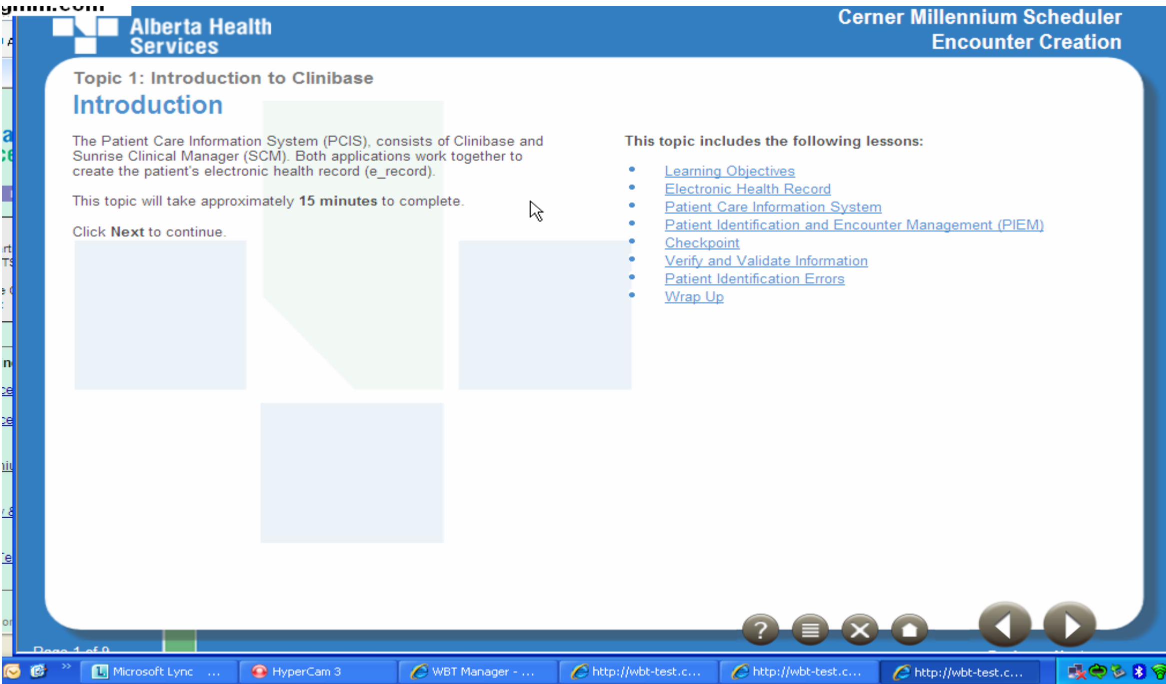
> It says that patient's should be discharged in a timely manner, and it shows the date of discharge in 2011 and we are talking about the pre-registration of this year, so, probable this date be changed to avoid confusion, this date should be 2012.



Screenshot 3.3: Topic 4, Caseload Management, Patient History

In this example, the informatics consultant user suggested some changes to the content in the "Introduction" window to clarify how two integrated systems work together. This is shown in Screenshot 1.1 and supported by the comment of a user in this quote:

> For introduction piece here, I think will be helpful to users when it says 'consists of Clinibase and … etc.,' may be mention that is the one way communication. So that Clinibase beats SCM. You know, because, I think, that one issues we having right now. They understand how they interact. They know the interactivity, but they don't know how. May be by having a little bit information…etc., kind of, to say, the communication goes from Clinibase to SCM.



Screenshot 1.1: Topic 1, Introduction to Clinibase

In conclusion, the CTA, when combined with the SUMI approach, was effective in identifying evidence from the comments of the informatics consultant users pointing to some problems related to e-learning educational website, to simplicity of the system navigation, organization and structure, and to relevance of the content to the user and to the learning process. Fixing these problems could lead to a site that has a simple navigational structure, better organization, and clear and engaging content for the learners who use WBT Manager for e-Learning.

6.2. Significance, Implication for Practice, and Recommendations

6.2.1. Quantitative Core Competency Measurement: User Performance Testing

In this study, the researcher developed an effective evaluation framework in which Low-cost Rapid Usability Engineering (LCRUE) Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE) criteria were adapted and combined with the Software

Usability Measurement Inventory (SUMI) for evaluation of the usability and usefulness of an e-learning module at a large Canadian healthcare organization. Specifically, this framework was used for the evaluation of the usability and usefulness of the MCEC-eLM for a patient clinical information system IT scheduling application. The goal of the MCEC-eLM is to provide employees with core competencies to fulfill the real-world business requirement of obtaining usernames and passwords for a patient clinical information system IT scheduling application to be accessed in a real production environment for managing patient waitlists and scheduling patient appointments.

Trainers are required to pass the MCEC-eLM/CCA with a minimum average score of 80%. By using this framework for evaluation, the researcher proved that the MCEC-eLM was useful in providing trainers with the core competencies and skills required to fulfill the real-business requirement by passing the MCEC-eLM/CCA. All users tested achieved higher-than- expected average performance scores on the MCEC-eLM/CCA. Frontline users passed the MCEC-eLM/CCA with an average score of 87%. Informatics consultant users passed the assessment with an average score of 86.2%. However, the approach was also able to determine, mostly through the usability testing component, usability issues and problems that, if addressed, could lead to better usability. The overall approach the researcher used is cost-effective and rapid in measuring user performance acceptance testing and usability at the same time. Practically, this has major implications for facilitating change and successful implementation of e-learning options in large healthcare organizations at the individual, organizational, and technical levels. Academically, this framework has drawn from concepts from different disciplines, including health informatics, engineering, cognitive science, education, and business

analysis and organization change management for system implementation. We recommend this framework for further application and research both in healthcare organizations and educational institutions for measuring and understanding the core competencies provided by e-learning applications to their users in these settings.

6.2.2. Subjective Usability Measurement Using SUMI Alone

In this thesis the researcher used the SUMI tool to measure subjectively users' perceptions and feelings about the usability of an e-learning module for a patient clinical information system IT scheduling application. We observed some important findings when we used this framework. At first, when the researcher subjectively measured only the usability satisfaction in a group of frontline users using the SUMI questionnaire, the researcher noticed that the users were efficient in completing their questionnaires and that the questionnaires did not indicate that they had been aware of any major problems related to the usability of user interfaces and the website. For example, all frontline users were satisfied, on global scale, with the usability of the MCEC-eLM. In addition, all of the frontline users rated higher than expected on scores for subjective quality subscales – efficiency, affect, learnability, and control. Overall, these results indicated that users did not experience problems related to general interface usability that might impact their satisfaction with these subscales. This result is consistent with evidence and observations from other studies in which the researchers noticed lack of consistency between conventional usability approaches, such as use of questionnaires, and results of usability testing (Kushniruk & Patel, 2004). Therefore, practically and academically, the researcher has found that using SUMI alone is cost-effective and rapid in measuring subjectively the usability of e-learning modules and platforms. However, the researcher

recommends combining it with other usability measurement approaches such as the Low-cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA) and use of heuristics for the evaluation of usability, both subjectively and objectively.

6.2.3. Objective and Subjective Usability Measurement: CTA and Use of HE with SUMI

The researcher adapted the Low-cost Rapid Usability Engineering (LCRUE) for usability testing and Cognitive Task Analysis (CTA) in which Heuristic Evaluation (HE) criteria were used for guiding analysis of video data. We combined these methods of usability testing and inspection with the SUMI questionnaire in the testing of a group of informatics consultant users in this thesis. The conceptualized framework the researcher used was effective in identifying not only evidence about SUMI poorly rated subscales but also for some SUMI subjective sub-scales rated within the norms. In addition, the framework was effective in identifying areas with features of strength as well. We identified from the comments of the informatics consultant users 66 areas that either didn't comply with the usability heuristic criteria for e-learning or had strength features. Of these, 58 were areas with problematic issues and 8 were areas with strength features.

Of all the problematic areas, the researcher identified some objective evidence to explain results from two SUMI poorly rated subscales – efficiency and control. With regard to these, the researcher identified three (3) problematic areas related to general interface usability, including problematic issues related to recognition rather than recall, consistency and adherence to standards, and visibility of system status. In addition, the researcher also identified two (2) problematic areas related to e-learning in educational websites, including problematic issues related to the need for simplicity of site

navigation, organization and structure, and relevance of site content to the learner and the learning process. The researcher noticed that all of these problems had negative impact on both the interface usability and the subjective perceptions and feelings of the informatics consultant users toward the usability of the site, especially toward efficiency and control over the system, as demonstrated by examples in this study. The researcher explored these results by using this conceptualized framework and has encouraged other researchers to validate these results in future studies. The researcher also noticed that using this framework was effective in identifying a large number of problems. This result is also consistent with the results of other studies (Kushniruk & Patel, 2004). For this reason, the researcher has also recommended that researchers use the approach that developed and conceptualized in this study for identifying problematic areas related to general interface usability and educational websites. The researcher also has recommended that healthcare organizations can use it because it is cost effective and rapid in identifying problematic areas related to general interface usability and educational websites, including the content of the modules used in these sites. The researcher also observed that identifying these problems has highlighted more opportunities for improvement (OFI) to the producers, developers, and designers of the e-learning modules and platforms in the organization. Fixing these problems could assist in not only improving general interface usability, educational website and learner-centred instructional design, but also facilitating widespread adoption and implementation at individual, organizational and technical levels.

Moreover, relative to e-learning, the framework was effective in identifying problematic areas related to learner-centred instructional design. From this perspective,

the framework enabled the researcher to identify a number of problems related to level of learner control; cognitive error recognition; diagnosis and recover; and feedback, guidance and assessment.

In addition, the framework enabled the researcher to effectively identify many areas with strength features related to the interface of the educational website and learner-centred instructional design from the comments of informatics consultant users. In conclusion, the researcher strongly believes that combining the Low-cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA), and the use of Heuristic Evaluation criteria with the SUMI method was an effective approach. The combined approach was used for identifying usability objective evidence not only for criteria poorly rated in the SUMI questionnaire but also for criteria the users had not been aware of or possibly not characterized by using SUMI alone. It was used for identifying areas with problematic issues related to general interface usability, educational websites and learner-centred instructional design. In addition, it helped for exploring areas of strength and positive features. Fixing areas with problematic issues could lead to a significant improvement in general interface usability, educational websites and learner-centred instructional design. Eventually, this could lead to wider adoption and successful implementation of e-learning options at individual, organizational and technical levels.

6.2.4. Comparison of Usability Evaluation Methods Used in this Study

Kushniruk and Patel (2004) broadly defined the usability as “the capacity of a system to allow users to carry out their tasks safety, effectively, efficiently, and enjoyably “(p.56). According to Arh and Blazic (2008), the *de facto* definition of usability “is based on the implicit assumption that users are rational agents, interacting with a system by

using their knowledge and deriving information from the system's reactions to achieve their specific goals." (p. 175). From the review of the literature, a consolidated evaluation methodology to evaluating e-learning usability does not yet exist (Costabile et al., 2005). Costabile et al. (2005) asserted that the goal of e-learning is to offer the users the possibility to become skilful and acquire knowledge in a new domain. Based on this description, Costabile argued that the evaluation of educational software must consider its pedagogic effectiveness as well as its usability (p.1) in terms of multiple factors such as ease of learning, ease of use, effectiveness of the system, and user satisfaction (Arh, & Blazic, 2008).

In general, Arh and Blazic (2008), classified usability evaluation methods into inspection methods (conducted without end users) – for identifying usability problems and improving the usability of an interface design by checking it against established standards – and test methods (conducted with users) that provide direct information about how people use our systems and their exact problems with a specific interface (p.176). According to Arh and Blazic, the inspection methods include heuristic evaluation (HE), cognitive walkthroughs, and action analysis. The test methods most commonly include thinking aloud, field observation, and usability testing.

Most of these methods are discussed under either conventional or modern usability evaluation methods that fall under either subjective-based or objective-based evaluation methods (Kushniruk, & Patel, 2004). Kushniruk and Patel discussed the limitations of conventional methods when used alone: "The use of interviews or questionnaires alone may be insufficient for revealing how health care workers actually use a system to perform a complex task and may need to be complemented by using other

methods." (p.58 – 59). For this reason, in this study we adapted the Low-Cost Rapid Usability Engineering (LCRUE) testing method, Cognitive Task Analysis (CTA), and aspects of Heuristic Evaluation (HE) for analysis and combined them with the Software Usability Measurement Inventory (SUMI) questionnaire.

The LCRUE testing approach is a cost-effective and a rapid way of usability testing that originated from usability engineering and involves video recording of the entire user's interaction with the system (Kushniruk, & Borycki, 2006, p. 99). Usability testing refers to the evaluation of information systems involving testing of participants who are representative of the target population as they perform representative tasks using an information technology and generally includes "think aloud" reporting (Kushniruk, & Patel, 2004). The think aloud (THA) method is described as one of the most valuable usability engineering methods and it involves having an end user continuously thinking out loud while using the system (Arh, & Blazic, 2008). In this study, the researcher adapted the LCRUE usability testing method and found it cost-effective, efficient and easy to use overall. The researcher used it for observing a group of informatics consultant users to evaluate the usability of an e-learning module (as used in a WBT Manager for e-Learning). The content of the video-based processing data and computer screenshots were thematically analyzed using a CTA approach in which coding categories were used from a list of heuristics (Kushniruk, Patel, & Cimino, 1997).

The CTA approach is concerned with characterizing the decision-making and reasoning skills of subjects as they perform activities (Kushniruk, & Patel, 2004; Kushniruk, Patel, Cimino, 1997, 219). According to Kushniruk et al. (1997), this method involves developing principled coding schemes and practical approaches to video coding

and it combines aspects of usability inspection methods for performing video analysis (p. 220). Heuristic evaluation (HE) is the most common inspection method. It involves having usability specialists who judge whether each dialogue or other interactive element follows established usability principles (Arh, & Blazic, 2008). It also defined a set of heuristics to evaluate whether a user interface conforms to defined usability principles (Ssemugabi, & De Villiers, 2007). In a recent study based on Nielsen's heuristics, Ssemugabi and De Villiers (2007) established a custom-designed heuristics for web-based learning (p. 137). In the study described in this thesis, the researcher adapted heuristics for a novel use – i.e. for guiding video analysis of usability problems in MCEC-eLM (as used in a WBT Manager for e-Learning) as collected from conducting usability testing. We used these principles and effectively identified 58 areas as usability problematic areas.

Finally, the researcher adapted the above-mentioned usability testing and inspection methods and combined them with a subjective usability satisfaction conventional measurement of evaluation. For this purpose, the researcher adapted the Software Usability Measurement Inventory (SUMI) questionnaire for measuring user satisfaction with the usability subjectively.

Based on the SUMI method, satisfaction can be measured in terms of efficiency, affect, helpfulness, control, and learnability aspects (Kirakowski, & Corbett, 1993; Arh, & Blazic, 2008: Debeve, & Bele, 2004). According to Arh and Blazic (2008), efficiency refers to the user feeling that the software is enabling the task(s) to be performed in a quick, effective and economical manner or, at the opposite extreme that the software is getting in the way of performance. Affect is a psychological term for emotional feeling

that refers to the user feeling mentally stimulated and pleasant or not as a result of interacting with the software. Helpfulness refers to the user's perception that the software communicates in a helpful say and assists in the resolution of operational problems. Control refers to the degree to which the user feels that he/she, and not the product, is setting the pace. And learnability refers to the ease with which a user can get started and learn new features of the product.

In this study, the researcher used the SUMI questionnaire and the results showed that within two groups of users, the frontline users were most satisfied with the usability of the e-learning module (as used in a WBT Manager for e-Learning). The informatics consultant users, overall, were satisfied with the usability of the module. However, they rated the "efficiency" and "control" aspects of the module as used in the WBT Manager lower than the frontline users did.

These findings might be explained by the results obtained from the analysis of the content material collected from the informatics consultant users. The researcher identified areas with problematic issues related to general interface usability, educational site, and learner-centred design. Some of these issues might account for poorer efficiency and control ratings of the e-learning module.

These results indicated that Low-Cost Rapid Usability Engineering (LCRUE), Cognitive Task Analysis (CTA) and use of Heuristic Evaluation (HE) criteria, when combined with the SUMI questionnaire is not only efficient and effective in finding objective evidence about aspects of usability and user satisfaction in an e-learning module (as used in a WBT Manager for e-Learning), but also in identifying areas with strength features and problematic issues related to general interface usability, educational

site, and learner-centred instructional design. Fixing the usability problematic issues could lead to improving the quality of e-learning platforms and increase user satisfaction. Eventually, this could lead to wider adoption and successful implementation of e-learning programs across the entire region.

6.3. Recommendation for Future Research and Limitations

Academically, the researcher developed and conceptualized an evaluative framework based on usability and usefulness concepts that emerged from user-centred evaluation. These concepts were driven from the usability engineering and psychometric reasoning theory for health technology acceptance (HTA) in health informatics. This framework has drawn from both qualitative and quantitative mix methods. The researcher used the Low-cost Rapid Usability Engineering (LCRUE) for usability testing, Cognitive Task Analysis (CTA) and Heuristic Evaluation (HE), combined with the Software Usability Measurement Inventory (SUMI) approach. The conceptual framework was effectively used not only for measuring subjective usability satisfaction but also for finding objective evidence from the comments of the users (and videos of user interactions) in a rapid and inexpensive way using a mobile usability testing laboratory and the SUMI standard questionnaire for benchmarking.

The conceptualized framework that was used for evaluation in this study was found effective in measuring both the usability and the usefulness of the MCEC-eLM (as used in WBT Manager for e-Learning) and identifying both areas with problematic issues and areas with strength features. The researcher has encouraged researchers in health informatics disciplines and in other related fields and studies to validate its usage,

especially in human-interaction-related research. The researcher seeks its usage and application in healthcare quality and patient safety in the future.

Despite its usefulness and strengths, the time spent in analyzing video-based data from multiple users informally limits its generalization and use. We encourage researchers to incorporate efficient and dedicated qualitative data analysis (QDA) software with the Low-cost Rapid Usability Engineering (LCRUE) testing mobile laboratory, Cognitive Task Analysis (CTA), Heuristic Evaluation (HE) and Software Usability Measurement Inventory (SUMI) to overcome this limitation.

6.4. Conclusions

Electronic learning (e-learning) applications have "been widely adopted as a promising solution by many companies to offer learning-on-demand opportunities to individual employees in order to reduce training time and cost" (Wang et al., 2007). Alberta Health Services (AHS) has expanded methods of learning through adoption of an e-learning option for patient clinical information system IT applications. In this study, the researcher conceptualized a cost-effective and rapid evaluation framework to facilitate wider adoption and successful implementation of e-learning.

The researcher conceptualized the framework based on the usability and usefulness concepts that emerged from user-centred evaluation methods aimed at measuring the usability and usefulness of e-learning module for a patient clinical information system IT scheduling application (As used in a WBT Manager for e-Learning Manager) For this aim, the researcher adapted and combined the Low-cost Rapid Usability Engineering (LCRUE) testing method, Cognitive Task Analysis (CTA),

and Heuristic Evaluation (HE) criteria with the Software Usability Measurement Inventory (SUMI) questionnaires. In addition to the usability and usefulness evaluation, the effectiveness of the LCRUE, CTA and HE criteria when combined with the SUMI questionnaire was also investigated in this study. The researcher tested this conceptualized framework in two groups: frontline and informatics consultant users.

