INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) LITERACY IN TEACHER EDUCATION: A CASE STUDY OF THE UNIVERSITY OF BRITISH COLUMBIA

by

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ABSTRACT

The purpose of this research was to increase an understanding of the practices and issues of information and communications technology (ICT) literacy in the teacher education program at the University of British Columbia, Canada. I explored characteristics related to (ICT) literacy: A) program effects on ICT competencies; B) gender and ICT literacy; C) age and ICT literacy; D) attitudes toward technology and ICT literacy; and E) program effects on ICT use.

Mixed methods were applied to analyse quantitative data and interpret interviews and observations in the program. The data were collected from large-scale pre- and post-program surveys of student teachers in the 2001-2002 and 2003-2004 years. A research team in the Faculty of Education at UBC administered questionnaires to the teacher education students in September 2001 (n = 877) and 2003 (n=828) at the beginning of the academic year and post-program instruments were completed in May and June 2002 and 2004. Data included interviews with student teachers, observations of student teachers in courses, and videotapes of student teachers' microteaching sessions for evidence of pedagogical integration.

Findings from both quantitative analyses of this study suggest that the perception that both female and male students have of their ICT competencies significantly increased between the start and end of the program. Male students had significantly higher means than females at the start of their program. An increase of the female students was significantly higher than the increase of the males at the end of the program, but was not enough to offset the difference. Teacher candidates' attitudes toward technology also changed significantly by the end of the program. Findings from this study revealed that the teacher candidates' attitudes toward ICT and their ICT competencies were highly correlated. ICT competencies varied with attitudes. ICT competencies increase or decrease with changes of attitudes. No significant effects were found for a digital divide by age in this study. There were strong correlations between the students' perceptions of their ICT competencies and their ICT uses in schools. Results from this study inform the pedagogy of integrating technology into curriculum and instruction and suggest further research on effective uses of ICT in teacher education.

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To my family, my brothers and sisters, and my friends near and far, for their unconditional love, patience, and encouragement that give me strength to accomplish my educational goals.

To my son Eric Jing Guo for his understanding and support throughout my education at UBC: May he be blessed abundantly with his own education.

CHAPTER ONE
INTRODUCTION

Although a large volume of literature exists at the level of ICT policy for pre-service and in-service teachers, policy recommendations are not matched by research into *practice*. In Canada in general, and in BC specifically, there is virtually no documentation of pre-service teaching practices with ICT. There are reports of small-scale pilot projects, but little on large scale practices in teacher education in Canada.

Public expectations for ICT and educational systems have increased with the ubiquity of digital technologies in daily life. To date, the discourse has been predominantly instrumental, focusing on skills and the use of ICT in the service of curriculum and instruction. Although computers have been widely available in educational settings for well over two decades, a concern remains that teachers (in-service and pre-service) are neither confident nor competent users of ICT. Studies by Kerry (2000) and Wetzel, Wilhelm and Williams (2004), for example, indicate that many practicing teachers feel unprepared to use ICT in their classrooms. Similarly, Watson (1997) found that many student teachers have low self-efficacy towards ICT and have negative attitudes towards ICT. These studies suggest that teacher education programs often fail to provide a structure through which teacher candidates can gain confidence and competence with ICT, and this inadequacy limits the possibility for meaningful use of technologies within educational settings (Watson, 1997).

Willis and Mehlinger (1996) noted that universities and teacher education programs typically fail to offer enough instruction to enable pre-service teachers to develop the necessary competencies and understandings for effectively incorporating ICT in their own teaching practices. This widespread problem contributes to feelings of inadequacy on the part of teacher candidates. "Consequently," observed Gibson and Nocente (1998), "faculties of education throughout the country are experiencing increased pressure from government and school district level initiatives to produce graduates who are both confident and competent in using technology in their classrooms" (p. 324).

Despite a demand for increasing investments to introduce computers and Internet access in the classroom, Cuban (2001) claimed that there was no evidence that ICT increased students' academic achievement from his 2000-2001 study of Silicon Valley schools. He disputed the policymakers who accelerated the placement of computers into schools without much regard for educators who are expected to improve students' learning with the new technologies. Cuban reported that less than ten percent of the teachers used their classroom computers at least once a week. He used Stanford University for an example, where professors had been using computers for decades. The vast majority of these professors had computers at home and used them for their own work in the 1980s. But by 1994 only 27 percent of the faculty surveyed said they ever used a computer in the classroom for instruction and only eight percent said they used it often. Most said that it was due to lack of time to locate relevant instructional software. About half said they had no time to learn about classroom uses of computers although help was available at five university centres.

