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Assessing the Efficacy of a Web-based Training Module

by

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Abstract

The purpose of this study was to examine the efficacy of a web-based training module by examining student achievement and student satisfaction with the learning module. Thirty four students from two different vocational colleges were randomly assigned to one of two test groups and asked to complete a Quality of Learning Questionnaire and two post-tests. Data from the two post-tests and questionnaire was analysed using the t-statistic, regression analysis, and correlation analysis. Results indicated that the learning module was effective in teaching the concepts associated with WHMIS, based on the scores that students achieved on the post-tests. The majority of students who completed the questionnaire expressed satisfaction with the online learning environment, and indicated that they would be willing to take additional online courses. Greater refinement of the subscales used to assess the quality of learning offered by the module was seen to be needed given that the existing subscales had low reliability.

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Chapter 1: Introduction

Purpose

Many studies have compared the efficacy of computer based or assisted instructional environments with that of traditional classroom settings (Allen, Bourhis, Burrell and Mabry, 2002; Collins, 2000; Johnson, Aragon, Shaik and Palma-Rivas, 2000; Mayzer and Dejong, 2003). However, the current study looked at the efficacy of a web-based learning module for two different populations of students by applying the theoretical framework of the Input-Environment-Output or I-E-O model that was adapted for use in the assessment of web-based learning environments (McGorry, 2003; Thurmond, Wambach, Connors, and Frey, 2002). This model was designed to separate the effects of the learning environment/treatment (for example, Internet-based, classroom-based, video conference-based, audio conference-based, paper-based correspondence) from the effects of various inputs, such as, learner characteristics (age, gender, prior knowledge), on the outcomes of a particular treatment (learner achievement, student satisfaction). A Quality of Learning Questionnaire was administered to students once they completed the learning module, and was used to gather data on each of the elements of the I-E-O model (input variables, environmental variables, and outcomes) as they applied to the current study.

Description of Module

An online instructional module was developed that provided instruction on Workplace Hazardous Materials Information System (WHMIS) and related concepts

through a series of learning activities. These learning activities included instruction in all aspects of WHMIS:

- Basic Principles
- Interpretation of symbols
- Preparation of labels
- Preparation of MSDS
- Responsibilities of employees, employers and suppliers

An example of a learning activity has been provided in Appendix A. The module was designed to be used in the context of any course with a WHMIS component, such as science courses with a laboratory component, or practical nursing courses. The target populations for the module were students in two regional vocational colleges. Students who participated in the study could access and complete the module from their respective colleges or from their home computers. When students completed the module, two of the outcome variables, learner achievement and learner retention, were assessed by comparing the student's performance on the two post-test tests that were administered at two different points in time. The outcome variables student satisfaction and student learning (self-report) were assessed using data collected by the Quality of Learning Questionnaire (Appendix E).

Statement of Problem

Research Questions

The specific questions that this study attempted to answer included:

1. Did learners retain an understanding of material in the WHMIS module over a

period of time, as demonstrated by their post-test scores (scores remain the same), over the two testing periods?

2. Were features of the learning environment, such as flexibility of that environment, ease of use of learning materials, and hours worked per week correlated with learner outcomes, such as, achievement on post-tests and self-reported learning?
3. Were certain learner characteristics (prior WHMIS training, educational attainment, age, gender, comfort with computer technology) significantly correlated with the learner outcome variables self-reported learning and achievement on the two post-tests?, and
4. Was the learner outcome variable, self-reported learning, an accurate reflection of student learning, based on the student's actual scores on the two post-tests?

Definition of Terms

Environmental Variable. Students' actual experiences during the course of an educational program as mediated by the type of learning environment (classroom, online, teleconference) in which the learning occurs.

Far (or General/Vertical/Non-specific) Transfer. This type of transfer involves learning concepts or tasks that are quite different from the original knowledge or tasks. Learners must have the ability to grasp the underlying principles of the original task/knowledge, to locate the similarities between the original task and the new task, and

to apply that knowledge to a new task. For example, to calculate percentages a learner must know how to divide and multiply.

Input Variable. The personal qualities that students bring to an educational program, such as their prior knowledge, their educational background and their knowledge of computer-based learning environments.

Learner Achievement. Demonstration of an understanding of the material contained in the learning activities that are to be completed by each student, as measured by the scores obtained in the two post-tests that are administered to all students participating in the study.

Learning Environments. This term refers to the type of environment in which the majority of the learning in an educational program takes place. Examples of learning environments include web-based environments, and classroom environments.

Near (or Lateral/Specific) Transfer. Near transfer occurs when a student applies their prior knowledge and skills to situations that are very similar to the ones in which the original learning takes place.

Outcome Variable. Talents or skills that an instructional program tries to develop in the learner by the conclusion of the program.

Prior Knowledge. Domain specific knowledge that a learner possesses before beginning a program of instruction that may assist them in assimilating new knowledge.

Quality of Learning. This concept refers to the value of a particular instructional program as it is assessed through the data gathered from responses to questions about student satisfaction with instruction offered and student performance on post-tests.

Retention of Learning. Evidence that knowledge gained at one point in time is retained over time as evidenced by consistency in performance on tests over time.

Self-Reported Student Learning. Student self-reports of learning in the web-based environment are used to determine whether students feel that the learning objectives of the learning program are clearly outlined and expected learning outcomes are, in fact, achieved. This measure is also used to assess the degree to which students are engaged in the learning process.

Student Satisfaction. This is the degree of satisfaction that students express with their learning experiences in web-based learning environments and it is used to predict how likely it is that a student will take additional web-based courses.

Transfer of Learning. The effective application of the learner's prior knowledge and skills to a novel learning situation (Macaulay and Cree 1999).

Chapter 2: Literature Review

Introduction

Many courses offered by distance and traditional educational institutions are now delivered on the Internet, as entire courses or as elements of courses, such as, course outlines or notes. In the year 2000, American universities offered over 54,000 courses in the online environment and had an enrollment of 1.6 million students (McGorry, 2003). According to an Industry Canada sponsored survey conducted in 2000 of 134 participating educational institutions that included 49 universities, 75 colleges, and 10 CEGEPS, the universities offered an average of 30 online courses per institution per year, while the colleges offered 26 online courses per institution per year, and the CEGEPS offered 4 online courses per institution per year (Campus Computing International (Canada), 2000). These numbers have likely increased over the intervening four years as more and more post-secondary institutions now offer online course components or entire courses in the online environment. There are also virtual universities in Canada, such as the Canadian Virtual University (CVU), a consortium of existing educational institutions that offers 2,200 courses and 280 degree, diploma and certificate programs through online and traditional delivery methods. The rationale for using online learning formats is that the method of delivery is more cost-effective, flexible, convenient, and has the potential to enhance the quality of the learning experience (Allen et al., 2002; Bourne, McMaster, Rieger and Campbell, 1997; Mayzer and Dejong, 2003).

While many educators and educational institutions have decided to deliver educational programs online they have not adequately considered how they will evaluate

the effectiveness of these online programs. Recent studies have addressed the issue of quality in the online educational programs (Fresen, 2002; Sonwalkar, 2002) by looking at student performance (as assessed through formal and informal evaluations) and satisfaction in both online and face-to-face learning environments.

Other researchers have looked at the mechanics of how learners operate in the online environment and have tried to determine whether navigational aids ensure more effective learning experiences (Muller-Kalthoff and Moller, 2003). Still others have tried to determine whether learner characteristics have a greater influence on learner outcomes, such as achievement on tests and satisfaction with the learning experience, than do elements in the learning environment itself (Astin, 1993; Dochy, Segers, and Buehl, 1999; Grayson, MacDonald and Saindon, 2001). The literature review conducted for this research project included an assessment of published research reports in the following domains: quality of learning, satisfaction with the online learning environments, application of the I-E-O model, retention of learning, learner achievement, prior knowledge, and transfer of learning. The work of other researchers in the relevant fields was reviewed in an attempt to gain a better understanding of the factors in the learning environment and the learner's background that might have a positive or negative impact on learner outcomes.

Quality of Learning in Online Learning Environments

In her review article examining the issue of quality in online learning environments McGorry (2003) found that students' preference for online courses was strongly related to the following features of the learning environment:

- flexibility,

- responsiveness and student support,
- self-reported learning,
- participation in learning,
- perceived usefulness and ease of use of technology,
- technical support, and
- student satisfaction.

She adapted existing flexibility measures that were used to assess the effectiveness of videoconferenced learning environments for use in assessing the perceived flexibility of online learning environments. Each of the constructs used to assess flexibility was measured using a 5-point Likert scale, ranging from a low of 1 (Strongly Disagree) to a high of 5 (Strongly Agree). Examples of the questions asked to assess flexibility included the following:

- there were no serious disadvantages to taking this class via the Internet, and
- taking this class via the Internet allowed me to arrange my work for the class more effectively.

McGorry (2003) described responsiveness and student support as the institutional resources that must be available to assist students in completing their online coursework or programs. This included access to living human beings, such as instructors, but extended to the electronic resources that allowed the student to stay connected. McGorry (2003) assessed self-reported learning by adapting items developed at the University of Illinois. Some of these items included questions regarding how well students understood the concepts presented, were able to communicate effectively about the subject and identify the goals and outcomes of the instructional program as well as how actively they

were engaged in the learning process. The third factor that was used to assess the quality of online learning environment was how often students interacted with peers and instructors and participated in classroom activities. The fourth feature, the perceived usefulness and ease of use of technology, concerned how easy it was for students to use the navigational features of the learning management system, and how their experience with that system shaped their perceptions of the online learning experience. The fifth factor used to assess the effectiveness of online learning environments was an assessment of the quality of technical support that was available to learners. The last factor, student satisfaction, was a measure of how likely a student was to take another online course.

Buck (2001) found that there was no statistical difference between online and classroom based learning environments in terms of the quality of the instruction offered. However, Williams' (2002) felt that online learning environments were more effective than traditional face-to-face learning environments because online learning environments were non-linear and made better allowance for mental connections to be formed between the reading assignments and exercises and the concepts being taught. McDonald (2002) suggested that the effectiveness of online learning environments could be attributed to the presence of various computer mediated communication tools in these environments.

Student Satisfaction with Web-based Learning Environments

Thurmond et al. (2002) suggested that the major limitation of studies on student satisfaction with web-based learning environments was that they could not link the environmental variables, that is, the mode of instructional delivery (online, face-to-face), with the students' perceptions of their learning or with their actual learning outcomes.

They, as did Weirs-Jenssen, Stensaker and Grogaard (2002), found that students' expressed satisfaction with online learning environments was not so much an endorsement of that type of learning environment as it was a measure of the students' own prior knowledge of the course content, individual abilities, exam results, and their comfort with and skill in using computers.

Thurmond et al. (2002) tried to address the limitations of their study by controlling for learner characteristics, such as prior knowledge. They did this by applying the Input-Environment-Outcome (I-E-O) model developed by Astin (1993), which provided a framework for assessing educational programs in higher education. The basic premise of this model was that any assessment of the effectiveness of instruction could not be considered complete unless the evaluation process included information on student inputs, the educational environment and learning outcomes. Student inputs were defined as those personal traits, abilities or limitations that students brought to the educational programs they participated in, for example, their prior knowledge, as well as possible distractions from their school work, such as part time employment. Features of educational environment that could be included in any assessment of that environment include the mode of delivery of instruction, for example, online versus face-to-face or a specific instructional approach, such as drill and practice. An example of a learning outcome as defined by Astin (1993) would include a test score or a course grade. The I-E-O model was designed to control for differences between learners, so that an accurate determination of the impact of specific features of the learning environment on learning outcomes could be obtained.

The I-E-O model follows the principles of what Chickering and Gamson (1987) defined as good educational practice in undergraduate education. The principles on which Chickering and Gamson based their idea of good educational practice included:

- encouragement of faculty/student contact,
- development of reciprocity and cooperation,
- engagement in active learning,
- provision of timely feedback,
- emphasis on the amount of time dedicated to a task,
- communication of high expectations, and
- demonstrated respect for diversity.

Arbaugh (2000a, b) identified four factors that can influence student experiences in the online learning environment - perceived usefulness of course, flexibility, interactivity, student experience and engagement – that should be assessed in any evaluation of an online learning environment. Longhurst (2003, p.344) added another factor to this list, which he called readability, which he defined as "the ease with which the meaning of the text can be apprehended". In his study of students who took an online course at Carnegie Mellon University, Longhurst (2003) found that students were satisfied with web-based learning materials for the most part, but that they objected if the materials exceeded a certain length and became what they defined as less readable. Longhurst (2003) attributed the students' comments regarding online reading materials to problems with the structuring the materials, not to the students' overall dissatisfaction with the learning environment. As evidence for his position he noted that Carnegie Mellon University, the institution at which the study took place, was one of the most

'wired' universities in the U.S. and as such, its student body was quite familiar with the kinds of learning experiences that were available in the online environment.

Thurmond et al. (2002) found that certain variables, such as timely comment, variety of ways of assessing learning, and teamwork, had considerable predictive value in determining whether students were satisfied with their web-based courses. Their findings indicated that certain features of an online learning environment (communication tools, etc.) had a greater impact on student satisfaction than did learner characteristics. The current study examined the influence learner characteristics had on student satisfaction and compared that the influence to the influence of the learning environment.

Johnson, Aragon, Shaik and Pama-Rivas (2000) suggested that student satisfaction was positively influenced when the following criteria were met:

- transparent and functionally reliable and convenient technology,
- course design supported learner centred instructional strategies,
- instructors role was that of facilitator and coach, and
- learning environment was reasonably flexible.

In the Steele, Johanson-Palensky, Lynch, Lacy, and Duffy (2002) study that compared student satisfaction with a computer assisted instructional (CAI) package to use of a text book containing the same content, students expressed ambivalence about their use of CAI, although they were enthusiastic about certain aspects of the CAI program, such as the opportunity for immediate feedback on their responses to self-test questions. Feedback, or responsiveness, was one of the constructs that McGorry (2003) described as being an essential feature of the online learning environment. Steele et al.'s (2002) findings add weight to McGorry's (2003) assertion that online learning environment are

most effective when they are responsive to students, in terms of their provision of timely feedback. However, in a meta-analysis of studies that assessed student satisfaction with both classroom and distance-based instructional settings (included settings that used computer and web-based technologies), Allen et al. (2002) found that students expressed higher levels of satisfaction with classroom-based settings than with distance learning settings.