The researcher used this framework for evaluating the usability and usefulness of the MCEC-eLM (as used in a WBT Manager for e-Learning) that was used to provide employees with core competencies to fulfill the real-world business requirement of obtaining usernames and passwords for accessing patient clinical information IT scheduling application in a real production environment.

From the analysis, the researcher found this framework was effective for measuring not only user perceptions and feelings toward the usability of MCEC-eLM, but also in finding objective evidence about both areas with problematic issues and areas with strength features that impact the user's perceptions and feelings towards usability. Fixing these problems could lead to significance improvements in general interface usability (GIU), the site, and learner-centred instructional design and content. Eventually this could facilitate widespread adoption and successful implementation of e-learning at individual, organizational and technical levels. For these reasons, the researcher has recommended this approach for practical use in healthcare organizations and in academic research projects.

In conclusion, the SUMI questionnaire was found to be very useful for subjective measurement of the usability and usefulness of the MCEC-eLM. However, using it alone

was insufficient for revealing objective evidences to lower rated usability subjective criteria and may need to be complemented by using other methods such as LCRUE.

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APPENDICES

Appendix A: Certificate of Approval, University of Victoria

University of Victoria

Human Research Ethics Board
Office of Research Services
Administrative Services Building
PO Box 1700 STN CSC
Victoria British Columbia V8W 2Y2 Canada
Tel 250-472-4545, Fax 250-721-8960
Email ethics@uvic.ca Web www.research.uvic.ca

Certificate of Approval

PRINCIPAL INVESTIGATOR	**Tarig Dafalla**	**ETHICS PROTOCOL NUMBER**	**12-147**
UVic STATUS:	**Master's Student**	ORIGINAL APPROVAL DATE:	14-May-12
UVic DEPARTMENT:	**HEIS**	APPROVED ON:	14-May-12
SUPERVISOR:	**Dr. Andre Kushniruk**	APPROVAL EXPIRY DATE:	13-May-13

PROJECT TITLE: **Evaluating the Usability and Usefulness of an E-Learning Module for a Patient Clinical Information System IT Application at a Large Canadian Healthcare Organization: An E-Learning Quality**

RESEARCH TEAM MEMBERS: Joyce Tutty, Research Sponsor (Alberta Health Services)
Bernice Kitchin, Research Coordinator (Alberta Health Services)

DECLARED PROJECT FUNDING: **None**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

12-147

Appendix B: Certificate of Approval, AHS/University of Calgary

FACULTY OF UNIVERSITY OF
MEDICINE CALGARY

OFFICE OF MEDICAL BIOETHICS
Room 93, Heritage Medical Research Bldg
3330 Hospital Drive NW
Calgary, AB, Canada T2N 4N1
Telephone: (403) 220-7990
Fax: (403) 283-8524
Email: omb@ucalgary.ca

2011-11-10

Ms. Joyce Tutty
Cubicle # 1438
Unit 13, # 240 Midpark Way S.E.
Calgary, Alberta
T2X 1N4

Dear Ms. Tutty:

RE: Measuring the Usability, User Acceptance Performance and Satisfaction for a New Scheduler eLearning Module published in an eLearning Management System at a Large Canadian Healthcare Organization: A Quality Improvement Evaluation Study

Ethics ID: E-24213

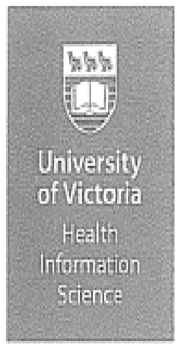
The above-named research, including the Questionnaire (Software Usability Measurement Inventory Questionnaire Sample), Consent Form (version 00.01, October 31, 2011), Script (User Acceptance Testing Assessment Script Example), Protocol , Email (Funding Email, October 15, 2011) has been granted ethical approval by the Conjoint Health Research Ethics Board of the Faculties of Medicine, Nursing and Kinesiology, University of Calgary, and the Affiliated Teaching Institutions. The Board conforms to the Tri-Council Guidelines, ICH Guidelines and amendments to regulations of the Food and Drugs Act re clinical trials, including membership and requirements for a quorum.

You and your co-investigators are not members of the CHREB and did not participate in review or voting on this study.
Please note that this approval is subject to the following conditions:
(1) appropriate procedures for consent for access to identified health information have been approved;
(2) a copy of the informed consent form must have been given to each research subject, if required for this study;
(3) a Progress Report must be submitted by **November 10, 2012**, containing the following information:

- i) the number of subjects recruited;
- ii) a description of any protocol modification;
- iii) any unusual and/or severe complications, adverse events or unanticipated problems involving risks to subjects or others, withdrawal of subjects from the research, or complaints about the research;
- iv) a summary of any recent literature, finding, or other relevant information, especially information about risks associated with the research;
- v) a copy of the current informed consent form;
- vi) the expected date of termination of this project.

4) a Final Report must be submitted at the termination of the project.

Appendix C: Request for Using the SUMI Questionnaire for Research



School of Health Information Science
PO Box 3050 STN CSC
Victoria BC V8W 3P5
Canada

Tel 250-721-8575
Fax 250-472-4751
Email his@uvic.ca
Web http://hinf.uvic.ca

To whom it may concern,

Tarig Dafalla is a graduate student **at the School of Health Information Science, University of Victoria** and I guarantee that his usage of SUMI is solely for research purposes, and forms part of his research leading to **a Master of Science in Health Informatics** (I am his supervisor on his Masters thesis). I guarantee that the student is not working in a consultancy relationship with any commercial interest as far as their use of SUMI is concerned, and that I will help the student to take reasonable steps to protect the intellectual property rights and copyright of SUMI.

Appendix D: Invitation Letter

Dear: Participant

I, Tarig Dafalla, am completing a research project for University of Victoria on the usability and usefulness of independent learning for IT applications.

On ---------, after completing your independent learning course and assessment for Millennium Scheduler/Encounter Creation Management, you are invited to complete 2 short questionnaires; a Demographic and the Software Usability Inventory Measurement (SUMI) questionnaire. Please, be assured that the demographic information is collected for data classification purpose **ONLY**. To clarify that, no data will be stored in Cork University or any location outside Canada.

This research will provide an understanding of the demographics of users of the module, and valuable information to assist AHS implement more effectively customized E-Learning options for patient clinical information system IT applications .

Complete confidentiality and anonymity is guaranteed by me and Andre Kushniruk, a Professor at Health Information Science and NONE of the individual survey responses will be disclosed to anyone at AHS. Aggregate data will be used and disclosed for research purposes **ONLY**. Your feedback will be included **ONLY** to shape and improve the learning options at AHS.

If you require more information you can contact Andre Kushniruk at andrek@uvic.ca or Tarig Dafalla at tdafalla@uvic.ca at University of Victoria.

I, _____________________________, agree to participate in Tarig Dafalla's UAT Research project on the usability of the e-learning scheduler application. I have read the consent form and understand that I can withdraw from the study at any time.

Signature______________________________ Date_________________________

Appendix E: Participant Consent Form

School of Health Information Science
University of Victoria, British
Columbia Participant

Participant Consent Form

Evaluating the Usability and Usefulness of an E-Learning Module for a Patient Clinical Information System IT Scheduling Application at a Large Canadian Healthcare Organization

You are invited to participate in a study entitled [Evaluating the Usability and Usefulness of an E-Learning Module for Patient Clinical Information System IT Scheduling Application at a Large Canadian Healthcare Organization: An E-Learning Quality Management Research] that is being conducted by Andre Kushniruk and Tarig Dafalla Mohamed Dafalla.
Tarig is a graduate student in the department of Health Information Science at the University of Victoria and you may contact him if you have further questions by email at tdafalla@uvic.ca or by phone at (403) 943-6926.
As a graduate student, I am required to conduct research as part of the requirements for a master degree of Science in Health Informatics. It is being conducted under the supervision of Andre Kushniruk. You may contact my supervisor at andrk@uv.ca or by phone at (250) 472 – 5432 if you have further questions.

Purpose and Objectives
The purpose of the study described in this thesis is to evaluate the usability and usefulness of E-Learning module for a patient clinical information system IT scheduling application at Albert Health Services. This evaluation is a part of an E-Learning quality management validation process. The major objectives of this study include:

- The results that will be obtained from the data collected by the Software Usability Measurement Inventory (SUMI) questionnaire will be used to determine the level of user satisfaction with the format and usability of the E-Learning module for a patient clinical information system IT scheduling application. This is an essential final step in the development of the E-Learning module to facilitate acceptance and successful implementation in the organization. Executive managers, project managers and all other stakeholders are interested to know whether an E-Learning option is useful and can enable users to fulfill their jobs effectively and efficiently. In addition, these results will provide feedback and recommendations to the developers and designers of the E-Learning module. E-Learning Web-Based Training Manager (WBT) to ensure that design is of high quality to facilitate acceptance and successful implementation at both technical and organizational (human factors) levels.

- The study results will also feed into a research base process, providing further understanding about how the E-Learning module for patient clinical information IT application facilitates learning and improves learning of the end users in using these applications in their clinical practice. This result can also be used “to reduce unintended usability problems at a point that they will be easy and much less expensive to fix” (Kushniruk & Patel 2004).
- In addition, while providing feedback to the developers and designers of the E-Learning module, the results will be used by the organization to improve future E-Learning projects.
- It is hoped that the results will add to our understanding of how to apply and integrate the usability testing methods into user acceptance testing. This will be an important contribution to this thesis on education and training in health informatics. Combining usability and user acceptance testing would be a part of E-Learning quality management process.
- Finally, recommendations will be incorporated to enhance change acceptance and successful implementation of the E-Learning for patient clinical information system IT applications.

Importance of this Research
Research of this type is important because many healthcare organizations are implementing health information systems and they need to enhance their ability to provide training independently and more cost effectively. This study is part of E-Learning quality management process in which rigorous evaluation methods will be used to not only improve the quality of the E-Learning module but also to facilitate acceptance and successful implementation of the changes at organizational and technical levels.

For the purpose of the evaluation, the standard “Software Usability Measurement Inventory” questionnaire is used for measuring the usability and usefulness of the E-Learning module for patient clinical information system IT scheduling application at Alberta Health Services. Significantly, this evaluation will assist in measuring changes at the organizational and technical levels to facilitate acceptance and successful implementation of an e-Learning system in healthcare organizations.

Participants Selection
The tested subjects will be selected from Alberta Health Services adult employees who are invited to participate in this research.

To fulfill the sample requirement of the usability testing and SUMI methods, a convenience sample of ten to fifteen (10 -15) participants will take part in this study. Only the E-Learning team including the Research Coordinator (Bernice Kitchin), Solution Centre and staff’s mangers will know the names of the participants who will agree to participate in this study and only for the purpose of enrollment. However, your individual identifies and information will be kept confidential in accordance to the AHS’s Confidentiality and Privacy Agreement, as shown in Appendix 5. The Research

Coordinator will be involved in subjects' recruitment and send out the invitation and consent forms to participate.
The researcher will provide a short presentation to the participants prior to the class and provide the consent forms to the potential participants. For consideration, the participants will be asked to voluntarily participate in this research. To sign the consent, the participant must be 18 years or older and fluently speak, read and write English.
All participants must have minimum computer and Web access skills to access and complete independent E-Learning module lessons and knowledge-based assessment as published in the E-Learning Web-Based Training Manager.

What is involved?
On the day of the E-Learning module evaluation, participants will come to FMC ST1012. After finishing the module and the assessment, participants will be asked to sign an invitation and consent forms in the room. After consenting to participate, the participants will complete the following phases:

1. Combined User Acceptance Testing (UAT) and Usability Satisfaction:
   User acceptance testing (UAT) and usability satisfaction are conducted in the same session. You will be asked to log onto WBT, the E-Learning Web-Based Training Manager, using the username and password provided to you in the training room. After logging into the WBT you will be asked to work with the E-Learning module and assessment at the end of the module. The assessment is composed of 20 questions that contain a variety of multiple choice questions and scenario tasks.
   Completing 2 short questionnaires; the User Demographic Questionnaire and the electronic SUMI Questionnaire: After completing the E-Learning module lessons and the core competency assessment at the end of the module, you will be briefed on how to complete the User Demographic and the electronic SUMI questionnaires. Then, you will be provided with your password to complete the SUMI electronic questionnaire. These questionnaires will be completed anonymously. Data gathered in this research study is stored and maintained in accordance to the confidentiality and privacy guidelines and policies for the University of Victoria and Alberta Health Services. To clarify, no data will be stored at Cork University. The SUMI questionnaire will be used as standard method for measuring the usability and user acceptance. The questionnaire is anonymously completed. Aggregate data will be collected and disclosed for research purpose only.

Inconvenience
Participation in this study may cause some inconvenience to you. It will take approximately three to four hours of your time.
Risks
There are no known or anticipated risks to you by participating in this research. The researchers are not evaluating your performance. They are only interested in developing a high quality framework that will help employees and employers accept and successfully implement E-Learning technology in healthcare organization**.** Please, be assured that the

demographic information is collected for data classification purpose ONLY. Please be assured that both of the User Demographic and the electronic SUMI questionnaires will be completed anonymously. None of the individual survey responses will be disclosed to any one at Alberta Health Services. Aggregate data will be used and disclosed for research purposes ONLY. Complete confidentiality and anonymity is guaranteed in accordance to the confidentiality and privacy policies and guidelines in university of Victoria And Alberta Health Services.

Benefits

The potential benefits of your participation in this research include: (1) your participation in this study will help the organization develop more efficient and effective training methodology.

Voluntary Participation

Your participation in this research **must be completely voluntary**. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will be destroyed**.**

On-going Consent

To make sure that you continue to consent to participate in this research, I will confirm your consent for each component**.**

Anonymity

In terms of protecting your anonymity participant names will not be recorded for the questionnaires or the aggregate results.

Confidentiality

Your confidentiality and the confidentiality of your data will be protected by the Researchers (Tarig Dafalla) in accordance to the confidentiality and privacy guidelines and policies in University of Victoria and Alberta Health Services. You are aware that the information you will provide will be kept confidential. Only the E-Learning team including the Research Coordinator (Bernice Kitchin, Solution Centre and staff's managers will have access to your name and only for the purpose of enrolment in the E-Learning independent course. However, your individual identifies and information will be kept confidential in accordance to AHS's Confidentiality and Privacy Agreement.

Dissemination of Results: It is anticipated that the results of this study will be shared with others in the following ways: presentations, conference papers, published article, and thesis/dissertation/class. Only aggregate data will be disclosed.

Disposal of Data

Data from this study will be disposed of. All data will be kept in a secure location that will protect privacy and confidentiality, and the data will be maintained at University of Victoria for 5 years and then destroyed. All reasonable security measures will be taken until the questionnaires are destroyed and deleted

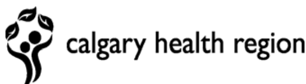
Contacts
Individuals that may be contacted regarding this study include Andre Kushniruk and Tarig Dafalla. Their contact information is mentioned on the invitation letter.
In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Your signature below indicates that you understand the above conditions of participation in this study, that you have had the opportunity to have your questions answered by the researchers, and that you agree to participate in this research project.

I agree to participate in this research by performing the tasks required for completion of user acceptance testing, usability testing and user satisfaction described above in this consent form.

______________________________	______________________________	________________
Name of Participant (Print)	**Signature**	**Date**

Appendix F: AHS, IT Security and Access Requirement



Information Systems User Agreement

Last Name	First Name	Employee Number (if applicable)	Initials

Please indicate:	Role (tick box)	Job Title (e.g. Physician, Analyst, Nurse, etc.)
	☐ Employee ☐ Contractor, Volunteer or Student ☐ Privileged Health Care Provider	

A. The Calgary Health Region ("Region") owns and operates multiple information systems that contain or access individually identifiable health information as well as other applications such as email and web-browsers (collectively the "Region Systems"). The Region is a custodian of health information pursuant to the Alberta Health Information Act ("HIA"), and is responsible for the proper use and disclosure of this health information as well as the proper use of its other applications. This Information Systems User Agreement (the "Agreement") will help the Region and its affiliates meet their responsibilities under the HIA and Region policy.

B. The individual named above ("User") is either:

1. an employee of the Region;
2. a contractor, volunteer or student performing a service for the Region; or
3. a health care provider located and licensed in Alberta (or an authorized employee of the health care provider) to whom the Region has granted privileges to access and use the Region Systems, and who needs access to a Region System in connection with their duties and responsibilities to the Region (or other purpose authorized by the Region's Information & Privacy Office).

C. The Region recognizes and supports patient privacy rights. All Users are expected to treat patient information as confidential in accordance with Region policy, applicable legislation and the User's Confidentiality Agreement with the Region. Access to, and use of, a Region System will be granted in accordance with applicable Region policy.

D. All Users must enter into this Agreement before the Region will grant access to a Region System. This Agreement sets forth the terms and conditions of using any Region System. Users may be required to comply with additional terms and conditions before accessing a specific Region System.

