ATHABASCA UNIVERSITY

STUDENT-STUDENT INTERACTION IN AN ONLINE CONTINUING PROFESSIONAL DEVELOPMENT COURSE: TESTING ANDERSON'S EQUIVALENCY THEOREM

BY

LINDA MARKEWITZ

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The undersigned certify that they have read and recommend to the Athabasca University Governing Council for acceptance a thesis STUDENT-STUDENT INTERACTION IN AN ONLINE CONTINUING PROFESSIONAL DEVELOPMENT COURSE: TESTING ANDERSON'S EQUIVALENCY THEOREM submitted by LINDA MARKEWITZ in partial fulfillment of the requirements for the degree of MASTER OF DISTANCE EDUCATION.

Dr. Martha Cleveland-Innes
Committee Supervisor

Dr. Thomas Jones
Committee Member

Dr. Moira Grant
Committee Member

Date: December 10, 2007

DEDICATION

This thesis is dedicated to my husband Garth, our daughter Crystal and our recently deceased son John. You have been an integral part of my journey and I could not have endured those years without your love and support. You have shared in the responsibilities and sacrificed so much along the way. This work is as much yours as it is mine.

Knowledge is a tree whose roots are nourished by the sweat of a family.

ABSTRACT

Continuing education programs for laboratory professionals benefit from the creation of a community of inquiry which encourages students to think critically and learn deeply. Student-student interactions are an essential factor in that structure. This research asked the question, “Is interaction between students a necessary component of online learning for medical laboratory professionals?” The study examined the impact of student-student interactions in an online professional development course in medical laboratory science. Anderson’s equivalency theorem serves as a theoretical frame and identifies categories of the independent variable, student-student interaction. Three dependant variables were explored: (1) student test scores; (2) quantities of student-content and student-instructor interactions; and (3) change in student approaches to learning. Results show statistical significance for student-content and student-instructor interactions. Findings approached the level of significance for surface approach scores. Simple measures of effect showed the relationship of a mildly positive change in deep approach scores combined with a moderately negative change in surface approach scores for the treatment group. Although the study was hampered by a short experimental time-frame and a small sample size, evidence supports the inclusion of student-student interactions via CMC in online instruction for medical laboratory continuing education programs.

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> *"Research is formalized curiosity. It is poking and prying with a purpose. It is a seeking that he who wishes may know the cosmic secrets of the world and that they dwell therein."*
>
> Zora Neale Hurston, 1942

I would also like to express my appreciation to all who contributed as research participants in my study. Thank you for submitting to my "poking and prying".

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CHAPTER 1

INTRODUCTION

Change is a constant in today's workplace. This is especially true for the field of health care where technological advances alter medical practice and new knowledge has the potential to translate into improved patient care. For the specialties contained under the umbrella of the Medical Laboratory Sciences, provincial licensing as well as professional and moral obligations form an imperative to continually update knowledge (Government of Alberta, 2002; Government of Ontario, 1991). These influences combine to create an increased need for continuing professional education for laboratory professionals.

Computerization and automated technologies have been an integral part of the medical laboratory for several decades. This has led some to believe that laboratory professionals make the ideal population for technology-based distance education programs (Nordin, 2006; Willis, 1998). In recent years, accessibility of the internet, web-based online courses and e-learning has expanded considerably. Technology supported distance education has emerged as a means of meeting the accelerated demand for professional development for medical laboratory professionals (Randell, 2001).

The Canadian Society for Medical Laboratory Science (CSMLS) recently developed an online training portal, the "E-learning Society" (ELS). This is a new initiative from the CSMLS, an organization offering continuing professional development through distance education since the 1970's (L. Agro, personal communication, October 12, 2007). It represents the culmination of many years' work and a considerable investment in continuing education by the society. The success or failure of this venture depends upon many factors. Crucial among those aspects is a clear understanding of the design elements that lead to educational success for the discipline of medical laboratory science.

In 2004, the CSMLS conducted a continuing education survey of laboratory professionals. The purpose of the survey was to improve understanding of CSMLS continuing education customers and potential customers (Canadian Society for Medical Laboratory Science [CSMLS], 2005b). Of the 189 respondents who completed the survey, not one person indicated that the opportunity to interact with other students factored into their choice of CSMLS continuing education courses (CSMLS, 2005a). Designing courses with a customer focus is a strategic goal of the CMSLS (CSMLS, 2005b). Would the purposeful design of instruction without student interactions meet educational objectives?

Students perceive the collaborative element as one of the components least valued in studies of learning environment factors (Price, 2005; Wright, 1999). Actual student performance was in keeping with their perceptions. For example, in an internet-delivered programme on change management in primary health care, Fox, O'Rourke, Roberts and Walker (2001) found that students without access to discussion forums fared better in terms of the number of learning objectives showing an increase over the 12-week course. Student-student interaction in a Master's degree program was found to be the least important form of interaction and did not contribute critically to the success of the students in that program (Kelsey & D'souza, 2004).

Others disagree. The incorporation of interpersonal interaction into the education of health professionals assists in modelling expert behaviour prior to practice thereby enhancing the learning experience (Bischoff, Bisconer, Kooker & Woods, 1996). Green (2005) found that peer discussions during online computer conferences played an important role in the critical thinking processes of rehabilitation practitioners. It can be argued that the healthcare environment requires a collaborative educational approach (Thiele, Stucky & Allan, 1999). Since the working reality of health professionals generally demands teamwork, group tasks involving interactions between students mimics real life experience (Townsend, Campbell, Curran-Smith, McGinn, Persaud, & Peters, et al., 2002). Participating effectively in teams, communicating with colleagues and dealing with clients are part of the role of a laboratory professional. Highly developed skills in these areas are critical to both occupational and personal success (Anderson, 2003b).

From the adult education perspective, Gunawardena (1999) states that web-based adult learning environments must be designed to allow interactions that validate information, negotiate meaning and construct knowledge via social negotiations. Members of a functional learning community support and challenge each other which leads to a more effective and relevant construction of knowledge (Anderson, 2004). With this dichotomy between participant preferences and perceptions, and the assertions of researchers, we are left with a question: Is interaction between students a necessary component of online learning for medical laboratory professionals?

Theoretical perspective

> *"unless research is grounded in theory, it cannot be much more than data gathering. The development or existence of a theory makes it possible to generate hypotheses about good practice, to frame questions that will test them, and so to develop more soundly based guides to practice."*
>
> Perraton, 2000, p1

The framework of this study follows the work of Anderson (2003a, 2003b, 2004) surrounding interaction in the adult higher distance education environment. Some suggest that higher education curriculum should assist students to develop as competent lifelong learners (Cleveland-Innes & Emes, 2005b). From this perspective, learning is viewed in part, as a process of student development. Excellence in medical laboratory professional practice also requires a commitment to lifelong learning. Up-to-date skills, knowledge and expertise are needed to keep pace with rapid changes in medical laboratory science (CSMLS, 2002). In order for laboratory professionals to function fully as a part of multidisciplinary health care teams, knowledge needs must go beyond a simply technical focus (Dominelli &Wheeler, 2006). The broader view includes development of abilities in critical thinking, problem solving and communication (CSMLS, 2002; Longo, 1998).

Anderson's theorem involves a continuum of interactions. At one end of the spectrum is the possibility of a community of inquiry with high levels of student-student interactions and corresponding restrictions placed on students' temporal independence. The other end of the spectrum comprises independent studies with its focus on high levels of student-content interactions possibly utilizing semantic web technologies which allow a high degree of student independence (Anderson, 2003a). Based upon informal distance education student polls and literature debate over the need for interaction, Anderson (2003a) developed an equivalency theorem as follows:

> *"Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student-teacher; student-student; student-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience."*
>
> *"High levels of more than one of these three modes will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences*."
>
> Anderson, 2003a, p4

"This theorem implies that an instructional designer can substitute one type of interaction for one of the others (at the same level) with little loss in educational effectiveness – thus the label of an equivalency theory." (Anderson, 2003a, p4) Following that logic, student-student interaction need not be included in the instructional design. This would have no negative effect on deep and meaningful learning provided that either student-teacher or student-content interaction exists at a high (or the same) level.

To test this strategy, a Module of instruction was designed in two formats: one with integrated student-student interaction opportunities and one with no opportunity for student-student interactions. A pre and post questionnaire was administered to determine levels of deep and surface learning approaches utilized by students (Biggs, Kember & Leung, 2001). Following the Module, quantities of student-content and student-teacher interactions were tallied. A post-Module quiz was also administered.

Purpose

> *"Too much of our practice in distance education is not "evidence based", and our actions and instructional designs are often grounded on untested assumptions about the values of modes of interaction (or lack thereof)."*
> Anderson, 2003b, p141

> *"Developments in education often lack this theoretical foundation and are frequently inspired by social processes or ideological beliefs…"*
> Long, 2000, p6

Early distance learning, in its correspondence mode, was essentially limited to a one-on-one relationship between the teacher and student. Students did not have a formal occasion to connect with other students. As distance education progressed from this basic communication method to online learning, the opportunity for interaction has increased (Woods & Baker, 2004).

Some students will take part in online peer discussion activities only if the course assessment distributes marks for doing so (Kear, 2004). Bonilla-Romeu (2001) delineates tactics to increase student-student interactions in a virtual learning scenario. Oliver (1994) outlines strategies to promote or "force" interaction between students in telecommunicated courses. If Anderson's (2003a) theorem holds true, these efforts may not be necessary.

The linkage between pedagogy and an academic discipline are complex. Any attempt to introduce change requires sensitivity to the particular field or specialty involved (Becher & Trowler, 2001). Donald (2002) outlines three questions to guide the exploration of learning needs within a discipline: (1) what is the learning environment of that discipline; (2) what knowledge and higher order thinking processes should these students learn; and (3) how do we optimally cultivate these thinking processes. The unique culture of the institution, discipline, region and user group will determine their expectations for levels of interaction (Anderson, 2003b).

Laboratory professionals have indicated overwhelmingly that the opportunity to interact with other students is not an important consideration when choosing a continuing education course (CSMLS, 2005a). With the CSMLS continuing education program embarking on an evolution to e-learning, the need to critically and empirically assess the value of various forms of interaction within the laboratory professional group becomes crucial. The purpose of research is to inform practice. It is anticipated that this study will contribute to theoretical knowledge regarding interaction from both a distance education and laboratory professional education perspective. Research results specific to the laboratory milieu can therefore influence future instructional design for the CSMLS's "E-learning Society" program as well as online offerings of other laboratory-related organizations.

Assessment of the various modes of interaction utilizing a variety of research tools and methodologies has been recommended by researchers (Anderson, 2003b; Kearsley, 1995). This study explored the influence of student-student interactions by isolating that component and examining the impact on student test scores, quantities of student-content and student-instructor interactions, and the adoption of a deep approach to learning. In doing so, it serves as a test of the validity of Anderson's Equivalency Theorem as it applies to a new online distance delivery continuing education program for laboratory professionals

Research questions

1) What is the relationship between student-student interaction and performance as measured by test scores? Is there a significant difference in test scores between a class that experiences student-student interactions in their course and a class who does not?

2) What is the impact on the quantity of student-initiated student-teacher and student-content interactions when student-student interactions are a component of a Module of instruction? How do the quantities of student-initiated student-teacher and student-content interactions differ between a class who experiences student-student interactions in their course and a class who does not?

3) What is the relationship between student-student interaction and the adoption of a deep approach to learning? Is there a significant difference in the adoption of a deep approach to learning between a class who experiences student-student interactions in their course and a class who does not?

4) What are medical laboratory continuing education student expectations towards student-student interactions in the online environment?

Research hypotheses

1) There is no significant difference in test scores between the two groups.

   Null hypothesis: H_0: $\mu_1 = \mu_2$

   Where μ_1 = Group A, μ_2 = Group B

2) The Group A (treatment group with student-student interactions) will have lower quantities of student-initiated student-teacher and student-content interactions than Group B (control group with no student-student interactions).

   Null hypothesis: H_0: $\mu_1 < \mu_2$

   Where μ_1 = Group A, μ_2 = Group B

3) There is no significant difference in the adoption of a deep approach to learning between the two groups.

   Null hypothesis: H_0: $\mu_1 = \mu_2$

   Where μ_1 = Group A, μ_2 = Group B

Assumptions

1. Almost all medical laboratories throughout Canada have some degree of computerization. It was assumed that study participants would have a basic degree of knowledge and familiarity with computers.

2. It was assumed that the study participant's awareness of being involved in this research would not affect their normal behaviours as students in the Preanalytical Process course.

3. It was assumed that the selection of medical laboratory technologists and assistants as research subjects would yield a group of professionals who would recognize the importance of research and would participate in those activities in an honest and reflective manner.

Biases

It is not unreasonable to expect a certain degree of researcher bias. As a distance education student, my own positive experiences of online interactions with my peers could predispose me to be an advocate of the use of CMC in online learning and student-student interactions. To counter potential selection bias on the part of this researcher, subjects were enrolled into the program and randomly placed into their respective groups by CSMLS educational department staff.

As the instructor of the program under study, any bias could alter my interactions with the student research participants. Since student-instructor interactions would be measured as a dependant variable, I framed my approach to create equal opportunities and similar experiences for both groups. I made every effort to initiate my communications to students in an equivalent manner. For example, questions posed to group A in a discussion forum were emailed to group B students to allow the same initial opportunity for interaction on exactly the same questions. I attempted to not over-involve myself in the discussion forums of group A, but to interact in a manner consistent with how I continued to facilitate the class after the research study. With group B students who emailed an answer to the questions, I attempted to challenge their thinking and ask probing questions to continue the discussion. Potential bias in data collection was also considered. I endeavoured to maintain a strictly consistent method of applying measurement criteria between groups. (See criteria for “student-initiated” interaction in the definition of terms section of this thesis).

The students in this study were aware that I acted as both course instructor and researcher. Relationships between students and instructor or researcher involve power and trust. Both associations placed me in a position of power over the students. It would be possible for a student to attempt to gain favour by acting in a manner they perceive to be beneficial to my research. To avoid this prospect, I withheld information on the exact nature of the experimental variables under study, revealing only a general overview of the research method. (See Appendix B)

Ethics begin and end with the researcher (Neuman, 2006). Before, during and after this study, I reflected upon my behaviours and used my own values as a guide for my actions. At all times, my attempt was to act in an ethically responsible manner.

Significance

Kearsley (1995) indicates that various interactive components of distance education need to be isolated and tested. Anderson (2003b) states that each mode of interaction in distance education needs systematic empirical research utilizing a variety of methods. Saba (2000) identifies instructional interaction grounded on the theory of transactional distance as a core issue for future research. Garrison and Cleveland-Innes (2005) propose further qualitative study to understand the nature of online interaction that supports high levels of learning. Cleveland-Innes and Emes (2005a) suggest studying factors such as peer relationships as potential influences on student approaches to learning.

Information from the medical laboratory perspective is also needed. Grant and Davis (2004) condemn the lack of research foundation underlying educational practices for laboratory technologists. While their comments relate to the situation of clinical placements for students of medical laboratory science, it is relevant beyond that context. Research specific to the medical laboratory is genuinely deficient. Studies found are most often from the United States. In that framework, the entry-level educational requirements for laboratory workers are much more varied and as such the findings of their research may not be applicable to the Canadian situation.

Limitations

This study was limited by the number of students willing to participate. While a financial incentive was offered by the CSMLS in terms of reduced course fees for study participants, the short time frame between advertising the course and the course start date necessitated a quick response by interested parties.

Delimitations

Although the “Preanalytical Phase” course is designed for more categories of students, this study was delimited to Medical Laboratory Technologist (MLT) and Medical Laboratory Assistant (MLA) participants. It was also delimited to CSMLS certified members. Both measures help to ensure the prior attainment of a minimum educational level by the study participants and a more uniform population for the study. In addition, the short one month research period was delimited by the practical considerations of the Master of Distance Education (MDE) program and my own deadlines for research and completion of this thesis.

Definition of terms

The following functional definitions outline the fundamental concepts that have been addressed by the research questions.

> Achievement learning: The student is orientated towards and motivated by external rewards. Ego is enhanced via competition (Biggs, 1986). Activities are focused on those that will garner the highest marks regardless of if the student finds the materials interesting (Biggs, 1986; Cleveland-Innes & Emes, 2005a; Garrison & Cleveland-Innes, 2005). The student strives for the most effective use of time as it relates to achievement within the course structure

(Biggs, et. al, 2001). Achievement students behave as “model students” (Biggs, 1986).

Computer Mediated Conferencing (CMC): This is the method in which a group of students or participants exchange messages for the purposes of discussing a topic of mutual interest via a system of networked computers (Gunawardena, Lowe & Anderson, 1997). CMC is generally asynchronous and text-based. It supports a “many to many” communication scenario. Messages can be linked, organized in branches or topics and searched. CMC can provide a shared working and learning space supporting both formal and informal exchanges well-adapted for collaborative activities (Kaye, 1991).

Deep learning: The student fully utilizes the materials at hand to search for meaning and understanding (Biggs, 1986). Comprehension is directed towards the intentional content of the learning materials or trying to appreciate the principal ideas and overall point of the information (Marton & Saljo, 1976). Detailed attention is paid to the intricacies, substance and limits of a subject area. Students are intrinsically motivated and engage themselves in the learning experience for its own sake (Biggs, 1986; Biggs, et. al, 2001; Cleveland-Innes & Emes, 2005a; Garrison & Cleveland-Innes, 2005). Learners read widely and relate ideas to previous relevant knowledge and experience (Biggs, 1986). “When using the deep approach in handling a task, students have positive feelings: interest, a sense of importance, challenge, even of exhilaration. Learning is a pleasure." (Biggs, 1999, p16). They look for patterns and underlying principles, check evidence, examine logic and argument critically, and become actively interested in the course content (Weigel, 2002).

Distance education: A "generic term that includes the range of teaching/learning strategies used by correspondence colleges, open universities, distance departments of conventional colleges or universities and distance training units of corporate providers. It is a term for the education of those who choose not to attend the schools, colleges and universities of the world but study at their home, or sometimes their workplace." (Keegan, 1996a, p34) It is characterized by the "quasi-permanent separation of teacher and learner throughout the length of the learning process" and the "quasi-permanent absence of the learning group throughout the length of the learning process" (Keegan, 1990, p44). Technical media such as print, audio, video and computer are utilized to unite teacher and learner, as well as to carry the course content (Keegan, 1990). Today, these technical means are utilized to unite the learning group as well.

Interaction: An exchange in which two objects and two actions mutually influence one another (Wagner, 1994). In interactions between humans, the intent is to influence thinking in a critical and reflective manner (Garrison &

Cleveland-Innes, 2005). The focus of interactions is on people's behaviours (Wagner, 1997). It relates to the *process concerns* surrounding the technology integration strategies and the tactics of how that technology will be applied (Wagner, 1994).