Other researchers found that learner characteristics had a significant impact on student satisfaction with the online learning environment. In a study done by Fredrickson, Pickett, Shea, Pelz and Swan (2000) women reported higher levels of perceived learning than men when both groups were involved in online learning environments. Additionally, this group of researchers learned that the oldest students in their study population, individuals between the ages of 36 and 45 years, reported much higher levels of satisfaction with their experiences in the online learning environment than the youngest cohort of students, those aged 16 to 25 years.

Researchers also discovered that a student's mood at the time of survey completion may influence his or her responses to questions in a student satisfaction survey (Wiers-Jenssen, Stensaker and Grogaard, 2002). However, as it is almost impossible to assess the influence of student mood at the time of evaluation, no attempt was made to collect data on student mood for the current study.

Elliott and Shin's (2002) study of undergraduate students taking an online course at a University in the American Mid-West revealed that student satisfaction with the learning environment may also be influenced by how well that learning environment matched the student's own preferences, for example, the student's need or desire for

interaction with peers and the instructor. The current study addressed these concerns to some degree by comparing the relative influence of learner characteristics on learning outcomes with specific features of the learning environment.

Learner Achievement and Web-based Learning Environments.

In their review of several studies on the efficacy of hypermedia Chen and Dwyer (2003) found that there was little empirical evidence showing that hypermedia or web-based learning environments improved learning outcomes. They outlined three major problems with hypermedia learning environments.

1. Students missed the most important information and spent too much time on unnecessary information, because of necessity of filtering through large amounts of information.
2. Students often had problems with spatial orientation in the context of the node-link structure of hypermedia learning environments and displayed a 'lost in hyperspace' syndrome, the symptoms of which included not knowing where they came from, and where they should go next.
3. Knowledge acquisition was hampered by learner's cognitive overload, resulting from the shear volume of information with which they are confronted.

The first two problems were essentially information retrieval problems and the last was related to human information acquisition, specifically cognitive overload. Chen and Dwyer (2003) suggested that designers of hypertext systems were primarily focused on information retrieval rather than learning. To remedy this they suggested that

designers develop a learning environment that focused on the learning process and not on the information retrieval process. In the current study instructional objectives were used to guide the learning process. They were used in conjunction with opportunities for exploratory learning as presented by exercises at the end of each learning activity that required research on specific topics on specific websites.

Chen and Dwyer's (2003) other criticisms of previous studies included the flaws in their methodological design, such as their lack of experimental controls, small sample sizes, and lack of application of research methods used in the social sciences. They also felt that most studies they reviewed were too technologically oriented and not grounded in knowledge of applied cognition.

The current study tried to address some of these concerns by using a quasi-experimental design in which students at each site were randomly assigned to two different test groups. It was not possible to use a true experimental design as the constraints imposed by one of the institutions at which the research was conducted included a stipulation that there would be no differential treatment of students, in terms of the instruction received.

Another criticism that Chen and Dwyer (2003) leveled at hypermedia studies was that they lacked a theoretical foundation in the design of their hypermedia systems, that is, they were designed with no instructional theoretical foundation, and simply emphasized the technical features of the learning environment. Again the current study attempted to address this concern by applying instructional system designs approach in the development of the instructional module and the I-E-O model as a theoretical frame with which to interpret the results of the study.

In contradiction to the findings of Chen and Dwyer (2003), Piccoli, Ahmad, and Ives (2001) determined that technologically mediated learning environments did have a positive influence on student achievement, as well as improving student attitudes towards their learning experiences, based on their review of the literature.

Prior Knowledge and Learning Outcomes

Chen and Dwyer (2003) also felt that previous studies on the effectiveness of online learning materials failed to pay attention to learner pre-requisites, that is, they failed to consider the learner's previous knowledge, aptitude, reading comprehension, and other characteristics. These learner traits have been found to be critical learning variables in determining how well students perform. This study addressed the concerns of Chen and Dwyer (2003), in part, by gathering information on students' past training in the specific knowledge domain being taught, as well as their experience in online learning environments and their highest level of educational attainment.

In addition to the research of Chen and Dwyer, there has been a considerable amount of research into the influence that prior knowledge has on student achievement in new learning contexts. In their review of the literature on prior knowledge Dochy, Stegers and Buch (1999) noted that there were two particular deficits in the theoretical grounding of the research in the area: vague definitions and confusion in the use of terminology. Based on their research they found a number of different terms for prior knowledge, such as, shared knowledge, archival memory, experiential knowledge, background knowledge, and personal knowledge. Dochy et al. (1999) defined prior knowledge as the whole of a person's actual knowledge that was

- available before a certain learning task,
- structured or based on a schema,
- declarative or procedural,
- partly explicit and partly implicit, and
- dynamic in nature and stored in an individual's knowledge base.

Their review of the research on the phenomenon of prior knowledge was limited to those studies that were empirically based, that is, those studies that used standardized assessment measures to evaluate achievement (i.e. multiple choice tests, open questions/completion tests, association tests, and free recall). Dochy et al. (1999) concluded that the availability and accessibility of prior knowledge may be related to another quality of knowledge that has also been investigated – the structure of prior knowledge. The literature on prior knowledge indicated that an expert learner structures knowledge hierarchically, a practice that allows these learners to make greater use of the information available to them. Dochy et al.'s (1999) review of the literature revealed that prior knowledge, specifically domain contingent knowledge, can be used to explain a considerable amount of variability in learner performance in novel learning situations.

In their study of how prior knowledge influenced the extent to which learners encountered problems navigating hypertext environments Muller-Kalthoff and Moller (2003) found that learners with less prior knowledge seemed to have greater difficulty navigating online content than did learners with high prior knowledge of a particular topic. They suggested that giving less knowledgeable learners fewer opportunities to get 'lost in hyperspace' may be one solution to the navigation problems certain learners experience. A learner was likely to be experiencing cognitive overload (Muller-Kalthoff

and Moller, 2003) in the hypertext environment if they experienced the following symptoms:

- difficulty gauging the scope of hypertext,
- uncertainty about the route taken to arrive at current location,
- uncertainty about where one was in relation to other nodes of hypertext,
- difficulty deciding which node to move to next, and
- being unaware of which nodes had already been visited.

Retention of Learning and the Online Learning Environment

While prior knowledge has been found to be an important piece of baseline information to have in terms of determining the efficacy of a learning program, it has also been shown to be necessary to know how well learners retain information over time. Neafsey, Strickler, Shellman, and Chartier (2002) conducted a study to test the efficacy of a CAI program designed to teach elderly people about the potential for adverse outcomes when over-the-counter medications were taken in conjunction with alcohol. Their findings led them to conclude that there was no significant time effect on either self-efficacy (willingness of people to apply the knowledge gained as result of computer based training on an ongoing basis) or knowledge assessment (test administered following training).

In a study that compared the efficacy of computer-based instruction with a classroom program, Issa, Cox and Killingworth (1999) found that student performance improved from the first post-test to the retention test, which was administered three weeks following the initial test. They suggested that this increase in score could be

attributed to the testing formats (multiple choice and True/False) that were used. When the retention scores for students trained in each of the settings were assessed for statistical significance the analysis indicated that there was a significant advantage associated with use of the CD-ROM training program as compared to the classroom-based training program. Issa, Cox and Killingworth (1999) hypothesized that students using the CD-Rom program received multiple exposures to the material, and that these multiple exposures produced increased levels of retention. This theory of multiple exposures producing improved learning was similar to a phenomenon called 'overlearning' that Farr (1987) discussed in his review of the literature on learning and retention. He suggested that overlearning can reduce or delay the loss of information. Farr (1987) tried to quantify the rate of knowledge/skill loss by proposing a formula for calculating the 'curve of retention'. This curve of retention was based on a comparison of the time that it took a person to re-learn material previously learned but lost, with the amount of time it took for the original learning to occur. Farr (1987) suggested that the type of learning tasks involved might also influence the rate at which the knowledge of it was lost. Specifically, he suggested that motor skills were more resistant to loss.

The current study looked at how well students retained information from review of the WHMIS module by comparing test scores from one testing period to another and determining whether there were any factors in the learning environment or any learner characteristics that influenced the retention rate.

Transfer of Learning

Like knowledge retention, transfer of learning has been found to be an essential part of the process by which students store and utilize the information they acquire in learning environments. The first individual to systematically study the phenomenon of transfer of learning was Thorndike (Gick and Holyoak, 1987; Singley and Anderson, 1989). His theory of transfer was referred to as theory of the 'identical element', and it suggested that training in one situation only actively transferred to another situation if the activities involved in each learning situation shared common stimulus-response elements. The main criticism of Thorndike's theory of transfer was that it essentially denied the existence of transfer by insisting on the duplication of conditions from learning situation to another (Singley and Anderson, 1989).

Gagne also investigated the phenomenon of transfer and distinguished between two types of transfer, lateral and vertical (Singley and Anderson, 1989). He defined lateral transfer as transfer that spreads over a broad set of situations at roughly the same level of complexity, for example the type of transfer learning required for second language learning. Vertical transfer has been defined as transfer between lower and higher level skills, where lower level skills constitute pre-requisites that need to be mastered before higher level skills can be acquired.

Marini and Genereux (1995) criticized earlier research on the phenomenon of transfer of learning for fuzziness in the definition of transfer, and for a lack of focus on the context in which transfer took place. Cormier and Hagman (1987) found that many previous studies on transfer included errors in measurement which were produced by small sample sizes, and differential treatment of groups.

The work of Macaulay and Cree (1999) and Singley and Anderson (1989) both suggested that there were some essential elements in successful incidences of transfer of learning: the learner (their knowledge and characteristics), the task, and the learning context. Singley and Anderson (1989) further subdivided the element of learning context into the instructional context (original context in which learning occurred) and the transfer context (context in which the prior learning was to be applied).

Successful transfer may also be dependent on the learner's ability to access the resources needed to facilitate the transfer. Marini and Genereux (1995) suggested that learners must be able to recognize appropriate transfer situations and must have the necessary motivation to take advantage of transfer opportunities. Their ideas were similar to those of Macaulay and Cree (1999) who stressed the importance of a suitable learning climate and a productive learner attitude.

The current study attempted to assess the efficacy of the learning module and thus the learning environment by gathering information on the learners' prior knowledge of the content of the module and their experience with computer technology and web-based learning environments. However, given that transfer of learning has been described as a subconscious process by Macaulay and Cree (1999), in which the learners reconstruct old knowledge so that it fits with new knowledge or experiences, it was difficult to gather accurate data on the phenomenon.

Halpern and Hakel (2003) came to the conclusion that the most important factor in the promoting long term retention of knowledge and transfer of learning is "practice at retrieval", based on their review of the literature on transfer of learning. The basic principle behind this technique is that the more frequently information is retrieved, the

more retrievable it becomes. Their research indicated that additional practice or increases in the amount of time spent reviewing material, if not used in concert with retrieval behaviors, are not that effective. Halpern and Hakel (2003) suggested that students be asked to practice retrieval of information throughout an educational program, whether the program is online or face-to-face.

Gick and Holyoak (1987) suggested that transfer only occurred if conditions at retrieval (transfer situation) were such that they allowed the learner to access and apply the appropriate knowledge to the new learning situation. In addition, their model emphasized the importance of prior knowledge in the success of transfer. The current study tried to address the imbalance between practice and retrieval by asking students to complete problem-based exercises as part of the learning module. Although the exercises were optional students were advised that it was in their best interest to complete them. The study also attempted to gain information about the prior knowledge students had of the topic being taught.

Evaluating Online Instructional Materials

While student evaluations of the effectiveness of online instructional modules have a place in assessing such modules, it has been suggested that to be truly representative evaluations should look at all of the following elements - learning outcomes, cost/benefits of producing instructional package, learner motivation, and learner attitudes towards instruction (Schmeeckle, 2003). Some authors have expressed the view that the majority of research studies that purported to evaluate the effectiveness of online instructional modules were flawed because they started from the assumption

that one mode of instructional delivery was superior to another, that is, they compared classroom teaching to technology mediated instruction (Joy and Garcia, 2000) or they relied on student self-reports of learning effectiveness (Rovai, 2003). Studies on the effectiveness of the online learning environment have also tended to conflate a number of different variables, such as medium of instruction, learning environment (online versus face-to-face), technical issues (problems accessing online resource materials), and the student's proficiency in computer-based learning environment into a single variable (delivery mode) (Joy and Garcia, 2000). The current study attempted to separate the influences of student characteristics (prior knowledge, level of education, age) from the effect of the learning environment by controlling for student characteristics in the data analysis.

McGorry (2003) suggested that there were seven concepts/constructs that needed to be evaluated in online learning environments – flexibility, responsiveness and student support, self-reported learning, interaction, ease of use technology, technical support, and student satisfaction. The current study focused on four of the concepts discussed by McGorry (2003) – flexibility, student self-reported learning, technology, and student satisfaction – as the other concepts could not be assessed due to limitations of the web-based instructional module that was utilized. The module did not include a conferencing component, as it was intended to operate as a standalone module that could be used by a number of different instructors in a variety of courses. As a result faculty-student and student-student interaction was absent, as were elements of technical support (except for statements indicating the technical requirements for participation in the module, and any

assistance that instructors who were facilitating the current provided to the students at their institution).

Summary

A review of the research in the literature indicated that there were a variety of factors that influenced how successful an instructional program was, in terms of its ability to impart the relevant information to the learner. One of the measures of an instructional program's success was how well learners retained information taught by the program. Retention of information learned was a function of the original learning event, learner characteristics (how able a learner is), and the type of activity being learned. Another factor that was found to influence learning outcomes was how much prior knowledge learners had of the content being taught. Much of the research on prior knowledge found that learners with greater background knowledge seemed to do better in new learning situations than did learners with limited background knowledge. This could be attributed to their status as experts in the field relative to other learners and thus better users of the available information. How well the novel learning situation was able to facilitate the transfer of knowledge from one knowledge domain to another also had an impact on how well the information was encoded and retained. The literature reviewed indicated that there were two basic types of transfer: lateral and vertical. Lateral transfer occurred in learning situations that were quite similar to one another and vertical transfer occurred in learning situations in which the knowledge being applied was quite different than the knowledge acquired in the original learning situation. Prior knowledge, degree of transfer

of knowledge and the amount of knowledge retained over a given time were all found to impact the success of instructional programs.