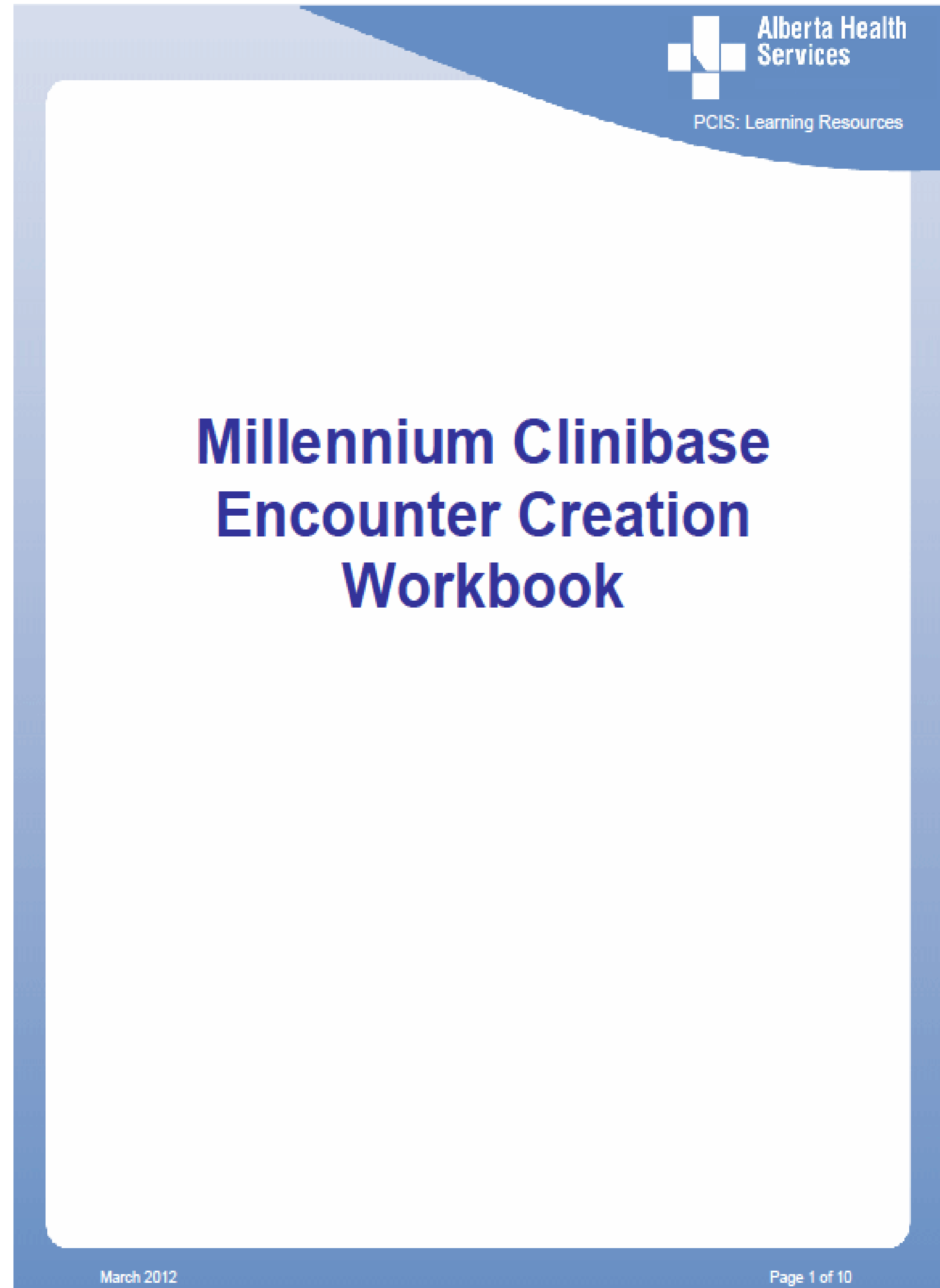
Agreement

I, the undersigned User, agree as follows:

Login Information

1. I will keep any Region System login information in my possession confidential, and will not share this login information with any other person (except as may be expressly authorized in writing by the Region's Information & Privacy Office).
2. I am responsible for any use of any Region System performed under my login information, and will not leave my workstation unattended without logging out of or otherwise securing the Region System.
3. I will not use or attempt to learn another person's login information for any Region System.
4. I understand that the Region may require that I periodically change my password and other login information for a Region System.
5. I will immediately change my password and notify the IT Security Office at itsecurity_breach@calgaryhealthregion.ca if I suspect my login information may be known by another person or if I become aware of any inappropriate or illegal use of a Region System or a breach of confidentiality by any user.

Appendix G: Workbook for MCEC-eLM



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Welcome

This is a blended learning style class. During this class a combination of two methods will be used to help you learn Clinibase functionality:

- A self-paced e-learning module
- Workbook exercises to facilitate practice in the Clinibase training environment

This workbook provides practice exercises and is intended to be used in conjunction with the Millennium Encounter Creation Placemat as a guide. The Facilitator is available throughout the class to answer questions and provide assistance if required.

Objectives

Following this class, students should:

Understand:

- The significance of the role Patient Identification Encounter Management (PIEM) plays in patient safety.
- The importance of verifying mandatory data and validating core data.
- The relationship between Clinibase, Millennium and all the downstreams.
- The RHRN Creation process completed by Admitting to create a new patient in Clinibase and your responsibilities .

Be able to demonstrate the following Clinibase functions:

- Search for a patient record using regional search guidelines
- Modify patient demographics including relations
- Update family physician and transfer attending physician
- Be able to identify a patient's encounter status using Patient History
- Create a referral and accept or decline a referral
- Close an OP Pre-registration
- Discharge a patient encounter

Practice Exercises

- Remember to use the placemat and the practice patients that are included on the Logon sheet to assist you in completing these exercises.
- The facilitator will be available throughout the class to answer questions or provide further explanation if required.

Exercise 1: Patient Search

Tell Me

Correct patient identification is vital in maintaining the integrity of the e-record. Information in Clinibase flows to many downstream systems e.g. Sunrise Clinical Manager (SCM), Finance, Health Records, Diagnostic Imaging (DI), Lab and Pharmacy.

Use to maximize the Clinibase window after logging on; this ensures that you see all tabs and fields while working in the application.

After searching for a patient, all windows relating to that patient must be closed (by clicking on the Identification window) and a new Identification window opened before searching for a new patient. If more than one patient record is open at the same time it can result in errors including accidentally discharging or transferring the wrong patient.

Using **Section 1** on the placemat as a guide:

- Search for **Patient A** using the Regional Health Record Number (RHRN)
- Search for **Patient B** using the regional search guidelines for name search
- Search for **Patient C** using regional search guidelines for Date of Birth (YYYYMMDD)

Exercise 2: Verify and Validate

After searching for the patient's record, it is important to verify that it belongs to the correct patient and to validate that the information is correct.

When the patient arrives at your clinic their information must be verified and validated.

If you discover any of the **mandatory data** is incorrect, do not proceed. Contact Admitting to update this information before activating the registration.

Core data should be corrected when the patient presents, prior to activation of the registration.

Try Me

- On the facesheet handout, provided in class, identify:
  - All 5 mandatory data with an 'M'
  - All core data with a 'C'
  - The preferred (Usual) name with a 'X'
- Mark on the facesheet how you would indicate that you have completed the verify/validate process with the patient.

Hand the completed facesheet to your facilitator for review.

Exercise 3: View Patient History

Tell Me

After searching for the patient record, always check Patient History to determine if the patient has an active encounter for your clinic area. If there is no active encounter, the clinic can proceed with creating a referral.

The Patient History window provides a summary of all past and present encounters. An encounter represents an episode of care.

In the Patient History window the font color indicates the type of encounter:

- Black font: Active Encounter
- Red font: Closed Encounter
- Blue font: Confidential Encounter

Remember to click [Search] to view the history. Click [Detail] to find more information associated with a particular encounter.

Try Me

- You have received a referral for **Patient C.** Check the Patient History to see if the patient has an existing encounter for your clinic.

Exercise 4: Change Patient's Usual Name

When Admitting creates a new patient record in Clinibase the legal and usual names are the same. If a patient prefers to be called by a different first name you can modify their usual name to reflect this and this will be displayed in Clinibase. It is rare that you would ever have to add an "Other" name.

To enter a new usual name click Names... button.

- **Patient C** advises you that, although his health care card shows his legal name, he wishes to be referred to as "**Smurf**". Use **Section 1c** on the placemat as a guide to update the patient's usual name..

Exercise 5: Modify an Address

Tell Me

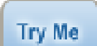
Updating a patient's demographic information is an essential component of the verify/validate process.

Always ensure you modify an address using the Addresses.. button.

Address entries must conform to Canada Post regulations (i.e. proper capitalization and no punctuation).

Never overwrite an address. It is important to maintain a history of all addresses for the patient as these may need to be cross-referenced later.

Using **Section 1d** on the placemat as a guide:



- **Patient A** has arrived for their appointment and informs you they have moved. Their new permanent address is 65 9987 Rodeo Ave SE, Calgary, T0L 2C2. The phone number is 403-555-1147.

Please have your facilitator check this change before proceeding.

- **Patient C** checks in and informs you they have moved. Their new address is 3528 Oaktree Pl NW, Calgary, T3L 2T2. Phone number is 403-555-5012.

Exercise 6: Update Family Physician

If a patient's Family Physician has changed it needs to be updated in Clinibase. This will ensure that results are sent to the correct family physician and promote continuity of care. Always search for the physician using

- Change the Family Physician for Patient C to Dr. Ian Kendal. Use **Section 1e** on the placemat as a guide.

Exercise 7: Modify Emergency Contacts (Relations)

When a patient record is created by Admitting for all patients that are 18 years of age, Admitting enters a Resource Type of FR (Financially Responsible). Admitting is responsible for any changes to this resource type as this relates to PHN billing.

Clinibase only allows for one person to be recorded as Emerg 1 or Emerg 2 resource type.. If the family asks you to record additional emergency contacts use a different resource type such as Emergency 2 or Other so that all can be recorded on the patient record.

Remember, always click the on-screen list prior to entering a new contact to ensure that they are not already listed.

- Patient A would like their brother listed as his new emergency contact. His name is Water Slide, Phone number is 403-555-7456 and cell phone is 403-555-9875. Use **Section 1f** on the placemat as a guide.

Exercise 8: Create a Referral

The triage nurse has received a referral from Dr.Neil Gray for **Patient** B to be seen in your clinic. If tests are required prior to the appointment a referral needs to be created and accepted in Clinibase. When referrals are created it is very important that Program Category and Program are selected correctly. For this exercise use:

Program Category = Surgery
Program = Ophthalmology
Care Unit = Ophthalmology (will autopopulate when Program selected)
Dr. Neil Gray's phone number = 403-255-2467.

This referral will show as a Referred status in the Patient History.

- Create a referral for **Patient** B using **Section 2a** on the placemat as a guide. Check **Patient History** to see the encounter status after the referral has been created..(should show as **Referred**)

Exercise 9: Accept the Referral

The physician has agreed to see the patient and the referral can be accepted.You will need to accept the referral so that an encounter number can be created for the patient and documentation can occur in SCM prior to booking the appointment in Millennium.

- Complete the decision to accept the referral for **Patient** B using **Section 2b** on the placemat as a guide.

Exercise 10: Close a Waitlisted Encounter

After the referral has been accepted and the patient is waiting for a scheduled appointment, the patient calls in to say they he have been able to make an appointment elsewhere and will not need an appointment in your clinic. You must now go to the OP Pre-Reg window and close the waitlisted encounter.

If the patient **does not have a scheduled date and time for an appointment** always close the waitlisted encounter in the OP Pre-Reg window

NOTE: You will only need to close waitlisted encounters if a referral was created AND you had not scheduled an appointment yet.

- Close the waitlisted encounter for Patient B using **Section 3b**on the placemat as a guide.

Exercise 11: Transfer Attending Physician

The Attending Physician is the physician most responsible for the care of the patient in clinic. When asked to change the Attending Physician use the PT/Bed Activity shortcut and select Trf Phys / Grp

Clinics may need to transfer patients from one attending physician to another (i.e. physician retires or will no longer be responsible for the patient's care). After completing the transfer, **print new labels for the chart**.

- Transfer **Patient F**'s Attending Physician to Dr. Jagdish Anand. Use **Section 5** on the placemat as a guide.

Exercise 12: Closing a Pre-registration

An appointment has been booked for **Patient E** and the patient has called to say that he is moving out of the country and no longer needs an appointment. Since the patient will never attend your clinic you will need to manually close the Pre-registration in Clinibase.

Always close a scheduled pre-registration using the middle pane – i.e. **Pre-Registration**

Try Me

- Close the pre-registration for **Patient E** using **Section 3**a on the placemat as a guide.

Exercise 13: Discharge a Patient

Patients need to be discharged in Clinibase when care is complete.

The discharge date/time defaults to current date/time but may be backdated as required. The reason for discharge must always be complete.If the clinic receives notification that the patient is deceased, the discharge reason from your clinic must still reflect treatment complete.

Try Me

- **Patient F** must be discharged from your clinic as their course of treatment is complete. Enter the current date and time. Check the Patient History to view the encounter in red. Use **Section 6** on the placemat as a guide.

Final Scenario

Patient D has arrived for their appointment. You have pulled the facesheet from the chart and asked the patient to verify that all the information is correct. The patient informs you that they moved three months ago and you need to update this information in Clinibase before checking the patient into Millennium.

Change the address to:
10 Apple Tree Rd NW
Calgary Alberta
T7G 9L7
403-566-0000

Change their Family Physician to Dr. Margot Patterson. They also want a new Emergency 1 contact added to Penny Wise (friend) 403-555-2222. They have confirmed that the previous Emerg 1 contact must be removed from the record. Please **change their Emergency 1 information.**

HAVE YOUR FACILITATOR CHECK ALL EXERCISES.

Appendix H: Placemats for the MCEC-eLM

Clinibase

April 2012

MILLENNIUM ENCOUNTER CREATION
STOP! CHECK! CORRECT! SAVE!

BEFORE PERFORMING ANY TASK IN CLINIBASE, ALWAYS REMEMBER TO:

- VERIFY & VALIDATE PATIENT INFO.
- CHECK PATIENT HISTORY
- ENSURE YOU ARE ON THE CORRECT PATIENT ENCOUNTER
- ENSURE YOU HAVE ONLY ONE PATIENT RECORD OPEN

1. Patient Identification

1a. Patient Search:

Regional Search guidelines in priority order for searching:

- Click Identification
- Click
- **Search by:**

  1. 1st 3 letters of the last name (Bro) and 1st 2 letters of the first name (Mi) **only**
  2. Date of Birth (YYYYMMDD)
  3. Telephone Number
  4. Health Care Number (PHN

1b. Verify & Validate:

- Once the mandatory and core data has been verified and validated, if there are NO changes to the data
- Click
- Click to save

1c. Modify Names:

- Click Names...
- Click to display all names
- Click to modify an existing **'Usual'** or **'Other'** name
- Click to save

1d. Addresses:

- Click Addresses...
- Click to display all addresses. Note: Never delete or overwrite a pre-existing address. Previous addresses should be maintained in the system for reference purposes.

Add a new address:

- Click
- Enter the street address, **City/Town**, **Postal code** and **Home Tel No.**
- Select the **correct button** to indicate the type of address being added

- If the address is a new permanent address check the **Correspondence** and **Usual** check boxes

  Correspondence Usual

- Click to save

Modify an existing address:

- Click
- Modify information as required
- Click to save

1e. Family Physician:

- Click Complementary Info.

- Select **Status** In The List
- Click
- Type the 1st **four letters of the physician's last name**
- Click
- Select the physician
- Click OK

OR

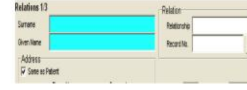
- Select **Status** Not In List if patient has a family physician, but is not in the list
- Type the physician's last name, first name in the **Name or Clinic** field

OR

- Select **Status** No Family Physician if patient has no family physician
- Click to select the walk-in clinic, or type in the clinic name if not in the list

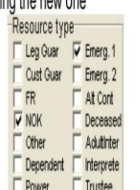
1f. Relations:

- Click Relations
- Click to display all contacts
- Click or to view previous or next record
- Click to add a Relation / Emergency contact
- Type in **Surname**, **Given name**.
- Select Relationship from the **Relationship** dropdown list
- **At minimum**, type in a telephone number for the contact person



Services

- Select a **Resource Type. Note:** Only one **Emerg. 1** contact may be saved for the patient. If an **Emerg. 1** contact changes, deselect the original **Emerg. 1** before adding the new one



- Click to save

2. Referral

Always check **Patient History** prior to creating an encounter to ensure one doesn't already exist for your clinic.

2a. Create a Referral:

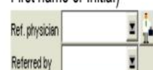
- Click Referrals
- Click
- Enter **Referral date**

  Referral date 0000/00/00

- Select **OP Clinic** from the **Reason** dropdown list

  Reason OP Clinic

- **Ref. Physician:** Click , search for and select the appropriate physician; OR, type the name of the person referring the patient directly in to the field (Last name, First name or Initial)



- **Referred by:** Click , select the referral source from the dropdown list
- **Phone No. (Ext):** Referral source's phone number if known
- **Site:** Should default to your site

Appendix I: User Demographic Questionnaire

No:……………..(for research use)

This modified questionnaire is adapted from Tsakonas and Papatheodorou (2011). It aims to give us an outline of your preferences. Please answer the questions by completing with sincerity your characteristics and your preferences.

1. Age
   a. Under 25
   b. 25– 35
   c. 35 – 45
   d. Over 45
2. Professional Status: (E.g. RN, Clerk). ………………………………………
3. Professional Location:……………………………………….
4. Gender
   a. Male
   b. Female
5. Internet and Computer Use
   a. Rarely (Less than once in a month)
   b. Sparingly (Less than once in 15 days)
   c. Regularly (Once in a week)
   d. Frequently (Daily)
6. Aim: What is the reason for completing this module (E-Learning)
   a. Research
   b. Education
   c. Other (Please Complete). …………………………………………..

Appendix J: Instructions for Completing the Electronic SUMI Questionnaire

Evaluating the Usability and Usefulness of an E-Learning Module for Patient Clinical Information System IT Application at a Large Canadian Healthcare Organization: An E-Learning Quality Management Research

Information for completing the Demographic and the Electronic SUMI questionnaires:

- When completing the **SUMI questionnaire** there is frequent reference to **"Software".** For the purpose of this study," software" refers to "Millennium Clinibase Encounter Creation" E-Learning Module as published in E-Learning application – the E-learning Web-Based Training (WBT) Manager

- To log into the electronic SUMI questionnaire
  - Type http://sumi.ucc.ie/en/ in the Internet address bar and click ENTER. The SUMI questionnaire will appear.
  - You MUST enter the Password **------------** (case in not sensitive) into the Password box.
  - Then, proceed to answer all the questions.
  - When you're finished, click the "SEND" button to submit your questionnaire.
  - Hand in your Demographic questionnaire to Tarig Dafalla or Bernice Kitchin

Thank for your participation and have a nice day

Appendix K: SUMI Questionnaire

Software Usability Measurement Inventory

SUMI

NB The information you provide is kept completely confidential, and no information is stored on computer media that could identify you as a person.

This questionnaire has 50 statements. Please answer them all. After each statement there are three boxes.

- Check the first box if you generally AGREE with the statement.
- Check the middle box if you are UNDECIDED, or if the statement has no relevance to your software or to your situation.
- Check the right box if you generally DISAGREE with the statement.

In checking the left or right box you are not necessarily indicating strong agreement or disagreement but just your general feeling most of the time.

There are also five general questions at the end.