Interactivity: The technological capability for establishing connections from point-to-point in real time. The focus of interactivity is on the technology (Wagner, 1997). It relates to the *product concerns* surrounding technology systems and their hardware and software (Wagner, 1994).

Module: This term has two meanings within this thesis. It is first used to refer to the unit of instruction designed in two ways (with or without opportunity for student-student interactions) for the research experiment. When this definition is intended, it is referred to as "Module 1". The second use refers to the various features and plug-ins of the Moodle program platform (Moodle, 2007). When used in this connotation, it is simply referred to as "module".

Surface learning: The student puts forth the least amount of effort in order to meet minimum requirements. The focus is on the text of the academic discourse itself by reproducing discrete facts or utilizing rote learning (Biggs, 1986; Marton & Saljo, 1976). Lower level cognitive activities prevail (Biggs, 1999). Motivation is derived from simply completing the task (Cleveland-Innes & Emes, 2005a; Garrison & Cleveland-Innes, 2005). Students will "cut corners" and under-engage. The surface appearance is of tasks completed fully and properly when that is not really the case, and memorization to give the impression of understanding instead of true understanding (Biggs, 1999). A fear of failure may be the incentive to learn (Biggs, et. al, 2001).

Student-content interaction: Access of the online course content by the student for the purposes of learning relating to the "Preanalytical Phase" course. This term is used interchangeably with learner-content interaction.

Student-initiated: For the purposes of data collection, a student-initiated interaction was considered to be one by which the nature of the initiation of communication or response to a communication was at the discretion of the student. For example, a response to a direct request by the instructor to respond to an ELS message (email) was not counted as a student-initiated interaction. However, if a control group student responded to an ELS messaged question that they had the option of simply reflecting upon or discussing by messaging the instructor, that message was counted as a student-initiated interaction.

Student-student interaction: Communication between two or more students in a class for the purpose of information exchange and support relating to the "Preanalytical Phase" course. This term is used interchangeably with learner-learner interaction.

Student-teacher interaction: Communication between a student and the teacher or instructor for the purpose of information exchange and support relating to the “Preanalytical Phase” course. The terms teacher and instructor, and student and learner are used interchangeably.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

This research posed the question, “Is interaction between students a necessary component of online learning for medical laboratory professionals?” Anderson (2003a) projected that either student-instructor or student-content interaction could be substituted (at the same level) for student-student interaction with little loss in educational effectiveness, and no negative effect on deep and meaningful learning. The framework of this equivalency theorem is based upon the contrast between the community of inquiry (Garrison, Anderson & Archer, 2000; Lipman, 1991) vs. independent learning (Anderson, 2003a; Moore, 1973; Wedemeyer, 1978).

Traditional concerns of distance educators are the human values of freedom, individualism and self-direction on the part of the learner (Moore,1986). This extends to include independence of pace, space and time (Keegan, 1996b; Wedemeyer, 1978). Today’s technologies allow the distance educator an array of choices and the ability to combine different modes of interaction via synchronous or asynchronous means. Anderson (2003a) argues that if we choose modes of interaction that restrict students’ independence, gains in learning must be sufficient to justify that restriction.

Quality management philosophies have now made their way into distance education creating an environment where a customer (learner) focus is paramount

(McIlroy & Walker,1993). Medical Laboratory Technologists have indicated their preference for independent study (CSMLS, 2005a). However, a learner's felt need does not always translate into an actual need since even adult learners may not be the best judges of their own interests (Garland, 1994). The best way to meet customer (learner) needs for interaction is by basing our decisions and instructional designs on pedagogical grounds.

The following literature review examines interaction in general. The relationships between transactional distance, constructivist learning and interaction are explored. The terms interaction and interactivity are compared. Various modes of interaction and the changes experienced through generations of DE are discussed. The progression of thinking towards the development of Anderson's (2003a) model of online learning and Garrison, Anderson and Archer's (2000) community of inquiry are presented. Finally, the analysis will focus on defining deep and meaningful learning by examining student approaches to learning (Biggs, 1986, 1999; Biggs, et. al, 2001; Cleveland-Innes & Emes, 2005a; Entwistle, 1981; Garrison & Cleveland-Innes, 2005). This review will provide a background in several important issues surrounding the key concepts contained within the equivalency theorem and how these various schools of thought contribute to current thinking.

Interaction

Dewey (1916) stated that all communication is educative and that to receive communication is to have an enlarged and changed experience. Inert information is conveyed to the student from another person and this information is constructed into knowledge that is personally meaningful and applicable (Dewey, 1916). Thus, interaction is perceived as being vital to the exchange of information in an educational context (Keegan, 1996a). In the traditional sense, interaction has focused on the dialogue that occurred in the classroom between students and teachers (Anderson, 2003b). But all learning involves some form of interaction, whether as an internal conversation where a solitary student reflects on information in a textbook or when two or more people are in conversation with each other (Daniel & Marquis, 1979).

Transactional distance

While Keegan's (1996a) definition of DE describes it in terms of a geographic separation between students and teachers, the experience is not that simple. From a pedagogical standpoint, the teacher-learner relationship in DE encompasses a world created by the instructional program, interactions between learners and teachers, and the degree of autonomy and self-directedness of the learner (Moore, 1993). The physical separation that occurs between learners and teacher in DE creates a psychological and communication space where misunderstandings between the instructor and learner are possible. This "transactional distance" as defined by Moore (1993), varies throughout the learning experience and is not a discrete variable and an absolute term, but rather a continuous awareness and a relative term. Transactional distance is a perception and a perceived lack of interpersonal closeness can be more evident and potentially more problematic in an online environment (Bischoff, et al., 1996; Moore, 1993).

While normally thought of in terms of teacher-student interactions, instructional dialogue can include interactions among learners. In an online environment, it is difficult to separate the effects of student-student dialogue from teacher-student dialogue since teachers play the role of facilitator in computer mediated discussions (Ehrlich, 2002). Transactional distance in the current online context can be further defined as the perception of interpersonal closeness between the instructor and student, or among the students themselves (Bischoff, et al., 1996).

Constructivist learning environment

Constructivism is focused on the development of learning and the development of knowledge in the mind of the learner (Kear, 2004). Learners are active in this process, constructing their own unique meaning and understanding. Piaget (1954) referred to these knowledge constructions as schemata. Piaget's schemata encompassed the range of methods in which a child would perceive and think in order to make meaning of the world. Learning is accomplished through the interplay of the bi-polar forces of assimilation and accommodation (Piaget, 1954, 1970). The learner can assimilate new experiences or information into their pre-existing knowledge thereby expanding that knowledge. But when new information is contradictory to pre-existing knowledge, the learner must then accommodate to the new experience in their thoughts thereby changing their knowledge.

> "it is clear that on the plane of representative thought, which is at the same time that of social relationships or coordination among individual minds, new assimilations and accommodations become necessary and these in turn begin with a phase of chaotic un-differentiation and later proceed to a complementary differentiation and harmonization."
>
> Piaget, 1954, p. 380

This process recognizes the importance of the stimuli that could possibly be provided by the social environment of the learner and exposure to the contradictory views of others (Anderson & Garrison, 1995).

In 1978, Vygotsky described what he called the Zone of Proximal Development (ZPD).

> "It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers."
>
> Vygotsky, 1978, p. 86

Vygotsky (1978) contends that the origin of higher functions in the child; such as voluntary attention, logical memory and the formation of concepts, originates from relations between human individuals. It creates a transition from inter-psychological to intra-psychological functioning. So, the ZPD is situated and grounded in social activity (Olszewski, 2006). While the works of Piaget and Vygotsky deal with the realm of child psychology and development, that context has been extended by research into the world of adult and higher education (Duncan, 2005; Harland, 2003).

Cognitive development can progress further as a social process with teaching presence or through interaction with peers (Vygotsky, 1978). Groups of students working together can team up to assist each other in the mastery of academic materials (Fox, et al, 2001; Kaye, 1991). Education as collaboration ensures the integration of social and personal knowledge by challenging the learner's existing views and compelling the consideration of alternative perspectives (Garrison & Shale, 1990). So, in a social constructivist environment, learners develop personal conditionalized knowledge and metacognition collectively via interactions and dialogue with other members of a learning community (Weigel, 2002). In the online environment, CMC is the almost ubiquitous vehicle employed to create these learning communities (Hewitt, 2005).

<u>Interaction or interactivity?</u>

It is necessary to have the term interaction delineated within the situation of the DE environment since the definitions used by communication researchers studying face-to-face dialogue does not translate well to the CMC setting (Gunawardena, et al., 1997). Some researchers, such as Gilbert and Moore (1998), and Kearsley (1995) use the terms interaction and interactivity interchangeably. Borsook and Higginbotham-Wheat (1991), and Jaspers (1991) classify various media types according to their levels of interactivity. In both of these cases, the classification schemes focused on the capabilities of the media itself. In 1994 and further in 1997, Wagner separated the concepts of interaction and interactivity, with the former having a focus on the behaviours of people and the latter on the technology that facilitates interactions in the distance education environment.

Daniel and Marquis (1979) defined the term interaction to include only those activities where the student was in two-way communication with another person or persons in order to elicit responses specific to their own contributions to the conversation. In contrast, Wagner (1994) characterizes interaction in the DE context as requiring at least two objects and two actions to mutually influence each other. In this perception, interaction relates to the *process concerns* surrounding the technology integration strategies and the tactics of how that technology will be applied (Wagner, 1994). Concerned about what he perceived to be the lack of inclusion of non-humans in Wagner's structure, Anderson (2003b) inevitably concluded that her definition was simple enough to apply within the DE framework but broad enough to include the essential nature of interaction without restricting the range of possible types.

Modes of interaction

> *"At the heart of higher education is the three-way transaction between the student, his teacher, and the material being studied."*
>
> Entwistle & Ramsden, 1983, p2

In order to examine and more fully define interaction, Moore (1989) described three types of interaction within the DE framework: learner-content, learner-instructor and learner-learner. It seems obvious that without some form of learner-content interaction, there cannot be education (Moore, 1989). No matter how that educational content is conveyed to the learner, the learner must interact with and process the information on an intellectual level. Cognitive structures in the mind change as the information is either assimilated or accommodated by the learner. The value of content depends upon its ability to engage students in mindful interactions which lead to knowledge development (Anderson, 2003a).

In learner –instructor interactions, the instructor plays a number of roles but most importantly responds to the learner's application of knowledge (Moore, 1989; Gunawardena, 1999). Is the learner applying the new knowledge correctly, as extensively as possible and are they aware of all of the potential areas of application in the real world (Moore, 1989)? In the online environment, an instructor guides interactions through facilitation, by modelling appropriate behaviour and by providing leadership and direction through the creation of a purposeful instructional design (Garrison, Anderson & Archer, 2001; Garrison & Cleveland-Innes, 2005a; Garrison, 2006).

Finally, learner-learner interaction provides the means of socially negotiating knowledge and constructing new meaning. There is an enrichment of education when collaboration and cooperation between learners occurs. Sustained communications between learners provide opportunities to critically examine the opinions of others (Garrison, et. al, 2000). Having the chance to confront conflicting views in how the learning materials are interpreted and how they could possibly be applied “forces” the learner towards a deeper understanding (Anderson, 2003b).

Formal education at the post-secondary level requires that interaction or opportunities for interaction be designed specifically towards defined learning objectives (Anderson, 2003a). The quality of the outcome of learning is a product of the macro-level educational relationships between teacher, learner and content as well as the micro-level features of control including independence, support and proficiency (Anderson & Garrison, 1998). Earlier models of online learning saw the facilitation of meaningful learning as a balance between the student’s metacognitive behaviours and the human (teacher and support services) and non-human (content and technology) resources of the course (see Fig 1).

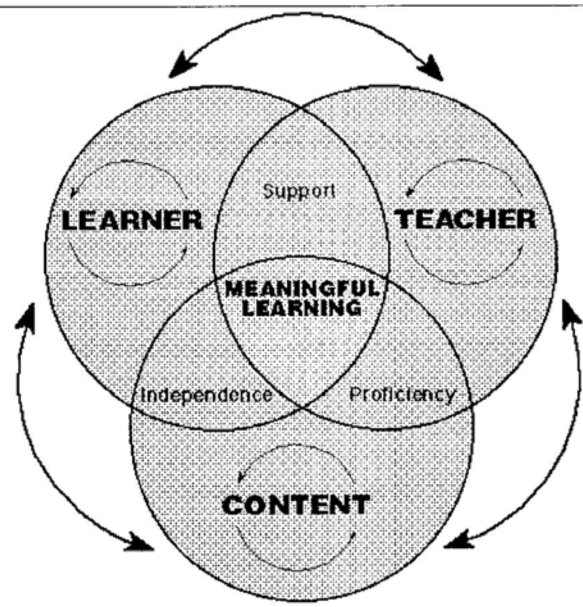

Figure 1. Transactional relationships in higher education from Anderson & Garrison (1998)

(Adapted from Garrison, 1989)

While this depiction of the educational process did describe interaction more fully, it did not take into account interactions outside of the immediate course structure but within the realm of the educational setting. In 1998, Anderson and Garrison expanded upon Moore's initial categorizations with the addition of: teacher-teacher, teacher-content and content-content (see Fig 2). Our current availability of low-cost multimedia networks means that benefits extend beyond the students. Teachers now have the possibility of interacting with each other as never before. Teacher-teacher interactions extend the premise of a learning community and the benefits of a shared pool of knowledge and experience of teaching. Teachers-content interactions occur when instructors update their courses in real time. This can be in response to specific classroom situations or student needs. Learning objects can also be created by teachers and shared beyond the course itself.

Internet search engines are just one example of newer technologies that allow content to interact with content (Anderson, 2003b).

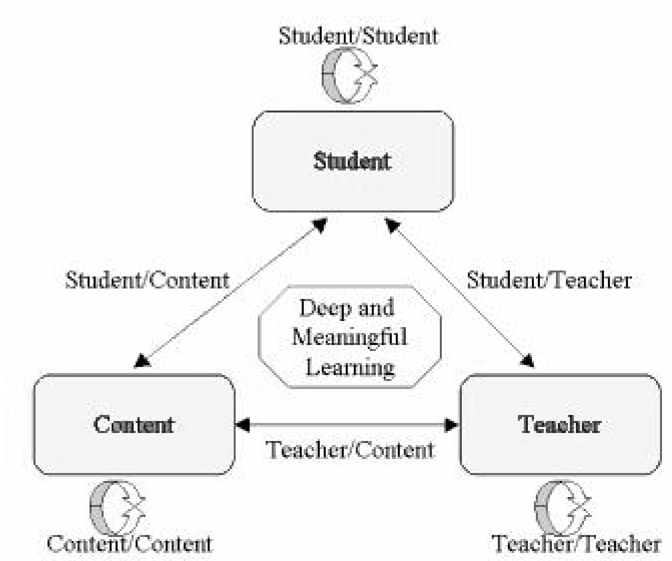

Figure 2. Modes of interaction in distance education from Anderson, 2003a
(Adapted from Anderson & Garrison, 1998)

<u>Generations of distance education</u>

Distance education (DE) is distinguished from conventional education in that the distance learner receives instruction via some form of communications media in a non-contiguous manner (Saba, 1988). First generation DE operated via the correspondence model utilizing print technologies (Taylor, 2001). The logistics of geographic distance combined with a lack of technology made the emphasis of early DE's interactions to be on a one-on-one relationship with the instructor (Olliges & Mahfood, 2003). The adoption of new technologies by distance educators led to an evolution through a second generation multi-media model utilizing print, audio and video to a third generation telecommunications method allowing synchronous communications with instructors and fellow students (Taylor, 2001) (see Table 1).

Models of Distance Education and Associated Delivery Technologies	Characteristics of Delivery Technologies				Institutional Variable Costs Approaching Zero
	Flexibility			Advanced Interactive Delivery	
	Time	Place	Pace		
First Generation - The Correspondence Model					
• Print	Yes	Yes	Yes	No	No
Second Generation - The Multi-media Model					
• Print	Yes	Yes	Yes	No	No
• Audiotape	Yes	Yes	Yes	No	No
• Videotape	Yes	Yes	Yes	No	No
• Computer-based learning (e.g. CML/CAL)	Yes	Yes	Yes	Yes	No
• Interactive video (disk and tape)	Yes	Yes	Yes	Yes	No
Third Generation - The Telelearning Model					
• Audioteleconferencing	No	No	No	Yes	No
• Videoconferencing	No	No	No	Yes	No
• Audiographic Communication	No	No	No	Yes	No
• Broadcast TV/Radio and Audioteleconferencing	No	No	No	Yes	No
Fourth Generation - The Flexible Learning Model					
Interactive multimedia (IMM)	Yes	Yes	Yes	Yes	Yes
Internet-based access to WWW resources	Yes	Yes	Yes	Yes	Yes
Computer mediated communication	Yes	Yes	Yes	Yes	**No**
Fifth Generation - The Intelligent Flexible Learning Model					
Interactive multimedia (IMM)	Yes	Yes	Yes	Yes	Yes
Internet-based access to WWW resources	Yes	Yes	Yes	Yes	Yes
Computer mediated communication, using automated response systems.	Yes	Yes	Yes	Yes	**Yes**

Table 1. Models of Distance Education - A Conceptual Framework, Taylor (2001)

At the beginning of the millennium, fourth generation flexible learning with online delivery via the Internet was still gaining momentum (Taylor, 2001). In tandem with the third and fourth generation technologies was the change from strictly instructor-student interactions to a scenario in which student-student interactions could be accommodated and encouraged. Online delivery via the internet allows students to relate to content in an interactive and non-linear manner. Although synchronous communications are sometimes utilized, student interactions with instructors and other students are accomplished mainly through asynchronous computer-mediated conferencing (CMC).

Today's fifth generation intelligent, flexible learning model offers the possibility of linking automated response systems and intelligent object databases to the fourth generation structures. A single document source allows students the choice of courseware delivery via print, online, CD or DVD for their content interactions (Taylor, 2001). CMC interactions can be tagged and stored in a database where they can be re-used by the automated response systems. Fourth generation CMC is resource intensive on the part of the instructor. Taylor (2001) describes the advantages of interactions in a fifth generation system as follows:

> " Upon receipt of an electronic query from a student, the search engine seeks an appropriate match with a previously asked question, which if successful, triggers a personalized response to the current question without concurrent human intervention. At this stage of development, a tutor must check the validity of the match between the current question and the answers generated automatically from the database before forwarding to the students following a quick scan and with a single "click". Such a quality control mechanism may become redundant in the future. If no appropriate match is discovered in the database of previously answered questions, the query is automatically routed to the relevant tutor for an appropriate response, which is then added to the database with a single point and click. Depending on the pedagogical design of the course, these responses can be directed to the whole cohort of students, to groups of students, or to individuals. The system has the advantage of providing more-or-less immediate pedagogical advice to students, a significant increase in institutional responsiveness, at minimal variable cost."
>
> Taylor, 2001, p7

Anderson (2003a) suggests that these technological changes create an opportunity for transforming student-instructor and student-student interactions into enhanced forms of student-content interactions. However, it is not clear what problematic outcomes may occur as a result of the suggested transformation. What can we expect if we leave out one or more aspects of the elements of DE? Interaction in online learning today has become increasingly complex and multifaceted, yet it remains the key to a successful learning experience (Anderson, 2003b; Garrison & Cleveland-Innes, 2005; Woods & Baker, 2004).