A review of the literature dealing with the efficacy of the online learning environment revealed that there were significant differences of opinion among researchers as to the relative influences of learner characteristics and the actual learning environment on the quality of the learning taking place. In order to distinguish between the effects of learner characteristics and the learning environment on learner outcomes (learner achievement, student satisfaction) one needs to control for one of these two factors. This study took the approach that McGorry (2003) proposed, that involving control of learner characteristics. This was done so as to increase the validity of the conclusions drawn from this study as to the source of positive learner outcomes. The theoretical framework used to assess the efficacy of the learning environment/setting, was the Input-Environment-Outcome model first developed by Astin (1993). This model was used because of its reported ability to assist in distinguishing between the influences of various inputs, such as, learner characteristics and environmental variables.

Chapter 3: Methods

Research Questions

The specific questions that this study attempted to answer included:

1. did learners retain an understanding of material in the WHMIS module over a period of time, as demonstrated by their post-test scores (scores remain the same), over the two testing periods?
2. were features of the learning environment, such as flexibility of that environment, ease of use of learning materials, and hours worked per week correlated with learner outcomes, such as, achievement on post-tests and self-reported learning?
3. were certain learner characteristics (prior WHMIS training, educational attainment, age, gender, comfort with computer technology) significantly correlated with the learner outcome variables self-reported learning and achievement on the two post-tests?, and
4. was the learner outcome variable, self-reported learning, an accurate reflection of student learning, based on the student's actual scores on the two post-tests?

Sampling Method

A true experiment is typified by randomization, or the random assignment of different treatments to individuals involved in the study. Although this study did not use different treatments, it did use the principle of randomization to conform to the constraints of a post-test only experimental design outlined in Campbell and Stanley (1963). While this type of experimental design did not have a true control group, it did

allow for examination of the relative effects of an intervention/treatment. The specific type of random sampling used in this study was defined by Bloom, Bos and Lee (1999) as the blocked random assignment method. This method of random sampling required that half of the individuals from each of the study sites be assigned to one test group, while the other half were assigned to the second test group. Selection of the individual names occurred by assigning each student a personal identification code and placing pieces of paper with these unique codes on them in a container. Every second name selected from the container was assigned to test group two. All remaining names were assigned to test group one. Instructions on how to assign students randomly to each of the two test groups were provided to the individuals who performed the random assignments at each of the college sites.

Sample Populations

Students from two different vocational colleges participated in this study. One group of students was from a vocational college in a city in the southern part of the province referred to as Mountain View College. The students from Mountain View College who participated in this study ranged in age from 23-45, most were ESL students while others were students in programs designed to upgrade their current qualifications and to allow them to obtain better employment. Many of the ESL students had technical, college, or university training in their countries of origin, and they sought employment in their fields by increasing their functionality in English. The second group of study participants was a group of Emergency Medical Technicians who took courses through a vocational college in the northern part of the province referred to as Boreal Forest

College. These students took the module as part of a distance learning course.

Limitations of Study

There were several limitations to the current study, however, the major limitation of this study was the lack of a control group. The ethical guidelines at one of the educational institutions at which this study took place did not allow for differential treatment of students, a fact that necessitated the use of alternate means to test the efficacy of the module. In order to mitigate the situation, an alternate research design was selected that involved the collection of data from two post-tests and a quality of learning questionnaire. Another limitation of the study was the process by which variables were categorized as input, environmental and outcome variables. However, an attempt was made to address this concern by categorizing variables based on the best fit between the definition of the variable types and the specific variables.

Another limitation of the study was also related to variable assignment to the three variable categories but concerned the decision to include certain variables (i.e. age, gender, prior knowledge) in certain categories, such as Inputs, but not include other variables (i.e. college GPA). The variables selected were chosen because they represented variables for which data could be easily collected. For example, it was not possible to collect data on the student's college GPA. An additional limitation was the reliance on self-report data from the Quality of Learning Questionnaire While self-reports were not an ideal way to gather information they were the most practical means of gathering information on student perceptions of the efficacy of the learning module and their satisfaction with their learning experiences. This deficiency was addressed in the

current study by comparing the results of the student satisfaction survey data with learner achievement on the two post-tests.

An additional difficulty was the lack of preliminary testing of the subscales that were used to collect data on flexibility of learning environment, student satisfaction with learning, self-reported student learning and ease of use of technology. Given the short time frame over which the study was conducted, it was not possible to assess the quality of learning subscales with a preliminary group of participants. It also proved necessary to reduce the number of questions asked for each of the subscales due to the fact that the institutions at which the study was to take place would not permit a longer survey.

The constraints imposed during the development of the module highlight another limitation of the study, which was the number of features of the online learning environment that were available for evaluation. The module was a standalone learning tool that could be used by any instructor with a WHMIS requirement for their course. As a result, the conferencing facilities that were part of the learning management system were not enabled. This meant that there was limited interaction between faculty and students and between students. Certain features of the online learning environment that researchers assessed in previous studies (interaction between students and faculty, technical support) were not assessed in the current study. However, this did not mean that students had no contact with faculty just that this study was unable to track that interaction.

Other limitations of this study were related to the extraneous variables about which no data was collected. These variables include

- the site at which the students accessed the module (home, school, public library),
- the connection speed of the modem used, and
- whether peer learning strategies occurred.

Definition of Variables

Using McGorry's (2003) adaptation of Astin's I-E-O model there were three types of variables for which data were gathered in this study: input, environmental, and outcome. The outcome variables were dependent on the environmental and input variables. The environmental and input variables were projected to have predictive value with respect to the outcome variables.

Input Variables

- Age (Independent)
- Gender (Independent)
- Familiarity with technology (Independent)
- Highest level of educational attainment (Independent)
- Comfort Level in Online Environment (Independent)
- Previous Online Courses

The input variable data was used as baseline information on how prepared students were in terms of earlier learning, and computer experience, prior to their exposure to the environmental variables, such as, learning environment and associated features.

Environmental Variables

- Hours worked per week (Independent)
- Flexibility of learning environment (Independent)
- Ease of use of technology (Independent)

Outcome Variables

- Learner achievement (Dependent)
- Retention of learning (Dependent)
- Student satisfaction (Dependent)
- Self-reported student learning (Dependent)

The dependent variable learner achievement was the aggregate of the two scores an individual obtains on the two post-tests administered following completion of the module. Learner retention was measured by comparing the first test score with the retention test (second post-test) score. Information on the outcome variables student satisfaction and self-reported student learning was gathered using a questionnaire that was administered after students completed the learning module. A copy of this survey was provided in Appendix E.

Materials

The instructional module that was used in this study was designed in adherence with the Mountain View College guidelines for instructional materials and conformed to a structure that has the following basic elements:

- Statement of learning goals

- List of key concepts to be covered
- Directions as to what needs to be done
- Reading material
- Exercises
- Review
- Discussion
- Test

The module was estimated to take two to four hours for students to complete, and consisted of nine learning activities. Students were expected to read or view the instructional material, then complete the exercises in each learning activity. Feedback consisted of providing answers to the exercises contained in the learning activities. At Mountain View College students had the option of completing this module in the college's learning centre or at an offsite location (that is, a home computer). At Boreal Forest College, students completed the module on their home computers.

The online learning environment can be seen as resource rich, and can be assumed to provide learners with the opportunity to search the Internet for information on a particular subject. One assignment in the module used in this study required that the learners search the Internet for information on a particular hazardous product and then prepare a label from that information. An example of a learning activity was provided in the Appendix A.

An example of the kind of exercises that were used in the context of learning activities was provided in Appendix B.

Method of Assessing Learner Achievement

Post-Tests. Assessment of learner achievement was based on individual students' performance on the two post-tests. Each post-test was twenty questions in length. Questions were based on material covered in each of the learning activities. Those topic areas considered more crucial have been more heavily weighted (more questions will be included in the test from these categories). The two post-tests used to gather data on learner achievement were submitted to two sets of experts for review and were approved by these experts.

Measurement of Prior Knowledge

Prior knowledge referred to domain specific knowledge, specifically to prior training in WHMIS. One of the questions on the Quality of Learning Questionnaire asked participants to indicate whether they had prior training in WHMIS.

Measurement of Retention of Learning

Student retention of learning from the learning module was assessed by comparing the post-test score obtained during the first testing period with the score obtained during the second testing period. The time period between the first test and the second test ranges in length from two and four weeks. Because the different institutions had different schedules (for example, the vocational college in the northern part of the province met infrequently and there was a gap of four weeks between the two post-tests, based on the scheduling of the face-to-face sessions of what is for the most part a distance education course) it was not possible to administer the two post-tests at exactly the same intervals at

each of the institutions. The table below illustrates how the testing scheme was used to measure retention.

	Assigned Test Group	Test Administration Sequence	
Institution 1	1	Post-Test I	Post-Test II
	2	Post-Test II	Post-Test I
Institution 2	1	Post-Test I	Post-Test II
	2	Post-Test II	Post-Test I

Measurement of Student Learning (Self-Report)

Assessment of student learning based on self-reports of learners was accomplished using data gathered from the Quality of Learning Questionnaire (Appendix E) which included directions on which questions in the survey were used to measure student learning. The questions ask students about their engagement in the learning process, whether they felt that they had adequate information to complete the module successfully, and whether they felt the module expanded their knowledge of the subject matter.

Measurement of Student Satisfaction

The degree to which students were satisfied with their online learning experience was measured through the use of a Quality of Learning Questionnaire (Appendix E), and specifically through the questions that were developed to assess student satisfaction. Examples of the questions that were asked included whether students would be willing to take another course that was delivered by the Internet based on their experience with the learning module, and whether they felt satisfied with the instruction they received through

the learning module. Specific examples of the types of questions are provided in Appendix E.

Measurement of Flexibility of Learning Environment

This was a measure of how flexible learners considered the online learning environment to be as measured through questions contained on the Quality of Learning Questionnaire (Appendix E). Examples of questions asked to assess the flexibility of the learning module/environment included whether students felt that there were any disadvantages associated with use of the Internet to complete the module, and whether the learning module allowed them to arrange their work schedule more effectively.

Measurement of Ease of Use of Technology

This subscale measured how easy the online learning module and related materials (videos, exercises, links) were to access and use. Examples of the types of questions that were asked to assess ease of use include whether students had problems while working through the module, whether the layout of the page was simple to use, and whether the environment increased their productivity. The specific questions used to assess this measure are listed in the Quality of Learning Questionnaire (Appendix E).

Data Analysis

A paired samples t-test was used to compare the results obtained on the two post-tests. This statistical method was selected because it allowed for testing the null hypothesis that the difference in the means of two related variables (the two post-test scores) was zero. A paired samples t-test was used to determine whether the two post-test scores were significantly different. In addition, the Pearson's correlation coefficients was

calculated to assess the relationship between predictor variables, such as, highest level of education, work hours per week, prior WHMIS training, comfort with computers, experience in online learning environments and the variables being used to measure learning outcome (learner achievement on two post-tests, retention of learning, student satisfaction, self-reported student learning). The post-test scores were evaluated by calculating Pearson's correlation coefficient. Correlation coefficients for the questions contained in and the subscales derived from the Quality of Learning Questionnaire were also calculated to determine the degree of inter-item (inter-question) and inter-scale interaction.

A hierarchical multiple regression analysis was conducted to control for the influence of learner characteristics on learning outcome measures. This analysis was based on a similar one undertaken by Thurmond et al. (2002). By controlling for learner characteristics it was hoped that the relationship between student satisfaction and the learning environment variables, such as flexibility of learning environment and ease of use of module, could be made more explicit.

The reliability of the subscales used to assess the quality of the learning were evaluated using Cronbach's alpha.

Ethics

Students were informed through a consent statement and an accompanying letter as to the purpose of the study, the kind of commitment that the researcher was asking for, and also the ethical standards of the institution which had approved the study, the University of Alberta. Specifically students were informed that their identities were protected, that the information that was being gathered would be used for the purposes of

completion of a Master's thesis and possibly for publication, and that they had the option to withdraw from the study at any point. Participating students were also instructed that the researcher would endeavour to ensure that no harm should come to them as a result of participating in this study.

Chapter 4: Results

Survey/Post-Test Completion Rates

Two different sample populations, one from Boreal Forest College and one from Mountain View College, participated in the current study. A total of 25 students from Mountain View College participated in the study and of that number 18 students completed both tests, while only 15 responded to the student satisfaction survey. Of the individuals from Mountain View College who completed the Quality of Learning Questionnaire, only one individual did not complete all questions in the survey. There were a total of 20 participants at the start of the study at Boreal Forest College, all participants completed at least one of the post-tests, while only 16 people completed both post-tests. Of the people who participated in the study at Boreal Forest College ten individuals completed the Quality of Learning questionnaire. However, the data collected at the site was not linked to individual participants, so it cannot be compared to scores obtained on the two post-tests. Based on communications with the person who tabulated the data it was discovered there was no way to link the data with individual participants.

Demographic Data

Table 1 provides demographic data on the students who participated in the study at the Boreal Forest College site.

Table 1: Population Statistics for Boreal Forest College

Population Measure	Frequency	Valid Percent
Gender		
Males	14	87.5
Females	2	12.5
Age Group		
20-24	1	10
25-29	3	30
30-34	1	10
35-39	2	20
39-44	2	20
45-49	1	10
No Information	10	

The students at Boreal Forest College were all students in a Emergency Medical Technician program, and of a total of 20 original participants, 16 were male and four were female. Of the 16 students who completed both post-tests (there was some attrition from the total due to illness (three students), and one student quit the course), 14 were male and two were female.

Table 2 summarizes the population statistics for students from Mountain View College who participated in the study.