Password:

Statements 1 - 10 of 50.	**Agree**	**Undecided**	**Disagree**
This software responds too slowly to inputs.	○	○	○
I would recommend this software to my colleagues.	○	○	○
The instructions and prompts are helpful.	○	○	○
This software has at some time stopped unexpectedly.	○	○	○
Learning to operate this software initially is full of problems.	○	○	○
I sometimes don't know what to do next with this software.	○	○	○
I enjoy the time I spend using this software.	○	○	○
I find that the help information given by this software is not very useful.	○	○	○
If this software stops it is not easy to restart it.	○	○	○
It takes too long to learn the software functions.	○	○	○

Statements 11 - 20 of 50.	**Agree**	**Undecided**	**Disagree**
I sometimes wonder if I am using the right function.	○	○	○
Working with this software is satisfying.	○	○	○
The way that system information is presented is clear and understandable.	○	○	○
I feel safer if I use only a few familiar functions.	○	○	○
The software documentation is very informative.	○	○	○
This software seems to disrupt the way I normally like to arrange my work.	○	○	○
Working with this software is mentally stimulating.	○	○	○
There is never enough information on the screen when it's needed.	○	○	○
I feel in command of this software when I am using it.	○	○	○
I prefer to stick to the functions that I know best.	○	○	○

Statements 21 - 30 of 50.	**Agree**	**Undecided**	**Disagree**
I think this software is inconsistent.	○	○	○
I would not like to use this software every day.	○	○	○
I can understand and act on the information provided by this software.	○	○	○
This software is awkward when I want to do something which is not standard.	○	○	○
There is too much to read before you can use the software.	○	○	○
Tasks can be performed in a straight forward manner using this software.	○	○	○
Using this software is frustrating.	○	○	○
The software has helped me overcome any problems I have had in using it.	○	○	○

The speed of this software is fast enough.	○	○	○
I keep having to go back to look at the guides.	○	○	○

Statements 31 - 40 of 50.	**Agree**	**Undecided**	**Disagree**
It is obvious that user needs have been fully taken into consideration.	○	○	○
There have been times in using this software when I have felt quite tense.	○	○	○
The organisation of the menus seems quite logical.	○	○	○
The software allows the user to be economic of keystrokes.	○	○	○
Learning how to use new functions is difficult.	○	○	○
There are too many steps required to get something to work.	○	○	○
I think this software has sometimes given me a headache.	○	○	○
Error messages are not adequate.	○	○	○
It is easy to make the software do exactly what you want.	○	○	○
I will never learn to use all that is offered in this software.	○	○	○

Statements 41 - 50 of 50.	**Agree**	**Undecided**	**Disagree**
The software hasn't always done what I was expecting.	○	○	○
The software presents itself in a very attractive way.	○	○	○
Either the amount or quality of the help information varies across the system.	○	○	○
It is relatively easy to move from one part of a task to another.	○	○	○
It is easy to forget how to do things with this software.	○	○	○
This software occasionally behaves in a way which can't be understood.	○	○	○
This software is really very awkward.	○	○	○
It is easy to see at a glance what the options are at each stage.	○	○	○

Getting data files in and out of the system is not easy.

I have to look for assistance most times when I use this software.

What, in general, do you use this software for?

How important for you is the kind of software you have just been rating?

- Extremely important
- Important
- Not very important
- Not important at all

How would you rate your software skills and knowledge?

- Very experienced and technical
- I'm good but not very technical
- I can cope with most software
- I find most software difficult to use

What do you think is the best aspect of this software, and why?

What do you think needs most improvement, and why?

When you've answered all the questions, please click the 'Send' button.

Send

SUMI EN 4.0 Copyright © 2011 Jurek Kirakowski

Appendix L: SUMI Items Consensual Analysis for Frontline Users

Item 1	This software responds too slowly to inputs.			
	Agree	Undecided	Disagree	
Observed	3	2	9	
Expected	2.7	2.0	9.3	
Chi Square	0.03	0.00	0.01	0.04

Item 2	I would recommend this software to my colleagues.			
	Agree	Undecided	Disagree	
Observed	11	2	1	
Expected	8.8	3.5	1.8	
Chi Square	0.56	0.62	0.33	1.50

Item 3	The instructions and prompts are helpful.			
	Agree	Undecided	Disagree	
Observed	11	1	2	
Expected	8.7	3.1	2.2	
Chi Square	0.63	1.46	0.02	2.11

Item 4	The software stops unexpectedly sometimes.			
	Agree	Undecided	Disagree	
Observed	3	5	6	
Expected	6.8	1.3	5.9	
Chi Square	2.13	10.07	0.00	12.20

Item 5	Learning to operate this software is full of problems initially.			
	Agree	Undecided	Disagree	
Observed	0	4	10	
Expected	2.9	2.4	8.7	
Chi Square	2.91	1.12	0.19	4.23

Item 6	I sometimes don't know what to do next with this software.			
	Agree	Undecided	Disagree	
Observed	1	3	10	
Expected	4.2	2.3	7.4	
Chi Square	2.48	0.20	0.88	3.57

Item 7	I enjoy my sessions with this software.			
	Agree	Undecided	Disagree	
Observed	9	4	1	
Expected	8.0	4.3	1.8	
Chi Square	0.14	0.02	0.34	0.49

Item 8	The help information given by this software is not very useful.			
	Agree	Undecided	Disagree	
Observed	2	2	10	
Expected	2.9	4.7	6.4	
Chi Square	0.27	1.53	1.97	3.77

Item 9	If this software stops it is not easy to restart it.			
	Agree	Undecided	Disagree	
Observed	1	6	7	
Expected	2.3	5.1	6.6	
Chi Square	0.76	0.18	0.02	0.96

Item 10	It takes too long to learn how to work with this software.			
	Agree	Undecided	Disagree	
Observed	0	4	10	
Expected	1.4	2.2	10.3	
Chi Square	1.44	1.37	0.01	2.82

Item 11	I sometimes wonder if I'm using the right command.			
	Agree	Undecided	Disagree	
Observed	2	4	8	
Expected	5.0	2.1	7.0	
Chi Square	1.78	1.84	0.15	3.76

Item 12	Working with this software is satisfying.			
	Agree	Undecided	Disagree	
Observed	7	5	2	
Expected	7.6	4.5	1.8	
Chi Square	0.05	0.04	0.01	0.11

Item 13	The way that information is presented is clear and understandable.			
	Agree	Undecided	Disagree	
Observed	9	3	2	
Expected	8.8	3.3	1.9	
Chi Square	0.01	0.03	0.00	0.03

Item 14	I feel safer if I use only a few familiar commands or operations.			
	Agree	Undecided	Disagree	
Observed	6	5	3	
Expected	5.6	2.4	6.0	
Chi Square	0.03	2.97	1.54	4.53

Item 15	The software documentation is very informative.			
	Agree	Undecided	Disagree	
Observed	11	3	0	
Expected	4.9	7.0	2.1	
Chi Square	7.47	2.27	2.08	11.83

Item 16	This software seems to disrupt the way I normally like to arrange my work.			
	Agree	Undecided	Disagree	
Observed	1	6	7	
Expected	1.2	3.1	9.6	
Chi Square	0.05	2.59	0.71	3.35

Item 17	Working with this software is mentally stimulating.			
	Agree	Undecided	Disagree	
Observed	6	6	2	
Expected	5.4	5.0	3.6	
Chi Square	0.06	0.21	0.69	0.95

Item 18	There is never enough information on the screen when it's needed.			
	Agree	Undecided	Disagree	
Observed	0	5	9	
Expected	2.3	3.0	8.6	
Chi Square	2.34	1.27	0.02	3.63

Item 19	I feel in command of this software when I am using it.			
	Agree	Undecided	Disagree	
Observed	10	4	0	
Expected	8.2	3.7	2.1	
Chi Square	0.40	0.02	2.11	2.54

Item 20	I prefer to stick to the operations I know best.			
	Agree	Undecided	Disagree	
Observed	8	2	4	
Expected	6.1	2.6	5.3	
Chi Square	0.62	0.15	0.32	1.09

Item 21	I think this software is inconsistent.			
	Agree	Undecided	Disagree	
Observed	0	3	11	
Expected	1.8	3.6	8.6	
Chi Square	1.81	0.09	0.66	2.56

Item 22	I would not like to use this software every day.			
	Agree	Undecided	Disagree	
Observed	1	3	10	
Expected	3.1	2.3	8.6	
Chi Square	1.38	0.20	0.22	1.80

Item 23	I can understand and act on the information provided by this software.			
	Agree	Undecided	Disagree	
Observed	11	2	1	
Expected	10.2	2.7	1.1	
Chi Square	0.07	0.18	0.02	0.26

Item 24	This software is awkward when I want to do something which is not standard.			
	Agree	Undecided	Disagree	
Observed	0	5	9	
Expected	4.2	5.7	4.2	
Chi Square	4.17	0.08	5.60	9.85

Item 25	There is too much to read before you can use the software.			
	Agree	Undecided	Disagree	
Observed	0	3	11	
Expected	2.3	3.0	8.7	
Chi Square	2.27	0.00	0.59	2.86

Item 26	Doing what you want to do with this software is straightforward.			
	Agree	Undecided	Disagree	
Observed	10	2	2	
Expected	9.8	2.4	1.8	
Chi Square	0.01	0.07	0.02	0.09

Item 27	Using this software is frustrating.			
	Agree	Undecided	Disagree	
Observed	1	3	10	
Expected	2.4	3.0	8.6	
Chi Square	0.85	0.00	0.24	1.09

Item 28	The software has helped me overcome any problems I have had in using it.			
	Agree	Undecided	Disagree	
Observed	10	4	0	
Expected	4.0	7.1	2.9	
Chi Square	9.05	1.35	2.91	13.32

Item 29	The speed of this software is fast enough.			
	Agree	Undecided	Disagree	
Observed	12	1	1	
Expected	7.9	2.3	3.8	
Chi Square	2.08	0.73	2.04	4.84

Item 30	I keep having to go back to look at the guides.			
	Agree	Undecided	Disagree	
Observed	3	4	7	
Expected	2.8	3.0	8.2	
Chi Square	0.02	0.31	0.18	0.50

Item 31	It is obvious that user needs have been fully taken into consideration.			
	Agree	Undecided	Disagree	
Observed	7	5	2	
Expected	5.6	5.1	3.3	
Chi Square	0.37	0.00	0.50	0.87

Item 32	There have been times in using this software when I have felt quite tense.			
	Agree	Undecided	Disagree	
Observed	3	3	8	
Expected	5.0	2.2	6.8	
Chi Square	0.82	0.31	0.21	1.34

Item 33	The organisation of the menus and lists seems fairly logical.			
	Agree	Undecided	Disagree	
Observed	10	1	3	
Expected	10.4	2.1	1.6	
Chi Square	0.01	0.54	1.31	1.87

Item 34	You don't have to do a lot of input to make this software work.			
	Agree	Undecided	Disagree	
Observed	10	3	1	
Expected	8.9	3.2	1.9	
Chi Square	0.13	0.02	0.40	0.55

Item 35	It is hard to learn to use new functions.			
	Agree	Undecided	Disagree	
Observed	3	3	8	
Expected	1.9	3.4	8.7	
Chi Square	0.63	0.04	0.06	0.73

Item 36	There are too many steps required to get something to work.			
	Agree	Undecided	Disagree	
Observed	3	3	8	
Expected	2.9	2.7	8.5	
Chi Square	0.01	0.04	0.02	0.07

Item 37	Sometimes this software gives me a headache.			
	Agree	Undecided	Disagree	
Observed	2	2	10	
Expected	3.3	2.9	7.8	
Chi Square	0.49	0.29	0.61	1.39

Item 38	Error prevention messages are inadequate.			
	Agree	Undecided	Disagree	
Observed	2	3	9	
Expected	3.4	5.7	4.8	
Chi Square	0.60	1.30	3.59	5.49

Item 39	It is easy to make the software do exactly what you want.			
	Agree	Undecided	Disagree	
Observed	6	2	6	
Expected	5.7	4.9	3.3	
Chi Square	0.01	1.75	2.19	3.95

Item 40	I will never learn to use all the functions in this software.			
	Agree	Undecided	Disagree	
Observed	1	5	8	
Expected	4.2	3.6	6.1	
Chi Square	2.45	0.50	0.56	3.51

Item 41	The software hasn't always done what I was expecting it to do.			
	Agree	Undecided	Disagree	
Observed	5	3	6	
Expected	6.6	2.9	4.5	
Chi Square	0.40	0.00	0.50	0.90

Item 42	The software has a very attractive presentation.			
	Agree	Undecided	Disagree	
Observed	11	2	1	
Expected	8.1	3.8	2.1	
Chi Square	1.02	0.85	0.56	2.44

Item 43	The amount or quality of the help information varies across the system.			
	Agree	Undecided	Disagree	
Observed	7	4	3	
Expected	4.3	7.1	2.5	
Chi Square	1.62	1.37	0.09	3.08

Item 44	It is relatively easy to move from one part of a task to another.			
	Agree	Undecided	Disagree	
Observed	11	3	0	
Expected	10.0	2.1	1.9	
Chi Square	0.10	0.36	1.88	2.34

Item 45	It is easy to forget how to do things with this software.			
	Agree	Undecided	Disagree	
Observed	6	2	6	
Expected	3.6	2.5	8.0	
Chi Square	1.68	0.09	0.49	2.26

Item 46	Sometimes this software behaves in a way which I don't understand.			
	Agree	Undecided	Disagree	
Observed	2	4	8	
Expected	4.6	3.3	6.1	
Chi Square	1.49	0.14	0.62	2.26

Item 47	This software is very awkward to use.			
	Agree	Undecided	Disagree	
Observed	0	4	10	
Expected	0.9	2.5	10.6	
Chi Square	0.90	0.85	0.03	1.78

Item 48	You can see at a glance what the options are at each stage.			
	Agree	Undecided	Disagree	
Observed	8	3	3	
Expected	8.2	3.1	2.8	
Chi Square	0.00	0.00	0.02	0.03

Item 49	Getting data files in and out of the system is not easy.			
	Agree	Undecided	Disagree	
Observed	1	4	9	
Expected	2.0	5.3	6.8	
Chi Square	0.48	0.30	0.74	1.52

Item 50	I have to seek assistance when I use this software.			
	Agree	Undecided	Disagree	
Observed	1	3	10	
Expected	1.7	**1.9**	10.4	
Chi Square	0.26	0.59	0.02	0.87

Appendix M: SUMI Items Consensual Analysis for Informatics Consultants

Item 1	This software responds too slowly to inputs.			
	Agree	Undecided	Disagree	
Observed	3	0	2	
Expected	1.0	0.7	3.3	
Chi Square	4.31	0.73	0.52	5.55

Item 2	I would recommend this software to my colleagues.			
	Agree	Undecided	Disagree	
Observed	4	0	1	
Expected	3.1	1.2	0.6	
Chi Square	0.24	1.24	0.22	1.69

Item 3	The instructions and prompts are helpful.			
	Agree	Undecided	Disagree	
Observed	3	1	1	
Expected	3.1	1.1	0.8	
Chi Square	0.00	0.01	0.06	0.08

Item 4	The software stops unexpectedly sometimes.			
	Agree	Undecided	Disagree	
Observed	0	0	5	
Expected	2.4	0.5	2.1	
Chi Square	2.43	0.48	4.04	6.95

Item 5	Learning to operate this software is full of problems initially.			
	Agree	Undecided	Disagree	
Observed	0	0	5	
Expected	1.0	0.8	3.1	
Chi Square	1.04	0.85	1.14	3.03

Item 6	I sometimes don't know what to do next with this software.			
	Agree	Undecided	Disagree	
Observed	3	2	0	
Expected	1.5	0.8	2.7	
Chi Square	1.45	1.66	2.66	5.77

Item 7	I enjoy my sessions with this software.			
	Agree	Undecided	Disagree	
Observed	2	3	0	
Expected	2.8	1.5	0.6	
Chi Square	0.25	1.42	0.63	2.30

Item 8	The help information given by this software is not very useful.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	1.0	1.7	2.3	
Chi Square	1.03	0.27	1.26	2.55

Item 9	If this software stops it is not easy to restart it.			
	Agree	Undecided	Disagree	
Observed	0	2	3	
Expected	0.8	1.8	2.4	
Chi Square	0.83	0.02	0.17	1.02

Item 10	It takes too long to learn how to work with this software.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	0.5	0.8	3.7	
Chi Square	0.52	0.05	0.03	0.59

Item 11	I sometimes wonder if I'm using the right command.			
	Agree	Undecided	Disagree	
Observed	4	0	1	
Expected	1.8	0.7	2.5	
Chi Square	2.79	0.73	0.89	4.41

Item 12	Working with this software is satisfying.			
	Agree	Undecided	Disagree	
Observed	3	2	0	
Expected	2.7	1.6	0.7	
Chi Square	0.03	0.09	0.66	0.77

Item 13	The way that information is presented is clear and understandable.			
	Agree	Undecided	Disagree	
Observed	3	2	0	
Expected	3.1	1.2	0.7	
Chi Square	0.01	0.58	0.70	1.28

Item 14	I feel safer if I use only a few familiar commands or operations.			
	Agree	Undecided	Disagree	
Observed	2	0	3	
Expected	2.0	0.8	2.2	
Chi Square	0.00	0.84	0.33	1.17

Item 15	The software documentation is very informative.			
	Agree	Undecided	Disagree	
Observed	2	3	0	
Expected	1.8	2.5	0.7	
Chi Square	0.03	0.10	0.74	0.88

Item 16	This software seems to disrupt the way I normally like to arrange my work.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	0.4	1.1	3.4	
Chi Square	0.44	0.01	0.09	0.55

Item 17	Working with this software is mentally stimulating.			
	Agree	Undecided	Disagree	
Observed	2	3	0	
Expected	1.9	1.8	1.3	
Chi Square	0.00	0.84	1.27	2.11

Item 18	There is never enough information on the screen when it's needed.			
	Agree	Undecided	Disagree	
Observed	1	2	2	
Expected	0.8	1.1	3.1	
Chi Square	0.03	0.77	0.38	1.18

Item 19	I feel in command of this software when I am using it.			
	Agree	Undecided	Disagree	
Observed	2	1	2	
Expected	2.9	1.3	0.8	
Chi Square	0.29	0.08	2.06	2.43

Item 20	I prefer to stick to the operations I know best.			
	Agree	Undecided	Disagree	
Observed	1	2	2	
Expected	2.2	0.9	1.9	
Chi Square	0.63	1.20	0.01	1.83

Item 21	I think this software is inconsistent.			
	Agree	Undecided	Disagree	
Observed	1	0	4	
Expected	0.6	1.3	3.1	
Chi Square	0.19	1.27	0.28	1.74

Item 22	I would not like to use this software every day.			
	Agree	Undecided	Disagree	
Observed	4	0	1	
Expected	1.1	0.8	3.1	
Chi Square	7.78	0.83	1.41	10.01

Item 23	I can understand and act on the information provided by this software.			
	Agree	Undecided	Disagree	
Observed	5	0	0	
Expected	3.6	1.0	0.4	
Chi Square	0.51	0.96	0.40	1.88

Item 24	This software is awkward when I want to do something which is not standard.			
	Agree	Undecided	Disagree	
Observed	1	3	1	
Expected	1.5	2.0	1.5	
Chi Square	0.16	0.47	0.16	0.79

Item 25	There is too much to read before you can use the software.			
	Agree	Undecided	Disagree	
Observed	1	1	3	
Expected	0.8	1.1	3.1	
Chi Square	0.04	0.00	0.00	0.05

Item 26	Doing what you want to do with this software is straightforward.			
	Agree	Undecided	Disagree	
Observed	2	2	1	
Expected	3.5	0.9	0.7	
Chi Square	0.64	1.53	0.19	2.35

Item 27	Using this software is frustrating.			
	Agree	Undecided	Disagree	
Observed	0	2	3	
Expected	0.9	1.1	3.1	
Chi Square	0.87	0.81	0.00	1.68

Item 28	The software has helped me overcome any problems I have had in using it.			
	Agree	Undecided	Disagree	
Observed	2	2	1	
Expected	1.4	2.5	1.0	
Chi Square	0.23	0.11	0.00	0.35