Ungerleider and Burns (2002) claimed similar findings in Canadian schools: there was no relationship between the presence of a computer in the classroom and the achievement of third grade students from an analysis of data gathered in 1997 from 115,000 third graders in Ontario's English-speaking schools. The Statistics Canada report (Tremblay, Ross, & Berthelot, 2001) revealed that 70% of teachers in Ontario schools reported that their students had either limited access or no access to a computer at school. Factors included a poor ratio of Internet connections to students, poor distribution of equipment and insufficient teacher preparation time might affect the student academic achievement, Tremblay et al. commented.

Despite these shortcomings in teacher education programs, ICT can be integrated in ways that make a difference. For instance, in a study with 222 primary/junior pre-service teachers at a university in southwest Canada, Kellenberger (1996) found that pre-service teachers increased self-efficacy toward ICT through their program. Kellenberger reported that pre-service teachers' perceptions of ICT were quite favourable at the end of the teacher education program because they experienced successful learning outcomes. However, the critical components of ICT literacy have been largely ignored. One aspect of this dissatisfaction focused on the tension between the instrumental or functional use of ICT and the critical study of ICT. For example, Mitchell (2001) reported that there was a disconnection between the learning of ICT in UBC's Community of Inquiry for Teacher Education (CITE) cohort, an elementary teacher education program in the Faculty of Education at UBC, and the functional use of ICT in practicum schools. Mitchell noted that when the students did their practicum they had difficulties in applying the technological knowledge and skills they obtained in the Teacher Education Program. This tension further complicates the issue of ICT curriculum in teacher education.

Although the International Society of Technology in Education (ISTE, 2003) recommended that all teachers should be prepared to meet the standards of ICT operations and concepts, planning and designing learning environments and implementing curriculum that maximizes student learning in an ICT-based environment, my comparison of teacher education programs across Canada found little consensus on the ICT curriculum. Further research on **the status of ICT literacy and the effective use of ICT** in practice is necessary for the design of ICT curriculum at the pre-service level.

Doyle (1994) described ICT literate individuals are those who have learned how to learn and use ICT appropriately. They must recognize when ICT is needed and have the ability to locate, evaluate and use effectively the information for survival or a better life. They are independent, self-directed learners who will exhibit the following characteristics:

- Implements information processes
- Uses a range of information and communication technologies
- Values information and ICT applications
- Knows how to navigate the world of information and ICT
- Approaches ICT and information critically; assesses implications
- Has developed a personal ICT style

However, ISTE's pedagogical standards for ICT have broader range of indicators than that of personal uses of ICT. ISTE's (2003) *NETS for Teachers* (*NETS•T*), which focus on pre-service teacher education, defines the fundamental concepts, knowledge, skills, and attitudes for applying ICT in educational settings. All teacher candidates in teacher preparation should meet the following six standards with performance indicators:

- Technology of operations and concepts
- Planning and designing learning environments and experiences
- Teaching, learning and the curriculum
- Assessment and evaluation
- Productivity and professional practice

- Social, ethical, legal, and human issues

In teacher education programs, teacher candidates must continually observe and participate in the effective modeling of ICT use for both their own learning and the teaching of their students. ICT must become an integral part of the pedagogy in every setting supporting the preparation of teachers (ISTE, 2003).

UBC's Faculty of Education's key policy document has three main points: (I) learning technologies should be viewed as the responsibility of all of the Faculty rather than as an initiative of a single department or subgroup of faculty members; (II) the Faculty should support learning technologies in a way that allows them to grow in a variety of ways; and (III) learning technologies should be used in ways that allow for different technologies to enhance learning and teaching for all students. My research responded to this call by assessing technology competencies essential for student teachers to enhance effective design and delivery of curriculum that addresses both the functional and critical components of ICT literacy.