Table 2: Population Statistics for Mountain View College

Population Measure	Frequency	Valid Percent
Gender		
Males	10	71.4
Females	4	28.6
No Information	4	
Age Group		
30-34	4	28.6
35-39	3	21.4
39-44	7	50.0
No Information	4	

Table 3: Learning Inputs Data – Quality of Learning Questionnaire

	Response (Frequency)							
	Y [a]	N [a]	1	2	3	4	5	6
I have received WHMIS training in the past	13	12						
I feel comfortable completing coursework and assignments on the computer.	22	3						
I have taken courses that had web-based components (course schedule, assignments, readings) or were offered entirely online, prior to taking this learning module.	15	9						
My highest level of educational attainment (including degrees/diplomas awarded outside of Canada) is _____. [b]			1	3	3	3	6	9
I spend ___ hours per week working at my job. [c]			6	1	4	2	0	11

Note. [a] Y = Yes, N = No [b] Level of Education. [c] Hours worked per week. 1 = 1-3 hrs, 2 = 4-6 hrs, 3 = 7-9 hrs, 4 = 10-12 hrs, 5 = 13-15 hrs, 6 > 15 hrs

1 = Some High School, 2 = High School Diploma, 3 = Some College, 4 = College Diploma, 5 = Undergraduate Degree, 6 = Graduate Degree

Tables 1 and 2 provide information on the makeup of the population of students from each of the college's at which the study was conducted. Of students from Mountain View College who participated in all aspects of the study (completed both post-tests and the survey) ten were male and four were female. The majority of the participants (seven of a total of 15 participants) were between the ages of 39 and 44. Combining the data from both sample populations of individuals who responded to the Quality of Learning questionnaire, 24 of the participants were male and six were female.

Of all participants from both sites who responded to the questionnaire 13 indicated that they had received WHMIS training in the past, while 12 had not received such training. Most of the study participants who responded to the survey (22 individuals) expressed comfort with working in online learning environments. A small majority of participants (15 out of 24 respondents) who responded to the questionnaire indicated they had received some course work or instruction in the online environment, prior to completing the WHMIS module used in this study. The majority of people participating in the study indicated that they had some post-secondary training (21 of 25 individuals who responded to survey), and nine of those individuals who indicated that they had post-secondary training indicated that they had graduate degrees. Of those individuals who responded to the survey 11 out of 25 said that they spent more than 15 hours a week working.

The majority of people who responded to the survey (21 out of 25) Strongly Agreed or Agreed with statement, "This module expanded my knowledge and understanding of the subject matter". Of the people who completed the survey, 21 of 24

individuals either Strongly Agreed or Agreed with the statement "If I had another opportunity to take an instructional program via the Internet I would gladly do so". Of the individuals who completed the survey, 19 of 25 individuals either Strongly Agreed or Agreed with the statement, "The quality of instruction in this learning module served my needs well".

Table 4: Frequency of Responses to Quality of Learning questionnaire

	Response Frequency - Likert Scale Rating				
	1	2	3	4	5
The advantages of taking this course via the Internet outweighed disadvantages.	3	14	5	3	0
There were no serious disadvantages to taking this learning module via Internet.	1	19	2	2	0
Taking this learning module via the Internet allowed me to arrange my work schedule more effectively.	8	16	0	0	0
This module expanded my knowledge and understanding of the subject matter.	5	16	2	2	0
I was provided with all the information that I needed regarding the module's objectives and ideas.	9	10	6	0	0
I felt that I was actively engaged in the learning process as I worked through this module.	5	14	3	2	0
If I had another opportunity to take an instructional program via the Internet I would gladly do so.	5	16	2	2	0
I was very satisfied with the instruction that I received in this learning module.	4	15	2	3	0
The quality of instruction in this learning module served my needs well.	3	16	6	0	0
I felt that the quality of instruction offered by this module was largely unaffected by conducting it via the Internet.	3	14	5	2	0
I did not have any technical problems	5	14	1	0	3

as I worked through this module.					
The format and page design of the online module was easy to use.	7	12	2	1	2
I found that using the Internet to conduct research for this instructional module enhanced my productivity.	5	12	5	2	0

Note: Likert scale used in this study was one in which 1 = Strongly Agree, 2 = Agree, 3 = Don't Know, 4 = Disagree, and 5 = Strongly Disagree.

Subscale Reliability

Cronbach's alpha was calculated for each of the subscales for which data was gathered: Flexibility of Learning Environment, Student Satisfaction with Learning, Self-Reported Student Learning, and Ease of Use of Technology. A summary of the correlation coefficients for each of the questions asked was provided in Appendix H. This data was only available for the participants from Mount View College.

Based on the results of the correlation matrix for all questions that contribute to subscales designed to measure quality of learning, there were correlations within questions in the subscale and between subscale measures. The most significant correlation between questions within separate subscales was that between Question 13, part of the Self-Reported Learning subscale and Question 15, part of the Student Satisfaction subscale. The correlation between these two questions was 0.940 ($p < 0.01$, 2-tailed). The most significant correlation between questions within the same subscale was that between Question 18 and 19 which are part of the Ease of Use of Technology subscale. The correlation between these two questions is 0.766 ($p < 0.01$, 2-tailed). Table 5 summarizes the reliability coefficients for each of the subscales: flexibility of learning environment, student satisfaction, self-reported learning, and ease of use of technology.

Table 5: Reliability Coefficients for Quality of Learning Subscales

Subscale	Cases	Items	α
Flexibility of Learning Environment	14	3	.525
Student Satisfaction	14	4	.583
Self-Reported Learning	14	3	.625
Ease of Use of Technology	14	3	.345
All subscales	14	13	.734

None of the reliability coefficients is 0.80 or higher, which is considered to be an acceptable value for such coefficients in most Social Science applications. However, the alpha coefficient for all subscales is 0.734.

Research Question One

Did learners retain an understanding of material in the WHMIS module over a period of time, as demonstrated by their post-test scores (scores remain the same), over the two testing periods?

Hypothesis One

There was no significant difference between the results obtained on the two post-tests over the testing period (2-4 weeks in duration).

The paired samples t-test was calculated to assess whether the results from the two post-tests were significantly different from one another. A summary of the means for each of the post-tests was provided in Table 6.

Table 6: Descriptive Statistics for Post-Test Results

	Mean	N	SD	Std. Error Mean
Post-Test I (PTI)	17.35	34	2.07	.36
Post-Test II (PTII)	16.94	34	1.50	.26

The mean values for Post-Test I and Post-Test II differed by only ± .41.

The results of the analysis for the paired samples t-test were contained in Table 7.

Table 7: Paired Samples T Test for Post-Test Results

Pair	Paired Differences Mean	SD	SE Mean	t	df	Sig. (2-tailed)
PT I - PTII	.41	2.35	.40	1.022	33	.314

According to the results of the paired samples t-test the obtained value was t = 1.022, which was outside of the critical region ($-2.736 \leq t \geq 2.736$). This means that the null hypothesis cannot be rejected, that is, it cannot be assumed that the two post-test scores are significantly different. This finding indicated that the two tests were designed in such a way as to test the same content at the same level of difficulty.

Table 8: Change in Average Test Results over Two Testing Periods

College/Test Group	Average Score on Post Test		Standard Deviation	
	Post-Test I	Post-Test II	Post-Test I	Post-Test II
Boreal Forest				
Test Group 1	17.44	16.00	1.01	1.58
Test Group 2	17.14	16.71	2.27	1.70
Mountain View				
Test Group 1	16.88	17.38	2.03	1.19

Test Group 2	17.80	17.60	2.78	1.17

Table 8 summarizes the average test scores for each test group at each of the colleges at which this study was conducted. Based on the average test scores calculated for individuals attending Boreal Forest College there was a decrease in the average test score from the first testing period to the second for those individuals who were assigned to test group one, that is, those individuals who completed Post-Test I prior to completing Post-Test II. There was an increase in the average test scores, from the first to the second testing period for Boreal Forest students assigned to test group two, a group that consisted of those individuals who completed Post-Test II prior to completing Post-Test I. Table 9 provides data on how well students assigned to each of the test groups at each college retained information from the first to the second testing period by providing frequencies for the number of individuals whose scores did not change, increased or decreased.

Table 9: Summary of Retention Results for Both Institutions and Test Groups

Institution	Test Group	No Change	Decrease	Increase
Boreal Forest	1	2	7	0
	2	2	2	3
Mountain View	1	2	3	3
	2	1	3	6
Totals		7	15	12

The average test scores for individuals at Mountain View College did increase over time for both test groups. For individuals assigned to test group one there was an average increase of 0.5 points overall, while for individuals assigned to Test Group 2 there was a smaller increase of 0.2 points overall.

The finding that students at Mountain View College demonstrated a greater overall increase in their test scores over time than students at Boreal Forest College may be a result of the fact that the majority of the students at Mountain View College spent less time working each week than did students at Boreal Forest College. Of the ten individuals from Boreal Forest College who responded to the questionnaire, nine indicated that they worked more than fifteen hours per week. However, only two of the fifteen people from Mountain View College who responded to the questionnaire indicated that they worked more than 15 hours per week.

Of the 34 people who completed both post-tests 12 experienced an increase in their test score from the first to the second testing period. Fifteen of the individuals who completed both post-tests experienced a decrease in their test scores over the testing period. Seven individuals experienced no change in their score from the first to the second testing periods.

Research Question Two

Were the features of the learning environment, such as flexibility of that environment, ease of use of learning materials, and hours worked per week correlated with learner outcomes, such as, achievement on post-tests?

Hypothesis Two

There was no significant correlation between the independent (environment / predictor) variable, flexibility of learning environment and the dependent (outcome) variable, learner achievement.

Based on the analysis in Table 10 there was not a significant correlation (ρ = 0.067) between the environment variable, flexibility of learning environment, and the outcome variable, learner achievement. This finding did not allow for the rejection of the null hypothesis.

Hypothesis Three

There was no significant correlation between the independent (environment / predictor) variable, flexibility of learning environment and the dependent (outcome) variable, self-reported learning.

The analysis in Table 10 showed that the correlation (ρ = -0.084) between the environment variable, flexibility of learning environment, and the outcome variable, self-reported learning was not significant. This finding did not allow for the rejection of the null hypothesis.

Hypothesis Four

There was no significant correlation between the independent (environment / predictor) variable, ease of use of technology and the dependent (outcome) variable, learner achievement.

The analysis in Table 10 revealed that there was not a significant correlation (ρ = 0.333) between the environment variable, ease of use of technology, and the outcome variable, learner achievement. This finding did not allow for the rejection of the null hypothesis.

Table 10: Correlation Matrix Learner Characteristics and Learning Outcomes

	ACH	T1	T2	AGE	SEX	TRN	COM	WEB	EDU	HRS	FLX	RPT	SAT	EAS
ACH[a]	1.000													
T1[b]	0.528*	1.000												
T2[c]	0.780**	-0.119	1.000											
AGE	-0.236	0.043	-0.173	1.000										
SEX	0.145	-0.206	0.389	-0.493	1.000									
TRN[d]	0.600*	0.307	0.677**	-0.030	0.107	1.000								
COM[e]	0.212	0.155	0.223	0.013	-0.189	0.161	1.000							
WEB[f]	-0.196	-0.020	-0.407	-0.264	-0.289	-0.123	0.327	1.000						
EDU[g]	-0.035	0.266	-0.295	0.284	-0.839**	0.033	0.202	0.176	1.000					
HRS[h]	0.262	0.602*	-0.163	-0.070	-0.581*	0.035	0.063	0.511	0.582*	1.000				
FLX[i]	0.067	0.332	-0.137	0.528	-0.426	-0.145	0.416	0.047	0.216	0.203	1.000			
RPT[j]	0.284	0.130	0.407	0.415	-0.356	0.624*	0.199	-0.352	0.388	-0.160	-0.084	1.000		
SAT[k]	-0.055	0.004	0.057	0.604*	-0.383	0.198	0.116	-0.060	0.317	-0.045	-0.049	0.731**	1.000	
EAS[l]	0.333	0.219	0.437	0.430	-0.166	0.166	0.528	0.013	0.143	-0.123	0.109	0.556*	0.680**	1.000

Note. [a] ACH = Combined score on two post-tests. [b]T1 = First post-test. [c]T2 = Retention test TRN = [d]Prior WHMIS Training. [e]COM = Comfort Level in Online Environment. [f]WEB = Previous Online Courses. [g] EDU = Highest Level of Educational Attainment. [h] HRS = Hours worked per week.

[i] FLX = Flexibility of Learning Environment. [j]RPT = Self-Reported Learning. [k]SAT = Student Satisfaction with Learning. [l]EAS = Ease of Use of Technology.

* $p < 0.05$ level, 2-tailed. ** $p < 0.01$ level, 2-tailed.

Hypothesis Five

There was no significant correlation between the independent (environment/predictor) variable, ease of use of technology and the dependent (outcome) variable, self-reported learning.

Based on the analysis in Table 10 there was a significant correlation ($\rho = 0.556$, $p<0.05$, 2-tailed) between the environment variable, ease of use of technology, and the outcome variable, self-reported learning. This finding suggested that the null hypothesis of no significant relationship between the two variables should be rejected.

Hypothesis Six

There was no significant correlation between the independent (environment/predictor) variable, hours worked per week, and the dependent variable, learner achievement.

The analysis in Table 10 showed that there was no significant correlation ($\rho = 0.262$) between the environment variable, hours worked per week, and the outcome variable, learner achievement. This finding did not allow for the rejection of the null hypothesis.

Hypothesis Seven

There was no significant correlation between the independent (environment/predictor) variable, hours worked per week and the dependent (outcome) variable, self-reported learning.

Based on the correlation analysis in Table 10 there was no significant correlation ($\rho = -0.160$) between the environment variable, hours worked per week, and the outcome variable, self-reported learning. This finding did not allow for the rejection of the null hypothesis.

Research Question 3

Were certain learner characteristics (prior WHMIS training, educational attainment, age, gender, comfort with computer technology) significantly correlated with the learner outcome variables self-reported learning and achievement on the two post-tests?

Hypothesis Eight

There was no significant correlation between the independent (input/predictor) variable, prior WHMIS training, and the outcome variable, learner achievement.

There was a significant positive correlation ($\rho = 0.600$, $p<0.05$, 2-tailed) between the input measure prior WHMIS training and outcome measure, learner achievement. Based on this finding the null hypothesis was rejected.

Hypothesis Nine

There was no significant correlation between the independent variable, prior WHMIS training, and the self-reported learning.

There was a significant positive correlation ($\rho = 0.624$, $p<0.01$, 2-tailed) between the input measure prior WHMIS training and outcome measure, self-reported learning. Based on this finding the null hypothesis was rejected.