Model of online learning

For Anderson (2003a, 2003b, 2004), online education occurs as a result of the opportunities for each of three major elements to interact (see Fig 3). Students, teachers and content can interrelate; with each other and between themselves. These interactions can occur via synchronous or asynchronous technologies. Video, audio, CMC, real-time chat, or virtual world communications can provide a rich environment in which the honing of online social skills, collaborative content learning and the development of personal relationships between and among participants can occur (Anderson, 2004).

In creating a community of inquiry (see Fig. 3, left side of diagram), we move towards increased student-student interaction. Using those synchronous and asynchronous technologies, we bind learners in time forcing a group pace or semi-pace to learning. We also restrict the number of learners in order to preserve the "community". To modify a program towards independent self-paced study (see Fig.

3, right side of diagram), we shift away from student-student interactions and increase student-content interaction. This allows a greater degree of individual student self-pacing and the accommodation of greater numbers of students, but limits collaborative opportunities and the benefits associated with those activities. Semantic web fifth-generation technologies are suggested as a support for enhanced student-content interactions to replace student-instructor and student-student interactions in this scenario (Berners-Lee, as cited in Anderson, 2003a; Taylor, 2001).

> *"Getting the mix right involves a series of tradeoffs, and knowing how one type of interaction can effectively substitute for another, provides an essential decision making skill in the distance educators' knowledge base."*
>
> Anderson, 2003a

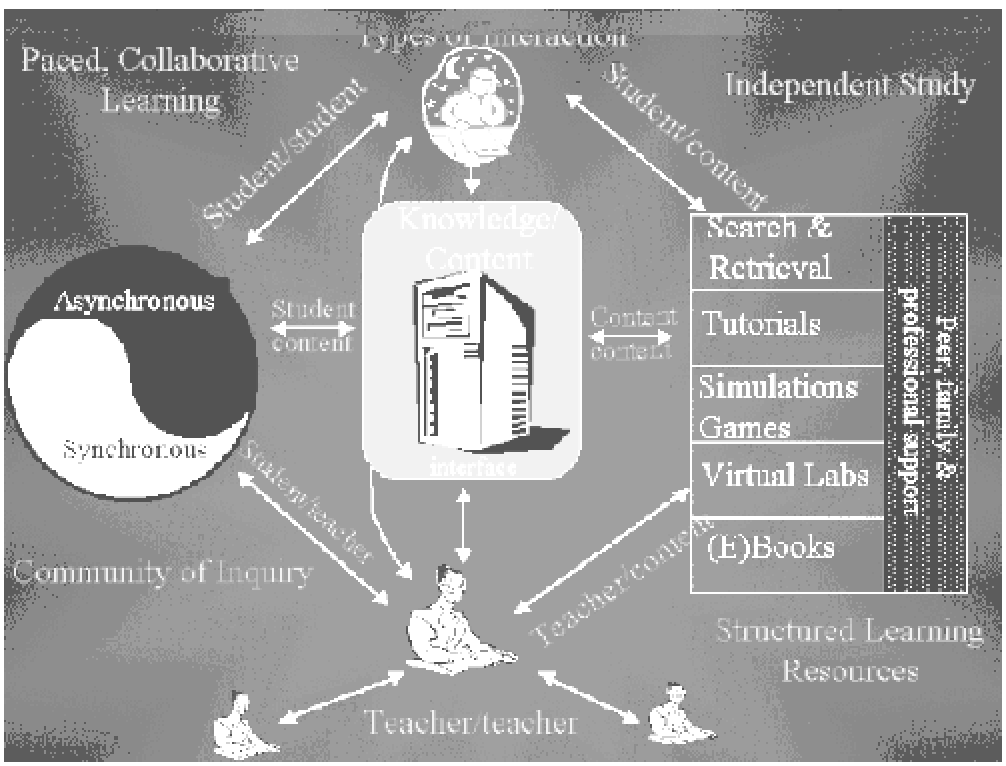

Figure 3. A model of online learning showing types of interaction from Anderson, 2003a

All forms of interaction, whether of an administrative or academic nature contribute to a student's sense of belonging and satisfaction within the DE environment (Quon, 2006). To be educative, communications should be two-way, voluntary, and the conversational control should be shared (Anderson & Garrison, 1998). In 1995, Holmberg proposed a theory of DE that incorporated 7 factors. Within that framework was the inclusion of both social and academic properties he deemed essential to student success.

> "Personal relations, study pleasure and empathy between students and those supporting them (tutors, counsellors, etc.) are central to learning in distance education. Feelings of empathy and belonging promote student' motivation to learn and influence the learning favourably. Such feelings are conveyed by students' being engaged in decision making, by lucid, problem-oriented conversation-like presentations of learning matter that may be anchored in existing knowledge, by friendly, non-contiguous interaction between students and tutors, counsellors and others supporting them, and by liberal organisational-administrative structures and processes."
>
> Holmberg, 1995a, p5

While these descriptions of the possible modes of interaction and their various levels and combinations assists with understanding the complexity of how one might learn online, it is the process of integrating ideas into a previously existing personal cognitive structure that creates new meaning and knowledge. So, there is a qualitative dimension to these educational interactions (Garrison and Cleveland-Innes, 2005). Dialogue and the exchange of ideas in learning environment conversations influence student motivation and in turn their strategies towards learning itself (Cleveland-Innes & Emes, 2005a).

Community of Inquiry

> *"The community of inquiry is in one sense a learning together, and it is therefore an example of the value of shared experience. But in another sense it represents a magnification of the efficiency of the learning process, since students who thought that all learning had to be learning by oneself come to discover that they can also use and profit from the experience of others."*
>
> Lipman, 1991, p240

When an individual studies in isolation, they are constrained by their previous socialization (Jarvis, 1987). Critical awareness and the development of deep insights require a sustained dialogue and negotiation of meaning between individuals (Garrison & Shale, 1990). The power of the social group expands and enhances learning thereby making sustained interaction between and amongst learners and teacher a logically necessary component of DE (Anderson & Garrison, 1995). The hallmark of higher education is the creation of a critical community of inquiry within the classroom (Garrison, Anderson & Archer, 2006). Lipman's (1991) characteristics of a community of inquiry include members who question one another, request reasons for another member's belief's, build on one another's ideas, deliberate among themselves, offer counterexamples to the hypotheses of others, point out possible consequences of one another's ideas, utilize specific criteria when making judgements and cooperate in the development of rational problem-solving techniques.

However, the online community of inquiry that arises from asynchronous collaborative learning is different from the spontaneous verbal system of face-to-face conversations (Garrison, Cleveland-Innes & Fung, 2004). The text-based format of

CMC allows opportunity for both reflection and interaction. Sustaining interaction and reflection by exploring and evaluating ideas, scaffolding concepts and modelling behaviours all contribute an environment that lends itself to higher-order learning outcomes (Garrison, et. al, 2004; Garrison & Cleveland-Innes, 2005a). Interaction alone does not sustain a community of inquiry. Group solidarity, the fostering of cognitive skills through dialogue, critique and judgement, as well as the presence of a teacher who guides the class through the discrete stages of building and sustaining that community is required (Lipman, 1991). A model of the online community of inquiry shows three core elements: cognitive, social and teaching presence (see Fig 4).

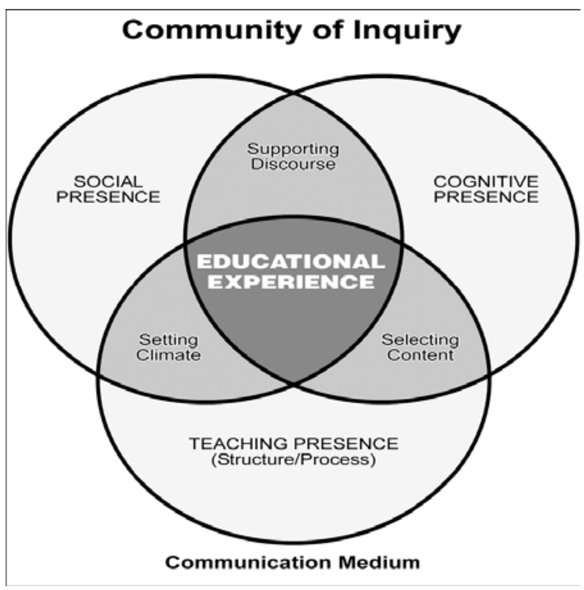

Figure 4. Elements of an educational experience from Garrison, Anderson & Archer, 2000

The creation of cognitive presence for educational purposes involves the construction of meaning and the confirmation of understanding (Garrison, et. al, 2004). It reflects the higher-order acquisition and application of knowledge, and is most associated with critical thinking (Garrison, et. al, 2006). It begins in the private world of the student with their unique pre-existing knowledge, understanding and culture. A student's cognitive presence progresses from the initial practical inquiry towards understanding through exploration, integration and finally resolution or application of that knowledge in a practical sense (Garrison, Anderson & Archer, 2001; Garrison, 2006). This sequence requires a triggering event from the shared world of the community (see Fig 5).

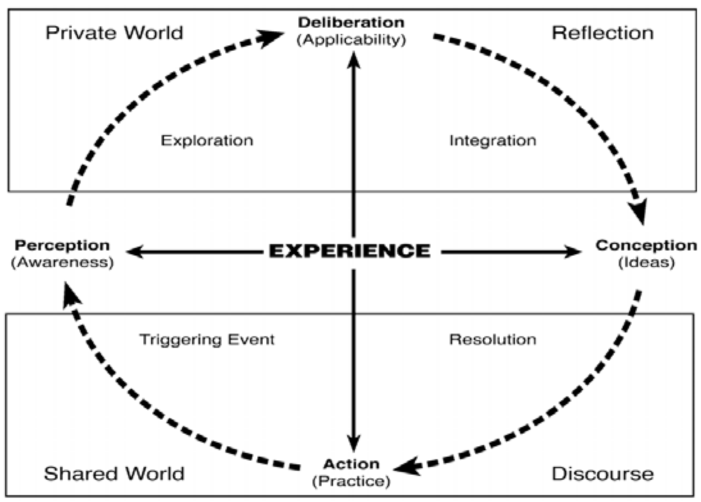

Figure 5. Practical inquiry model from Garrison, Anderson & Archer, 2001

Still, cognitive presence in isolation does not prolong critical inquiry within a community of learners. If learners are not comfortable relating to one another, sustained discourse is unlikely to occur. The dynamics of interpersonal relationships in the online environment must be considered. Failure to do so can produce greater feelings of student isolation, reduced student satisfaction, poor academic performance and increased attrition rates (Woods & Baker, 2004). Feelings, reactions and intuitions are the emotions that come into play as a critically thinking adult (Brookfield, 1987). Emotion is an integral part of cognition and behaviour (Lehman, 2006). Social presence requires an online projection of themselves as social and emotional “real people” (Garrison, et. al, 2000).

Teaching presence is also needed in these CMC discussions. The instructor’s purpose is to design, facilitate and direct these cognitive and social functions (Anderson, Rourke, Garrison & Archer, 2001). One way to engage students in meaningful discourse is to use techniques of effective questioning or inquiry (Garrison, Kanuka & Hawes, 2007). Good critical thinking skills are developed when people are challenged in their beliefs (Longo, 1996). Instructors play a leadership role in triggering discussion events, mentoring this cognitive progression and encouraging higher levels of thinking (Garrison, 2006; Garrison & Cleveland-Innes, 2005). Thus, the quality of the educational experience is a direct result of the interplay of content with students and instructors who are cognitively and socially present.

> “Teachers and students (leadership and people), co-intent on reality, are both Subjects, not only in the task of unveiling that reality, and thereby coming to know it critically, but in the task of re-creating that knowledge. As they attain this knowledge of reality through common reflection and action, they discover themselves as its permanent re-creators.”
>
> (Freire, 1993, p51)

Student's approach to learning

Anderson's (2003a) equivalency theorem forms the background context of our experimental design. Educators working within the structure of that theorem would note no negative effect on deep and meaningful learning as a result of their educational program change. In order to assess this aspect, some measure of deep learning is required. The student approaches to learning (SAL) model assists in the understanding the complex relationship between the educational context, learning processes and individual student outcomes (Biggs, 1986, 1999; Biggs, et. al, 2001; Cleveland-Innes & Emes, 2005a).

Cognitive psychology and information processing theories provide the preliminary framework for the development of learning inventories. As the community of inquiry model shows, an educational event is situated within a total system of factors that include the student's context and the teaching context. Approaches to learning are a combination of the individual student's characteristics combined with the educational environment (Entwistle & Ramsden, 1983). "Student-based factors are not independent of teaching" (Biggs, 1999, p17). However, the student's situation depends upon their motivation and study strategies (Entwistle, 1981). These factors combine to form their on-task approaches to learning. Student approaches to learning (SAL) can have a significant impact on the learning outcome. Biggs (1999) and Biggs, et. al (2001) schematize this arrangement in the 3P model.

3P model of teaching and learning

Student factors, teaching context, assignment-related student approaches to learning and the learning outcomes all interrelate in an ever-changing dynamic. Presage factors indicate what exists prior to the learning event. The student's preferred approach to learning, their relevant previous knowledge, interest in the topic, commitment to learning and their abilities as well as the nature of the course of study, the teaching methods, means of assessment, and the institutional climate are present at the start of the educational experience (Biggs, 1999; Biggs, et al., 2001). The learning activities themselves provide the process whereby the desired learning outcomes will either be produced or not. The reversible arrows in the diagram of this system indicate the ability of each item to adjust or change in response to the other factors (see Fig 6). Students in a course setting are rarely free to learn what they like and, when and how they like (Entwistle, 1981). The student's preferred approach to learning adjusts dependent upon the context and course being taught which in turn impact upon the learning outcomes.

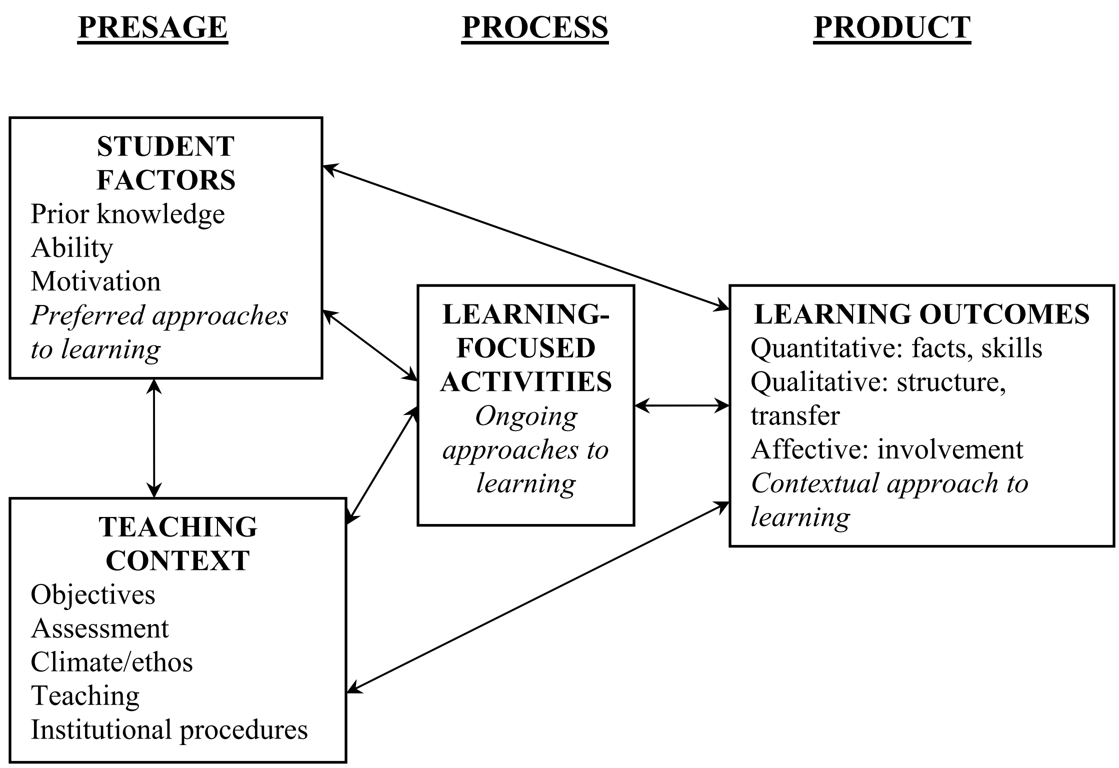

Figure 6. The '3P' model of teaching and learning from Biggs, 1999; Biggs, Kember & Leung, 2001

Three approaches to learning

Quality in higher education considers not only content issues, but process issues as well. How students approach their learning is as important as the content being taught (Garrison, Andrews & Magnusson, 1995). Student approaches to learning (SAL) are a composite dependant on a student's previous knowledge, their intellectual skills, and the balance between their hope for success and fear of failure (Entwistle, 1981). A student's approach to learning emerges from the combination of their perceptions, motivation and strategies towards learning (Biggs, 1986, 1999;

Biggs, et. al, 2001; Zeegers, 2002; Garrison & Cleveland-Innes, 2005a). There are three methods that student utilize in varying degrees; deep, surface and achievement approaches (Biggs, 1986, 1999; Zeegers, 2002; Cleveland-Innes & Emes, 2005a).

Students who utilize a deep approach are intrinsically motivated. They enjoy learning for its own sake and search for meaning and understanding in their quest for knowledge. Discourse is examined to comprehend principle ideas and overall point of view (Marton & Saljo, 1976). They relate new ideas to their existing experiences, looking for patterns (Weigel, 2002). They are active and interested, examining logic and new ideas critically. New concepts are linked to previous knowledge creating a personalized meaning that makes sense to them. Deep learning leads to long-term retention and understanding of concepts that allows its application in solving unfamiliar problems.

Students employing a surface approach expend the least amount of effort in order to meet minimum course requirements. Courses are treated as un-related bits of information (Weigel, 2002). Discourse within the course is treated as text (Marton & Saljo, 1976). Facts are memorized in isolation and without context, students study without reflection, and information is accepted tacitly. The inner complexities and implications of the materials are avoided. This superficial level of memorization does not lead to assimilation, understanding or long term retention of educational content. Motivation is related to the consequences of failure.