Item 29	The speed of this software is fast enough.			
	Agree	Undecided	Disagree	
Observed	1	2	2	
Expected	2.8	0.8	1.3	
Chi Square	1.19	1.71	0.32	3.22

Item 30	I keep having to go back to look at the guides.			
	Agree	Undecided	Disagree	
Observed	0	0	5	
Expected	1.0	1.1	2.9	
Chi Square	0.99	1.08	1.47	3.54

Item 31	It is obvious that user needs have been fully taken into consideration.			
	Agree	Undecided	Disagree	
Observed	3	2	0	
Expected	2.0	1.8	1.2	
Chi Square	0.51	0.01	1.17	1.70

Item 32	There have been times in using this software when I have felt quite tense.			
	Agree	Undecided	Disagree	
Observed	1	0	4	
Expected	1.8	0.8	2.4	
Chi Square	0.35	0.78	1.02	2.15

Item 33	The organisation of the menus and lists seems fairly logical.			
	Agree	Undecided	Disagree	
Observed	5	0	0	
Expected	3.7	0.7	0.6	
Chi Square	0.45	0.73	0.56	1.75

Item 34	You don't have to do a lot of input to make this software work.			
	Agree	Undecided	Disagree	
Observed	3	1	1	
Expected	3.2	1.2	0.7	
Chi Square	0.01	0.02	0.17	0.20

Item 35	It is hard to learn to use new functions.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	0.7	1.2	3.1	
Chi Square	0.68	0.03	0.25	0.96

Item 36	There are too many steps required to get something to work.			
	Agree	Undecided	Disagree	
Observed	0	0	5	
Expected	1.0	1.0	3.0	
Chi Square	1.02	0.96	1.30	3.28

Item 37	Sometimes this software gives me a headache.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	1.2	1.0	2.8	
Chi Square	1.17	0.00	0.52	1.69

Item 38	Error prevention messages are inadequate.			
	Agree	Undecided	Disagree	
Observed	0	3	2	
Expected	1.2	2.0	1.7	
Chi Square	1.23	0.44	0.04	1.71

Item 39	It is easy to make the software do exactly what you want.			
	Agree	Undecided	Disagree	
Observed	2	1	2	
Expected	2.1	1.8	1.2	
Chi Square	0.00	0.33	0.57	0.90

Item 40	I will never learn to use all the functions in this software.			
	Agree	Undecided	Disagree	
Observed	1	1	3	
Expected	1.5	1.3	2.2	
Chi Square	0.17	0.07	0.30	0.54

Item 41	The software hasn't always done what I was expecting it to do.			
	Agree	Undecided	Disagree	
Observed	3	1	1	
Expected	2.4	1.0	1.6	
Chi Square	0.17	0.00	0.23	0.40

Item 42	The software has a very attractive presentation.			
	Agree	Undecided	Disagree	
Observed	4	1	0	
Expected	2.9	1.4	0.7	
Chi Square	0.42	0.09	0.74	1.26

Item 43	The amount or quality of the help information varies across the system.			
	Agree	Undecided	Disagree	
Observed	3	1	1	
Expected	1.6	2.5	0.9	
Chi Square	1.35	0.94	0.01	2.30

Item 44	It is relatively easy to move from one part of a task to another.			
	Agree	Undecided	Disagree	
Observed	4	0	1	
Expected	3.6	0.8	0.7	
Chi Square	0.05	0.76	0.16	0.97

Item 45	It is easy to forget how to do things with this software.			
	Agree	Undecided	Disagree	
Observed	0	1	4	
Expected	1.3	0.9	2.9	
Chi Square	1.27	0.02	0.46	1.75

Item 46	Sometimes this software behaves in a way which I don't understand.			
	Agree	Undecided	Disagree	
Observed	1	1	3	
Expected	1.7	1.2	2.2	
Chi Square	0.26	0.03	0.32	0.61

Item 47	This software is very awkward to use.			
	Agree	Undecided	Disagree	
Observed	0	3	2	
Expected	0.3	0.9	3.8	
Chi Square	0.32	4.85	0.83	6.01

Item 48	You can see at a glance what the options are at each stage.			
	Agree	Undecided	Disagree	
Observed	3	1	1	
Expected	2.9	1.1	1.0	
Chi Square	0.00	0.01	0.00	0.01

Item 49	Getting data files in and out of the system is not easy.			
	Agree	Undecided	Disagre e	
Observed	0	5	0	
Expected	0.7	1.9	2.4	
Chi Square	0.71	5.19	2.42	8.32

Item 50	I have to seek assistance when I use this software.			
	Agree	Undecided	Disagre e	
Observed	0	0	5	
Expected	0.6	0.7	3.7	
Chi Square	0.59	0.69	0.44	1.73

Appendix N: Transcripts of Open-ended Individual Audio-taped Short Interview

The following questions were adapted from the Software Usability Measurement Inventory (SUMI) questionnaire. Although the participants answered these questions in the SUMI questionnaire, we sought more verbal elaboration on these questions. The questions asked in the interview included:

1. What do you think is the best aspect of this software, and why?
2. What do you think needs most improvement, and why?

Appendix O: Example of User Testing Performance Report from WBT Manager

Detailed results for Millennium/Clinibase E-Learning Module

LOGINID	Course	Lesson	Lesson status	Lesson status date	Number of times user entered lesson	total time spent in Lesson (minutes)
1320	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Lesson	Complete	08-Aug-12	1	45.7
3290	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Lesson	Complete	13-Aug-12	1	65.9
0430	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Lesson	Complete	13-Aug-12	1	80.6
3850	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Lesson	Complete	07-Aug-12	1	20.9
3490	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Lesson	Complete	10-Aug-12	1	48.0

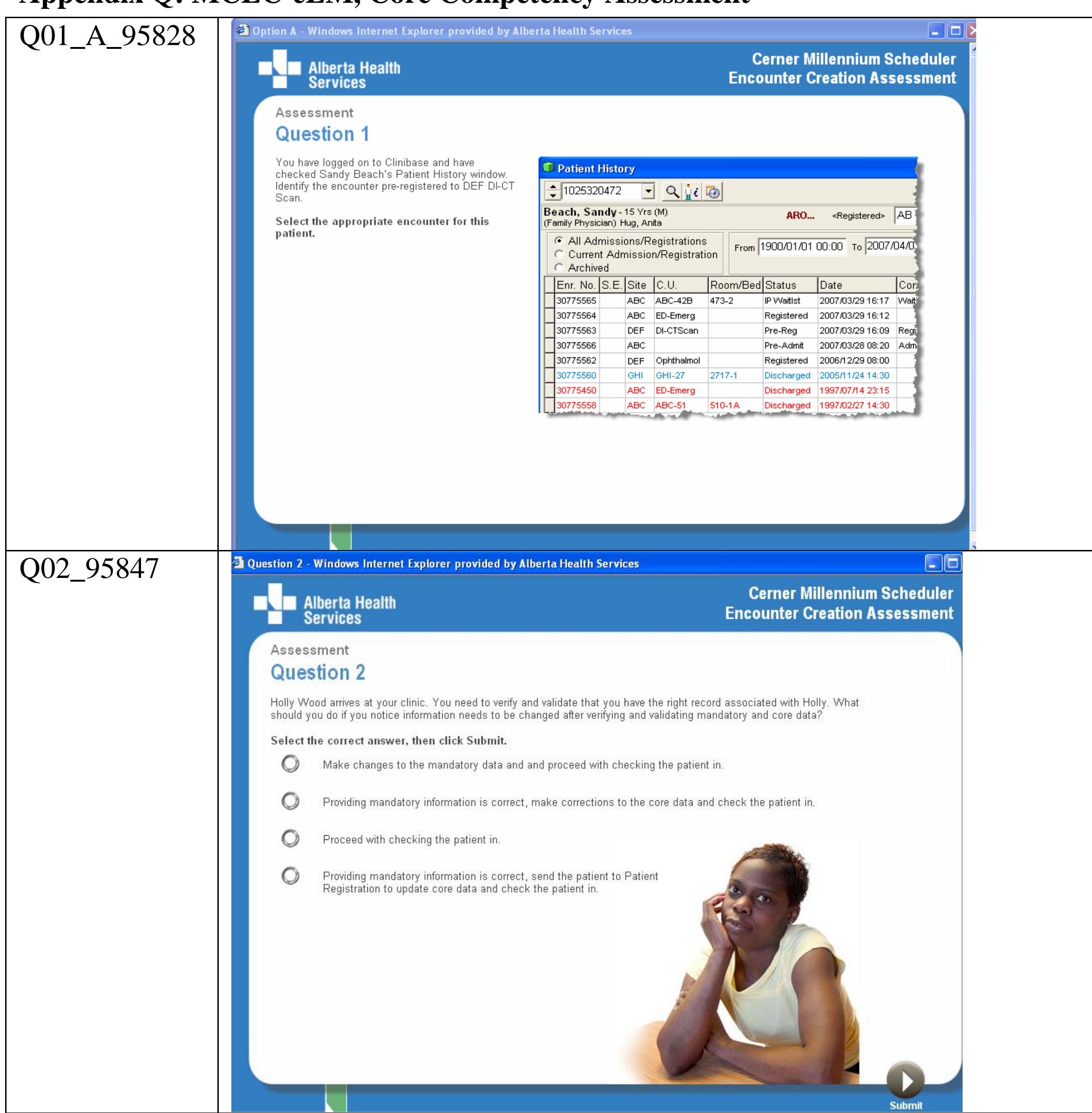
Detailed results for Millennium/Clinibase E-Learning Module Assessment

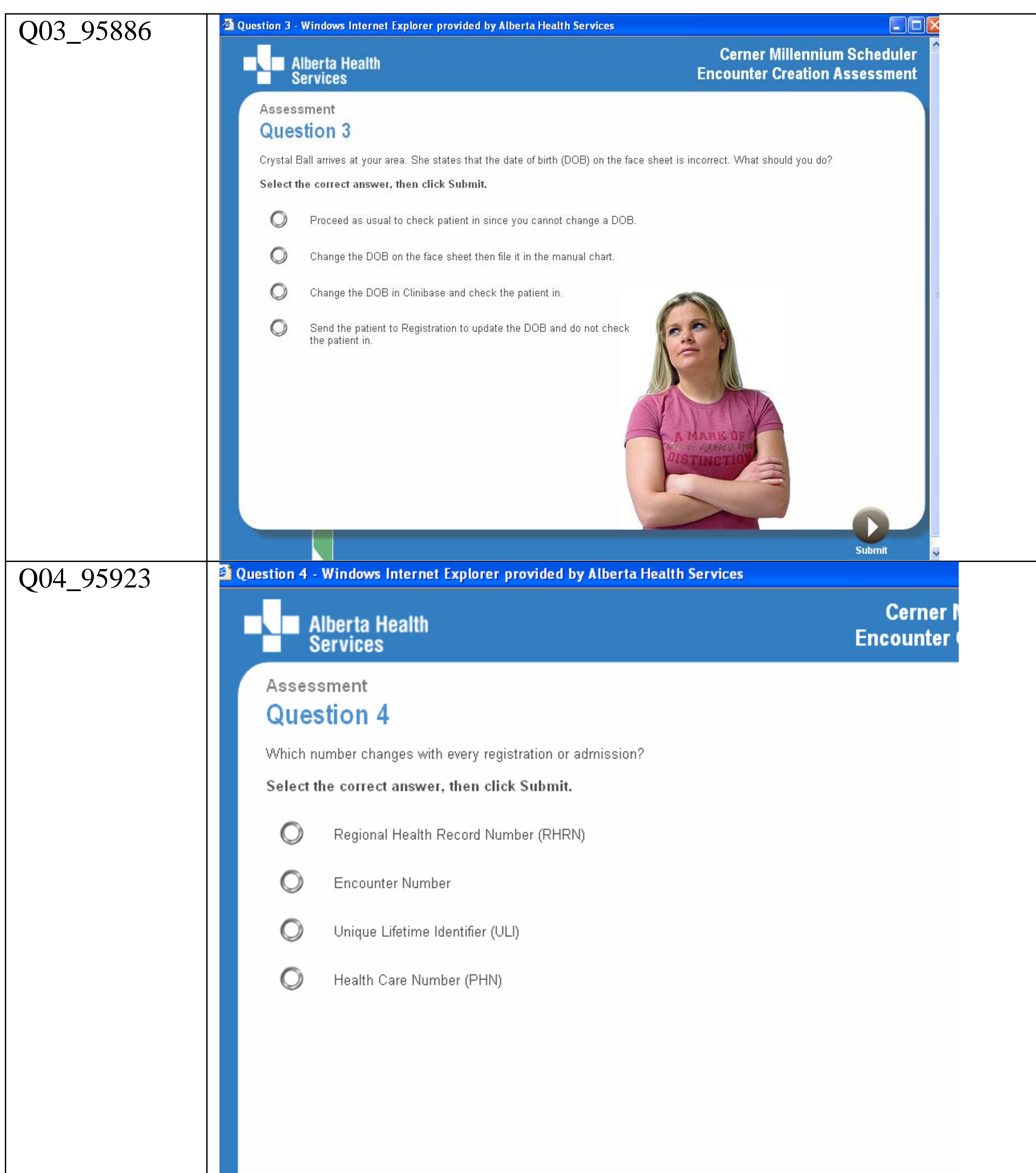
LOGINID	Course	Lesson	Lesson status	Lesson status date	SCORE	Number of attempts user needed to pass Assessment	Average Score on Assessment	Total time user spent in Assessment (minutes)
1320	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Assessment	Complete	08-Aug-12	81	1	81	11.4
3290	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Assessment	Complete	13-Aug-12	89	1	89	14.9
0430	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Assessment	Complete	13-Aug-12	86	1	86	23.9
3850	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Assessment	Complete	07-Aug-12	86	1	86	11.7
3490	Millennium/Clinibase Encounter Creation	Millennium/Clinibase Encounter Creation Assessment	Complete	10-Aug-12	89	1	89	15.9

Appendix P: Instruction Sheet for How to Logon to WBT Manager for e-Learning

Figure 12: How to logon WBT Manager for e-Learning1. Go to WBT **Test** website: http://wbt-test.crha-health.ab.ca/WBT/	You will know you are at the Test site because the background is Green and it has a big Test Site on the front
2. Click the link to Logon	
Enter Student ID/password Logon and password are set to be the same	
Launch the **Millennium/Clinibase Encounter Creation Course**	