Hypothesis Nine

There was no significant correlation between the independent variable, highest level of education, and the outcome variable, learner achievement.

There was no significant correlation ($\rho = -0.035$) between highest level of education, and variable, learner achievement. This finding did not allow for rejection of the null hypothesis.

Hypothesis Ten

There was no significant correlation between the independent variable, highest level of education, and the outcome variable, self-reported learning.

Based on the analysis in Table 10, there appeared to be no significant correlation ($\rho = 0.388$) between the input variable, highest level of education, and the outcome variable, self-reported learning. Therefore it was not possible to reject the null hypothesis.

Hypothesis Eleven

There was no significant correlation between the independent variable, comfort in the online environment, and dependent variable, learner achievement.

There was no significant correlation between the independent (input) variable, comfort in online environment, and learner achievement ($\rho = 0.212$). Therefore, it was not possible to reject the null hypothesis.

Hypothesis Twelve

There was no significant correlation between the independent (input) variable, comfort in online environment, and the outcome variable, self-reported learning.

Based on the results of the correlation analysis there was no significant correlation ($\rho = 0.199$) between the independent variable, comfort in online environment, and the outcome variable, self-reported learning. Therefore it was not possible to reject the null hypothesis.

Hypothesis Thirteen

There was no significant correlation between the independent variable, previous online courses, and learner achievement.

There was no significant correlation between the independent (input) variable, previous online courses, and learner achievement ($\rho = -0.196$). Therefore, it was not possible to reject the null hypothesis.

Hypothesis Fourteen

There was no significant correlation between the independent (input) variable, previous online courses, and the outcome variable, self-reported learning.

Based on the correlation analysis there was no significant correlation ($\rho = -0.352$) between the independent variable, previous online courses, and the outcome variable, self-reported learning. Therefore it was not possible to reject the null hypothesis.

Hypothesis Fifteen

There was no significant correlation between the independent (input) variable, age, and the outcome variable, learner achievement.

Based on the correlation analysis there was no significant correlation ($\rho = -0.236$) between the independent variable, age, and the outcome variable, learner achievement. Therefore it was not possible to reject the null hypothesis.

Hypothesis Sixteen

There was no significant correlation between the independent (input) variable, age, and the outcome variable, self-reported learning.

The data in Table 10 revealed that there was no significant correlation ($\rho = 0.415$) between the independent variable, age, and the outcome variable, self-reported learning. Therefore it was not possible to reject the null hypothesis.

Hypothesis Seventeen

There was no significant correlation between the independent (input) variable, gender, and the outcome variable, learner achievement.

Based on the correlation analysis there was no significant correlation ($\rho = 0.145$) between the independent variable, gender, and the outcome variable, learner achievement. Therefore it was not possible to reject the null hypothesis.

Hypothesis Eighteen

There was no significant correlation between the independent (input) variable, gender, and the outcome variable, self-reported learning.

The correlation analysis revealed no significant correlation ($\rho = -0.356$) between the independent variable, gender, and the outcome variable, self-reported learning. Therefore it was not possible to reject the null hypothesis.

Research Question 4

Was the learner outcome variable, self-reported learning, an accurate reflection of student learning, based on the student's actual scores on the two post-tests?

Hypothesis Nineteen

There was no significant correlation between learner achievement, and the outcome variable, self-reported learning.

The data in Table 10 failed to show a significant correlation between the self-reported learning measure and learner achievement ($\rho = 0.284$). Therefore it was not possible to reject the null hypothesis.

Regression Analysis

Learner Achievement as Dependent Variable

Table 11 provided a summary of the regression models for the dependent variable, learner achievement.

Table 11: Summary of Regression Models for Learner Achievement

Dependent Variable	Model	R	R^2	Adjusted R^2	SE of Estimate
Learner Achievement	1	.709[a]	.503	.007	1.26

	2	.949[b]	.901	.606	.791

[a] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender

[b] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender, Flexibility of Learning Environment, Ease of Use of Technology, Hrs Worked Per Week

The complete regression analyses for the dependent variables, learner achievement, self-reported learning and student satisfaction were provided in Appendices H, I, and J. The first step of the regression analysis only examined the influence of learner characteristics on the dependent variable, learner achievement. Based on the two linear regression models used in the current study, it appeared that 50% of all variability in learner achievement for the Mountain View College student population could be attributed to learner characteristics alone. Both learner characteristics and environmental variables (hours worked per week, flexibility of learning environment, and ease of use of technology) explained 90% of all variability in learner achievement.

Student Satisfaction as Dependent Variable

Table 12: Summary of Regression Models for Student Satisfaction

Dependent Variable	Model	R	R^2	Adjusted R^2	SE of Estimate
Student Satisfaction	1	.698[a]	.487	.047	.433
	2	.867[b]	.751	.192	.398

[a] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender

[b] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender, Flexibility of Learning Environment, Ease of Use of Technology, Hrs Worked Per Week

Table 12 shows the results of a regression analysis that controls for learner characteristics and which looks at student satisfaction. The results of the regression show that

approximately 49% of variability in the outcome variable, student satisfaction could be attributed to learner characteristics, while 75% of variability in that outcome measure was attributable to a combination of learner characteristic effects and environmental variable effects.

Self-Reported Student Learning as Dependent Variable

Table 13 shows data for the regression models where the Self-Reported Student Learning subscale was treated as the dependent variable. Based on that model 70% of variability in the outcome variable, self-reported student learning, can be attributed to learner characteristics, while 94% of variability in that outcome measure can be attributed to a combination of learner characteristic effects and environmental variable effects.

Table 13: Summary of Regression Models for Self-Reported Student Learning

Dependent Variable	Model	R	R^2	Adjusted R^2	SE of Estimate
Self-Reported Learning	1	.836 [a]	.698	.397	.332
	2	.969 [b]	.939	.758	.210

[a] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender

[b] Predictors: (Constant), Highest Level of Education Attained, WHMIS Training, Age, Comfortable in Online Environment, Taken Courses with Web-based components, Gender, Flexibility of Learning Environment, Ease of Use of Technology, Hrs Worked Per Week

Chapter 5: Discussion

This study used the Input-Environment-Outcome model that was first developed by Astin (1993) and later refined by Thurmond et al. (2002) and McGorry (2003) for application in the online learning environment, to assess the efficacy of an online learning module. The specific outcome measures that were assessed included

- student satisfaction with learning,
- self-reported learning,
- learner achievement, and
- retention of learning.

The research questions posed in this study were designed to assess how effectively these outcome measures were achieved.

Research Question 1: Did learners retain an understanding of material in the WHMIS module over a period of time, as demonstrated by their post-test scores (scores remain the same), over the two testing periods?

Based on a review of the post-test scores for Boreal Forest students, it appeared that students assigned to test group one experienced no increase in their test scores over time, in fact students assigned to this test group experienced an overall decline in their test scores over time, on the order of 1.4 points. The students assigned to test group two experienced an average increase in their post-test scores from the first to the second testing period of 0.43 points. Students from Mountain View College assigned to both test groups experienced a slight increase in their test scores from the first to the second testing period. Test group one experienced on average a 0.5 increase in post-test scores over the

testing period while students in test group two experienced an average increase of only 0.20 points in their test scores over the testing period.

Although there was an increase in post-test scores for some of the test groups at each educational institution it was difficult to determine whether this increase resulted from improved retention of the material due to the quality of the instructional content or was the result of student review of material prior to the administration of the second test. Students at Mountain View College were found to devote fewer hours per week to paid work than students at Boreal Forest College which meant that they potentially had more time to spend on study and review. In his study of how student characteristics impacted student outcomes House (2002) found that students who achieved higher grades tended to devote more time during the week to studying and completion of homework. An opportunity to focus more on their studies may explain the increase in the post-test scores that was observed for both test groups of Mountain View College students.

Issa, Cox and Killingsworth (1999) observed an increase in the retention test scores of their research participants over the original post-test score. They attributed this increase to the format of the retention test (multiple choice and true/false). They also found that the post-test scores of students who took their instruction from a CD-Rom program were 28% higher than the scores of students who took an equivalent instructional program in a traditional classroom setting. The current study did not allow for comparison of the effectiveness of the WHMIS module to another treatment, that is, classroom delivery, as there was no opportunity to conduct a parallel study.

Based on the theory of prior knowledge and learner achievement (Dochy et al., 1999), one would expect that students who had prior training in WHMIS would have

higher scores on the first post-test and on the retention test. Proportionately more Boreal Forest College students had prior training in WHMIS, according to the questionnaire results, than did the group of students from Mountain View College who participated in the study. However, the results indicated that while the Boreal Forest college students who were assigned to test group one did have higher first time test scores those students assigned to test group two, students from Mountain View College who were assigned to test group two also had high first time test scores, higher than the average score achieved by the students at Boreal Forest College (for either test group). Many of the students at Mountain View College had some level of post-secondary education, such as a degree or diploma, and according to the findings of House (2002) students who expressed higher drives to succeed and higher self-ratings of their overall academic ability tended to achieve better grades than those who had lower self-ratings. Many of the students at Mountain View College who participated in this study had achieved prior academic success in degree/diploma programs in their countries of origin, so one would expect that they would have high academic self-ratings, which would lead to expectations that they would perform well in formal learning environments, and thus expend greater effort in achieving their educational goals.

Research Question 2: Were the features of the learning environment, such as flexibility of that environment, ease of use of learning materials, and hours worked per week correlated with learner outcomes?

Based on correlation analysis there were no significant relationships between the environmental variables - flexibility of that environment, ease of use of materials, hours worked per week and the outcome variables - learner achievement and self-reported

learning. These findings may be due to the fact that the sample size was small.

In their study of efficacy of web-based education in a Swedish university Keller and Cernerud (2002) surveyed 150 students in two different schools, the School of Engineering and the School of Health Sciences, to assess student satisfaction with web-based education as compared to traditional classroom education. They used a seven point Likert scale that ranged from Total Agreement with the statements made to Total Disagreement and found that 48% of respondents reported that they totally or largely agreed with the assertion that the web platforms used by the school were easy to use. However, 45% of students totally disagreed or disagreed with the assertion that the web-platform was easy to use.

This was in contrast to the findings from the current study that showed that the majority of respondents were quite happy within the online learning environment. Of those who responded to a statement designed to assess whether technical problems had been experienced while using the module, 19 out of 24 individuals indicated that they strongly agreed or agreed with the statement that they had no technical difficulties while completing the module. In response to a statement affirming that the module's layout/navigation was easy to use, 19 out of 24 respondents indicated that they strongly agreed or agreed with the statement. When asked to indicate their level of support for the statement that the use of the Internet to conduct research helped enhanced their productivity, 17 out of 24 individuals responded that they strongly agreed/agreed with the statement.

Bryant, Campbell and Kerr (2003) compared the performance of students who completed their course work in web-based flexible learning environments to that of

students completing their course work in a traditional classroom setting. They found that students working in the web-based environment had better outcomes in concept tests (multiple choice, true/false), but that their performance on group projects and their engagement in the learning process, as measured through a learning folio used to record their learning activities, was not as good as that of students working in the classroom setting. The authors of the study attributed these differences, in the case of the group project, to the fact that students' networking and socialization processes were better established in the classroom setting than they were in the web-based learning environment.

Research Question 3: Were certain learner characteristics (prior WHMIS training, educational attainment, age, gender, comfort with computer technology) significantly correlated with the learner outcome variables self-reported learning and achievement on the two post-tests?

Significant positive correlations were found between prior WHMIS training and learner achievement, and between prior WHMIS training and self-reported learning. According to Dochy et al.'s (1999) review of empirically based studies on the topic of prior knowledge, some post-test variance can be explained by a learner's prior knowledge of a subject. Bloom (1976) found that correlations of 0.50 and 0.90 between pre-test and post-test scores. However, the findings in this study indicated that the correlation between the results obtained from the post-test and the retention test was only -0.119, which was not significant. However, Tobias (1994) found that prior knowledge explained a considerable amount of variance in performance from pre- to post-test. Since only post-tests were administered it was difficult to compare the results of the current

study to those of studies that compare pre- to post-tests.

Prior knowledge of a specific subject area has been linked to enhanced performance in novel learning situations. However, lack of prior knowledge of a computer or learning management system did not negatively impact the learning of students who participated in Shea's (2000) study of 1584 undergraduate students enrolled in online courses at a state university. In this study a minority of students (12 of 34) performed better on the retention test (or examination administered a few weeks after first testing period) than they did on the first test. Gagne, Bell, Yarbrough and Weidemann (1985) suggested that prior knowledge not only influenced the amount of learning that occurred in new learning situations, but the quality of that learning. Farr (1987) referred to the differential retrieval of information first discussed by Gagne et al. (1985) as an 'ideational scaffolding'.

Nine of the 10 people at Boreal Forest College who responded to the survey indicated that they had previous training in WHMIS, while only 11 of the 15 individuals at Mountain View College who responded to the survey indicated that they had previous WHMIS training. According to the theories of Muller-Kalthoff and Moller (2003) prior knowledge in a specific knowledge domain, such as WHMIS, should improve learning in new situations and enhance performance on outcome measures such as post-tests and while post-test scores.

Based on their study of learning in the online environment, Keller and Cernerud (2002) concluded that the more knowledgeable students were about the technology and its capabilities the less satisfied they were with the web-based learning platform. Their findings indicated that engineering students, tended to be more knowledgeable and less

satisfied overall with their online learning experiences than students in the health sciences. However, the background knowledge and level of experience with computer technologies seemed high in both groups of learners who participated in the current study.

In their review of the literature on student satisfaction in the online environment, Bollinger and Martindale (2004) noted that student satisfaction was negatively impacted by problems with access to course materials. In the current study, some individuals had difficulty accessing the course materials, based on their responses to the quality of learning questionnaire. The majority of students who had technical difficulties were those who attended Boreal Forest College and since these students were taking the module via distance education, one source of their greater technical problems may have been slower Internet connections.

Analysis of the responses to the Quality of Learning questionnaire showed that many participants had high levels of education, nine of the 25 respondents reported they had graduate degrees, six of the 25 survey respondents reported they had undergraduate degrees, and three of the 25 indicated that they had college diplomas. A large number of individuals who responded to the questionnaire, 22 out of 25, indicated that they were comfortable in the online environment while 15 out of 24 respondents indicated they had taken Internet-based courses or courses with online components.