Students with an achievement approach are competitive and are motivated by the external rewards such as grades and credentials. Ego and self-esteem are tied to academic accomplishments. Students utilizing an achievement approach will strategize their learning with a focus on the activities that will garner the highest marks (see Fig 7).

> "students adopting a deep approach also tended to spend longer in studying. Again this relationship is almost inevitable. Students who study their subjects deeply are also likely to find the material more interesting and easier to understand. Long hours of work become no hardship then. Students who adopt a surface approach are concentrating on an inappropriate technique of learning – rote memorization. It takes a long time to cover books in this way, and it is a tedious and unrewarding activity. Thus, eventually, students who persist with the surface approach are likely to do less and less work and eventually fail their examinations."
>
> Entwistle & Ramsden, 1983, p19

Three Approaches to Learning

Approach	**Motive**	**Strategy**
Deep	* Intrinsic interest * Develop competence	* Discover meaning * Linking * Full understanding
Surface	* Meets requirements * Balancing act	* Target essentials * Reproduction
Achievement	* Realize highest grades * Compete	* Identify what instructor wants * Organize and focus on what's pertinent to assignments/exams

Figure 7. Three approaches to learning from Cleveland-Innes & Emes, 2005a

From the teaching perspective, the nature of the course content, the methods of teaching and assessment and the institutional climate act together with the student composite factors to determine their ongoing approach to the educational tasks (Biggs, et. al, 2001). The student's approach can be strongly affected by the educational situation and by the student's perception of the intellectual demands being made of them in that situation (Entwistle, 1981; Trigwell, Prosser & Waterhouse, 1999). Approach to learning is not a stable trait. Both teacher and student are responsible for the educational outcome via the relationship between student, context and task (Biggs, 1986, 1999; Biggs, et. al, 2002).

A student's approach to learning is both a process that the student takes through the learning environment and an outcome that results from the levels of engagement within that learning environment (Garrison & Cleveland-Innes, 2005). All students are capable of utilizing any of the three approaches or a combination of approaches. They choose based upon the strategies deemed to be most effective within the requirements of the learning environment (Biggs, 1999; Garrison & Cleveland-Innes, 2005). Critical thinking and higher order knowledge construction are goals of the learning process. Clearly, a deep approach is what we would like to foster in higher education and for medical laboratory professional education.

Summary

> *"Technology should enrich the experience of learning. E-learning technologies may save some costs and add a measure of convenience, but if they do not deepen the learning experiences of students, they are not worth much."*
>
> Weigel, 2002, p1

DE is based upon the acquisition of intellectual learning matter and cognitive skills as an individual activity with guidance and support being received in a non-contiguous means (Holmberg, 1995b). In a CMC environment, that guidance and support is delivered via the complex network of interactions that occur in the conferences and within the community of inquiry. In higher education, these interactions not only impact student outcomes, but also how students approach learning itself (Cleveland-Innes & Emes, 2005a). Education must be structured purposefully in order to achieve defined learning outcomes (Garrison & Cleveland-Innes, 2005). Deep and meaningful learning in this scenario requires that the student be present and engaged in those online dialogues (Picciano, 2002). Ideally, these interactions affect the student's thinking, guiding it to become critical and reflective. A deep approach is necessary for higher order learning to occur and for the student to achieve greater academic success (Biggs, 1986, 1999; Zeegers, 2002). These learning process goals are best supported when educational conditions lead to the development of a community of inquiry (Garrison, et. al, 2000; Garrison & Cleveland-Innes, 2005; Weigel, 2002).

As technology workers in a complex health care environment, maintaining up-to-date technical knowledge and skills is not the sole focus. Higher order learning including how to think in a critical and reflective manner is needed. The development of critical and ethical inquiry is an important part of professional practice in the medical laboratory (Grant, 2004). Deep and meaningful learning is also required in the medical laboratory continuing education environment. A "good" educational system is one in which all aspects of teaching and student assessment integrate in the support of higher-order learning processes aligned to the intended outcomes (Biggs, 2003). This includes outcomes relating to developing and preparing our students to become competent as lifelong learners (Cleveland-Innes & Emes, 2005b). The question remains, can this be accomplished in an online distance education course without student-student interactions?

CHAPTER 3

METHODOLOGY

> A theory can be defined as *"a set of interrelated constructs (variables), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining natural phenomena"*
>
> Kerlinger, 1979, p.64

<u>Introduction</u>

This study employed a mixed methods scheme with experimental, quasi-experimental, comparative and exploratory aspects (Creswell, 2003). It investigated Anderson's (2003a) equivalency theorem by isolating student-student interactions. It measured the impact of an absence of student-student interactions on student test scores and the adoption of a deep approach to learning. Anderson's (2003a) theorem proposes that either student-instructor or student-content interaction could be substituted (at the same level) for student-student interaction with little loss in educational effectiveness and no negative effect on deep and meaningful learning. This necessitates an examination of the levels of student-content and student-instructor interactions, in that same scenario. The CSMLS (2005a) continuing education survey indicated a lack of interest in student-student interactions. Current student perceptions were briefly explored via an online post-experiment debriefing forum.

Quantitative research has a history of viewing a theory as a scientific prediction (Creswell, 2003; Kerlinger, 1979). These methods are well suited for verifying or testing hypotheses. Triangulation of measures or taking multiple measures of the same phenomena improves accuracy and increases confidence in results (Neuman, 2006). Measuring test scores and students' change in deep and surface learning gives three measures. If two or three of the three measures are consistent, the argument is more convincing than the situation in which only one measure is used. Combining the results from quantitative studies with qualitative data allows the convergence or confirmation of findings from one data source to the next. Triangulation of method by mixing qualitative and quantitative styles of research and data allows for a fuller and more comprehensive study (Neuman, 2006). In this case, methodological triangulation was performed sequentially with the elicitation of student opinions immediately following the final quantitative measures.

Approval for this study was obtained from the Athabasca University's Research Ethics Board and the board of directors of the Canadian Society for Medical Laboratory Science. A description of the research population, experimental design, data collection procedures and instrumentation, and data analysis follows.

Research population

Research participants were recruited from within the membership of the CSMLS, resulting in a convenience sample. These were Canadian Society for Medical Laboratory Science (CSMLS) certified members who enrolled in the CSMLS's online "E-learning Society" (ELS) course "The Preanalytical Phase" (course #4657). This is the first, and to date only, online course offered by the

CSMLS. Participants consisted of Medical laboratory technologists (MLT) and medical laboratory assistants (MLA).

The reasons for the purposive delimitation of study members were two-fold. First, membership within the CSMLS requires a minimum level of prior educational attainment. This was thought to produce a more uniform population for the study. Second, statistical methods assist researchers in making inferences about a large population by studying or observing a subset of that group (Creswell, 2003; Huck, 2000). By restricting the study population to CSMLS members, it would most closely mimic the full population that would utilize the CSMLS ELS web-site and its courses. The sample was one of convenience and was purposive in its delimitations.

Study participants were recruited through advertisements in the journal of the CSMLS (Appendix A) and e-mail correspondence to CSMLS members. Further information was provided to prospective study participants (Appendix B). Once students were recruited, an Informed Consent Document (Appendix C) was forwarded. These were electronically signed by participating students and returned to the CSMLS.

The course was scheduled into two classes. One beginning in March 2007 and then next in May 2007. Only students agreeing to participate in the research study were placed into the March 2007 course. Only the March 2007 course was utilized in this study. Thirty-two participants originally enrolled in the course and volunteered for the study. This resulted in the full involvement of all students in the March 2007 class. Twenty-one were MLTs and eleven were MLAs. This population became the purposeful sample for quantitative and qualitative data collection.

Experimental design

A true experiment can be characterised by the following: (1) a causal link between the independent and dependent variables, (2) the random assignment of participants to comparison groups, and (3) potential threats to internal validity are reduced as much as possible (Huck, 2000). For this research, we were attempting to discover if the independent variable of student-student interaction (treatment) impacted the dependent variables of test scores and the adoption of a deep approach to learning. Quasi-experimental designs were utilized.

A random selection of 16 participants who enrolled in the "Preanalytical Phase" e-learning course and volunteered for the research study were placed into treatment Group A. Treatment consisted of the purposeful inclusion of student-student interactions as a component of the educational design. A random selection of 16 participants who enrolled in the "Preanalytical Phase" e-learning course and volunteered for the research study were placed into control Group B. In order to avoid potential bias, these participants were enrolled into the course and research study, and placed into their respective research study groups by CSMLS educational department staff. From the original population who enrolled in the course and volunteered for the study, an endeavour was made to ensure that roughly equal numbers of MLTs and MLAs formed a part of each of the treatment and control groups. Research groups were not matched in any other manner. In an attempt to create a single-blind research design, students were not informed if they were a treatment or control participant. They were only identified as either "group A" or "group B" in order to gain access their respective web-site area. A double-blind design was not possible since the technical features required for the two groups differed and resulted in separate web-site areas for each group.

The following chart delineates the type of experimental designs utilized and the resulting data sources (see table 2) (Neuman, 2006):

Experimental Design	Data Sources Measured
Quasi-experimental Classical type	• MLT change in deep approach to learning • MLA change in deep approach to learning • MLT change in surface approach to learning • MLA change in surface approach to learning
Quasi-experimental Classical variation	• Total group change in deep approach to learning • Total group change in surface approach to learning
Two Group Post-test only Quasi-experimental	• MLT test scores • MLA test scores
Static Group comparison Quasi-experimental	• Total group test scores

Table 2. Chart of experimental design strategies

The instructional approach utilized for the course was a semi-paced, individualized self-study format. Students worked independently and followed a self-determined schedule during the five weeks of the research period. The only time stipulation was that all module activities were to be completed prior to the Module 1 quiz and post-Module 1 survey, conducted during the final week of the study. All students had access to all course components which included a study guide, textbook, online glossary of terms, online database of preanalytical interference factors, online lessons and additional online resource documents and web-links.

Access to the course instructor was available to all students first via the ELS messaging system and instructor's email, then by telephone.   Responses to enquiries to the course instructor were provided with 48 hours. Access to ELS technical support staff was provided first via ELS messaging and the ELS "Start e-learning" courses or "Help with e-learning society" web-site areas. Students with problems that could not be resolved were also given with telephone technical assistance. Technical assistance was supplied within 24 hours.

A one month "treatment unit" portion of the online course was designed combined with a one week introduction to the course and web-site components. This module contained integrated student-student interaction elements. The student-student interaction opportunities consisted of CMC or asynchronous online discussion forums, and asynchronous or synchronous chat sessions, as well as direct messaging to other course participants. The course instructor acted as facilitator for the online conferences and interacted with the students in this virtual group setting designed to stimulate critical discourse.

A one month "control unit" portion of the same online course was designed combined with a one week introduction to the course and web-site components. The documents and the corresponding web space made no mention of opportunity for student-student interactions. There were no discussion forums or group chat sessions. Messaging was technically manipulated to be limited to the course instructor, ELS technical support and CSMLS education department administrative staff. All other components of the module were identical to the "treatment unit".

Since student-student interaction was the variable to be tested, student-teacher and student-content interaction opportunities were attempted to be provided at the same rate for both groups. For example, communications from the instructor were given to both groups equally. However, for the treatment group, some communications from the instructor were posted to a CMC forum. Those same communications were messaged individually to each student of the control group via the ELS messaging system. Discussion questions posed to the treatment group in a CMC forum were also messaged individually to each student in the control group in a similar manner. Opportunity was given to these students to then simply reflect upon the questions individually or to message a reply to the instructor for further individualized discussion depending on their preference. Thus the opportunities for critical discourse were provided to both groups.

This design can be depicted as follows (see table 3):

Available Course Components	Group A - Treatment	Group B - Control
1 week introduction	Yes	Yes
4 week course	Yes	Yes
Student-student interactions via CMC	Yes	No
Student-student interactions via real-time chat	Yes	No
Student-student asynchronous via direct messaging	Yes	No
Student-instructor interactions via CMC	Yes	No
Student-instructor interactions via real-time chat	Yes	Yes
Student-instructor interactions via email or direct asynchronous messaging	Yes	Yes
Student-instructor interactions via telephone	Yes	Yes

Discussion questions	via CMC	via direct messaging
Opportunity for critical discourse	• via CMC with peers and instructor • via direct messaging with instructor • via telephone with instructor	• via direct messaging with instructor • via telephone with instructor

Table 3. Chart of course components

<u>Research instruments</u>

The platform for the ELS's course offerings is a Moodle derivative. This program employs a number of features or "modules" which were utilized for the course and experiment components. A Module 1 self-assessment quiz was created to assess learning outcomes. It consisted of a total of 20 multiple choice, fill in the blank and true/false questions which were related directly to the stated objectives of the course. Quiz questions were randomly generated from a question pool, so each student received a different set of quiz questions from the total pool of 32 possible questions. Although the self-assessment quiz marks did not form any portion of the official grade for the course, participants were asked to treat the quiz as if it did.

The Moodle Quiz application was also employed to administer a survey pre and post Module 1 for both groups of students. The survey instrument utilized was the revised two-factor Study Process Questionnaire: R-SPQ-2F more fully described below (Biggs, et. al, 2001). Since the application used resembled the appearance of a quiz, the survey was distinctly titled as a survey and any resemblance to a quiz such as scoring was removed. Students were asked to complete the questionnaire with reference to the Preanalytical Phase course in which they were enrolled (Appendix D). They completed the survey both before and after Module 1 of the

Preanalytical Phase course. General demographic information was collected with the "before" questionnaire.

Revised study process questionnaire: R-SPQ-2F

Originally developed in the late 1970s by John Biggs, the Study Process Questionnaire (SPQ) evolved from an information processing framework to its current focus of student approaches to learning (SAL) as the conceptual basis (Biggs, et. al, 2001). It was designed for the higher education context as a self-reporting inventory. Good teaching, especially in higher education, has the generic goal of discouraging students from using a surface approach to learning and to instead adopt a deep approach (Biggs, 1986, 1999; Biggs, et. al, 2001; Garrison & Cleveland-Innes, 2005; Zeegers, 2002).

SPQ scores can tell us if the individual student's motives, strategies and approaches to study of the course in question are predominantly deep (Biggs, et. al, 2001). By utilizing the questionnaire in a before/after scenario we can assess the change in student approaches to learning due to the effect of the educational program or context of the learning situation. The two-factor revised SPQ was chosen for its focus on deep and surface learning only since these are the indicators most relevant to the questions under study.

Data collection

All hypotheses were tested via the manipulation of the independent variable of student-student interaction. All measurements were conducted on both the treatment and control groups concurrently. The research ran from March 1, 2007 to

April 4, 2007. The pre-Module 1 survey questionnaire was administered during the first week of the course. The post Module 1 quiz and survey questionnaire was administered during the week of March 29 to April 4, 2007.

Hypothesis 1

For the quantitative portion of the study and to assess hypothesis 1, the dependant variable of test scores was measured. The Moodle Quiz module was utilized for the self-assessment Module 1 quiz administered to both the treatment Group A and the control Group B. The quiz was timed and automatically graded by the software program.

Hypothesis 2

To test hypothesis 2, quantities of the dependent variables of student-initiated student-content interactions and student-teacher interactions from each of the treatment and control groups were tallied. The operational definition of a student-initiated interaction was considered to be one by which the nature of the initiation of communication or response to a communication was at the discretion of the student. For example, a response to a direct request by the instructor to respond to an ELS message (email) was not counted as a student-initiated interaction. However, if a control group student responded to an ELS messaged question that they had the option of simply reflecting upon or discussing by messaging the instructor, that message was counted as a student-initiated interaction.

Measurement was by both the number of interaction initiations (hits) and the amount of time spent on the content interactions. The Moodle Messaging module is similar to email but operates within the ELS system. From these records and from recorded incidents of direct email correspondence and telephone contact with the course instructor, the numbers of student-initiated student-teacher interactions was tabulated. Some interpretation was required to define the criteria of a "student-initiated" interaction. The criteria that were utilized are detailed in the definition of terms section of this thesis. These criteria were applied equally to both groups.

Due to practical considerations, an attempt was made to quantify only the online student-content interactions. The Moodle platform accumulates user logging and tracking activity reports for each student including last access, postings, number of times read, etc... (See Appendix E). From these records and raw data, the numbers of student-content interactions were compiled. Time spent online in these activities was calculated as well. Again, some interpretation was required since the final log-off time is not recorded and long periods of inactivity between periods of activity would indicate that the student was logged on to the web-site, but not actively utilizing the course components. Interpretation criteria were established and applied equally to both groups as follows:

- If the final activity before the next date or time log-in was the "Preanalytical Considerations Part 1 or Part 2" online lessons, the average time of 1 hour was used. This time frame is consistent with other student time frames when that activity was conducted in the middle of an online session. It is also consistent with the time-frame allotted for that activity during the creation of the course.

- If the time between activities exceeded 30 minutes, other than for the Preanalytical Considerations Part 1 or Part 2 online lessons, a survey, quiz or study guide view, a log-out was considered to have occurred. The time tally would then continue with the next recorded activity. This interpretation would help to eliminate the effect of students who have long periods of inactivity between periods of activity. That pattern of behaviour would appear to indicate that the student was logged on to the web-site, but not actively utilizing the course components.
- If the time between log-in and the final recorded activity was one minute – the last activity was counted as one more minute

See Appendix E for an example of the above criteria as applied to an actual data log activity report.

Below is a summary of the data collection for these parameters (see table 4).

Parameter measured	Data source	Interpretation Criteria
Student-content interactions - Number	Moodle activity report	"Hit" count provided by program
Student-content interactions – Time	Moodle activity report	See Appendix E
Student-initiated, student-instructor interactions – Number	• ELS messaging system • Instructor's email • Log of telephone calls to instructor	Simple count of occurrences as defined in operational definition of "student-initiated"

Table 4. Chart of data collection methods

Hypothesis 3

To test hypothesis 3, the dependant variable of the change in how students strategize their learning was measured. The revised two-factor Study Process Questionnaire: R-SPQ-2F was administered directly online within the course structure (Biggs, et. al, 2001). Pre-data and post-data were collected from both groups and the change in approach scores for both deep and surface learning were calculated.

Additional data collection

Descriptive data were gathered from the research participants to determine relationships, if any, between individual characteristics and student behaviour. The demographics of age and gender, level of educational attainment, employment information and computer skills were surveyed.