Appendix Q: MCEC-eLM, Core Competency Assessment



Q03_95886	
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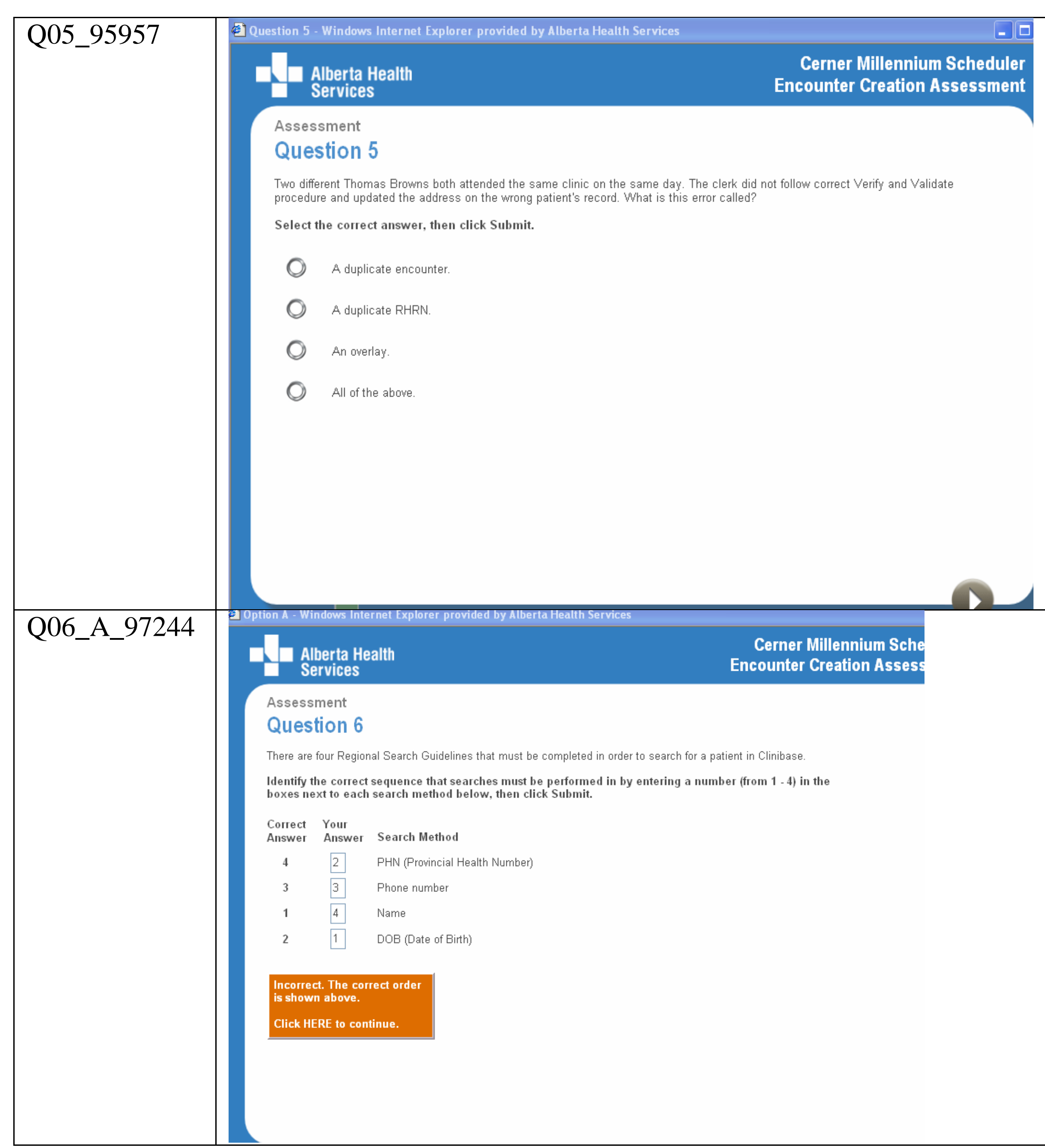
Q05_95957	
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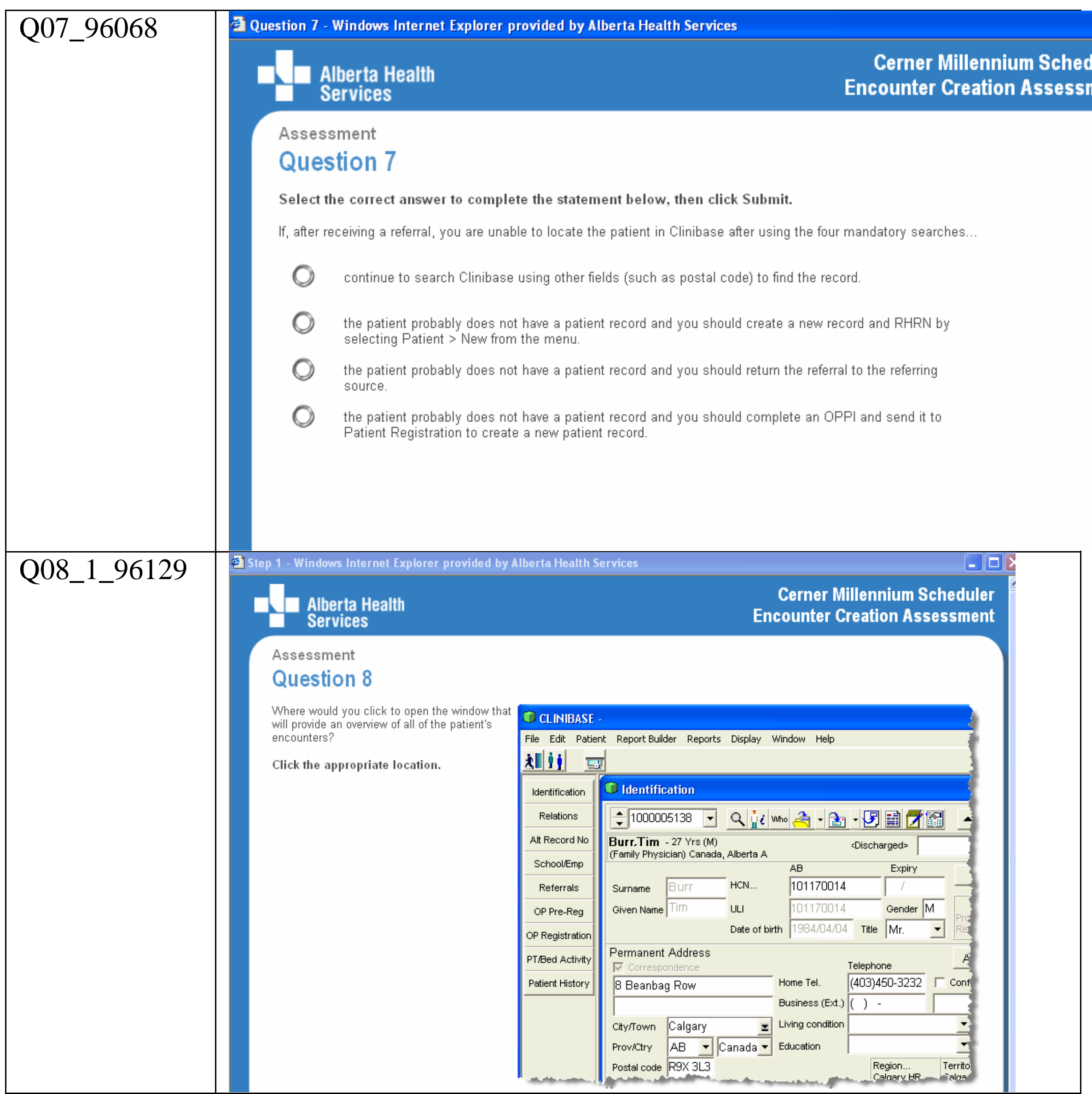
Q07_96068	
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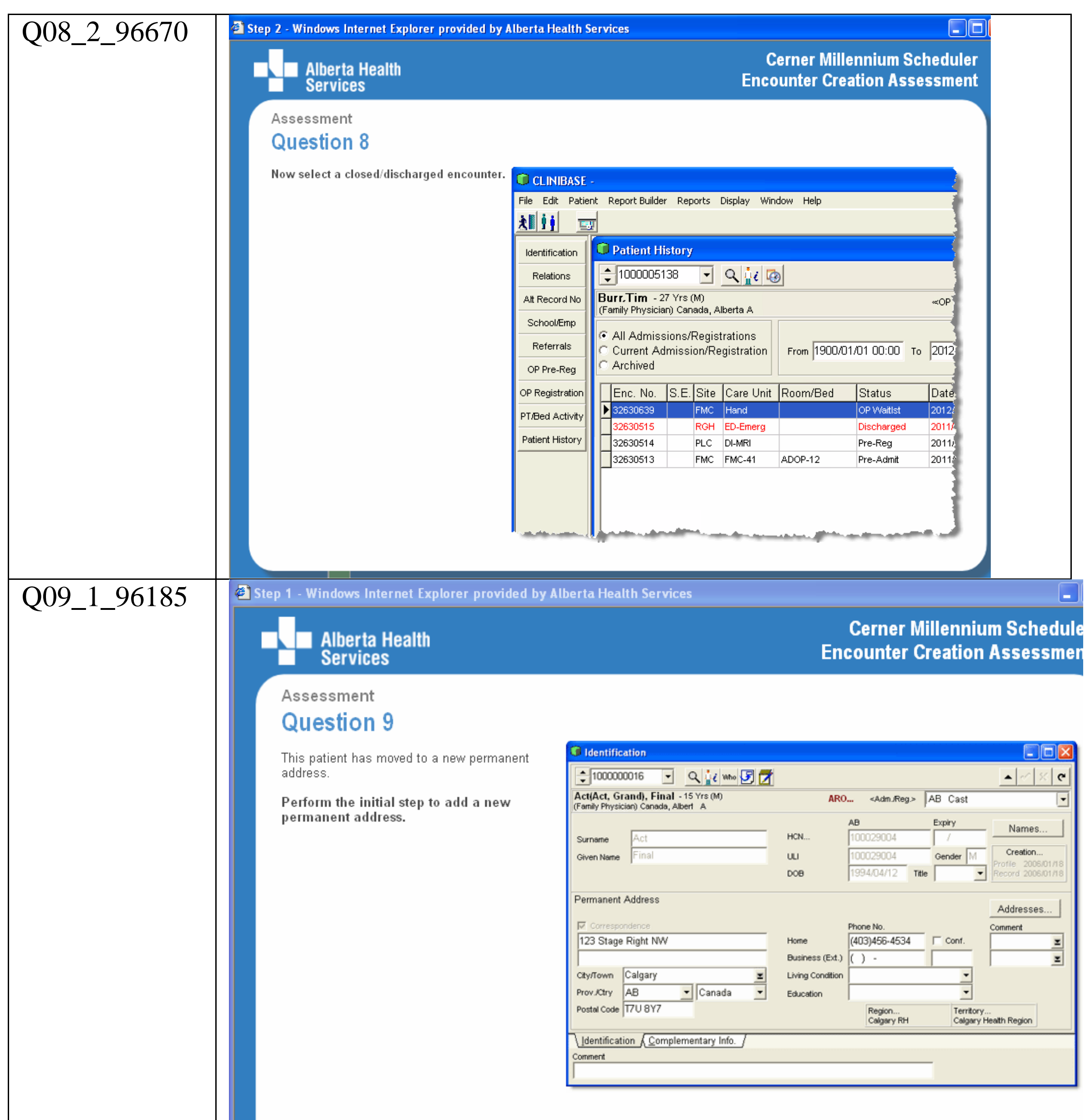
Q08_2_96670	
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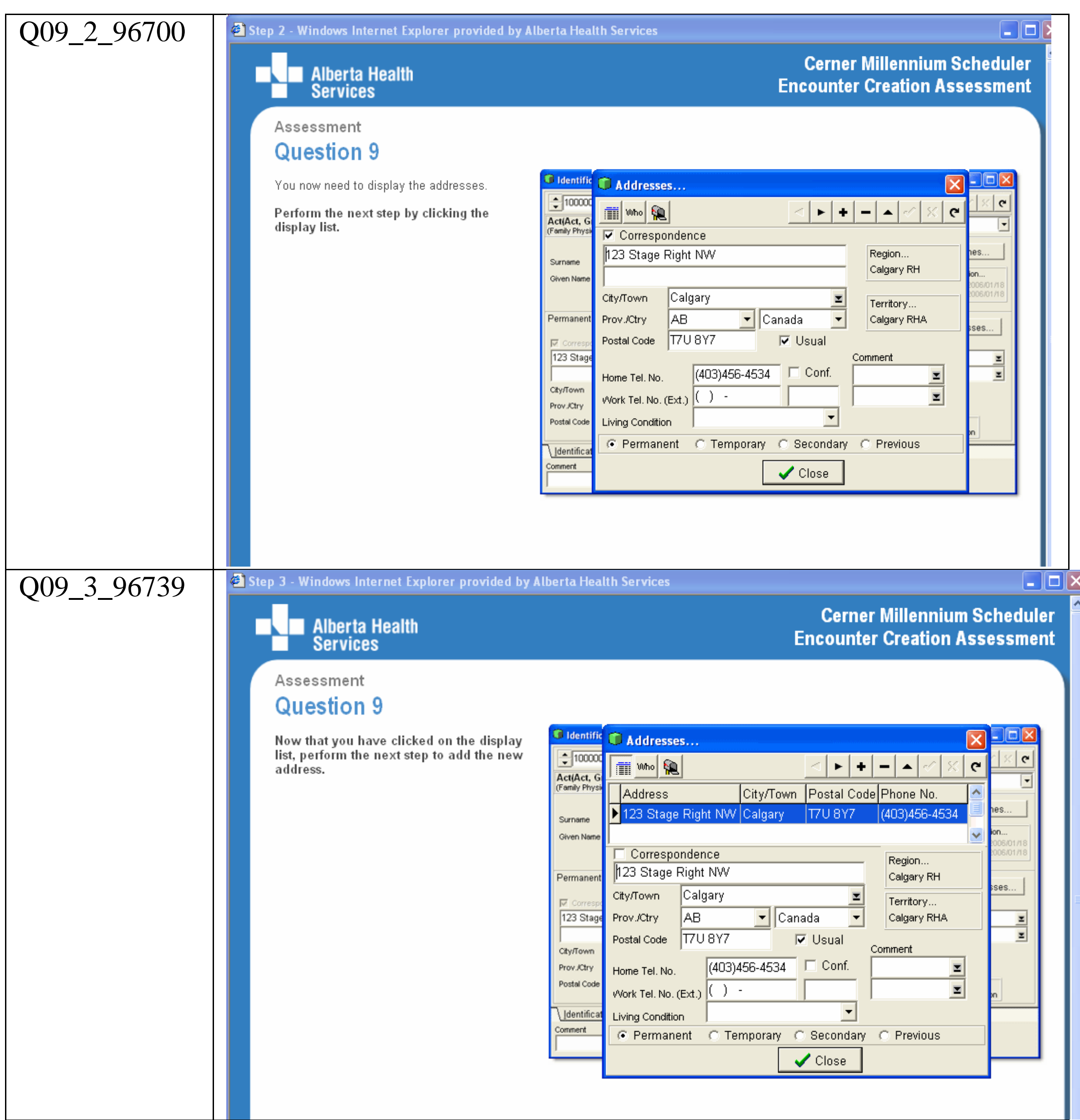
Q09_2_96700

Q09_3_96739



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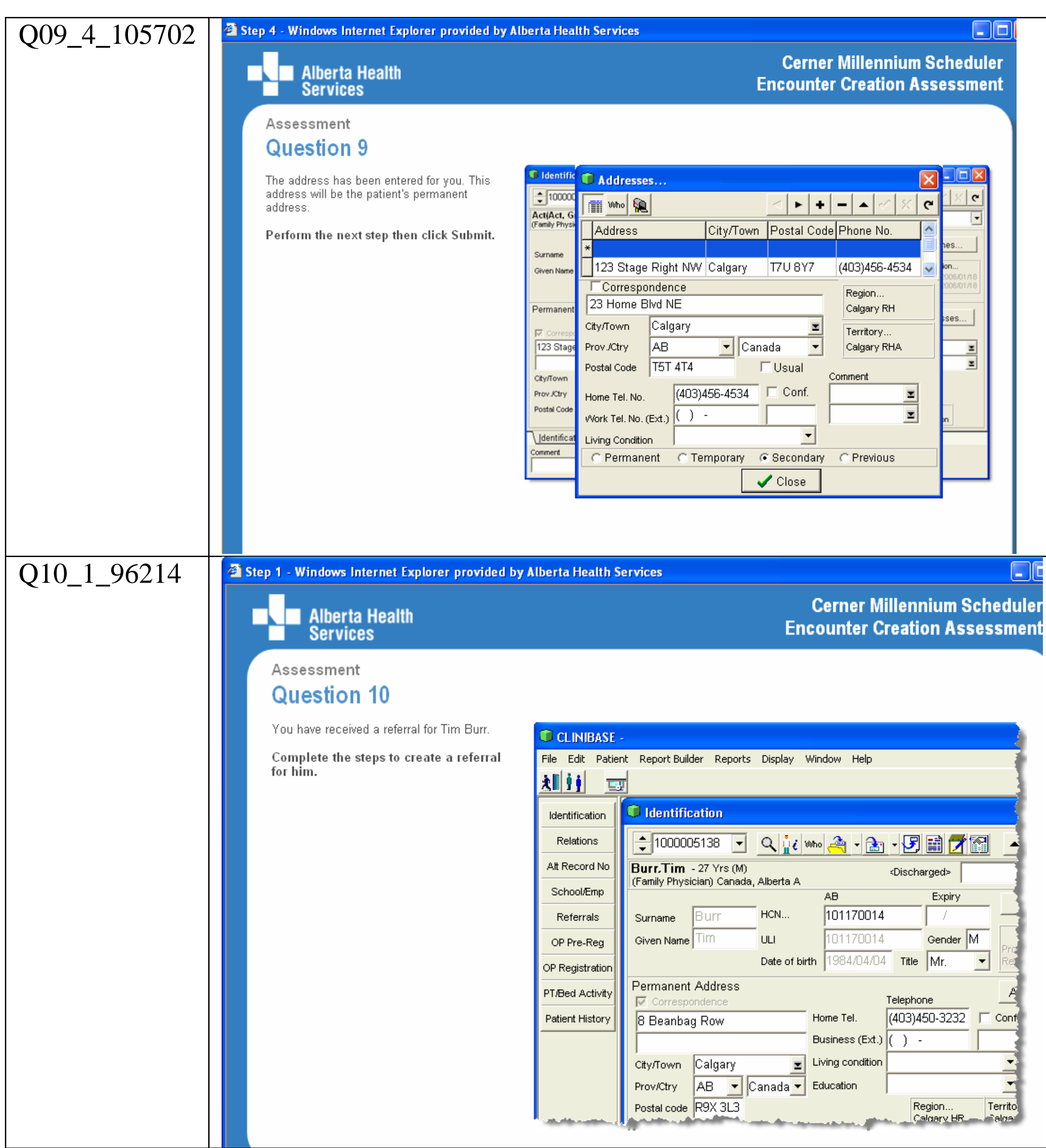
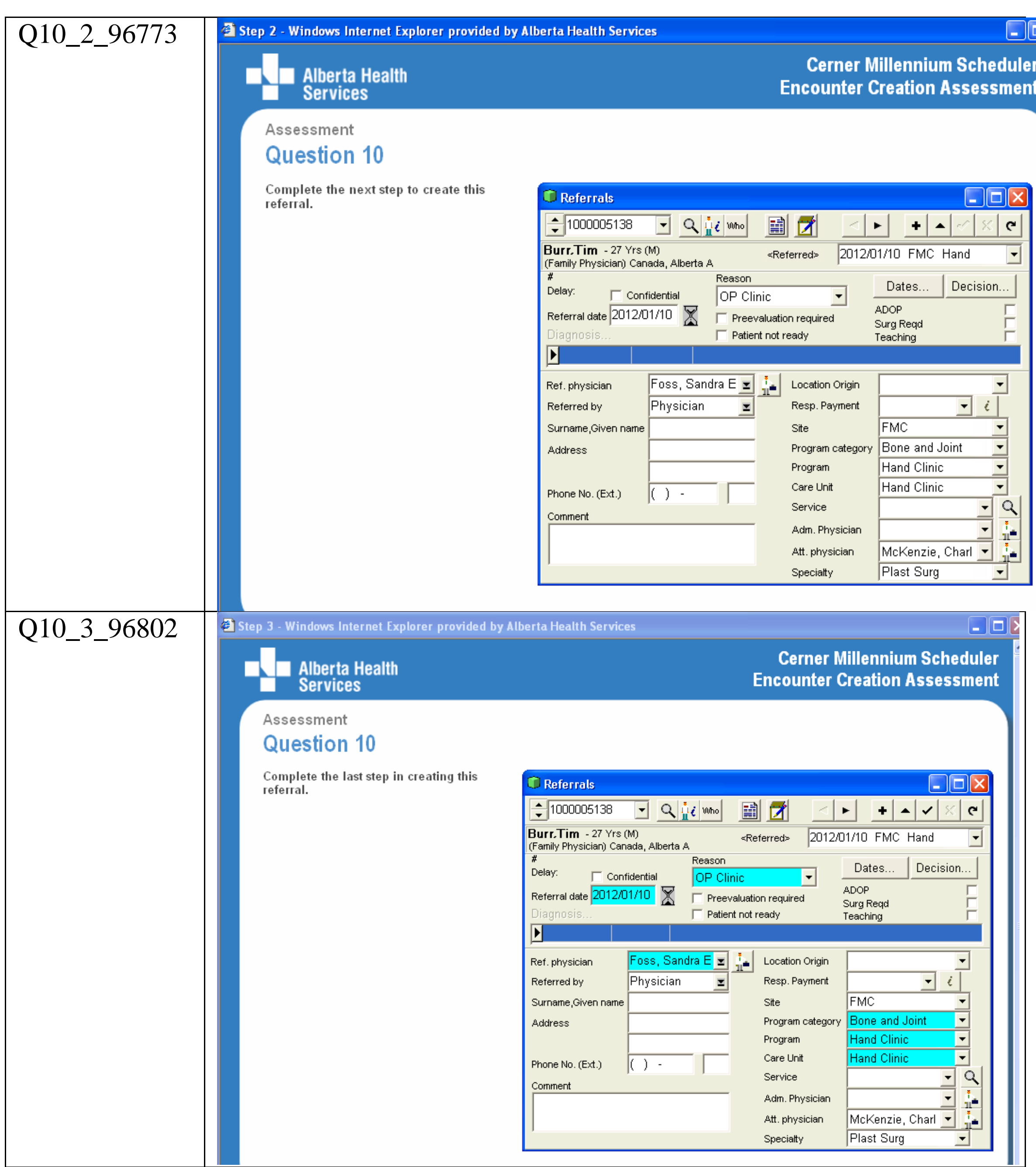
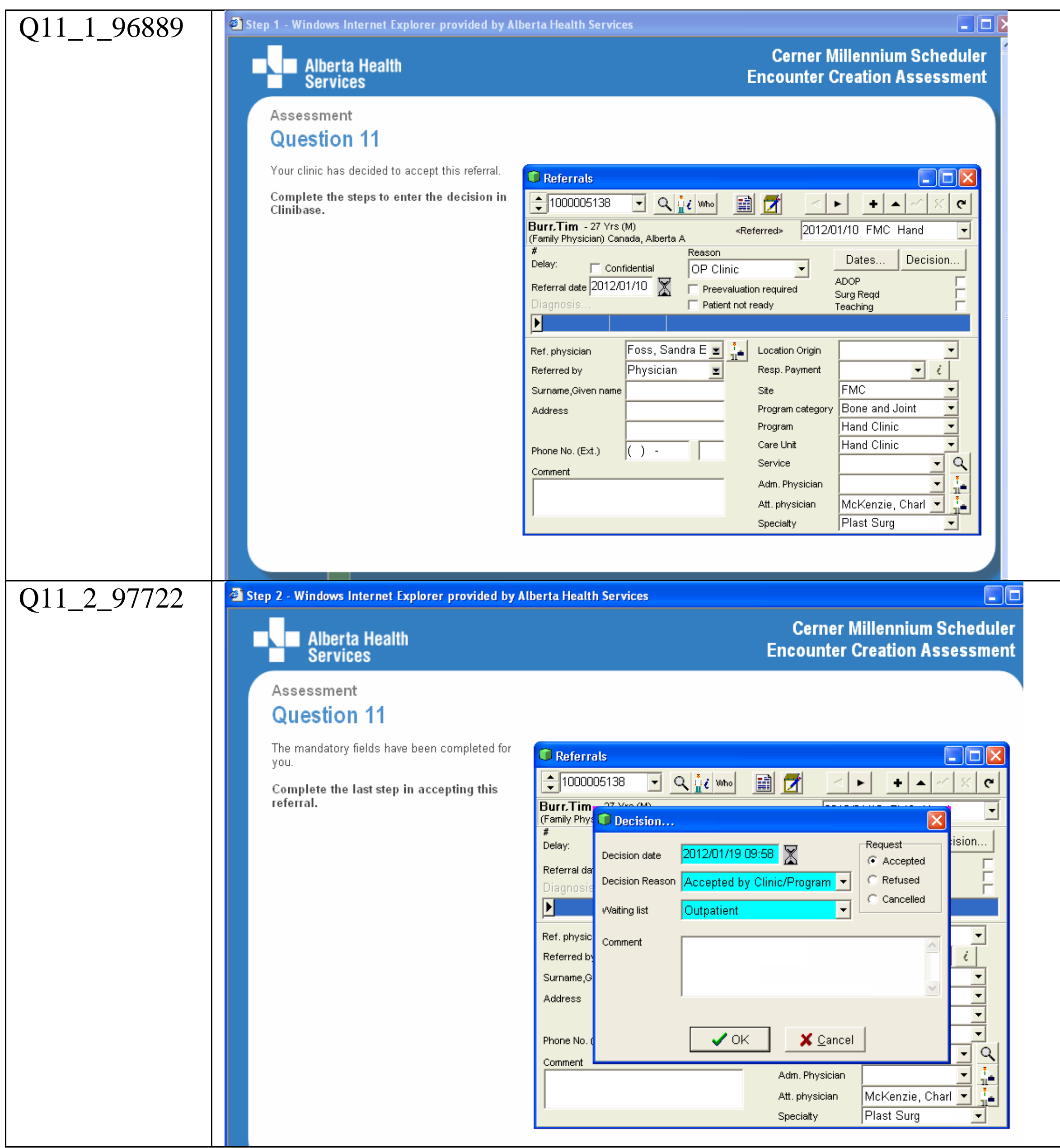
Q10_1_96214	