Levels of learner achievement were high overall, with an average score on Post-Test I of 17.35 (factoring in data from both educational institutions at which instruction took place) an average score of 16.94 on Post-Test II. The post-test scores of 12 out of the 34 participants who completed both post-tests increased from the first to the second testing period. If the scores achieved during the second testing period could be seen to be

influenced by the prior knowledge gained through the training provided by WHMIS module, then Muller-Kalthoff and Moller's (2003) assertion that domain specific knowledge positively impacts outcome measures received some support. However, increases in scores that were observed from the first to the second testing period may also be a result of student's review of the module content during the period between the first and the second testing periods. Halpern and Hakel (2003) suggested that one of the most important factors in promoting long-term retention of knowledge and transfer of learning was "practice at retrieval". However, there was no way to determine whether students were engaged in this practice, as there was no opportunity to observe students as they used the module.

Research Question 4: Is the learner outcome variable, self-reported learning, an accurate reflection of student learning, based on the student's actual scores on the two post-tests?

There was no significant correlation between the two outcome measures, self-reported learning and learner achievement. Based on a review of the statistics describing the frequency of affirmative responses to questions related to student satisfaction with the quality of instruction offered by the WHMIS module, the majority of students appear to be satisfied with the learning experiences offered by the module. There was a significant positive correlation ($\rho = 0.731$, $p<0.01$, 2-tailed) between self-reported student learning and student satisfaction with learning. In this study, self-reported student learning was used to assess how well learning objectives were met and explained, as well as how engaged students were in learning process. Satisfaction with learning was used to predict how likely it was that a student would enroll in additional courses that were delivered

through the Internet.

Based on the results of a paired samples t-test for the post-test scores in each of the two sample populations (two colleges) there appeared to be no significant difference between the mean scores achieved for either of the post-tests. There was greater variation in the post-test scores achieved by the Boreal Forest participants than those attained by the Mountain View College participants. This variation may be explained by the differences in the two populations of learners. The Boreal Forest College learner population consisted of individuals who were completing the WHMIS module as part of their course work for an Emergency Medical Technician program. The Mountain View College learner population consists of individuals who were taking academic upgrading, or specific vocational training. The two populations had vastly different educational levels, with the majority of individuals at Mountain View College having diplomas, or undergraduate or graduate degrees (from other countries). However, the Boreal Forest population of learners' prior knowledge of the subject matter seemed to represent a comparable advantage to that possessed by Mountain View College students through their higher levels of education.

Brooks and Dansereau (1987) suggested that learner characteristics have a significant impact on transfer. Specifically, they postulated that the content and structure of a student's memory was the major mediator between original learning and subsequent performance on a transfer task. A small majority of students who participated in the current study had received prior training in WHMIS (13 out of 25 respondents had previous training). Their memory of content learned in earlier training sessions no doubt had an impact on their understanding of the material covered in the WHMIS module.

However, lack of prior knowledge of a computer or learning management system did not seem to negatively impact the learning outcomes of students who participated in Shea's (2000) study of 1584 undergraduate students enrolled in online courses at a state university. In this study a large minority of students (12 of 34) performed better on the retention test (or examination administered a few weeks after first testing period) than they did on the first post-test. Gagne, Bell, Yarbrough and Weidemann (1985) suggested that prior knowledge not only influenced the amount of learning that occurred in new learning situations, but the quality of that learning.

Assessment of I-E-O Model

Learner achievement was not significantly correlated with any of environmental variables, but it was significantly positively correlated with the learner input variable, 'Prior WHMIS Training'. In his study of the college students' satisfaction with their educational institution House (1999) found that the input variable that was most effective at predicting student satisfaction with college was high school GPA. He also found that three of the environmental variables - satisfaction with overall quality of instruction, group project work and hours spent commuting - could be used to explain a significant amount of the variation in student satisfaction when learner characteristics were controlled for. Based on analysis of the correlation coefficients for the all variables – input, environmental, and output – there appeared to be no significant correlation between learner achievement and student satisfaction.

In their application of the I-E-O model to a web-based learning environment, Thurmond et al. (2002) found that input variables, such as, age, lack of computer skills, number of web courses taken, knowledge of technology and distance from campus, have

little ability to predict student satisfaction. However, environmental variables (instructional activities and interaction) in their study were found to account for 52% of variability in student satisfaction. In the current study input variables were found to predict 49% of the variability in student satisfaction. Environmental variables in combination with input variables were able to predict 75% of the variability in the dependent variable, student satisfaction.

Chapter 6: Conclusions and Recommendations

This study was designed to assess the efficacy of a stand alone web-based training module that was developed for use by instructors in courses that had a WHMIS requirement. The effectiveness of the module was assessed on the basis of how well students who completed on the module performed on two post-tests and on the results of a quality of learning questionnaire, designed to evaluate their satisfaction with the instruction offered by the module and their self-reported learning. The I-E-O model first developed by Astin (1993) and later modified by McGorry (2003) and Thurmond et al. (2002) for application to the online learning environment was the theoretical framework used to interpret the results of this study.

Based on the analysis performed on the data gathered through the two post-tests and the Quality of Learning questionnaire the majority of students seemed to understand the material contained in the module and to be satisfied with the instruction they received through the module. Satisfaction with the module was measured by assessing how willing students would be to take additional online courses, based on their experiences in the learning module used in this study. Their responses to the questionnaire indicated that the majority of questionnaire respondents would be interested in registering in additional online courses. A significant positive correlation between the environmental variable, Ease of Use of Technology and the outcome variable, Student Satisfaction, indicated that environmental variables did have an impact on how likely students were to register in additional online courses based on their experience with the module used in this study.

Prior knowledge was found to be a good predictor of student achievement in the online learning environment based on a significant correlation between Prior WHMIS Training and learner achievement. However, there was a significant correlation (0.624) between the environmental variable, Prior WHMIS Training and the outcome variable, Self-Reported Learning.

Correlation analysis revealed a positive relationship between prior knowledge of WHIMS and learner achievement. This study also found that satisfaction with learning was positively correlated with age. This finding was similar to that of Fredrickson et al. (2000) in which older learners (age range 39-45) were found to be more satisfied with online learning environments than were younger learners.

Regression analysis showed that much, but not all, of the variation in the learner outcome variables, self-reported learning, student satisfaction and learner achievement could be predicted by learner characteristics or inputs. However, environmental variables explained a certain amount of variation in the outcome variables.

Based on the findings in this study it can be concluded that the I-E-O model was a relatively effective theoretical tool for determining what variables most influenced student success and satisfaction in the online environment. However, the reliability of subscales that were calculated based on the responses to questions asked in the Quality of Learning Questionnaire was not satisfactory and these subscales should be refined. One specific recommendations is that the additional questions be added to the existing subscales (Ease of Use of Technology, Flexibility of Learning Environment, Student Satisfaction, and Self-Reported Learning) and that a larger population of study participants be found who can participate and assist in assessing the reliability of these

subscales. Another possible direction in a future study would be to expand the number of subscales used to include those that McGorry (2003) assessed in her study, such as interaction, technical support, and responsiveness and student support. This would only be possible if future studies could be conducted at institutions that were more receptive to giving the researcher greater access to information on student participants and on student-instructor interaction. Because the number of questions asked had to be reduced to facilitate participation of educational institutions, the validity of the quality of learning became an issue. However, all of the items included in the Quality of Learning questionnaire were taken directly from or adapted from existing questionnaires that were used to assess the effectiveness of online learning materials or programs. So at least in terms of face validity there was evidence that the questionnaire used was valid. McGorry's (2003) reliability analysis of the subscales in her questionnaire, which consisted of 60 items and 7 subscales, showed that her questionnaire items had an alpha coefficient of 0.95, indicating high internal consistency. The reliability analysis of the questionnaire items used in the current study was 0.54 and consisted of 13 items and four subscales. McGorry (2003) eliminated certain items from her questionnaire whose item-to-item correlations were below 0.40. This increased the alpha coefficient to 0.96. If the questionnaire used in the current study were expanded to include a greater number of subscales, and a larger number of questions per subscale, the reliability of the questionnaire may be improved. However, any modified questionnaire must be subjected to further testing and factor analysis, to allow for complete assessment of the relationship between questionnaire items and subscales.

The major concern that this researcher had with using the I-E-O model to assess

online learning environments was that the model was originally developed to assess student outcomes on a broad range of input and environmental variables that spanned an entire college career (from entry into college/university to exit). Using the model to assess a single course or a single learning module may be a misapplication of the purpose for which the module was developed. However, there were some indications that the model may have some application to the assessment of online learning programs, most specifically degree programs.

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Appendix A: Example of Learning Activity

Learning Activity #3: What is a WHMIS Label?

Learning Objectives

- Read a WHMIS label
- Prepare a worksite label
- Assess hazards associated with a product based on the contents of the label
- Identify the responsibilities of employers, suppliers and employees for labeling of hazardous products

Key Concepts

WHMIS labels are used to protect everyone in the workplace from harm.

The responsibility for creation, and revision of WHMIS labels is shared by everyone.

Directions

1. Read the material in this learning activity with the title "WHMIS Labels Explained".
2. Complete the Exercises.
3. Complete Reflection section of activity.
4. Review concepts covered in this learning material.

Reading Material

WHMIS Labels Explained

WHMIS labels contain information on hazardous products. These labels are designed to

- Help employers and workers to identify hazardous materials in the workplace.
- Indicate what precautions need to be taken when handling hazardous materials

The discussion of WHMIS labels is broken down into four different areas:

- Worksite labels
- Supplier labels
- Other kinds of labels
- Responsibilities for labeling

Worksite Labels

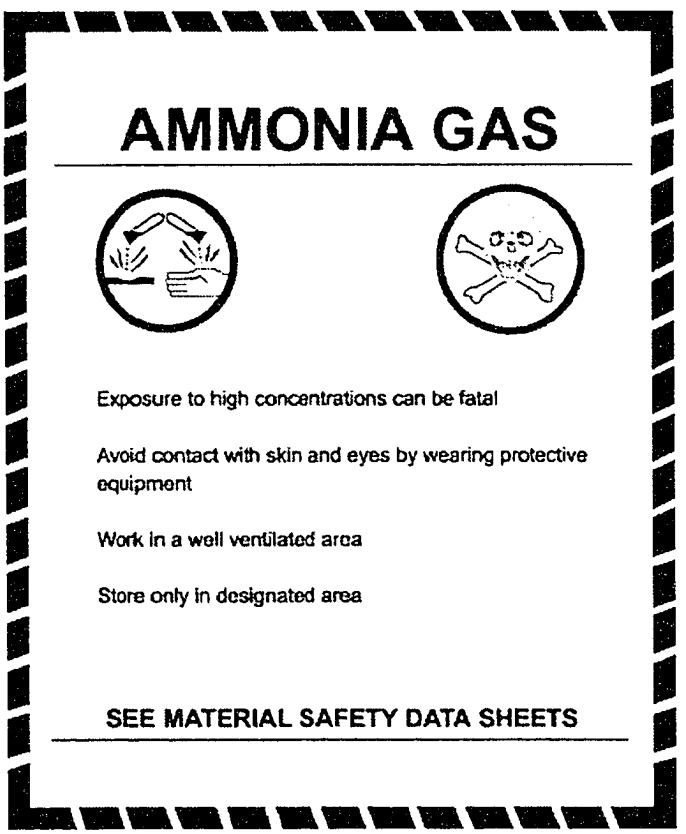
Worksite labels are used when

- controlled products are produced at a worksite,
- controlled products onsite do not require a supplier labels by law,
- containers are used to store bulk shipments of controlled products, and
- controlled products have been transferred from their original containers to new containers.

Three types of information need to be present on a worksite label:

- product name
- instructions on how to handle the product safely
- reference to MSDS
- may contain WHMIS symbols (optional)

An example of a worksite label is provided below.



Supplier Labels

There are three kinds of supplier labels:

- standard labels
- small container labels
- lab reagent labels

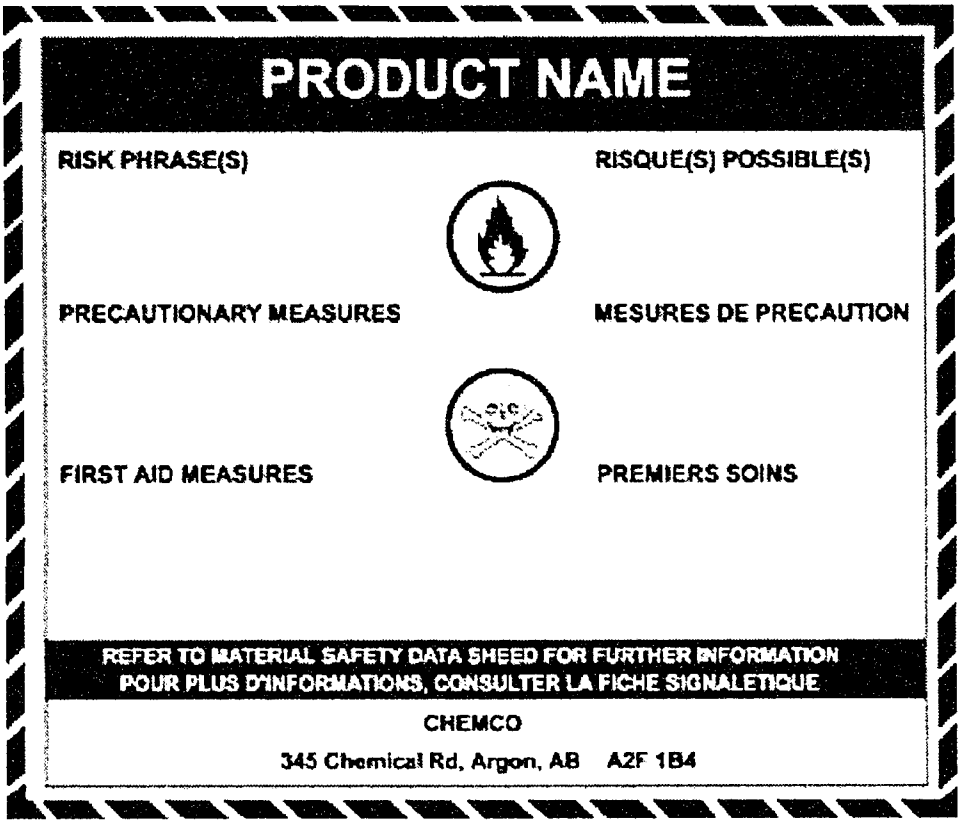
- product development samples

Standard Labels

These types of labels must be present on the controlled product prior to sale and must include the following types of information:

- name of the product
- supplier/manufacturer information
- where to find MSDS
- hazard symbol
- statement of risk associated with use or handling of the product. This statement is in addition to the symbol and contains information about the possible harm that could result if the product is misused or stored incorrectly
- statement of precautions that should be taken to prevent harm
- first aid measures if someone is adversely affected by the material
- distinctive hatched border that indicates that the information is WHMIS related
- label must be in French and English

The following is an example of what a supplier label may look like. Not all labels will look the same, but the same information should be contained within them.