Participants were asked to share their thoughts and experiences via a post-study de-briefing online discussion forum or via direct messaging with the course instructor. The "De-briefing Forum" remained open for student comments through to the first week in July 2007. Since the remaining 3 Modules of the Preanalytical Phase course progressed in a manner consistent with the treatment group format of Module 1, group B students had the opportunity to experience the course in both formats (i.e. with and without the opportunity for student-student interactions). The request for feedback on the two formats was requested from group B students in particular.

Data analysis

Statistical methods

Statistical analysis was performed using SPSS 9.0 Student Version and SPSS 14.0 software. Graphs and charts were created utilizing SPSS 9.0 Student Version and Microsoft Excel 2003.

1) Measures of central tendency, measures of variability, and independent samples T-tests were utilized to present the test score data and the numbers of student-initiated student-content and student-teacher interactions.
2) A two-way repeated measures Analysis of Variance was used to determine the interaction between pre and post survey results, and treatment or control group.
3) The Mann-Whitney U test was utilized as a non-parametric measure of samples not conforming to the underlying assumptions of normality and homogeneity of variance.
4) The Spearman's rho correlation analysis was performed post hoc on parameters yielding measures of statistical significance in the relationship between independent and dependent variables.

Internal Validity

Many threats to the internal validity of this study were possible. The following measures were taken in an attempt to reduce these. Random placement of participants into treatment or control group was performed by CSMLS education department staff. There was no selection of participants since all who matched the criteria and volunteered were utilized in this study.   Threats to internal validity regarding instrumentation, or the analysis of student activity logs for time calculations, were minimized through analysis criteria as noted above and in Appendix E.   A double-check of data by a second experimenter would have helped to ensure accuracy, but was not feasible in this situation.

External Validity

The validity of a true single-blind study format is under question. To achieve this goal, students were not informed if they were a treatment or control participant. They were only identified as either “group A” or “group B” in order to gain access their respective web-site area. However, an error in emailing the initial study guides occurred with some of the group B control group students receiving the group A introductory study guides. This was discovered quickly and a request was sent for those recipients to discard the initial emails and utilize the study guides from the second email message.

The group A study guides detailed how to use the CMC and Chat areas of the web-site. However, the group B web-site area did not contain these components, so Group B study guides did not provide this information. Group B students were not able to gain access to the group A web-site area nor were they able to utilize the instructions from the group A study guides regarding CMC or Chat in any manner. It is not known how many of the group B student read the study guide contained in the first email. Cues about the purpose of the study and possible student interpretations of expected behaviours could confound results.

Treatment diffusion or contamination was avoided by instructing study participants to not discuss aspects of the course with others during the research period (Neuman, 2006). When it was discovered that two participants (one from group A and one from group B) were employed at the same work-site, the situation was discussed with each of these participants who confirmed that they did not and would not discuss the course with each other during the research period.

Summary

A mixed methods research design scheme, with quasi-experimental, comparative and exploratory aspects was utilized to investigate Anderson's (2003a) equivalency theorem and the impact of student-student interactions in an online continuing education course for Medical Laboratory professionals. Results obtained from this study follow in the next chapter.

CHAPTER 4

RESULTS

<u>Introduction</u>

The purpose of this research study was to determine if student-student interactions impacted significantly on outcomes as measured by test scores and student approaches to learning. The influence of student-student interactions was also examined in terms of the quantity of student-initiated student-instructor and student-content interactions. The compiled data of these parameters as well as basic student demographics and specific student comments follow.

<u>Study population</u>

Thirty-two participants originally enrolled in the course and volunteered for the study. This resulted in the full involvement of all students in the March 2007 class. Twenty-one were MLTs and eleven were MLAs. This population became the purposeful sample for quantitative and qualitative data collection.

<u>Attrition</u>

Two MLT participants dropped out of the course at the beginning of the research period leaving a total population of thirty students who remained enrolled in the course at the end of the study. Since the two students who dropped out were from different groups, one from the treatment and one from the control, the population for each group remained equal. Both students who dropped from the course and research study cited their employment workload as the main contributing factor for their attrition.

Excluded results

Of the remaining students:

- One participant did not complete the pre-Module 1 survey (group B). Only results for the post-Module 1 quiz, and quantities of student-initiated student-content and student-instructor interactions were utilized from this student. Some demographic data on this student were gathered via information given in the introductory conference that occurred after the completion of the research period. This student did not proceed to complete the course after the research period and I was unable to gather the remaining information needed for the unanswered demographic questions.
- Two participants did not complete the post-Module 1 survey (one from group A and one from group B). Only results for the post-Module 1 quiz and quantities of student-initiated student-content and student-instructor interactions were utilized from these students.

Descriptive data

Basic demographic information was collected from study participants utilizing the pre-Module 1 survey instrument.

Age

Student reported ages are categorized as follows:

Age (years)	<21	21-29	30-39	40-49	50-59	>59
Treatment Group A N=15	6.7%	13.3%	6.7%	46.7%	26.7%	0%
Control Group B N=14	0%	21.4%	21.4%	7.1%	42.9%	7.1%

Table 5: Student ages

Gender

100% of students in both the treatment and control groups were female.

Treatment Group A: N=15, Control Group B: N=15

Employment

Students were employed concurrently as follows:

Employment category	Full-time	Part-time	Casual	Unemployed
Treatment Group A N=15	80%	20%	0%	0%
Control Group B N=14	86%	14%	0%	0%

Table 6a: Student concurrent employment

Students had been employed in the laboratory field as follows:

Years employed as MLA or MLT	<10	11-20	21-30	>30
Treatment Group A N=15	26.7%	26.7%	46.7%	0%
Control Group B N=14	35.7%	7.1%	14.3%	42.9%

Table 6b: Student employment years

Students were concurrently employed in the laboratory field as follows:

Employment Position	Bench or bedside level	Immediate Supervisor	Department Manager	Other
Treatment Group A Total: N=15	53.3%	33.3%	6.7%	6.7%
Control Group B Total: N=15	46.7%	26.7%	20.0%	6.7%

Table 6c: Student employment position

Level of education

Student assignments into either treatment or control groups was performed randomly with only the attempt to place roughly equal numbers of MLTs and MLAs into each group. The final counts were 10 MLTs and 5 MLAs in treatment group A and 9 MLTs and 6 MLAs participants in control group B. Students reporting a baccalaureate degree obtained were all MLTs. The highest level of education obtained by students was reported as follows:

Prior Educational Attainment	Community College Diploma	Baccalaureate	Masters	PhD
Treatment Group A N=15	93.3%	6.7%	0%	0%
Control Group B N=15	93.3%	6.7%	0%	0%

Table 7: Student prior educational attainment

Computer skills

Students were asked if this was their first online course. 100% of the MLA participants in both groups responded Yes to that question.

First online course?	Yes	No
Treatment Group A N=15	93.3%	6.7%
Control Group B N=15	93.3%	6.7%

Table 8a: Student's first online course?

Students reported their level of computer skills as follows:

Computer Skill Level	Novice	Intermediate	Skilled	Expert
Treatment Group A N=15	33.3%	53.3%	13.3%	0%
Control Group B N=15	20.0%	73.3%	6.7%	0%

Table 8b: Student self-reported computer skills

Testing of Hypothesis

Hypothesis 1:

There is no significant difference in test scores between the two groups.

(student-student interaction vs. no student-student interactions)

Null hypothesis: H_0: $\mu_1 = \mu_2$
Where μ_1 = Group A, μ_2 = Group B

Test scores

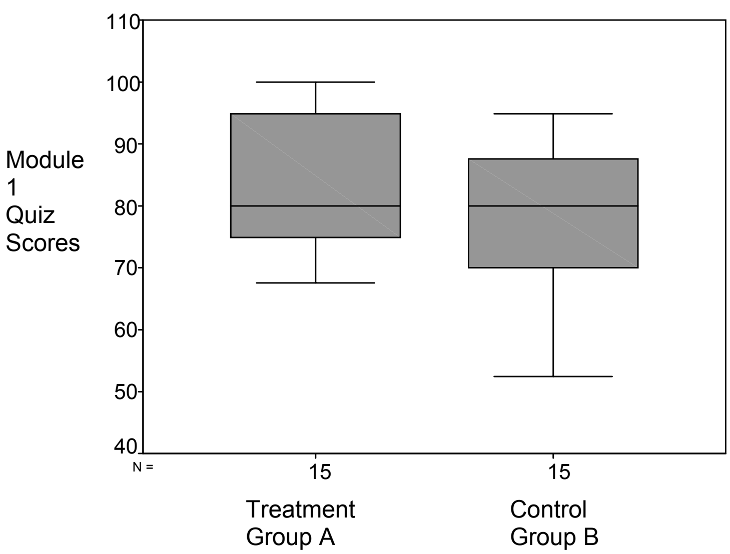

Figure 8a: Module 1 Quiz Scores

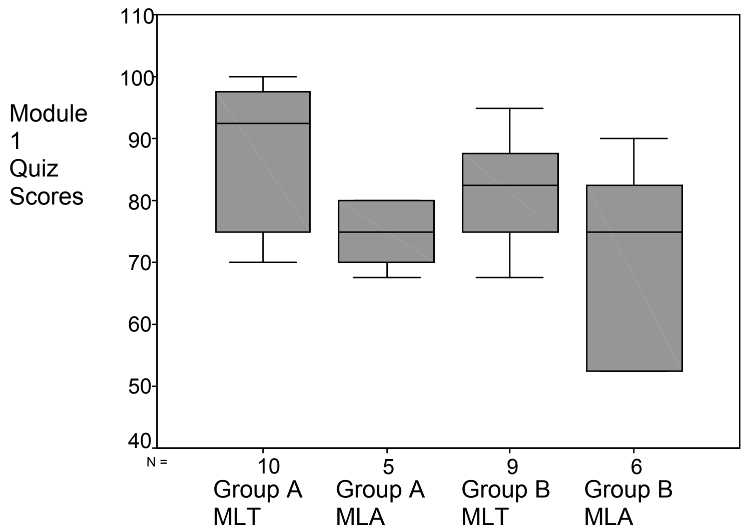

Figure 8b: Module 1 Quiz Scores by category

The results of the Module 1 Quiz scores were explored. Mean, standard deviation and measures of distributional shape were calculated using SPSS and are exhibited in the Box and Whisker Plots above (Fig 8a and 8b), and the chart below (Table 9a). Quizzes were scored out of a total possible mark of 20 and converted to percentages. The highest mark obtained was 100% and the lowest was 52.5%.

Group	Educational Category	N	Mean	Std. Deviation	Skew	Kurtosis
Treatment Group A	MLT	10	87.750	11.574	-0.432	-1.720
	MLA	5	77.500	10.897	1.268	1.488
	Total	15	84.333	12.044	0.025	-1.792
Control Group B	MLT	9	81.667	9.354	-0.272	-1.089
	MLA	6	71.250	15.871	-0.338	-1.817
	Total	15	77.500	12.956	-0.817	-0.019
Total	MLT	19	84.868	10.752	-0.128	-1.357
	MLA	11	74.091	13.568	-0.312	-0.381
	Total	30	80.917	12.773	-0.431	-0.224

Table 9a: Student quiz scores

No clear outliers were noted and distributional shape was found to be outside of the acceptable limits of “normal”. Therefore, the Mann-Whitney U test was utilized to compare the mean ranking of group A students and group B students. This test is the non-parametric equivalent of the independent samples T test. It was run using SPSS and results are exhibited in the chart below (Table 9b).

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Total #	Treatment group A	15	17.50	262.50		
online	Control group B	15	13.50	202.50		
hits	Total	30			82.500	0.211

Table 9b: Mann-Whitney U test – student quiz scores

Hypothesis 2:

The Group A (treatment group) will have lower quantities of student-initiated student-teacher and student-content interactions than Group B (control group).

Null hypothesis: H_0: $\mu_1 < \mu_2$
Where μ_1 = Group A, μ_2 = Group B

Interactions

Student-content interactions

Raw numbers of course content interactions were tabulated and are presented as mean values below in graphical format utilizing Excel (Fig 9a and 9b). Group A values were tabulated to include interactions occurring within the online discussion forums and with those interactions excluded from the tabulations (Adjusted values). Group A students did not utilize the Chat area at all, so there was no need to consider those possible interactions in the data collection and analysis.

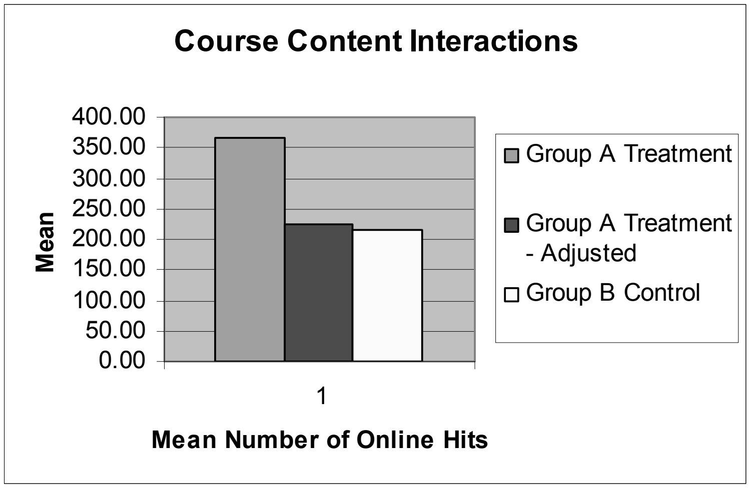

Figure 9a: Student-content interactions by number of hits

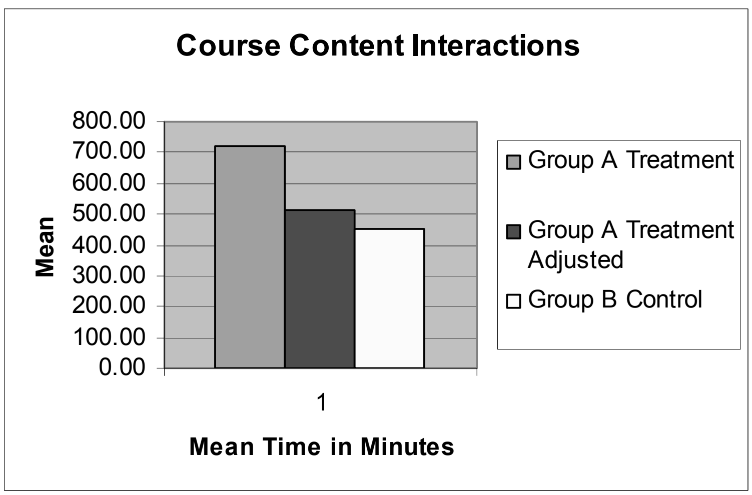

Figure 9b: Student-content interactions by time in minutes

Measures of distributional shape indicated a distinct outlier in group A with 1032 hits (601 adjusted hits) and 1934 minutes (1259 adjusted minutes) spent interacting with course content. The values obtained for this outlier were considerably higher than the next highest in group A (658, adj351 and 950, adj761) and the highest in group B (357, 923).

Removing the outlier did not yield a Gaussian distribution utilizing the total numbers of hits and minutes for group A. Therefore, the Mann-Whitney U test was then employed with the "outlier removed" "total number" data to compare the mean ranking of group A students and group B students. This test is the non-parametric equivalent of the independent samples T test. It was run using SPSS and results are exhibited in the chart below (Table 10a). Calculation of Spearman's rho shows a moderately negative significant correlation between group and both total numbers of hits and minutes of student-content interactions with a correlation coefficient (hits/minutes)of -0.429 and -0.404 respectively, N=29, p = 0.010 and 0.015 respectively (one-tailed).

	Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**Asymp. Sig. (2-tailed)**	**Asymp. Sig. (1-tailed)**
Total # online hits	Treatment group A	14	18.71	262.00			
	Control group B	15	11.53	173.00			
	Total	29			53.00	0.023	0.989
Total # minutes online	Treatment group A	14	18.50	259.00			
	Control group B	15	11.73	176.00			
	Total	29			56.00	0.032	0.984

Table 10a: Student-content interactions

However, removing the outlier did yield a normal distribution curve for all groups and sub-groups when adjusted hits and minutes for group A were analyzed. Utilizing this "outlier removed" "adjusted numbers" data, the independent samples T test was run using SPSS. Results are exhibited in the chart below (Table 10b).

	Group	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Sig. (1-tailed)
Adjusted total # online hits	Treatment group A	199.29	67.81				
	Control group B	214.87	80.36	-0.562	27	0.579	0.290
Adjusted total # minutes online	Treatment group A	462.36	191.77				
	Control group B	449.20	220.06	0.171	27	0.865	0.568

Table 10b: Student-content interactions (adjusted hits/minutes group A)

Student-instructor interactions

Raw numbers of student-initiated student-instructor interactions were tabulated and are presented as the mean value for each group below in graphical format utilizing Excel (Fig 10).

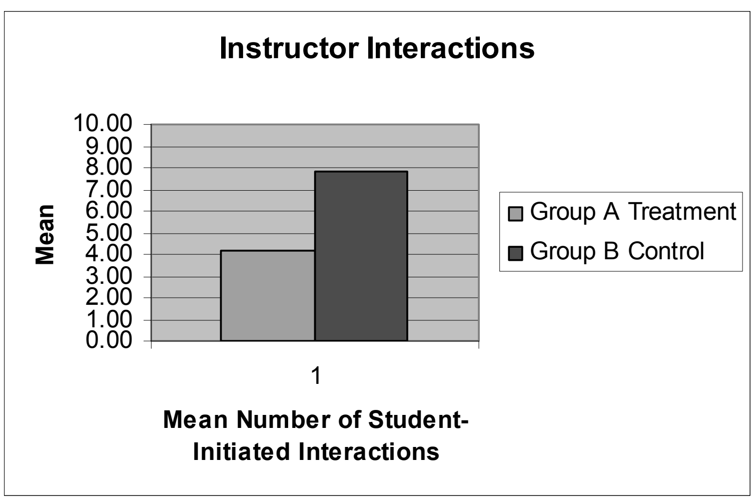

Figure 10: Student-initiated student-instructor interactions

Exploration of the data yielded no clear outliers and showed a non-normal distributional shape. Therefore, the Mann-Whitney U test was then employed to compare the mean ranking of group A students and group B students. This test is the non-parametric equivalent of the independent samples T test. It was run using SPSS and results are exhibited in the chart below (Table 11).

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)	Asymp. Sig. (1-tailed)
Total # student-instructor interactions	Treatment group A	15	11.87	178.00			
	Control group B	15	19.13	287.00			
	Total	30			58.00	0.023	0.012*

*P<0.05 (one-tailed)

Table 11: Student-initiated student-instructor interactions

Calculation of Spearman's rho shows a moderately positive significant correlation between group and numbers of student-instructor interactions with a correlation coefficient of 0.422, N=30, p = 0.010 (one-tailed).

Hypothesis 3:

There is no significant difference in the adoption of a deep approach to learning between the two groups.