Q10_2_96773
Step 2 - Windows Internet Explorer provided by Alberta Health Services
Alberta Health Services
Cerner Millennium Scheduler
Encounter Creation Assessment
Assessment
Question 10
Complete the next step to create this referral.
Referrals
Q10_3_96802
Step 3 - Windows Internet Explorer provided by Alberta Health Services
Alberta Health Services
Cerner Millennium Scheduler
Encounter Creation Assessment
Assessment
Question 10
Complete the last step in creating this referral.
Referrals

Q11_1_96889	
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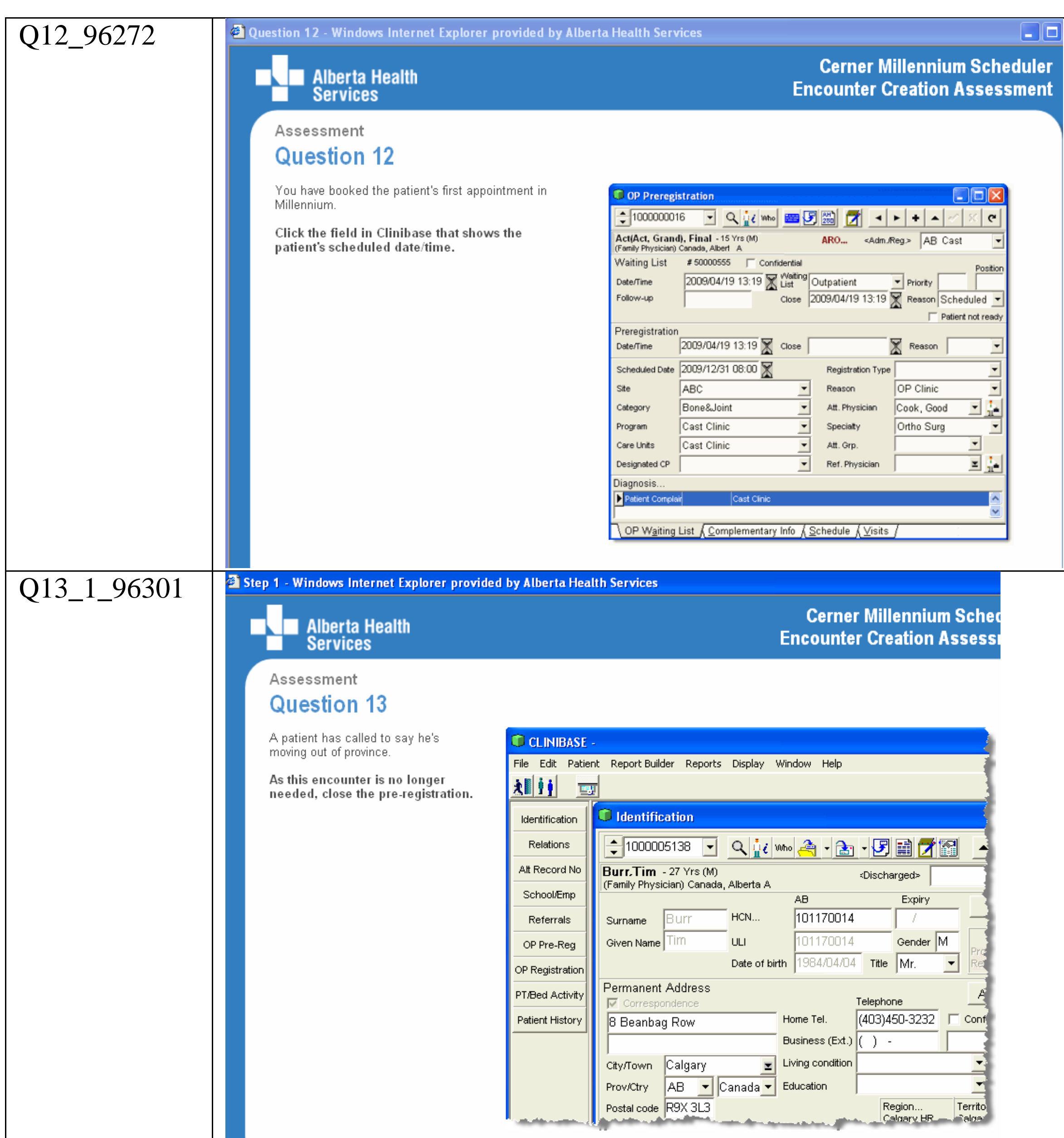
Q12_96272

Q13_1_96301



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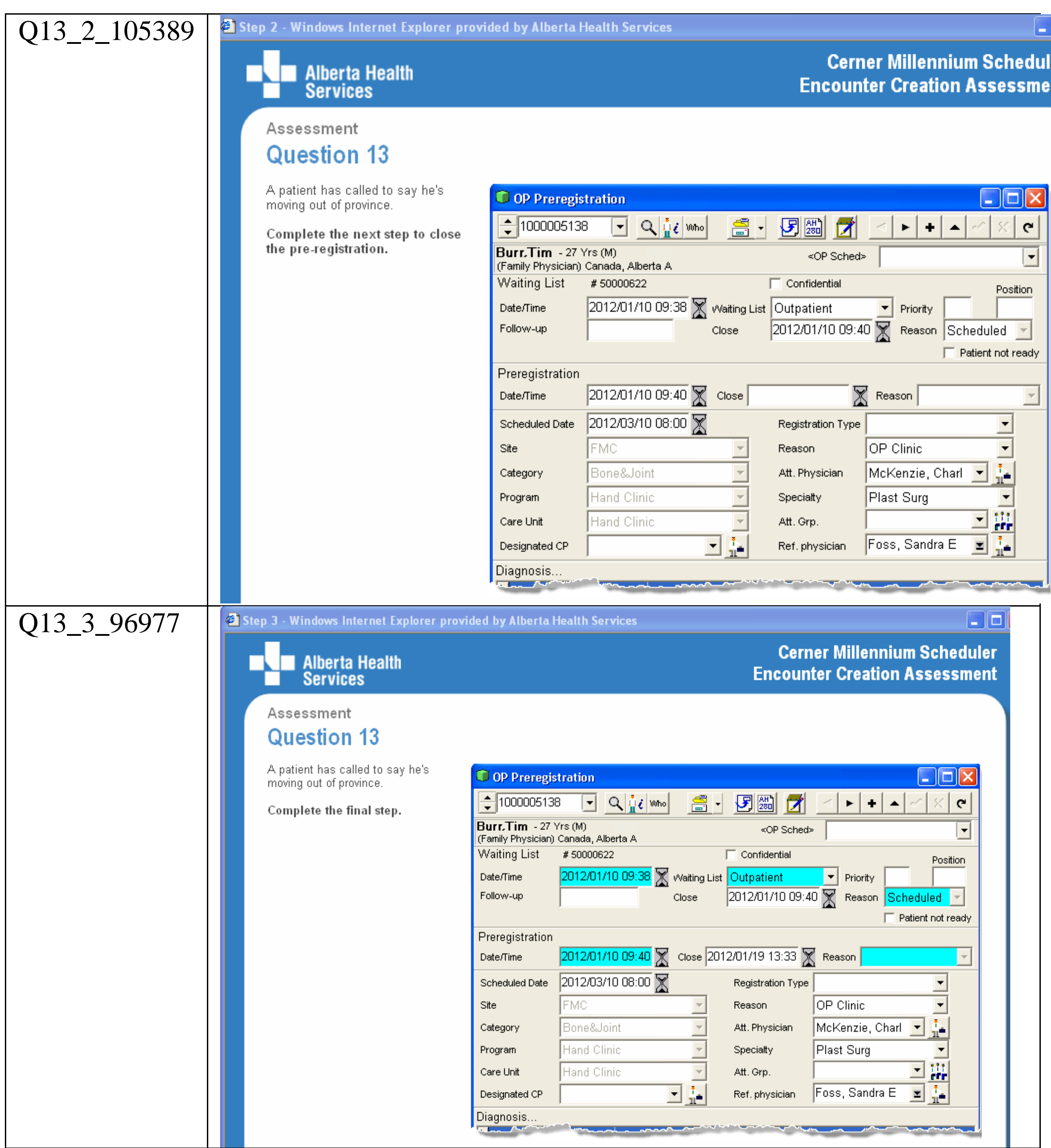
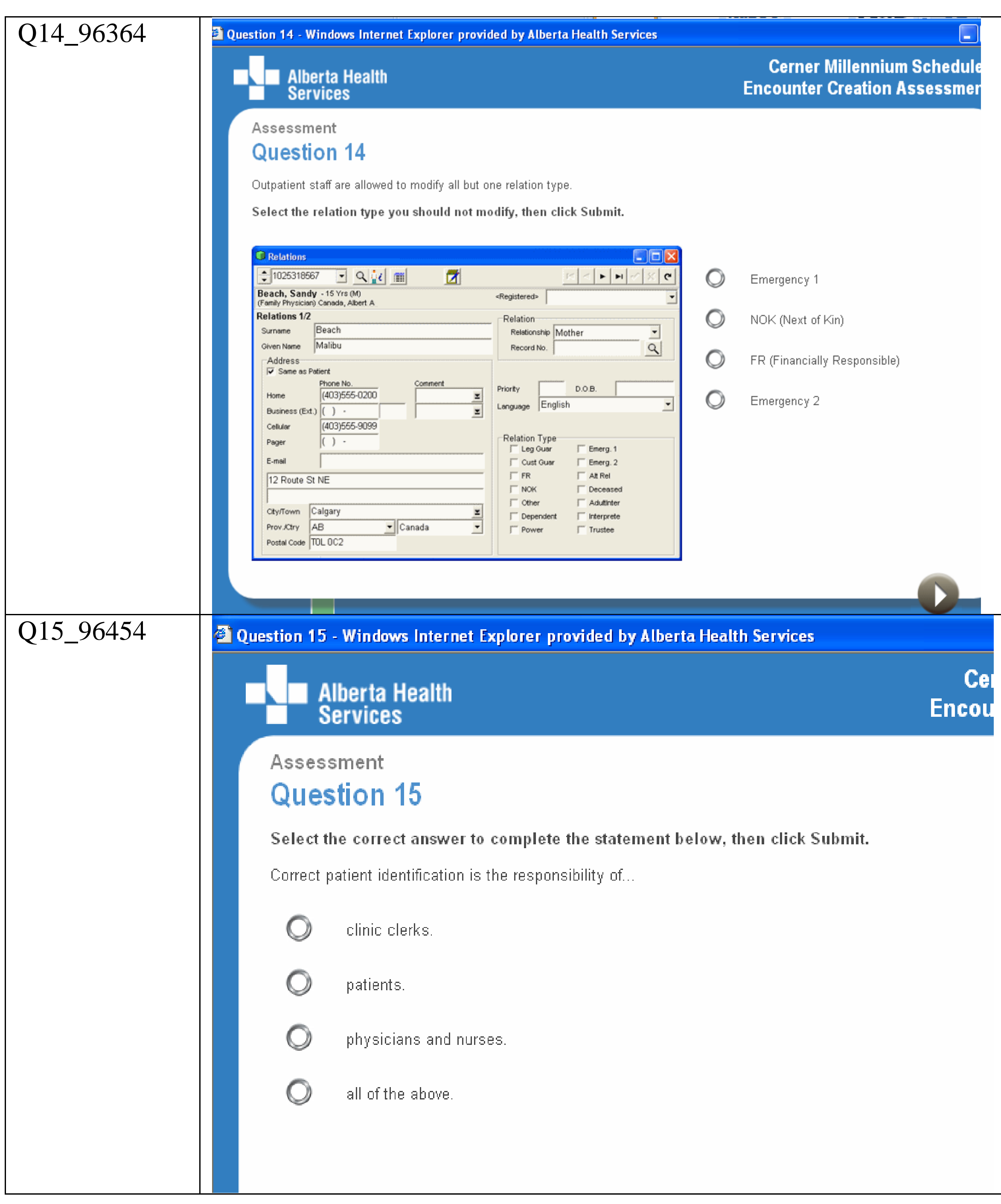
Q13_3_96977