Click on label to see what kinds of information is available in each section.

Small Container Labels

For containers that are less than 100 mls in volume there does not need to be a statement of risk. Basic information are contained on these labels:

- product name
- reference to MSDS
- hazard symbol(s)

Lab Reagent Labels

These are labels that are produced for chemical agents that are produced within the lab and which contain controlled products. The kinds of information that needs to be contained in these labels includes:

- product name
- reference to MSDS
- risks involved in handling
- measures that need to be taken to prevent injury
- first aid measures to take if injury occurs

Product Development Samples

These are new products that are produced as a result of a research and development process. Examples of such products include a new plastic or a genetically altered micro-organism. The kinds of information that must be contained on these kinds of labels includes:

- product name
- supplier information
- identification of hazardous chemicals
- emergency telephone numbers of suppliers

Other Kinds of Labels

These labels generally do not require the level of detail found in other types of labels. They are used in the following situations:

- material is no longer in original container

- substances are used for a lab procedure

Other kinds of labels are also need for nontraditional containers, that is, containers that are not bottles or barrels. The kinds of containers you may encounter include:

- pipe or piping systems
- process or reaction vessels
- tank cars
- secondary containers such as flasks or beakers

Like typical containers these need to be label. But the labels can also take the form of signs, tags, stickers, etc..

Responsibilities for Labeling

Three groups of individuals have a responsibility for ensuring that labelling requirements are met:

- suppliers
- employers
- employees

Supplier Responsibilities

Suppliers must develop labels for all products that are manufactured, sold, imported, or packaged for sale.

Employer Responsibilities

Employers responsibilities for labeling of controlled products on their worksites include:

- training of employees in interpretation of labels
- attachment of supplier labels to controlled products
- ensuring all controlled products have proper labels when they arrive onsite
- ensuring that labels are not removed

Employers need to ensure that existing labels are kept in good conditions and new labels are produced as needed. Examples of situations that require active production of labels include:

- situations in which supplier labels become illegible
- product is transferred from original container to another container
- waste products are produced onsite that need labels

Employee Responsibilities

Employees have the following responsibilities with respect to labeling:

- know how to interpret labels
- handle products based on information provided on label (and MSDS)
- be careful not to remove or destroy labels
- inform their supervisors when a label is not readable

Exercise

1. You are the manufacturer of a chemical called Glutaraldehyde. Your company is called Chemex and is located in Calgary, Alberta at 123 Chemical Avenue. Basic

product information about your product is contained at the COHS website. Create a standard supplier label that contains all necessary information about the product. Use this file (with images) to create your supplier label. For a completed version of the label, look here.

2. You are a technician in a research laboratory. A new reagent was recently produced in your workplace. Does it require a WHMIS label? If you answered yes, what kind of label do you think it requires? What information would you provide on the label? For the correct answers please refer to file.

3. Your job as an oil field technician requires you to ensure that all substances that need a WHMIS label have one. Your product (which is a controlled product) will be transported to a processing centre through a pipeline. Does this kind of container require a label? For the correct answers please refer to file.

4. While looking through some chemicals stored in the medical laboratory in which you work you find that a label on a controlled product is not legible. Is it your responsibility to do something about this situation? What would you do? For the correct answers please refer to this file.

Reflection

Look in your home and work environments for labels attached to hazardous or toxic substances. Note the amount of detail on a specific label in your Learning Log and indicate whether you think the amount of information is sufficient.

Review

Worksite labels are produced at worksite and must contain the following information - product name, instructions on safe handling of the product, reference to MSDS.

There are four kinds of supplier labels: standard, small container, lab reagents, and product development samples. The standard label is the one you will most frequently encounter. This label is attached to the product when it is sent by the manufacturer or supplier. A standard supplier label contains the following information: product name, supplier information, reference to MSDS, hazard symbols, statement of risk/precautions, first aid measures, hatched border, information in both French/English.

There are other kinds of labels that are used for non-traditional containers, that is, containers that are not bottles or barrels. These labels include signs, tags, stickers, etc. The kinds of containers that may be identified by other types of labels include pipes, reaction vessels, tank cars, or secondary containers (i.e. containers other than the original container).

Employers, suppliers and employees all have a responsibility to ensure that labels are created and attached to containers in which hazardous materials are held. Suppliers must develop labels for all products that they manufacture and sell. Employers must ensure that all products come with supplier labels, that employees are trained in how to interpret labels. Employees bear the responsibility of interpreting label contents, and handling hazardous material safely based on that interpretation.

Appendix B: Example of Exercises used in Learning Activity

Exercise 1

You are the manufacturer of a chemical called Glutaraldehyde. Your company is called Chemex and is located in Calgary, Alberta at 123 Chemical Avenue. Refer to the CCHOS's website (http://www.ccohs.org) for information about this material. Create a standard supplier label that contains all necessary information about the product. Use the images provided below to create your supplier label.

Symbols

Answer to Exercise 1

The following is the answer to Exercise 1. Your label does not have to be identical to the one depicted below but it should contain the same basic information.

Glutaraldehyde

Risk Phrase(s)

Harmful if swallowed and irritating to eyes

and respiratory tract

Corrosive to eyes and skin.

Can cause a severe allergic skin reaction.

Precautionary Measures

Engineering Controls

Personal Protective Equipment

First Aid Measures

Eyes: Flush eyes for 20 - 30 minutes

without interruption.

Skin: Flush with lukewarm water for

20 to 30 minutes.

Ingestion: Have victim swallow

240 to 300 ml of water. Do not induce

vomiting.

Appendix D: Release Form

I, _____ agree to participate in a research project under the following conditions:

- I have the right to withdraw from the project at any time. If I do so the information I provide will not be used in the project.
- I agree to participate in the completion of a questionnaire that is to be administered in an online environment.
- My identity will be kept strictly confidential. Any personal identifiers will be stripped from the data prior to its use.
- The data gathered in the study will be collected and analysed for the purposes of completing a Master of Education thesis and may, in the future, be published.
- I understand that this study is being conducted so that the researcher can evaluate the effectiveness of the particular learning module being used in the study and gain feedback on how to design more effective web-based instructional materials.
- I understand that each of the post-tests that need to be completed for this study will take a maximum of twenty minutes to complete.
- I understand that the Student Satisfaction Survey will take a maximum of twenty minutes to complete.
- I understand that if I request a copy of this study I will be able to obtain one by contacting the researcher, or by contacting the instructor/facilitator at my institution who assisted in the study and who will have up-to-date contact information for the researcher.
- I understand that this study has received ethics approval at the institution at which the study is being conducted and at the sponsoring institution, the University of Alberta.
- The researcher will endeavor to ensure that no harm will come to me through participation in this project.

I agree to these conditions:

Signed:_____

Appendix E: Quality of Learning questionnaire

The following questions ask about your background and your attitudes about the effectiveness of the learning module you have just completed. Some of the questions ask whether you agree/disagree with the statement being made. There are no right or wrong answers, just answer as accurately as possible.

Input Variables

Age

1. My age is in the range of _____.
   ❑ 15-19 ❑ 20-24 ❑ 25-29 ❑ 30-34 ❑ 35-39 ❑ 39-44 ❑ 45-49
   ❑ greater than 49

Gender

2. My gender is _____.
   ❑ Male ❑ Female

Prior Knowledge

3. I have received WHMIS training in the past.
   ❑ Yes ❑ No

Familiarity with Technology

4. I feel comfortable completing coursework and assignments on the computer.
   ❑ Yes ❑ No

5. I have taken courses that had web-based components (course schedule, assignments, readings) or were offered entirely online, prior to taking this learning module.
   ❑ Yes ❑ No

Educational Attainment

6. My highest level of educational attainment (including degrees/diplomas awarded outside of Canada) is _____.
   ❑ Some High School ❑ High School Diploma ❑ Some College
   ❑ College Diploma ❑ Undergraduate Degree ❑ Graduate Degree

Environmental Variables

Hours worked per week

7. I spend _____ hours per week working at my job.
   ❑ 1-3 ❑ 4-6 ❑ 7-9 ❑ 10-12 ❑ 13-15 ❑ >15

Flexibility of Learning Environment

8. The advantages of taking this learning module via the Internet outweighed any disadvantages.
   Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

9. There were no serious disadvantages to taking this learning module via the Internet.
   Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

10. Taking this learning module via the Internet allowed me to arrange my work schedule more effectively.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

Ease of Use of Technology

11. I did not have any technical problems as I worked through this module.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

12. The format and page design of the online module was easy to use.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

13. I found that using the Internet to conduct research for this instructional program enhanced my productivity.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

Outcome Variables

Self-Reported Learning

14. This module expanded my knowledge and understanding of the subject matter.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

15. I was provided with all the information that I needed regarding the module's objectives, concepts and ideas.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

16. I felt that I was actively engaged in the learning process as I worked through this module
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

Student Satisfaction

17. If I had another opportunity to take an instructional program via the Internet I would gladly so do.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

18. I was very satisfied with the instruction I received in this learning module.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

19. The quality of instruction in this learning module served my needs well.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

20. I felt that the quality of instruction offered by this module was largely unaffected by conducting it via the Internet.
    Strongly Agree.....Agree.....Don't Know.....Disagree.....Strongly Disagree

Appendix F: Post-Test I

1. What methods does WHMIS use to educate people about the hazards of the products they work with? Select the best answer.

a. Planning, Skills, Clean Up

b. Working, Labeling, Protecting

c. MSDS, Education, Labeling

d. Communication, Prevention, Disposal

e. Laws, Communication, Labeling

2. The greatest hazard presented by an oxidizing material is that it_____?

a. causes damage to skin

b. enhances a fire

c. produces acute illness

d. causes a skin rash

e. produces sterility

3. What type of controlled product does the symbol  represent?

a. Compressed gas

b. Biohazardous Material

c. Corrosive Material

d. Reactive Material

e. Poisonous Material

4. Which of the following is a flammable compound?

a. Vermiculite

b. Gas

c. Asbestos

d. Ammonia

e. Clay

5. Complete the following statement. A combustible material should be stored _____.

a. at room temperature

b. away from ignition sources

c. in an Erlenmeyer flask

d. in an area with a UV detector

e. in a vacuum chamber

6. You have just changed the oil in your car and you need to store the oil in a container in your garage prior to disposing of it. Which of the following symbol should you place on the label that you attach to the oil container to best describe the hazards associated with its use?

a. 

b. 

c. 

d. 

e. 

7. You are a member of the cleaning staff in a hospital emergency department. There is a piece of blood stained gauze on a tray. You should dispose of the gauze by placing it in a container with which of the following symbols on it?

a. 

b. 

c. 

d. 

e. 

8. Your employer has asked you to create a worksite label for a corrosive material that has just been transferred to a glass bottle. Which of the following WHMIS symbols would you place on the bottle?

a. 

b. 

c. 

d. 

e. 

a. Class C Compounds are referred to as _____ compounds.

a. infectious

b. combustible

c. reactive

d. poisonous

e. oxidizing

10. An employer must ensure that all products are properly labeled.

a. True

b. False

11. Which of the following is one of the pieces of information that MUST be contained on a standard supplier label?

a. Viscosity Index

b. Molecular Weight

c. Transportation Guidelines

d. Handling Precautions

e. Specific Gravity

12. A worksite label does NOT need to be used on containers _____.

a. storing controlled products manufactured at the worksite

b. with a capacity less than 200 milliliters in volume

c. that are not the original containers used to store the products

d. capable of storing large quantities of controlled products

e. that already have a suppliers label attached

13. A new supplier label must be obtained by the employer when

_____.

a. the original label becomes illegible

b. a WHMIS symbol is missing from the label

c. the molecular weight of the product is not provided on the label

d. the melting point of the product is not listed

e. the instructions on what engineering controls should be instituted are absent

14. Which of the following is NOT one of the purposes of the federal Hazardous Products Act?

a. Governs the labeling of consumer goods.

b. Establishes the format for the WHMIS labels.

c. Determines the contents of MSDS.

d. Governs what chemicals are listed on an MSDS.

e. Ensures that supplier labels are present on products at time of sale.

15. Michelle is a Technical Writer who develops MSDS for a chemical company, and she wants to know whether she needs to include all the names of the chemicals that a newly manufactured controlled product contains? Where should she look to find out

what to include?

a. Hazardous Products Listing

b. Dangerous Components Guidelines

c. Ingredients Exposure List

d. Toxic Materials Summary

e. Dangerous Goods Regulations

16. Which of the following items is a piece of information that is found in the **Hazardous Ingredients** section of an MSDS?

a. Product Name

b. Chemical Abstracts Number (C.A.S.)

c. Viscosity Index

d. Supplier/Manufacturer Address

e. Tensile Strength

17. The simplest and most effective way to determine that an MSDS matches the product label is to _____.

a. check the MSDS to see if precautions listed fit the attached WHMIS symbol

b. ask a co-worker if they know whether you are referring to the correct MSDS

c. compare the product name on the MSDS with that on the container

d. call the manufacturer of the product to ask whether they sent an MSDS

e. go on the Internet an do a search using the generic product name

18. Kelly has been assigned the task of determining which fire extinguishers the company needs to purchase for the factory where he is working. Where should he look in the MSDS for that information?

a. Section on Toxological Properties

b. Section on Physical Data

c. Section on Preventive Measures

d. Section on Fire and Explosion Data

e. Section on Personal Protective Equipment

19. Sally supervises cleaning staff in an office tower. Beth is a member of her cleaning staff and she needs to find information on a particular cleaning product with which she has no experience. All she can find for the product is a ratty 15 year old copy of an MSDS. What should Beth do?

a. Beth should ask Sally to make a clean copy of the MSDS

b. Beth should ask Sally to get an up-to-date copy of the MSDS from the supplier

c. Beth should guess at what precautions to take since one cleaning solution is much the same as another.

d. Beth should contact the manufacturer of the cleaning solution directly and ask for an MSDS

e. Beth should continue to work without asking for clarification, as MSDS is the responsibility of the supervisory staff only.