Null hypothesis: $H_0: \mu_1 = \mu_2$

Where μ_1 = Group A, μ_2 = Group B

Approach to Learning

The revised two-factor Study Process Questionnaire: R-SPQ-2F was utilized to measure individual student SAL responses (Biggs, et. al, 2001). Pre-data and post-data were collected from both group A and group B students. Individual student scores were calculated on deep and surface approach parameters. These scores are presented as mean values below in a graphical format utilizing Excel (Fig 11 a, b c, d, e and f). The possible scores range from 10 to 50 for each of the Deep and Surface Approach parameters. The actual range obtained was from seventeen to forty-six for deep approach and twelve to twenty-nine for surface approach, with the pre-test data demonstrating a range of 25 points in deep approach scores and 13 points in surface approach scores.

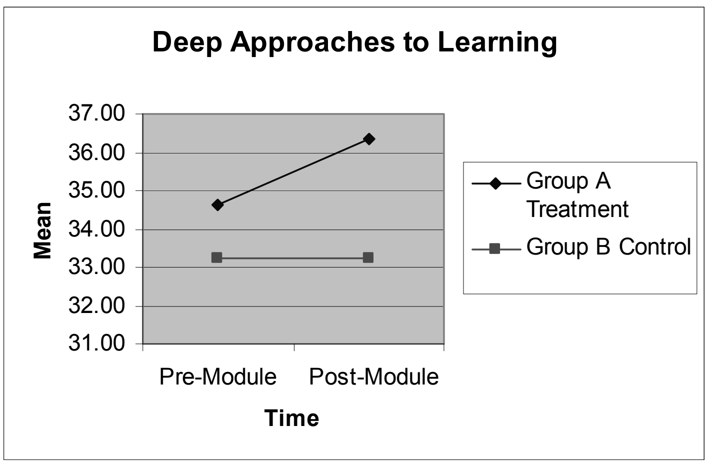

Figure 11a: Deep approaches to learning

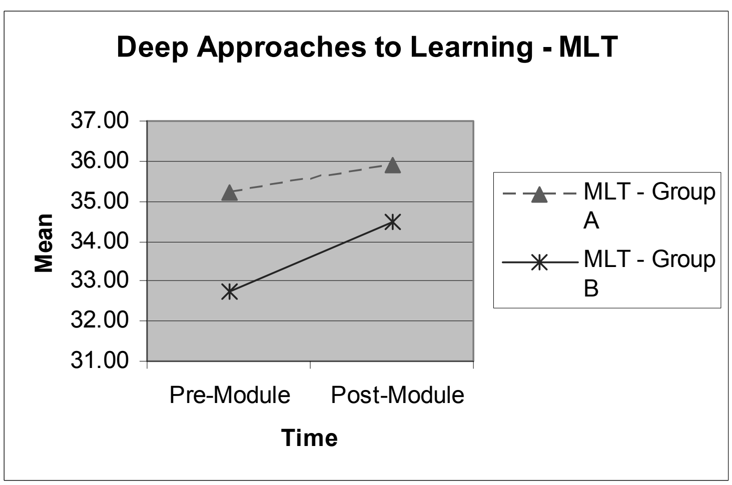

Figure 11b: Deep approaches to learning MLT

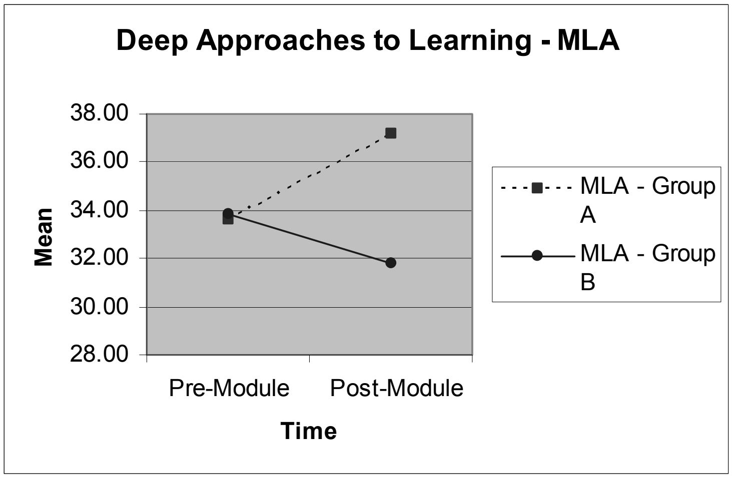

Figure 11c: Deep approaches to learning MLA

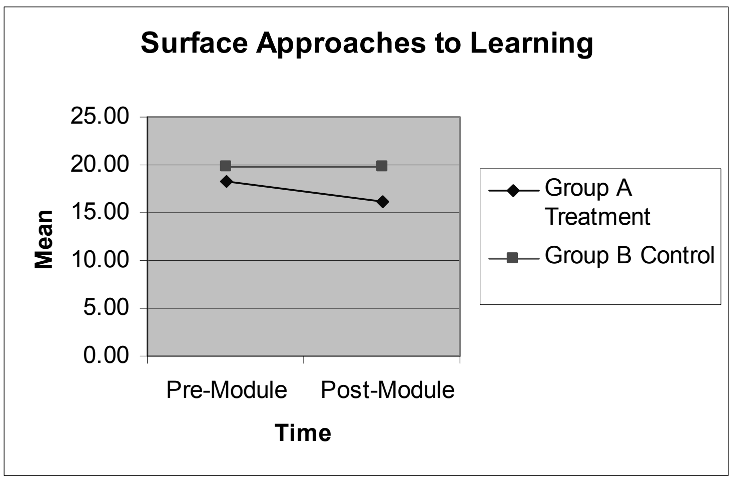

Figure 11d: Surface approaches to learning

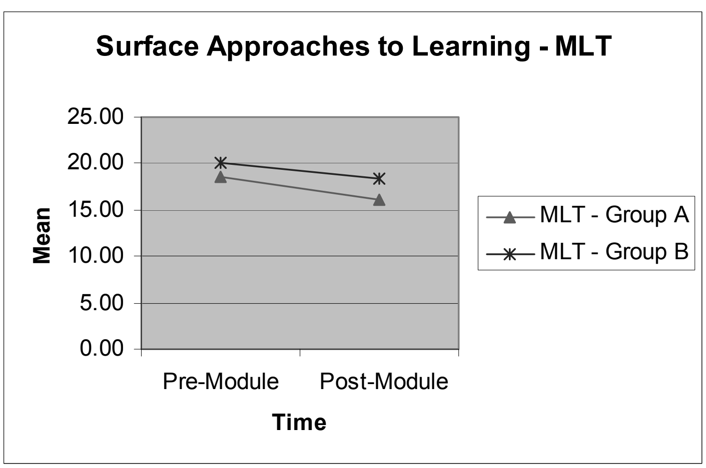

Figure 11e: Surface approaches to learning MLT

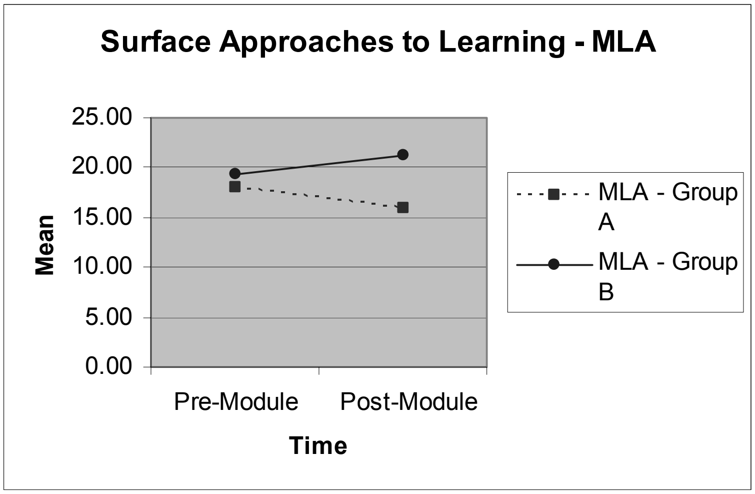

Figure 11f: Surface approaches to learning MLA

Exploration of the pre-Module 1 data yielded no clear outliers, a normal distribution of scores for surface approach data, a generally normal distribution of scores for deep approach except for a slight negative skew from group B. Post-Module 1 scores produced no clear outliers, a normal distribution of scores for deep approach data and a generally normal distribution of scores for surface approach other than a slightly platykurtic distributional shape from group A. Therefore, the data were first analyzed via a two way repeated measures ANOVA. Results are exhibited in the charts below (Table 12a and b).

Source	**df**	**SS**	**MS**	**F**	**Sig.**
Between Subjects	26				
Group	1	64.795	64.795	0.896	0.353
Error (between)	25	1808.538	72.342		
Within Subjects	27				
Time	1	13.779	13.779	1.116	0.301
Time x Group	1	6.668	6.668	0.540	0.469
Error	25	308.813	12.353		

Table 12a: Two-way repeated measures ANOVA – Deep approach scores

Source	df	SS	MS	F	Sig.
Between Subjects	26				
Group	1	77.724	77.724	3.515	0.073
Error (between)	25	552.868	22.115		
Within Subjects	27				
Time	1	22.668	22.668	3.568	0.071
Time x Group	1	13.187	13.187	2.076	0.162
Error	25	158.813	6.353		

Table 12b: Two-way repeated measures ANOVA – Surface approach scores

An equivalent means of measuring significance would be to utilize the independent samples T test and the R-SPQ-2F scores calculated as the percent difference deep approach (DA) or surface approach (SA) scores for each student. (i.e. % DA difference = DA post– DA pre/DA pre x 100). Since the percent difference scores on both DA and SA yielded non-normal distributions, the Mann-Whitney U test was once again employed to compare the mean ranking of group A students and group B students. This test is the non-parametric equivalent of the independent samples T test. It was run using SPSS and results are exhibited in the charts below (Table 12c).

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
% difference Deep Approach	Treatment group A	14	15.25	213.50		
	Control group B	13	12.65	164.50		
	Total	27			73.500	0.396
% difference Surface Approach	Treatment group A	14	11.93	167.00		
	Control group B	13	16.23	211.00		
	Total	27			62.000	0.159

Table 12c: Mann-Whitney U test – % difference deep and surface approach scores

Simple measures of effect size yield results of + 0.32 for deep approach and – 0.50 for surface approach.

Participant thoughts and experiences

Participants were encouraged to share their thoughts and experiences via a post-study de-briefing online discussion forum or via direct messaging with the course instructor. The “De-briefing Forum” remained open for student comments through to the first week in July 2007. My opening posting explained the purposes of the research study and the processes used during the study. It concluded with the following request to participants:

> “I welcome your comments on your impressions of the first unit and your experiences as a research subject. Please include in your posting if you were group A or group B. I will leave this forum open until partway into Module 3. This will allow the group B students to experience the full level of interactions and share their views on the differences between the two styles (with or without student-student interactions).”

Only a few comments were received, but those relating to student-student interactions, or lack thereof, are included below.

> “My own experience with distance education was when I completed my BMLSc through UBC. Although the study was very independent and I was able to maintain good grades, it was the many weeks during my summers at UBC completing labs (lots of interaction with the educators and peers) that really made the experience personally rewarding and fulfilling.”
>
> Group A MLT

> “As a group B student I found it a little different not having any class interaction. I didn't mind that format, but once we merged I realized how much I missed interaction with fellow classmates. After the merge I was shocked over how much I had missed out on being a group B student. I think some on-line courses may not be as affected by no class interaction as a pre-analytical course. I think that when we are studying pre-analytical errors you really want to discuss with other students procedures and policies they have with ones you have. The interaction amongst classmates is a good tool to use to help resolve pre-analytical errors you may make.”
>
> Group B MLA

“Other online course I have taken have had requirements for online postings that kept you "in" the course”

Group B MLT

“I enjoyed the first section although I always kept saying that I felt I was not 'getting' everything. I think somewhere, somehow I knew that there was more. I remember asking about the welcoming conference and had I missed something. I glad we are together and I will spend the next few days reading how it all works. I like to think I read most everything, so I am finding it difficult to try and read all the emails and retain the info. I look forward to hearing from the others, what a vast wealth of knowledge these people have!”

Group B – MLT

“I am glad to finally meet everyone. I was in group B and I can honestly say I was thinking this was going to be a pretty "sad" online course if we did not get to interact with each other “

Group B – MLT

CHAPTER 5

DISCUSSION

> *"As I read about the lack of importance of student-student interaction for MLTs in distance ed courses, I was reminded of everything I've ever heard about why a lot of MLTs chose this profession in the first place: it definitely wasn't so that they could work with people! In fact, a number of MLTs have emphasized that they selected the profession specifically to minimize the amount of interaction they would have with others (patients in particular). In addition, personality style inventories have suggested that MLTs are, in general, introverts, so their choice of a learning environment in which they can control the level at which they interact with others may not be too surprising."*
>
> Grant, M.M., personal communication, October 2006

Introduction

Formal research backs up Grant's comments above. William's 1972 study (as cited in Dominelli & Wheeler, 2006) of the Myers-Briggs type personality of 149 medical technologists indicated two dominant personality types, both with introversion as a main characteristic. More recent findings suggest that these qualities have not changed in the past 30 years. In 2006, Dominelli and Wheeler conducted personality tests on 120 medical laboratory technologists. Compared to the general public, these technologists scored significantly lower in the trait of extraversion and lower than average in social boldness (Dominelli & Wheeler, 2006). This suggests a timid nature with the tendency to be less sociable or outgoing and preferring to spend time alone. The CSMLS continuing education survey found similar results in that MLTs in particular indicated a preference towards educational programs that did not require collaboration with peers (CSMLS, 2005a).

Anderson (2003a) states that deep and meaningful learning can occur without student-student interaction provided that either student-content or student-teacher interactions occur at a high level. But, a review of the literature reinforces the view that a community of inquiry is an essential part of the online learning environment and that student-student interaction is an important component of that learning community. The purpose of this research was to investigate if deep and meaningful learning would occur in an online environment devoid of opportunity for student-student interactions. The following discussion considers the results of the data collected and analyzed in this study.

<u>Age</u>

Fundamental differences exist between generations. Values, ambition, world-views, mind-sets and ways of thinking and working diverge considerably (Dirkx, 2002). Shelly and Shelly (2004) demonstrate that individual cognitive and social-emotional development influences group dynamics and affects levels of participation in cohorts. Powerful emotional contexts can emerge when age-related differences exist among online group members (Smith & Dirkx, 2006). The treatment group encompassed a disparate range of ages from under 21 up to 59 years. The effect of age diversity on group dynamics, participation in CMC forums and learning was beyond the scope of this research but cannot be ruled out as a confounding factor in the final results.

Greater than 50% of the participants in this study fell into the 40 to 59 year age range, with the treatment group having a slightly larger proportion aged 40 years or older. While age alone does not ensure a mature cognitive, social and emotional intelligence, it is not unreasonable to assume a general development in these abilities as we grow older. More cognitively mature learners have an improved ability to apply prior experience to new contexts and more emotionally developed learners are better able to deal with complex tasks (Shelly & Shelly, 2004). The slightly older ages of the treatment group could be a contributing factor in the final results.

Data from a health human resources study of Nova Scotia indicate an average age of practicing MLT as 44 years (Health Care Human Resource Sector Council, 2003). Health human resources reviews investigating laboratory worker demographics across the nation support the notion of an aging profession (Davis, 2002). The CSMLS (2005a) continuing education survey indicated that greater than 50% of respondents were employed in the laboratory profession for more than 20 years. This would indicate age ranges similar to the research sample. The small population size of this research precludes further analysis of the data by age.

Gender

All participants in this study were female. This created a unique environment free of gender-based power relationships. Gougeon (1999) argues that men and women meet their own needs in a CMC environment differently with women being better able to adapt and thrive in this milieu. Kirkup & von Prummer (1990) raise questions of the concept of independence in DE and if it is based upon a male model and style of learning. A feminist pedagogy encourages communal, collective and cooperative learning environments (Briskin, 1990).

There were no statistically significant differences between the two groups of females in terms of quiz scores or progression to a deep approach to learning. This result may seem surprising considering the predominating views of feminist research. However, simple measures of effect did show the relationship of a mildly positive change in deep approach scores combined with a moderately negative change in surface approach scores for the treatment group. Is this relationship coincidental? If not, then is it the result of gender preferences or educational context? Considering the small sample size and short timing of the research period that have hampered this study it is difficult to draw any real conclusions. Whether an educational environment exclusive of student-student interactions is capable of meeting the needs of female students remains a question to be answered.

A review of health human resources in Nova Scotia revealed a gender split of 76% female and 24% male practicing technologists (Health Care Human Resource Sector Council, 2003). Unfortunately, Health Canada's (2001) health human resource review does not segregate the information by gender, but it is not unreasonable to assume a similar female to male ratio in other provinces. Anecdotal evidence supports a predominantly female workforce. With no male participants, an analysis of the data by gender was not possible. Readers are cautioned that results obtained from this research may not be representative of the normal population of continuing education users.

Employment

Adults who are cognitively and emotionally mature have the ability to use prior experiences in a new context and with new subject matter. In situations where they did not have expertise in the topic, their practical knowledge and general problem solving abilities were of benefit (Shelly & Shelly, 2004). Leadership positions in professional work require self-direction and the ability to make decisions in ill-structured situations. Smith and Dirkx (2006) noted that students who held leadership positions in their professional life were able to apply similar reasoning to collaborative group work.

Over 80% of the students were concurrently employed on a full-time basis and more than 45% had been in the profession for over 20 years. There were a significant number of students employed as supervisors and departmental managers, but no major differences in employment statistics between the two groups. The CSMLS (2005a) continuing education survey revealed that greater than 57.2% of respondents were employed in the laboratory profession for more than 20 years. However, only 22.8% of respondents in that survey specified that they held a management or supervisory position (CSMLS, 2005a). This indicates a research sample that is similar to the population of CSMLS continuing education users in terms of length of employment but over-represented in the numbers of supervisors and managers.

Level of education

One third of the study participants were MLAs and two thirds were MLTs, with roughly equal numbers of MLTs and MLAs present in each of the treatment and control groups. In 2006, the total membership of the CSMLS was 13799. Of those members, 352 were MLAs representing just 3% of the total population of CSMLS members (CSMLS, 2007a). The vast majority were community college diploma holders with only one member of each group possessing a baccalaureate degree. A flaw was noted in the demographics questioning of this study in that there was no choice allowed for those MLAs who possibly had not obtained their training via a community college. According to the CSMLS membership rules, an MLA could become a member if they had graduated from a formal MLA program from either an educational institution or a hospital-based program; or be a current practitioner who has had no formal training but has supporting documentation and a letter from their employer or supervisor (CSMLS, 2007b). Our sample for the study is over-represented in the number of MLAs compared to the general populace of CSMLS members and possible users of the CSMLS ELS program.