Q14_96364	
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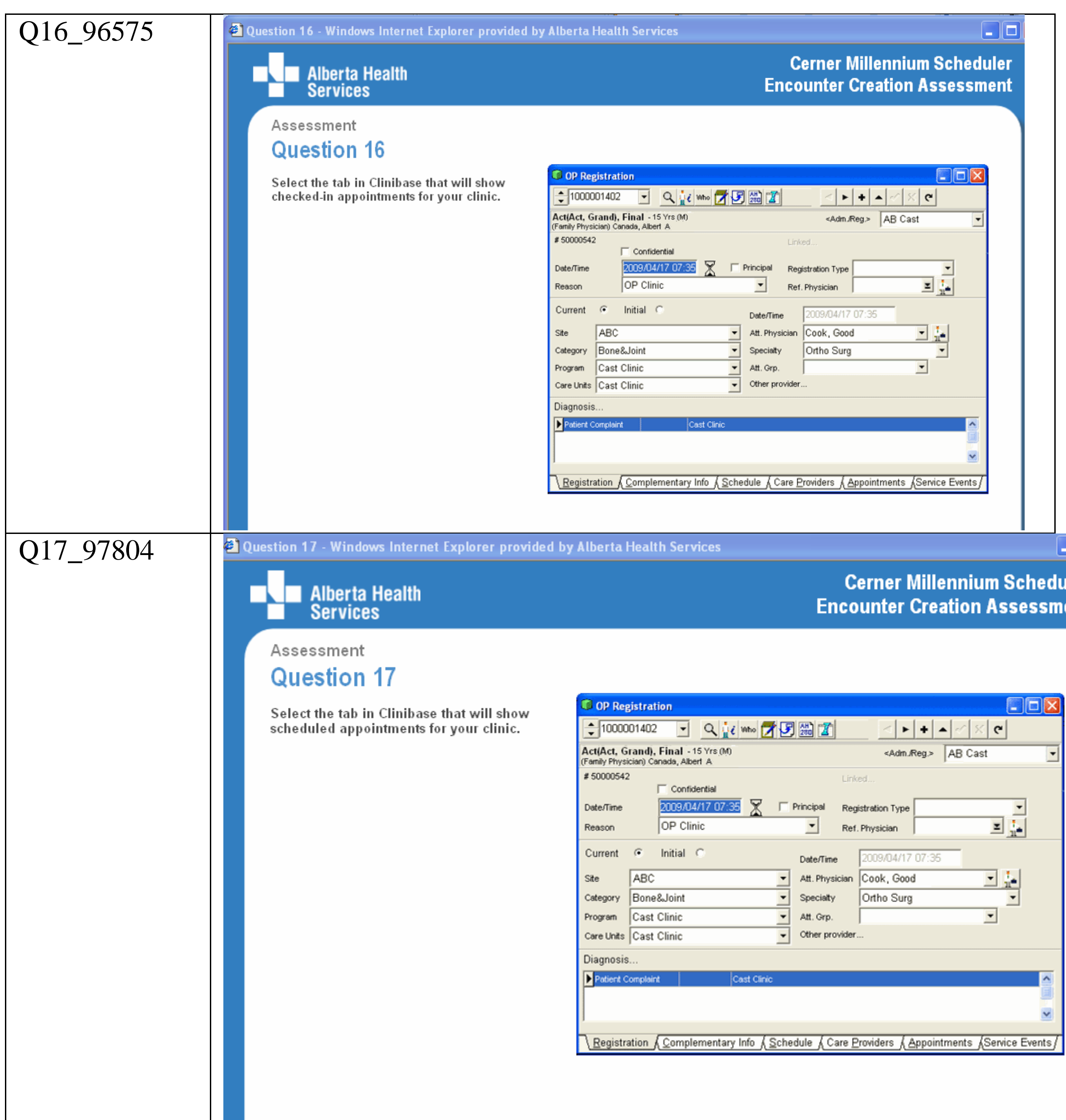
Q16_96575	
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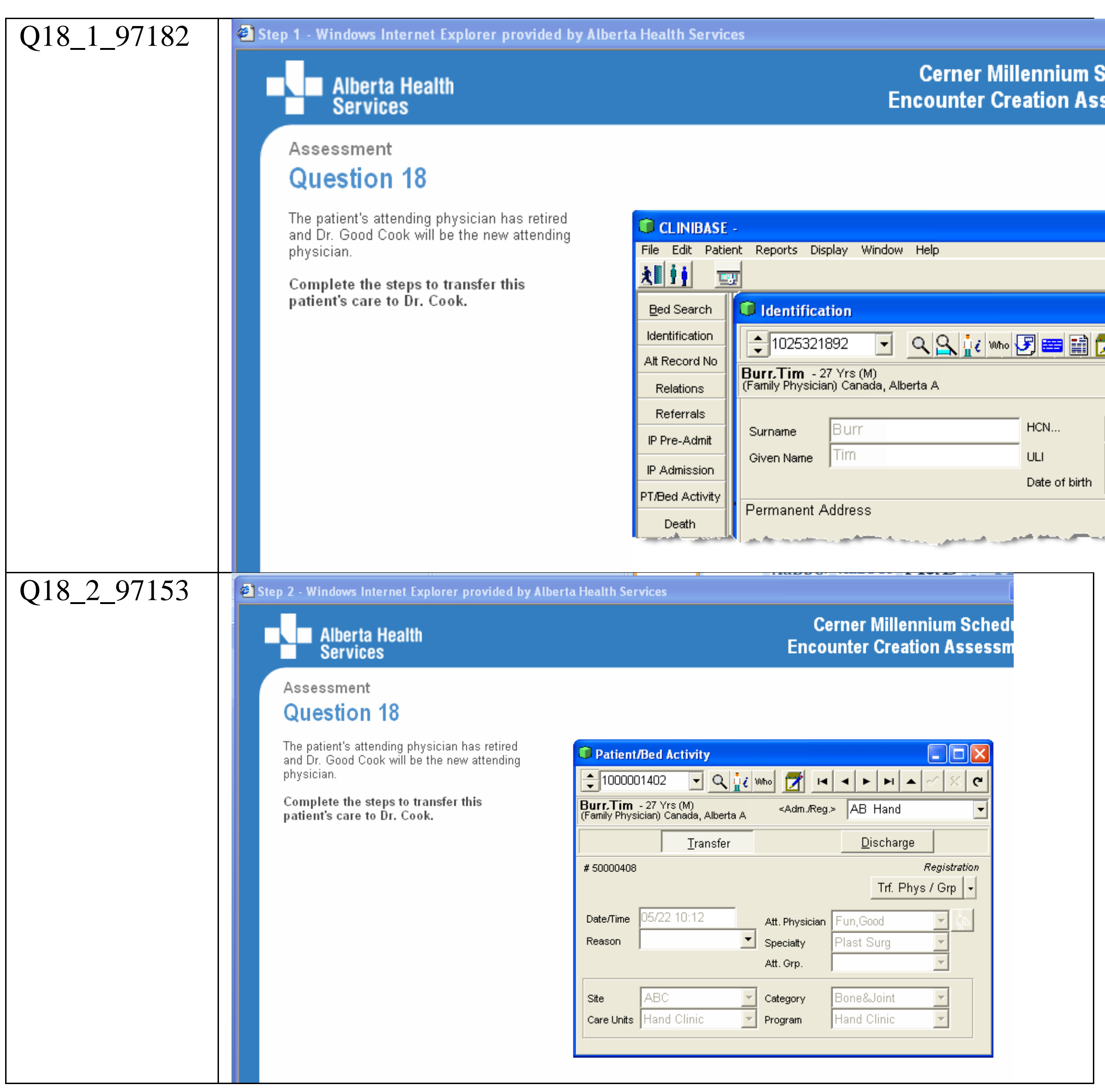
Q18_1_97182	
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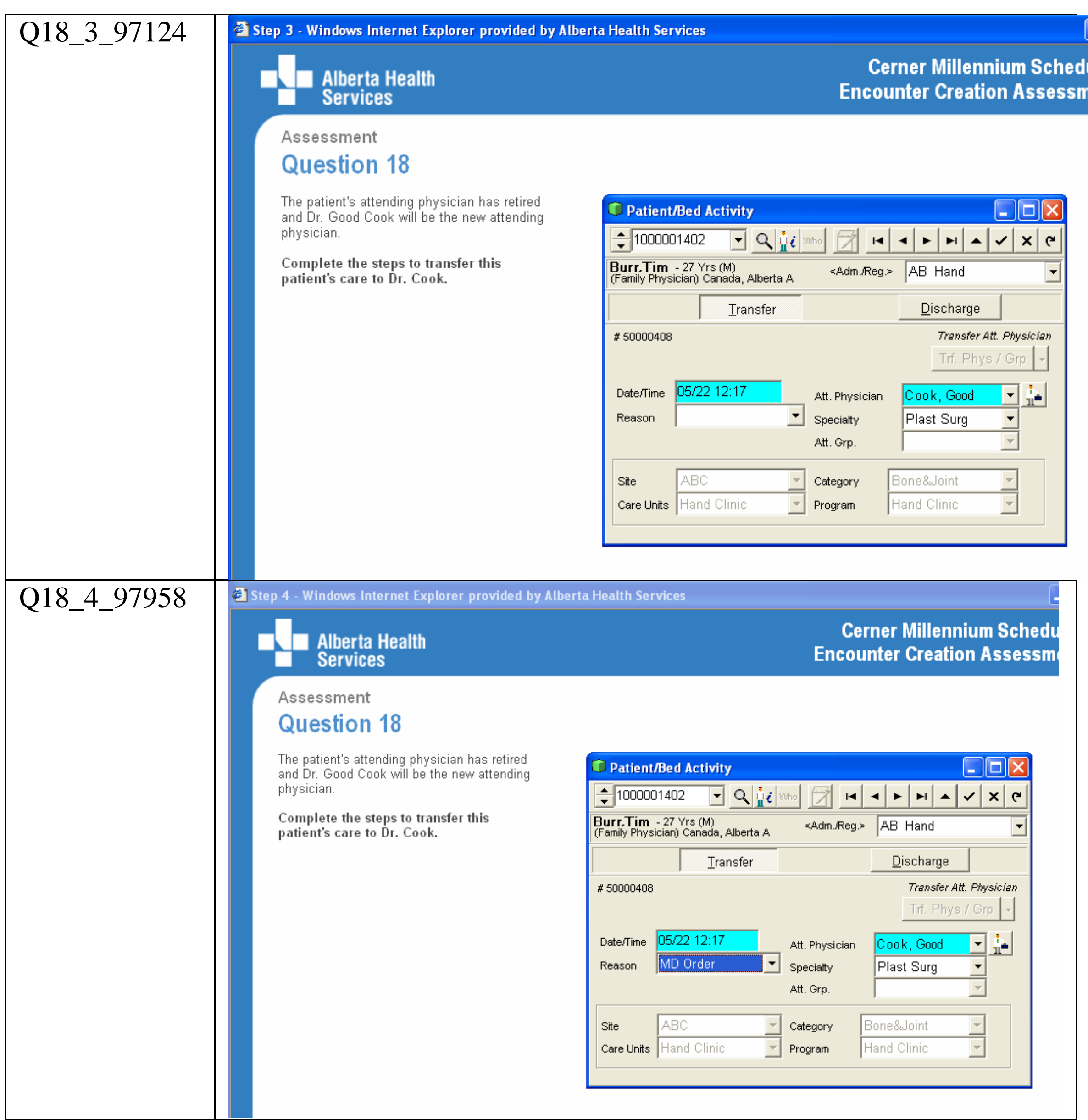
Q18_3_97124	
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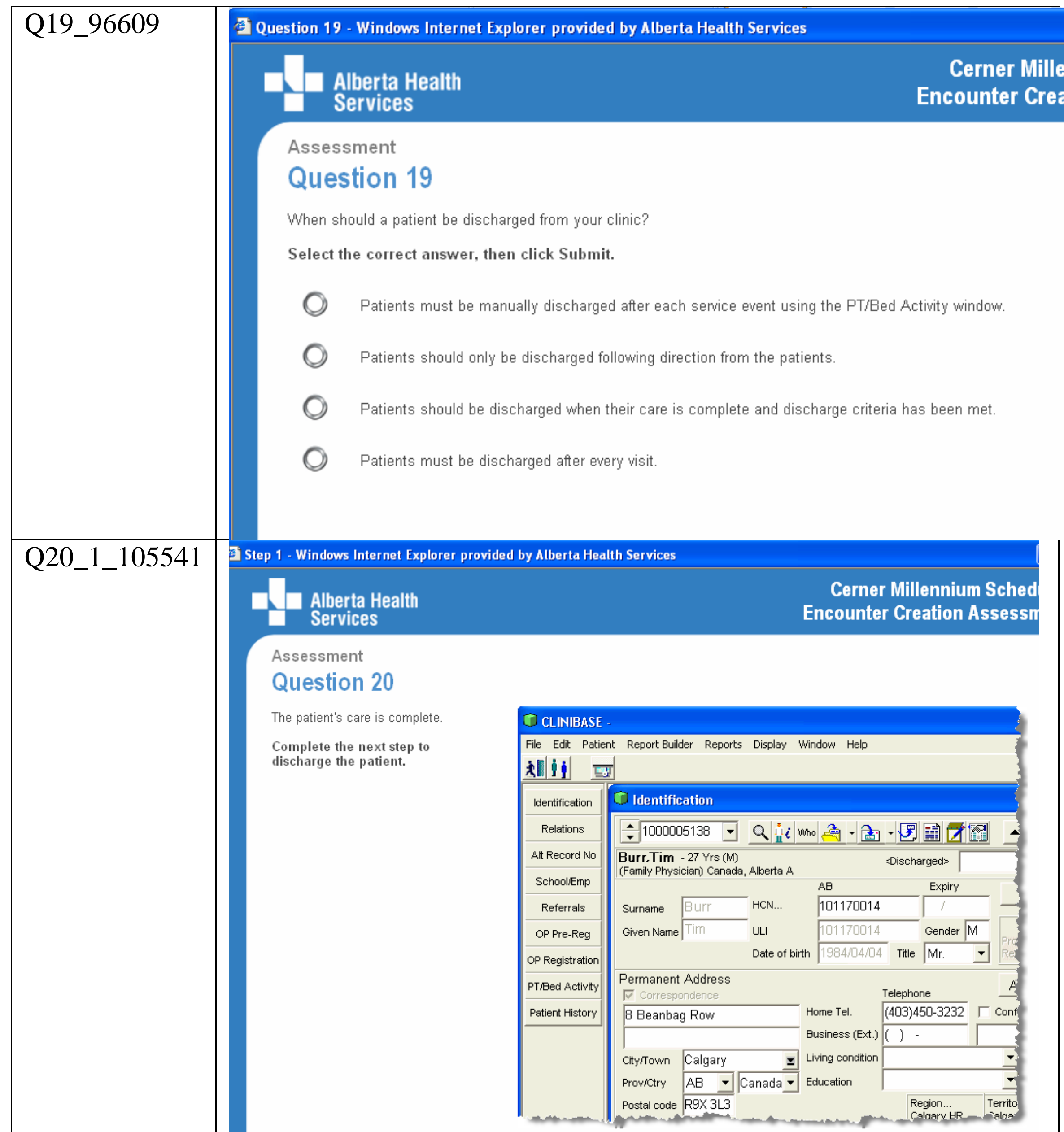
Q19_96609	
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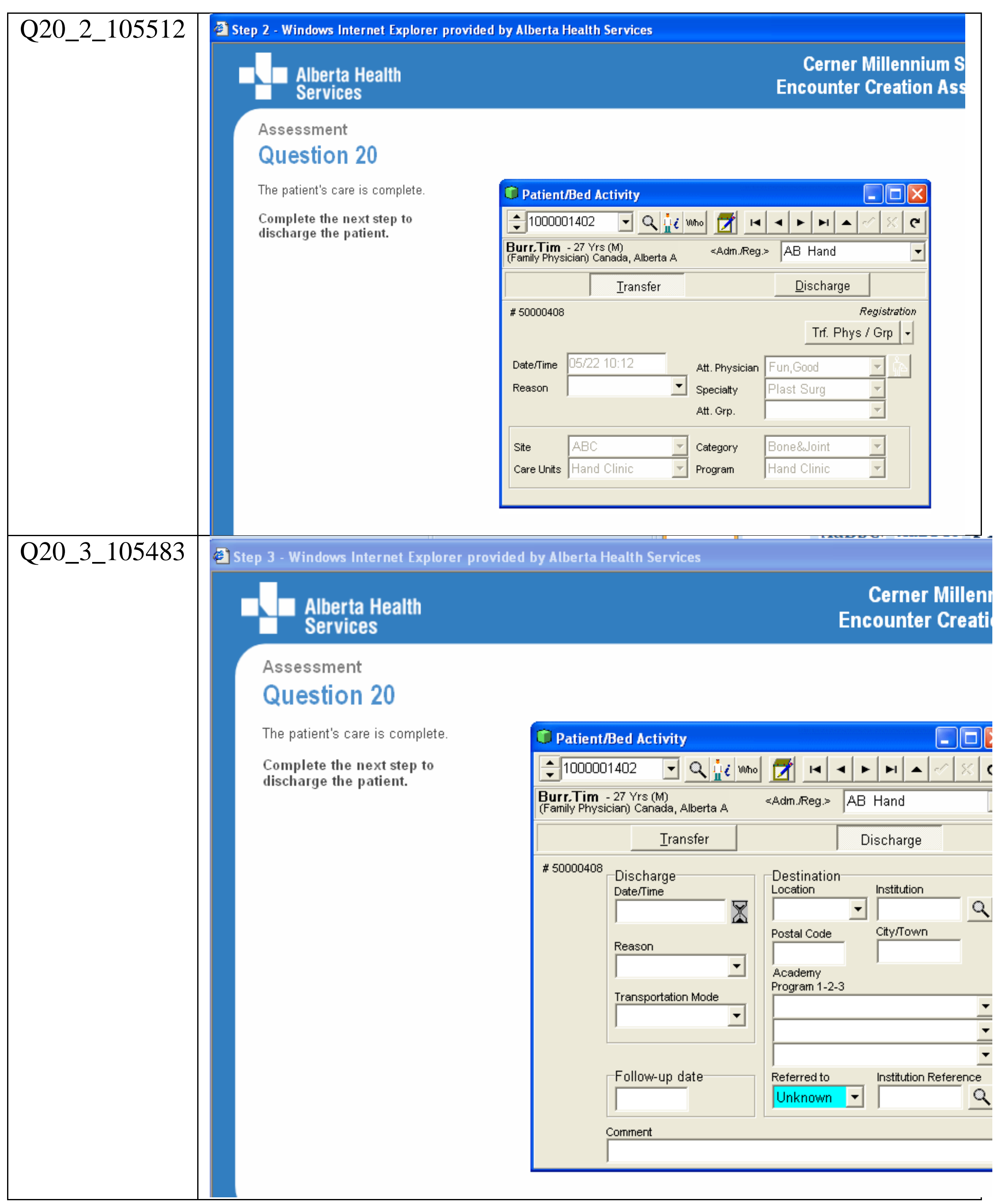
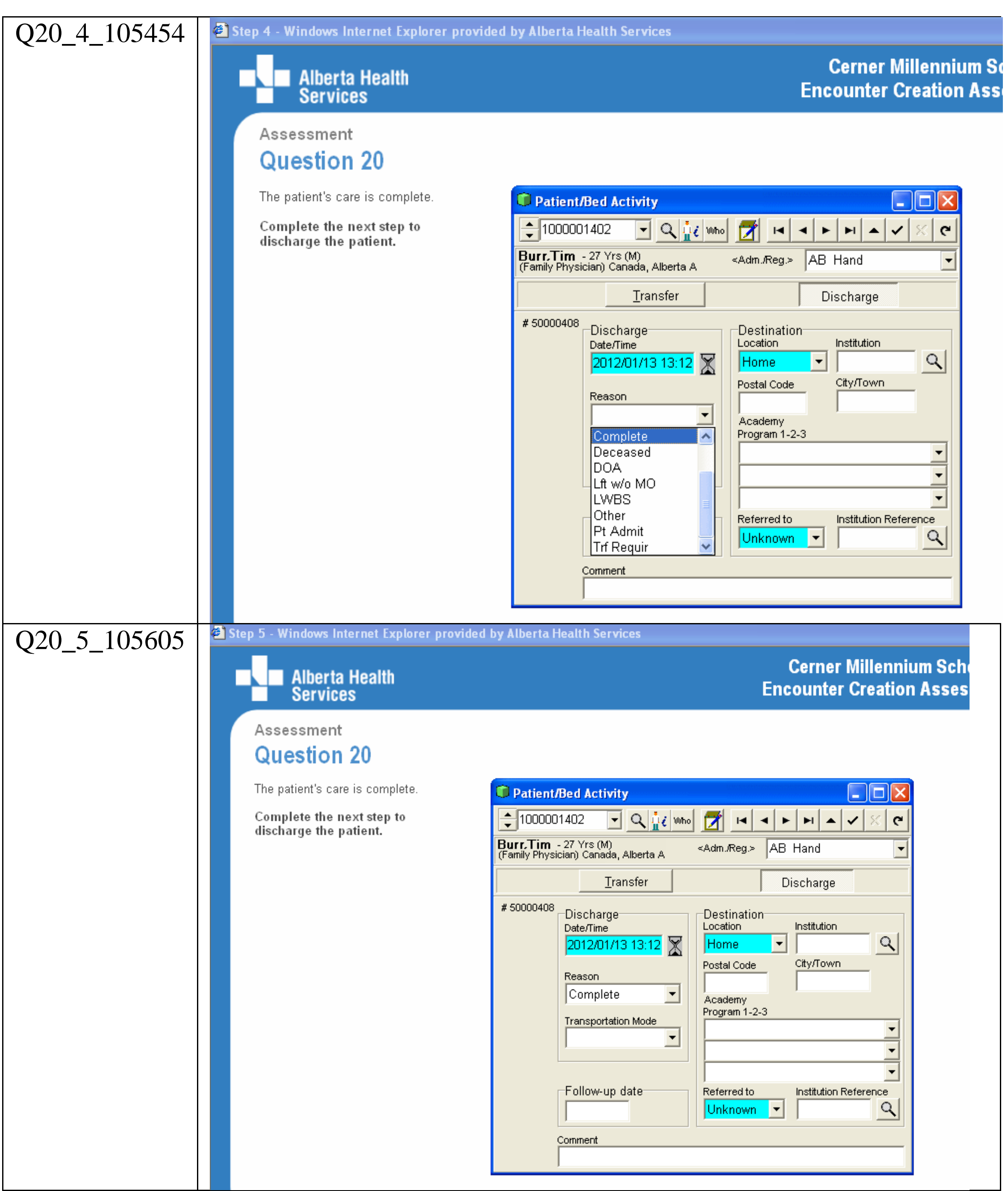
Q20_2_105512

Q20_3_105483



Q20_4_105454	
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