20. Fred is working with a solvent in a print shop and gets some in his eyes. He rinses his eyes but they still sting. Fred is taken to an emergency clinic by a co-worker. The physician needs to know exactly what Fred was working with. What should the physician do? Pick the best answer.

a. The physician should look for the information on the Internet

b. The Physician should contact the employer and ask them to provide a copy of the

MSDS

c. The physician should check through his catalogue of text books looking for the information.

d. The physician should call the poison control centre and describe Fred's symptoms.

e. The physician should consult with another doctor about Fred's symptoms.

Appendix G: Post-Test II

1. What does WHMIS stand for?

a. Workplace Hazardous Materials Information System

b. Workplace Health Maintenance Information System

c. Wellness and Health Monitoring Industrial System

d. Workplace Hazards Management Instruction System

e. Working Hazards Mitigation Indices for Safety

2. The greatest hazard presented by an oxidizing material is that it_____.

a. causes damage to the skin

b. helps a fire to burn

c. causes skin to break out into a rash

d. produces mutations in skin cells

e. is dangerously reactive when it is bumped

3. The symbol  should be applied to containers that hold _____ ?

a. used syringes

b. oven cleaner

c. mineral oil

d. solvents

e. acetone

4. _____ is an example of a household product that is corrosive.

a. Hydrogen peroxide

b. Rubbing Alcohol

c. Oven Cleaner

d. Mineral Oil

e. Latex paint

5. The propane tank that is attached to your gas barbecue is empty, so you remove it from the barbecue so that you can refill it. When you place the container in your vehicle the best safety precaution you can take is to _____.

a. wear protective gloves

b. wear a face mask

c. open a window

d. cover the tank with a dark cloth

e. secure the tank somehow

6. You are a commercial gardener and you prepare a large amount of a solution that contains insecticidal soap, some of which you plan to use later in the week. To ensure that no one mistakes the container for some other compound you place a label on it that states "Insecticidal Soap", and you draw the _____ symbol on the label to caution others.

a. 

b. 

c. 

d. 

e. 

7. A lab reagent label requires all of the following pieces of information EXCEPT:

a. product name

b. handling precautions

c. supplier address

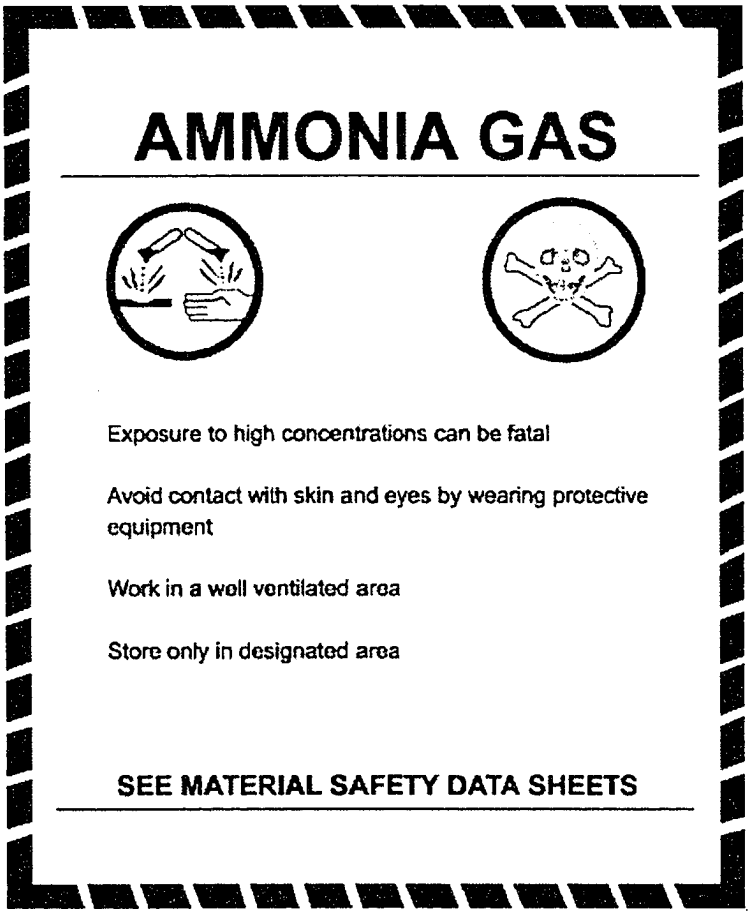
d. first aid measures

e. reference to MSDS

8. Which of the following is NOT an employer responsibility with regard to labeling?

a. Providing training to employees on how to properly read and interpret labels.
b. Developing supplier labels for controlled products that are manufactured offsite.
c. Ensuring that labels are not removed from product containers.
d. Checking that all controlled products have labels when they arrive from supplier.
e. Ensuring that labels are attached to controlled products used in the workplace.

9. What kind of label does the following image portray?



a. Lab reagent label
b. Standard label
c. Supplier label
d. Worksite label
e. Reactive product label

10. The product development sample label depicted below is missing information about _____.

a. the hazardous chemicals contained in product
b. the date on which the product was prepared
c. the chemical formula of the product
d. the supplier information
e. the product name

11. James works as a custodian in a school and he receives a new floor cleaning fluid that has been ordered for use by all schools in a particular district. The fluid has a supplier label and was shipped with an up-to-date MSDS. As an employee of the school board he has a responsibility to _____.

a. handle the new cleaning fluid based on the information on the product label and MSDS
b. contact the supplier and ask them to interpret the meaning of certain chemical terms in the MSDS for him
c. tell his cleaning staff that they need not read the MSDS or product label before they use the product
d. remove the label from the cleaning fluid container and replace it with one he feels is more informative
e. print the name of the product in bold letters over the label thereby obscuring pertinent

information about the product

12. What is the name of the Alberta legislation that governs WHMIS?

a. Hazardous Goods Guidelines

b. Chemical Ingredients Act

c. Dangerous Goods Regulations

d. Controlled Products Guidelines

e. Chemical Hazards Regulations

13. Which of the following is one of the roles of the federal Hazardous Products Act?

a. Governs the labeling of consumer goods that are dangerous to human health.

b. Provides guidance on how to transport dangerous goods within Canada.

c. Ensures that supplier labels are placed on controlled products at time of sale.

d. Provides guidance on how to properly dispose of toxic wastes.

e. Dictates that WHMIS symbols are found on all types of WHMIS labels.

14. What does the acronym MSDS stand for?

a. Managing Safety for Dangerous Substances

b. Market Standards for Degraded Strontium

c. Material Safety Data Sheets

d. Morrow Safety Devices System

e. Manufacturer's Sterility Data for Seedlings

15. Which of the following is information that you would find in the **Product Identification and Use** section of an MSDS?

a. Conditions under which material becomes dangerously reactive.

b. Chronic health effects associated with unprotected exposure to chemical.

c. Product name as provided by the supplier.

d. Exposure limits for specific components of the product.

e. Fire hazard associated with use and storage of product.

16. Information on the kinds of engineering controls that are needed for a particular product can be found in the _____ section of an MSDS.

a. Preventive Measures

b. First Aid Measures

c. Fire and Explosion

d. Reactivity Data

e. Toxological Properties

17. Joseph owns and manages a plastics manufacturing firm that uses controlled products in its processes. A supervisor comes to him requesting that he contact the manufacturer of a particular product to obtain a new MSDS as the existing MSDS has been misplaced. Is it Joseph's responsibility to obtain a new MSDS?

a. No.

b. Yes.

18. Richard, a newly hired supervisor in a chemical laboratory, is reviewing the binder containing the MSDS. He notices that several of the MSDS were prepared at least four years prior to the current date. What should he do?

a. Contact the supplier and request a replacement MSDS for all chemicals without an up-to-date MSDS.

b. Ignore the fact that several MSDS are out of date and proceed with his work without notifying anyone.

c. Prepare new MSDS's himself based on information gathered from an Internet search.

d. Assign the task of reviewing the binder and requesting new MSDS's to another person who has no experience with WHMIS.

e. Leave the issue unresolved until the next time he places his next order for chemicals that have out-of-date MSDS's.

19. Which of the following statements best defines what an MSDS is?

a. A technical description on the best method to use to transport a hazardous product over an international border.

b. A technical document that lists the chemical formula of each of the components in a hazardous product.

c. A technical document that provides information on the properties, contents, precautions and safe handling for a controlled product.

d. A brief description of the types of protective equipment that should be used when handling dangerously corrosive materials.

e. Technical specifications on how to design the engineering controls that should be put in place when dangerous substances are in use on a worksite.

20. Allison is looking for an MSDS for a particular product during the night shift but all of the MSDS are located behind a locked door that only the day shift supervisor has a key for and when he leaves at 5:00 pm he takes his keys with him. How should Allison deal with this situation? Choose the best answer.

a. Shrug and say, 'Oh well, there is nothing I can do anyway, let's go ahead.
b. Berate the day shift supervisor in front of her co-worker for being so stupid.
c. Contact the manufacturer by email requesting information on the product in question.
d. Inform her own supervisor that by law MSDS must be made easily available to staff.
e. Leave the responsibility of telling the supervisor of the problem to her co-worker.

Appendix H: Correlation Coefficients for Questions Used to Construct Subscale Measures

	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Q8	1.000												
Q9	.811**	1.000											
Q10	.569**	.366	1.000										
Q11	.847**	.786**	.610**	1.000									
Q12	.899**	.745**	.567**	.781**	1.000								
Q13	.891**	.843**	.617**	.917**	.883**	1.000							
Q14	.847**	.786**	.610**	1.000**	.781**	.917**	1.000						
Q15	.833**	.786**	.555**	.883**	.915**	.946**	.883**	1.000					
Q16	.899**	.850**	.567**	.781**	1.000**	.883**	.781**	.915**	1.000				
Q17	1.000**	.745**	.569**	.813**	.891**	.891**	.813**	.883**	.891**	1.000			
Q18	.819**	.811**	.550**	.898**	.784**	.900**	.898**	.929**	.784**	.819**	1.000		
Q19	.864**	.877**	.625**	.846**	.846**	.943**	.846**	.929**	.846**	.864**	.940**	1.000	
Q20	.926**	.777**	.646**	.893**	. 846**	.933**	.893**	.923**	.846**	.926**	.898**	.898**	1.000

Note: * $p < 0.05$ level, 2-tailed. ** $p < 0.01$ level, 2-tailed.

Appendix I: Summary of Hierarchical Multiple Regression Analysis for Variables Predicting Learner Achievement

Variable	B	SE B	β	t	Sig.
Step 1					
Age	-.493	.559	-.352	-.882	.411
Gender	-.550	2.224	-.191	-.247	.813
WHMIS Training	1.609	.815	.613	1.974	.096
Comfort in Online Environment	.655	1.480	.144	.442	.674
Courses with web-based components	-.472	.957	-.190	-.493	.639
Highest educational attainment	-.330	1.206	-.170	-.273	.794
Step 2					
Age	-.400	.589	-.285	-.680	.545
Gender	-.405	1.736	-.141	-.233	.831
WHMIS Training	.937	.603	.357	1.554	.218
Comfort in Online Environment	-.869	1.829	-.191	-.475	.667
Courses with web-based components	-1.840	.752	-.739	-2.447	.092
Highest educational attainment	-.888	.801	-.458	-1.108	.349
Hrs worked per week	.576	.276	.838	2.085	.128
Flexibility of Learning Environment	1.339	.929	.430	1.441	.245
Ease of Use of Technology	1.950	.847	.771	2.302	.105

Appendix J: Summary of Hierarchical Multiple Regression Analysis for Variables Predicting Student Satisfaction with Learning

Variable	B	SE B	β	t	Sig.
Step 1					
Age	.291	.153	.923	1.906	.098
Gender	.627	.764	.663	.820	.439
WHMIS Training	.204	.268	.216	.762	.471
Comfort in Online Environment	-.017	.495	-.011	-.035	.973
Courses with web-based components	.223	.320	.259	.699	.507
Highest educational attainment	.342	.414	.498	.825	.437
Step 2					
Age	.238	.251	.756	.950	.396
Gender	.148	.846	.156	.174	.870
WHMIS Training	.101	.268	.107	.376	.726
Comfort in Online Environment	.024	.908	.014	.026	.981
Courses with web-based components	.121	.322	.140	.377	.726
Highest educational attainment	.133	.403	.194	.330	.758
Hrs worked per week	.002	.113	.009	.019	.986
Flexibility of Learning Environment	-.429	.463	-.464	-.927	.406
Ease of Use of Technology	.321	.421	.377	.762	.488

Appendix K: Summary of Hierarchical Multiple Regression Analysis for Variables Predicting Self-Reported Learning

Variable	B	SE B	β	t	Sig.
Step 1					
Age	.057	.119	.197	.483	.646
Gender	-.198	.591	-.222	-.334	.750
WHMIS Training	.515	.213	.580	2.414	.052
Comfort in Online Environment	.198	.399	.128	.495	.638
Courses with web-based components	-.259	.269	-.307	-.962	.373
Highest educational attainment	.070	.323	.107	.215	.837
Step 2					
Age	-.103	.133	-.351	-.773	.496
Gender	-.813	.447	-.915	-1.819	.167
WHMIS Training	.529	.143	.595	3.700	.034
Comfort in Online Environment	-.401	.517	-.260	-.775	.495
Courses with web-based components	-.221	.173	-.262	1.278	.291
Highest educational attainment	-.081	.214	-.125	-.378	.731
Hrs worked per week	-.043	.073	-.158	-.594	.594
Flexibility of Learning Environment	-.130	.245	-.150	-.532	.632
Ease of Use of Technology	.539	.269	.643	2.002	.139