The difference in mean values among the MLTs and MLAs in this study was not statistically significant. Segregating the data by educational category significantly reduces sample size and correspondingly the statistical power of any analysis. Given the small sample size and short experimental timeframe, it is difficult to draw conclusions. However, the combination of: (1) the appearance of a possible trend of lower average test scores regardless of group assignment for MLAs, (2) a possible average trend towards deep learning and away from surface approaches for the group A MLAs, and (3) a possible variation in the trends in deep and surface learning between the average values for MLTs and MLAs in general, lends weight to the argument of a disparity. So although MLTs and MLAs represent an undergraduate population in general, there may well be noteworthy differences between the two categories worth exploring further.

Computer skills

Over 90% of study participants in both groups reported that this was their first online course, with the majority (>86%) in both groups self-assessing their own computer skills at a novice or intermediate level. In the Canadian Society for Medical Laboratory Science's (2005a) continuing education survey, the majority of respondents rated their skills as moderate or between moderate and expert. However, in that survey, the majority of respondents (96.3%) were MLTs (CSMLS, 2005a). Therefore, results from this study may not represent the general population of CSMLS ELS users.

The low level of computer skills reported by the study participants was not anticipated. It is important to note that the study was conducted over a short one month period with only a one week introduction to the ELS site. Online learning requires the development of competencies for this new role (Cleveland-Innes & Garrison, 2006). The learning curve would apply to both groups of students. Novice users in particular, would likely require a longer timeframe to acquaint themselves with the web-site components and longer to become accustomed to the rhythm of online studies.

Many online learners initially lack confidence when participating in CMC. They fear their postings will be judged inadequate and worry that they may have missed some important detail or were on the "wrong track" (Stodel, Thompson & MacDonald, 2006). This could account for the lack of statistically significant findings. Deep and surface learning measures in particular may be affected since students' first concerns would be discovering how to navigate in this new environment.

Hypothesis 1: Test scores

> *"Students need to engage with the subject, to develop an intellectual passion to understand."*
>
> Entwistle & Ramsden, 1983, p215

The findings showed no significant difference between the treatment and control groups regarding the independent variable of student-student interactions and the dependent variable test scores. We fail to reject the null hypothesis. These results corroborate prior research findings by Cadieux (2002) which found no significant difference between a sense of classroom community in an online class and course grades. At first glance this study's findings also appear to support Anderson's (2003a) theory. It is however, important to note that a quiz with true/false, multiple choice and matching questions has the disadvantage of testing students more for recognition than recall (Morrison, Ross & Kemp, 2004). It is also generally thought that exams test low-level learning such as the knowledge and comprehension of factual information (Cheaney & Ingebritsen, 2005). Since Anderson's (2003a) theorem involves deep and meaningful learning, it may be prudent to evaluate based on a combination of factors rather than just test scores in isolation.   And once again, the shortcomings of this research need to be factored into that equation.

Hypothesis 2: Interactions

Student-content interactions

Contrary to prediction, treatment group A on average had more interactions with course content. While the null hypothesis was rejected in regards to student-content interactions, the findings do show a significant difference between the treatment and control groups regarding the independent variable of student-student interactions and the dependent variable of student-content interactions as measured by the average total numbers of hits and minutes of online content interactions. In addition, a moderately negative significant correlation is found between group and both the average total numbers of hits and minutes of student-content interactions.

In hindsight it is not difficult to explain why this might be so. Treatment group A having access and opportunity to utilize the student-student interaction components, more specifically CMC, did so thereby raising their average numbers of interactions with the “course content”. Participating in CMC requires a considerable online presence to read, review and reflect upon the postings of others. This is demonstrated in the data gathered. Group B by design, did not have these opportunities.

It is worth noting that if one group spends an amount of time well in excess of the other with no significant difference in outcomes, then you would have to question the value and effectiveness of that different component. The key is in the way in which "outcome" is measured and defined. Adjusting the data to exclude the CMC interactions for treatment group A yielded a more level "playing field" between the groups. In this scenario, there were no significant differences between the groups.

The question of how we measure content interactions is an important one. Anderson (2003a) suggests:

"Differentiating between high and low levels of interactivity is largely a quantitative exercise in which a researcher, developer, or the participants themselves, count the number of times they are actively engaged with the other participants or content."

Anderson, 2003a

In this research, it was not practical to ask students to keep a count of the number of offline content interactions. It was presumed to be equivalent to the online quantities and this may not be an accurate assumption. In addition, the "count" method does not credit intellectualizations in which the solitary student reflects upon, and in that way interacts with, course content. The data collected in this research acts as a surrogate for the true values of student-content interaction.

Student-instructor interactions

According to prediction, treatment group A on average had fewer interactions with the course instructor than the control group B who experienced no student-student interactions. The one-tailed findings were statistically significant and the null hypothesis was accepted. In addition, a moderately positive significant correlation is found between group and the numbers of student-initiated student-instructor interactions.

The logic behind the prediction was that when students were given the opportunity to interact with their peers, their need for direct instructor interactions would diminish. This phenomenon is not remarkable considering that many of the questions that a student might have for the instructor could be addressed via the asynchronous system of CMC. In fact by posting a group message in this forum, the queries of many students could be answered simultaneously thereby making more efficient use of instructor time. In reality, many of the control group B student-initiated communications with the instructor were related to course logistics and were repeated among individuals.

In order to keep learning opportunities at the same level for both groups, the group A CMC forum discussion questions were messaged individually to each group B participant. The group B students were invited to either reflect upon the question individually or to message the instructor with comments for further discussion. For those that did reply, the effort was made to encourage continuation of the conversation in a critical and reflective manner. Only a few of the group B students used this instructor interaction opportunity. So while group B students interacted with the instructor more in terms of numbers of messages, the net effect was that group B students as a whole received less of the benefits of interpersonal discussion and critical discourse.

Interaction summary

The purpose of measuring student-content and student-instructor interactions was twofold. First, it was intended to ensure that high levels of student-teacher interaction or student-content interaction occurred in both the treatment and control groups. This is necessary since, according to the equivalency theorem, high levels of either of these interactions must be present when student-student interaction is removed. Tight control is required in a true experimental design and the concept was that this surveillance would manage that aspect. By comparing the adjusted numbers of hits and minutes between the two groups we have established that our control group did indeed interact with content at a sufficient level. Our results regarding student-instructor interactions showed our control group B interacting with the instructor at a high level. So, although there was no accommodations made for assessing the quality of these interactions, this situation does appear, on the surface at least, to satisfy the conditions of the equivalency theorem.

Second, it was thought that useful information about the laboratory professional group as a culture; and their expectations and need for student-content and student-teacher interactions could be discovered. Clearly, no matter the outcome of the quantitative data, student comments uncovered an expectation and desire for student-student interactions. Particularly as CMC is now so much a part of the distance education experience.

> "I was in group B and I can honestly say I was thinking this was going to be a pretty "sad" online course if we did not get to interact with each other "
>
> "Other online course I have taken have had requirements for online postings that kept you "in" the course" (group B student)

There also appeared to be a theme of the feeling of a missing element in comments from group B students.

> "I enjoyed the first section although I always kept saying that I felt I was not 'getting' everything. I think somewhere, somehow I knew that there was more. " (group B student)
>
> "As a group B student I found it a little different not having any class interaction. I didn't mind that format, but once we merged I realized how much I missed interaction with fellow classmates."

The perception and research evidence of laboratory staff as generally introverted people may well hold true. The above findings are not contradictory to this notion. In fact, CMC may be particularly suited to an introvert personality with those individuals being more willing to contribute to online asynchronous discussion forums than extroverts (Soles & Moller, 2001; Ellis, 2003).

Hypothesis 3: Approach to learning

The research findings showed no significant difference between the treatment and control groups regarding the independent variable of student-student interactions and the dependent variable of student approaches to learning. We fail to reject the null hypothesis based on the statistical findings of deep approach scores. Surface approach scores however, did generate results of borderline significance in respect to changes in surface approach over the course of the research period and borderline significance between the average scores of the two groups.

While the data overall did not yield statistically significant results, some practical considerations can be discovered by considering both the deep and surface approach scores in tandem.   Simple measures of effect showed the relationship of a mildly positive change in deep approach scores combined with a moderately negative change in surface approach scores for the treatment group. The desired consequence of an educational intervention, particularly at the post-secondary level, is a change in students' approach to learning towards a deep level and away from a surface level (Biggs, et. al, 2001; Garrison & Cleveland-Innes, 2005).

Uncertainties remain. Are these results are merely coincidental and did they occur simply by chance? If non-chance, then why didn't the results reach statistical significance? Once again, we are faced with the implications of a flawed research design. Hampered by a low sample size and short experimental timeframe, we are in effect, unable to definitively answer those questions.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Introduction

> *"Embedded in Vygotsky's social constructivist view of development is the idea that learning is the outcome of collaborative problem-solving, and that it is best facilitated through the use of whole and authentic activities."*
>
> Harland, 2003, p270

Cheaney and Ingebritsen (2005) provided evidence that problem-based learning stimulates higher-order learning in students whether utilizing a face-to-face approach or via online methods. Medical practice in general includes a base of traditional structured knowledge as well as a broader procedural knowledge or "art" which includes an element of intuition (Schon, 1983; Cervero, 1990; Jennett, 1993). Schmidt (as cited in Jennett, 1993) proposes that learning environments for medical education involve circumstances that promote: (1) the "hooking" of current knowledge to prior knowledge from the student's long-term memory, thereby creating a better understanding and better retention, (2) contexts which closely resemble the situations in which the new information may be applied, and (3) elaboration and redundancy to facilitate remembrance and recall.

While these concepts were developed in relation to physicians and their education, they can be expanded beyond that framework to the clinical practice of MLTs or MLAs. The ability to think critically is an underlying element of clinical interpretation in all of the health care disciplines (Bartlett & Cox, 2002). "Critical thinking can provide the reasoning and discriminating skills essential to technologists for making sense of the vast amount of information with which they come in contact, and for guiding their actions and clinical judgement." (Longo, 1996, p115).

The intellectual development of students includes learning to think critically within a particular discipline (Donald, 2002). Each discipline is unique, with differences in culture, methods of collaboration and definitions of excellence in practice (Becher & Trowler, 2001). Learning to think in the biological sciences involves "substantive concepts, manipulative skills, reasoning and the ability to cope with complexity, induction and inference" (Donald, 2002, p129). Optimal instruction in this domain includes demonstrating global principles and themes that integrate and organize concepts. Problem-based learning in which students can identify issues and investigate as a group is recommended (Donald, 2002). This need for a contextualized experience is demonstrated by the following participant comment:

> "I think some on-line courses may not be as affected by no class interaction as a pre-analytical course. I think that when we are studying pre-analytical errors you really want to discuss with other students procedures and policies they have with ones you have. The interaction amongst classmates is a good tool to use to help resolve pre-analytical errors you may make."

Brain power is a crucial resource and today's workers must be flexible, self-reliant and judicious thinkers (Boomer, 1992). Laboratory work has evolved into multiple roles with a wide variety of practice situations. Ethical inquiry is an important part of laboratory worker's clinical practice and our educational procedures must not alienate them from their own experiences (Grant, 2004). Collaborative skills are also needed since patient-focused care with shared interactions among health care providers is a requirement today (Health Canada, 2005). Economic and technological changes have created a globalization of work, including the work of the laboratory. This transformation requires an emotional intelligence involving feelings, morals and the "soft-skills" concerning the intricacies of human relationships (Cleveland-Innes & Ally, 2007). Discussion, collaboration and critical discourse within the community of inquiry and the CMC environment can provide for all of these aspects.

Conceptual triangulation

The multifaceted approach to this research does allow for some degree of methodological convergence between the various data sources. Treatment group A had, on average, higher test scores. They engaged in a larger volume of critical discourse over the timeframe of the experiment. They also progressed on average towards a deep approach to learning and away from a surface approach. While each parameter in isolation does not meet the criteria of statistical significance, the combination of factors does lend itself to the argument for incorporating student-student interactions into the online learning environment for this population.

The practical significance of this resolution depends upon a few factors. Is this intervention relatively inexpensive compared to other options? The answer to this question is yes. Student-student interactions in the form of CMC can be easily incorporated into the instructional design with minimal technology cost. It is also efficient in terms of the use of instructor's time. While instructor presence is vital to the creation of an online community of inquiry and the mentoring of participants towards critical discourse, much time is saved in the dealing with repeated student inquiries with similar content questions or regarding course logistics.

Is the effect achieved across groups of students and does the effect accumulate over time? These questions are more difficult to answer. Our sample is a somewhat representative sampling of the overall population of CSMLS continuing education users and medical laboratory professionals in general. There are however, some possible noteworthy variances. The research population was over-represented in the female gender as well as in the numbers of managers and supervisors. These factors may need to be examined more closely. Possible inconsistencies may also exist between prior education and computer skills. It is also difficult to answer to the long term effects. The research period covered only one month of an educational intervention. While we did find a trend towards deep and away from surface learning, the results were not statistically significant and it is not known if these trends would continue over time.

Future instructional design

> *"When we gauge the success of out efforts by how far people have developed their own critical thinking proficiencies, then we focus our attention on learner's development."*
>
> Brookfield, 1987, p236

The equivalency theorem's proposed function was as an understandable heuristic for the design of distance delivery systems. It was intended to provide a framework in which researchers and DE practitioners could interpret their findings and change their practices in a meaningful manner (Anderson, 2003a). The trial and error of previous practices combined with research findings form the foundation in which future instructional design can be created. This theorem provides a starting point for research. Its guidelines can structure investigations assessing the value of the various forms of interaction in the DE environment.

The balance of student-student, student-content and student-instructor interactions in an online environment is a delicate one. It includes a range of factors and the interplay of those factors outside of the scope of this research. While evidence supporting the need for student-student interactions for this population has been presented, it is far from definitive and would benefit from the contributions of future researchers.

Jarvis (2004) speaks of the ethical implications of educational relationships. He described teaching and learning as a dialogue between persons in which the teacher is concerned for the learner and positive personal relationships bond the community. Interaction is not simply a loop of data transmission, receipt and feedback. This characterization is more transaction than interaction. People develop by having a variety of experiences and rich connections (Jarvis, 2004). The equivalency theorem does not speak to the possible consequences of reducing or eliminating one or more of the facets of DE. How do people develop when the balance of communications shift? What are sufficient levels of deep and meaningful learning? Every student is different, but what would the “cost” to the student be, even if the “mix” is unique to the student’s preference and abilities?

Recommendations for further research

"*Theories can develop when researchers test a prediction many times.*" (Creswell, 2003).

Components of this study were designed to diminish threats to internal validity. In doing so, this reduces the degree to which results can be generalized. The best application of this research is as a foundation for further studies. Research regarding the balance of interaction modes is required. Measurements of content interactions should be as close as possible to the "real thing", taking into account online, offline and internal intellectualizations. Attention in these studies should focus more on the quality of interaction rather than the quantity. The concepts of deep learning and critical discourse relative to types of interaction or lack thereof would be beneficial. Anderson, Annand and Wark (2005) recommend the de-emphasis of moderated, group-paced CMC discussions via the use of fifth-generation semantic web. These resources were not available to this study. Research assessing the fifth generation technologies, particularly their effect on deep and meaningful learning would be timely and valuable.

Demographic impacts such as age, gender, culture or ethnicity could be explored. There are few published statistics on intergenerational needs for peer interactions in adult education. Mature aged entries into university classes are an area of expansion for many facilities (Bird & Morgan, 2003). The changing structure and organization of work and education has increased the mix of different age cohorts (Dirkx, 2002). This affects both higher and continuing education and research in this area is especially relevant now.

Differences between novice and more experienced computer users could also provide useful information. Good research requires sample populations of sufficient size and study periods encompassing adequate timeframes. From the laboratory perspective, the potential educational differences due to varying levels of prior education and employment experiences between MLTs and MLAs requires future study.

While the qualitative portion of this study did provide some insight into student perceptions, very few students provided feedback. Qualitative research assumes that everything has the potential of being a clue to unlocking further understanding (Bogdan & Biklen, 1982). Sometimes what is not said provides just as powerful a message. Future research should encompass methods of obtaining the reactions of all participants.

Finally, it is important to acknowledge an under-utilized opportunity for the creation of new knowledge in the laboratory field. Research about medical laboratory science performed by laboratory professionals themselves is sadly lacking (Grant, 2004). The evolution of the profession depends upon research activity to shape future educational and clinical practices. Theories are meant to be tested and "facts" that refute our understanding should not be accepted at face value. Each individual's experience and knowledge has worth. Questioning existing assumptions through personal reflection and collaborative discussion can help to formulate the issues on which future studies are founded.

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CSMLS LEARNING SOCIETY

Attention: MLAs and MLTs!

CSMLS Launches First Online Course!

The Pre-analytical Process: What every lab professional should know

Participate in our RESEARCH STUDY!
Receive a $150 REBATE on your course fee!

About the Course:

It is estimated that from 32% to 75% of laboratory errors occur in the pre-analytical stage. Many of these errors are preventable.
The Pre-analytical Process is a new course, and the *first* online course to be offered by the CSMLS. Learners will progress step-by-step through each stage of the pre-analytical process. Procedures and current standards of practice will be reviewed. Emphasis is on potential sources of error, and the consequences and prevention of error. This course is *only* offered online; learners will learn in a collaborative, interactive environment.

About the Study:

We hope to study effects on learning using different styles of course presentation. The study is conducted during the first module of the course. Participants will be asked basic demographic information and will complete short questionnaires at the beginning and end of the module. Your time commitment to answer the two questionnaires should be no longer than an hour. Your confidentiality will be protected and data will be analyzed at the group level.

One-time-only Fee Rebate:

In consideration of your time and participation in this study, the **CSMLS will reimburse $150 off of your course fee at the completion of the study period!** We are looking for both MLA and MLT applicants. Spaces are limited and first preference will be given to CSMLS members.

APPENDIX A

This research project is being done in partnership with the CSMLS and has been approved by the CSMLS Board of Directors.

For more information:

☑ **on course content,** Click here (link to: http://www.csmls.org/CE/CE_course_details.cfm?ID=4657&&CFID=1127639-341)

☑ For more information **on registration**, please contact Lucy Agro by email at coned@csmls.org

☑ If you have any **questions about the study**, please click here first: (link to document: information letter to potential study participants)

☑ If you **still have questions about the study**, please contact Linda Markewitz by email at PreanaStdnt@shaw.ca

To register on-line,

- **click here!** (link to: http://www.csmls.org/CE/CE_course_details.cfm?ID=4657&&CFID=1127639-341) On-line registration is below the course information.
- You will receive a confirmation of payment from the secure Moneris site. This is NOT a confirmation of registration
- CSMLS members will be chosen first for all study positions
- Those chosen for the study will be notified by email once all study positions are filled
- All study participants must give informed consent to participate in the study. The form and instructions will be emailed to you
- Those who are <u>not chosen</u> for the study may choose to apply their course fee to the next date this course is offered. However, there will be no rebate
- The rebate will be issued when study participants finish the first course module and the study surveys.

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PO/CP 2830, LCD 1/PDF 1, Hamilton, ON L8N 3N8 Tel: (905) 528-8642 Fax: (905) 528-4968

www.csmls.org www.scslm.org

APPENDIX B

CSMLS
Canadian Society for
Medical Laboratory Science

SCSLM
Société canadienne de
science de laboratoire médical

Dear CSMLS Learner and Study Participant,

As you may know, the "Preanalytical Process" is the first online course to be offered by the CSMLS. Based upon a continuing education needs assessment survey conducted by the CSMLS in 2004, a very distinct preference in course presentation style was noted. We are conducting research that centres around the affect of this factor on learning. Specifically a single module of online instruction will be presented either with or without this factor.

This research is being conducted for my graduate thesis. It is one component necessary for completing the Master of Distance Education degree at Athabasca University. I am also hoping that the results of this study will add to the knowledge base in the fields of distance education in general and medical laboratory technology continuing education in particular. There is a notable lack of data on learning and best practices in medical laboratory technology and this study will contribute to resolving that deficit.

The study period lasts 5 weeks and consists of the first module of the preanalytical course. At the beginning of the study you will be asked to complete a short questionnaire about your usual study habits and provide some basic demographic information. At the end of the first module you will proceed through a short quiz and another short questionnaire regarding your approach to the study of this module. I will also be collecting data via the E-Learning Society system about how often various aspects of the course content are accessed. You will not need to do anything to provide this additional data. There are no marks assigned for the module quiz, and I estimate that your time commitment to answer the two questionnaires will be no longer than an hour. Your confidentiality will be protected and data will be analyzed at the group level.

In consideration of your time and cooperation in this study, the CSMLS has generously offered to reimburse $150 off the course fees at the completion of the study period. If you are interested in participating in this study, please contact Lucy Agro, Continuing Education Coordinator at the CSMLS by email: coned@csmls.org. An informed consent form will be sent to you for completion.

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APPENDIX B

If you have any questions or concerns about the study you can contact me by email: PreanaStdnt@shaw.ca

Sincerely,

Linda Markewitz MLT BSc
Student, Master of Distance Education
Athabasca University
Ph: (250) 468-9729
Email: PreanaStdnt@shaw.ca

APPENDIX C

CSMLS
Canadian Society for
Medical Laboratory Science

SCSLM
Société canadienne de
science de laboratoire médical

The Preanalytical Process: What every lab professional should know

INFORMED CONSENT

Dear Learner,

Welcome to the CSMLS E-Learning Society 'Preanalytical Process' course and the research study group. This research is being conducted for my graduate thesis. It is one component necessary to complete the Master of Distance Education degree at Athabasca University. I am also hoping that the results of this study will add to the knowledge base in the fields of distance education in general and medical laboratory technology continuing education in particular.

The study period will last 5 weeks during module one of the 'Preanalytical Process' course. As mentioned in previous communications the components of this study are as follows:

- Gathering of some basic demographic information such as age, gender, occupational area, level of computer skills, etc.
- A pre-module questionnaire of 20 questions
- A post-module practice quiz which is normal part of the module for all students. No marks are assigned for this quiz.
- Data gathering from the E-learning Society's computer system of the quantities of access to the various online course components. You will not need to do anything to provide this data.
- A post-module questionnaire of 20 questions

I estimate that your time commitment to answer the two questionnaires will be no longer than an hour.

Please be assured that all reasonable precautions will be taken to protect your confidentiality with regards to the data collected. The data will be analyzed at the group level. Information obtained from this study will not be used to harm or demean participants in any way. This original data will only be accessible to me and system administrator staff at the CSMLS and the host file server. Upon request, participants will be given a printed copy of any published materials that arise as a result of this research.

In consideration of your time and cooperation in this study, the CSMLS has generously offered to reimburse **$150 off** of the course fee. This reimbursement will only be paid at the completion of the research period and after all of the research tasks described above are completed. I do hope that you will agree to take part in this study. You are entirely within your rights to refuse

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The Preanalytical Process: What every lab professional should know

to participate. This will in no way reflect negatively upon you and there will be no issues arising from a refusal other than non-payment of the reimbursement.

You are also within your rights to discontinue participation in the study at any point without a need for explanation. The decision to not participate or to drop out of the study will have no impact on grades or other assessment activities. These are your rights and they will be respected. By consenting to participate in this study, you do not waive any of your legal rights.

If you are willing to complete the above tasks while you work through the first module of instruction of the online "Preanalytical Process" course, please

1. Save this attached letter to your computer
2. Type in the date and your name in the spaces provided, below
3. Save the letter to your computer again
4. Send an email to coned@csmls.org
5. Include the letter as an attachment
6. Note in the subject line of the email: informed consent and your name

By responding to this email and sending the completed attachment, you are acknowledging that the components of the research study have been adequately explained to you, that you understand this explanation and your rights as a study participant, and that you agree to participate in this study.

Send replies to Lucy Agro, Continuing Education Coordinator at the CSMLS by email: coned@csmls.org

Date:

Name of Participant:

Researcher:

Linda Markewitz MLT BSc

APPENDIX D

Demographic Information:

1. Are you between the ages of: younger than 21, 21-29, 30-39, 40-49, 50-59, 60 or older
2. Are you: male, female
3. Are you presently working: full-time, part-time, casual, not at all
4. How many years have you been an MLA or MLT? Less than 5, 5-10, 11-20, 21-30, more than 30
5. Your present position is: bench or bedside level, immediate supervisor, department manager, other
6. What is the highest level of education that you have completed: diploma, baccalaureate, master's, PhD
7. Is this your first on-line course? Yes, No
8. What is your current level of computer skills? Novice, Intermediate, Skilled, Expert

John Biggs, et.al. - **R-SPQ-2F**

This questionnaire has a number of questions about your attitudes towards your studies and your usual way of studying.

There is no *right* way of studying. It depends on what suits your own style and the course you are studying. It is accordingly important that your answer each question as honestly as you can. If you think your answer to a question would depend upon the subject being studied, give the answer that would apply to the "Preanalytical Process" course that you are currently taking.

A – this item is *never* or *only rarely* true of me
B – this item is *sometimes* true of me
C – this item is true of me about *half the time*
D – this item is *frequently* true of me
E – this item is *always* or *almost always* true of me

Please choose the *one* most appropriate response to each question – the one that best fits your immediate reaction. Do not spend a long time on each item: your first reaction is probably the best one. Please answer each item.

Do not worry about projecting a good image. Your answers are CONFIDENTIAL.

Thank you for your cooperation.

1. I find that at times studying gives me a feeling of deep personal satisfaction.
2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.
3. My aim is to pass the course while doing as little work as possible.
4. I only study seriously what's given out in class or in the course outlines.
5. I feel that virtually any topic can be highly interesting once I get into it.
6. I find most new topics interesting and often spend extra time trying to obtain more information about them.
7. I do not find my course very interesting so I keep my work to the minimum.
8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.

APPENDIX D

9. I find that studying academic topics can at times be as exciting as a good novel or movie.
10. I test myself on important topics until I understand them completely.
11. I find I can get by in most assessments by memorizing key sections rather than trying to understand them.
12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.
13. I work hard at my studies because I find the material interesting.
14. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.
16. I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.
17. I come to most classes with questions in mind that I want answering.
18. I make a point of looking at most of the suggested readings that go with the lectures.
19. I see no point in learning material which is not likely to be in the examination.
20. I find the best way to pass examinations is to try to remember answers to likely questions.

APPENDIX E

Sample Student Activity Report and Data Analysis

Mon 2 April 2007, 02:58 PM	resource view	Preanalytical Course Schedule - 1st Term 2007
Mon 2 April 2007, 02:57 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:56 PM	resource view	PATIENT RELATIONS - Case Study
Mon 2 April 2007, 02:56 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:55 PM	user view	
Mon 2 April 2007, 02:55 PM	forum user report	
Mon 2 April 2007, 02:55 PM	forum user report	
Mon 2 April 2007, 02:55 PM	course user report	
Mon 2 April 2007, 02:54 PM	course user report	
Mon 2 April 2007, 02:54 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:54 PM	quiz view	Post-Module 1 Survey
Mon 2 April 2007, 02:54 PM	quiz close attempt	Post-Module 1 Survey
Mon 2 April 2007, 02:48 PM	quiz attempt	Post-Module 1 Survey
Mon 2 April 2007, 02:48 PM	quiz view	Post-Module 1 Survey
Mon 2 April 2007, 02:47 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:47 PM	quiz view	Module 1: Practice Quiz
Mon 2 April 2007, 02:46 PM	quiz review	Module 1: Practice Quiz
Mon 2 April 2007, 02:46 PM	quiz review	Module 1: Practice Quiz
Mon 2 April 2007, 02:45 PM	quiz close attempt	Module 1: Practice Quiz
Mon 2 April 2007, 02:37 PM	quiz attempt	Module 1: Practice Quiz
Mon 2 April 2007, 02:37 PM	resource view	LESSON: Preanalytical Patient Considerations: Part 1
Mon 2 April 2007, 02:37 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:37 PM	course user report	
Mon 2 April 2007, 02:35 PM	user view	
Mon 2 April 2007, 02:35 PM	course user report	
Mon 2 April 2007, 02:35 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 2 April 2007, 02:35 PM	quiz view	Module 1: Practice Quiz
Mon 2 April 2007, 02:34 PM	quiz view	Module 1: Practice Quiz
Mon 2 April 2007, 07:30 AM	user view	
Mon 2 April 2007, 07:30 AM	course user report	
Mon 2 April 2007, 07:29 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 26 March 2007, 10:41 AM	user view	
Mon 26 March 2007, 10:41 AM	course user report	
Mon 26 March 2007, 10:41 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 26 March 2007, 10:40 AM	quiz view	Post-Module 1 Survey
Mon 26 March 2007, 10:40 AM	quiz view	Module 1: Practice Quiz
Mon 26 March 2007, 10:36 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 26 March 2007, 10:34 AM	resource view	LESSON: Preanalytical Patient Considerations: Part 1
Mon 26 March 2007, 10:34 AM	course view	The Pre-analytical Process: What every lab professional

APPENDIX E

Sample Student Activity Report and Data Analysis

		should know group B
Thu 15 March 2007, 09:14 AM	resource view	Study Guide - Module 1 (right click to print)
Thu 15 March 2007, 09:13 AM	resource view	Relaxation Techniques
Thu 15 March 2007, 09:11 AM	resource view	Tips on Blood Testing
Thu 15 March 2007, 09:11 AM	resource view	Other Factors Affecting Test Results
Thu 15 March 2007, 09:11 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 15 March 2007, 09:08 AM	resource view	MLT Boundaries of Practice Guidebook
Thu 15 March 2007, 09:08 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 15 March 2007, 09:08 AM	resource view	PATIENT RELATIONS - Case Study
Thu 15 March 2007, 09:07 AM	resource view	Test Preparation: Your Role
Thu 15 March 2007, 09:07 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 15 March 2007, 09:06 AM	course user report	
Thu 15 March 2007, 09:05 AM	user view	
Thu 15 March 2007, 09:05 AM	course user report	
Thu 15 March 2007, 09:05 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Tue 13 March 2007, 07:55 AM	resource view	PATIENT RELATIONS - Case Study
Tue 13 March 2007, 07:55 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Tue 13 March 2007, 07:32 AM	resource view	MLT Boundaries of Practice Guidebook
Tue 13 March 2007, 07:32 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Tue 13 March 2007, 07:30 AM	resource view	Warfarin - A Guide for Patients
Tue 13 March 2007, 07:28 AM	resource view	Test Preparation: Your Role
Tue 13 March 2007, 07:27 AM	resource view	Preanalytical Course Schedule - 1st Term 2007
Tue 13 March 2007, 07:27 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Tue 13 March 2007, 07:27 AM	course user report	
Tue 13 March 2007, 07:24 AM	user view	
Tue 13 March 2007, 07:24 AM	course user report	
Tue 13 March 2007, 07:24 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 12 March 2007, 12:17 PM	resource view	Preanalytical Course Schedule - 1st Term 2007
Mon 12 March 2007, 12:16 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 12 March 2007, 12:13 PM	user view	
Mon 12 March 2007, 12:13 PM	course user report	
Mon 12 March 2007, 12:12 PM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 8 March 2007, 10:00 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 8 March 2007, 10:00 AM	resource view	Alternate file types: Preanalytical Considerations - Part 1 and Part 2
Thu 8 March 2007, 09:59 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Thu 8 March 2007, 09:58 AM	user view	
Thu 8 March 2007, 09:58 AM	forum user report	
Thu 8 March 2007, 09:57 AM	user view	

APPENDIX E

Sample Student Activity Report and Data Analysis

Thu 8 March 2007, 09:57 AM	course user report	
Thu 8 March 2007, 09:57 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Wed 7 March 2007, 10:00 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Wed 7 March 2007, 10:00 AM	course user report	
Wed 7 March 2007, 10:00 AM	user view	
Wed 7 March 2007, 09:59 AM	resource view	PATIENT RELATIONS - Case Study
Wed 7 March 2007, 09:56 AM	user view	
Wed 7 March 2007, 09:56 AM	course user report	
Wed 7 March 2007, 09:56 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Tue 6 March 2007, 10:03 AM	resource view	PATIENT RELATIONS - Case Study
Tue 6 March 2007, 10:02 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 11:29 AM	course user report	
Mon 5 March 2007, 11:29 AM	user view	
Mon 5 March 2007, 11:28 AM	course user report	
Mon 5 March 2007, 11:27 AM	resource view	Study Guide - Introduction (right click to print)
Mon 5 March 2007, 11:27 AM	course user report	
Mon 5 March 2007, 11:27 AM	user view	
Mon 5 March 2007, 11:27 AM	forum user report	
Mon 5 March 2007, 11:26 AM	course user report	
Mon 5 March 2007, 11:26 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 11:13 AM	resource view	Tips on Blood Testing
Mon 5 March 2007, 11:12 AM	resource view	Relaxation Techniques
Mon 5 March 2007, 11:09 AM	resource view	Effects of Age and Sex
Mon 5 March 2007, 11:08 AM	resource view	What is a reference range?
Mon 5 March 2007, 11:08 AM	resource view	Changes in analyte concentration after a tourniquet application time of 6 minutes
Mon 5 March 2007, 11:06 AM	resource view	Standards of Practice Document
Mon 5 March 2007, 11:03 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 11:02 AM	quiz view	Pre-Module 1 Survey
Mon 5 March 2007, 11:01 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 11:01 AM	quiz view	Module 1: Practice Quiz
Mon 5 March 2007, 11:00 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 10:58 AM	quiz view	Post-Module 1 Survey
Mon 5 March 2007, 10:58 AM	quiz view	Module 1: Practice Quiz
Mon 5 March 2007, 10:57 AM	quiz view	Module 1: Practice Quiz
Mon 5 March 2007, 10:46 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:46 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:40 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:40 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:40 AM	choice view	Case Study #1 - CHOICES
Mon 5 March 2007, 10:40 AM	choice choose	Case Study #1 - CHOICES

APPENDIX E

Sample Student Activity Report and Data Analysis

Mon 5 March 2007, 10:40 AM	choice view	Case Study #1 - CHOICES
Mon 5 March 2007, 10:37 AM	resource view	LESSON: Preanalytic Patient Considerations: Part 2
Mon 5 March 2007, 10:30 AM	resource view	LESSON: Preanalytical Patient Considerations: Part 1
Mon 5 March 2007, 10:11 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:11 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:06 AM	choice view	Case Study #1 - CHOICES
Mon 5 March 2007, 10:05 AM	resource view	Study Guide - Module 1 (right click to print)
Mon 5 March 2007, 10:04 AM	resource view	Study Guide - Introduction (right click to print)
Mon 5 March 2007, 10:03 AM	glossary view	Preanalytical Course Glossary of Terms
Mon 5 March 2007, 10:03 AM	glossary view	Preanalytical Course Glossary of Terms
Mon 5 March 2007, 09:59 AM	journal view	Preanalytical Course Learner's Journal
Mon 5 March 2007, 09:58 AM	resource view	Preanalytical Course Schedule - 1st Term 2007
Mon 5 March 2007, 09:54 AM	course view	The Pre-analytical Process: What every lab professional should know group B
Mon 5 March 2007, 09:54 AM	quiz view	Pre-Module 1 Survey
Mon 5 March 2007, 09:54 AM	quiz close attempt	Pre-Module 1 Survey
Mon 5 March 2007, 09:47 AM	quiz attempt	Pre-Module 1 Survey
Mon 5 March 2007, 08:59 AM	quiz view	Pre-Module 1 Survey

Data Analysis

Interpretation of March 5 activities:
- 08:59 am start-time
- 11:29 am log-off
- Gap in recorded activities of >30 minutes but in Survey so no log-off deemed
- Last recorded activity course user report
- Total time for this date = 148 minutes

Interpretation of March 6 activities:
- 10:02 am start-time
- 10:03 am log-off
- Last recorded activity resource view
- Total time for this date = 2 minutes

Interpretation of March 7 activities:
- 09:56 am start-time
- 10:00 am log-off
- Last recorded activity course view
- Total time for this date = 5 minutes

Interpretation of March 8 activities:
- 09:57 am start-time
- 10:00 am log-off
- Last recorded activity course view
- Total time for this date = 3 minutes

APPENDIX E

Sample Student Activity Report and Data Analysis

Interpretation of March 12 activities:

- 12:12 pm start-time
- 12:17 pm log-off
- Last recorded activity course schedule view
- Total time for this date = 5 minutes

Interpretation of March 13 activities:

- 07:24 am start-time
- 07:55 am log-off
- Last recorded activity resource view case study
- Total time for this date = 31 minutes

Interpretation of March 15 activities:

- 09:05 am start-time
- 09:14 am log-off
- Last recorded activity user view
- Total time for this date = 7 minutes

Interpretation of March 26 activities:

- 10:34 am start-time
- 10:41 am log-off
- Last recorded activity user view
- Total time for this date = 7 minutes

Interpretation of April 2 activities:

- 07:29 am start-time
- 07:30 am >30 minutes to next activity – log-off deemed
- 02:34 pm – long-on deemed
- 02:58 pm log-off
- Last recorded activity course schedule view
- Total time for this date = 2 + 24 minutes = 26 minutes

Total time = 234 minutes