Based on a reading of the literature, which suggests that pre-service teachers' competencies with ICT are good indicators of whether they successfully incorporate technologies in their teaching, the Faculty of Education at UBC designed a study to assess the student teachers' self-efficacy with ICT. One aspect of this research addressed equal access to technology use and resources. In 1998, research conducted by the American Association of University Women (AAUW) found that girls are falling behind in participating in technology-based classes and careers (Green, 2000). According to a recent report of gender and ICT in BC, there existed a range of gender inequities in enrolments and participation in technology-intensive courses of BC public secondary schools (Bryson, Petrina, Braundy and de Castell, 2003). A follow-up study indicates that girls continue to be under-represented in technology courses in secondary schools. Is this phenomenon mirrored in the teacher education programs? Is there a gender gap in ICT literacy in the UBC teacher education program? It is predicted that the fastest growing jobs for the next two decades will be in the ICT sector. If girls are not trained in these fields today, or do not have role models in ICT teaching, their opportunities may be diminished. An ICT gender gap seems to function as a barrier to the effective use of computers in secondary schools *and* in teacher education programs.

Purpose of the Research Study

The purpose of this study was to research ICT literacy in both elementary and secondary teacher education programs and to investigate **the status of ICT literacy among teacher education students at UBC.** My rationale for conducting this research lies in the following. First, the shift from traditional practice to the incorporation of newer technological practices in education is underway. Second, a systematic study of the characteristics and basic structure of ICT literacy will help policy makers effectively design technology curriculum. Third, making analytical comparisons between the data collected from pre- and post-program surveys on pre-service teachers' skills and beliefs pertaining to ICT literacy will provide better understanding of the pedagogical usefulness of technology.

Research Problems or Questions

As the integration of ICT in teacher education is an imperative for many universities, my research interest focused on how teacher candidates are prepared and how they obtain

ICT literacy. Although there exists a significant body of research addressing aspects of this double-pronged question, including some large-scale studies (e.g., Watson, 1997; Gibson & Nocente, 1998), much of the literature consists of reports of small-scale projects (Albion, 2001; Kellenberger, 1996; Watson, 1997; Watson, Proctor, Finger & Lang, 2004; Wetzel, Zambo, & Buss, 1996; Wetzel, 1993). These case studies suggest the degree to which educators are laboring to bring ICT into teacher education. However, these studies fail to present a more general sense of whether various efforts to integrate technology in teacher education programs are significantly improving student teachers' competence and comfort levels with ICT. With a view to examining this two-pronged question at UBC, the Faculty of Education conducted a large-scale study of pre-service teachers enrolled in two academic years (2001/2002 and 2003/2004).

This study was guided by the following research questions:

1. **Are there differences between pre- and post-program perceptions of ICT competencies?**
2. **Are there gender differences in student teachers' views of, and attitudes toward, ICT competencies?**
3. **How do the student teachers perceive their progress in ICT competencies?**

In order to answer question one and find out whether there are statistically significant differences between pre- and post-program competencies, a survey of teacher candidates perceptions of their ICT competencies at the start and end of their teacher education program was administered. The first question dealt with differences in ICT competencies over the duration of the program and also examined the student teachers' ICT literacy before they received training in the programs. It was designed to understand the student teachers' prior knowledge before focus was shifted to learning experiences with technology during the program. Sub-questions such as "what attitudes did pre-service teachers hold towards ICT at the beginning of the course?" and "did attitudes change over the course of the program?" and "how did pre-service teachers anticipate applying ICT in their future teaching positions?" were examined to see if the student teachers' ICT literacy was related to their attitudes toward technology.

The second question examined gender issues and ICT literacy and their attitudes toward technology. This question first explored the attitudes of the teacher candidates toward ICT, gender differences in dispositions toward ICT and then investigated if the dispositions changed over time. The third question investigated the factors that influenced student teachers' ICT literacy during the program. Both quantitative and qualitative analyses were applied to answer this question. It also represented pedagogical practices with ICT in the program and the roles of technologies. This question focused on one or a limited number of factors associated with learning, such as procedures, processes, and issues of ICT pedagogy, as well as the changes that resulted when instruction was delivered with ICT or through microteaching sessions. Sub-questions included "Was age a factor that affected ICT literacy in teacher education?" and "Were access and frequency of use of ICT predictors of ICT competencies?" The purpose of such examination was to contribute to knowledge about how technology was implemented, and therefore to formulate a vision for the role of ICT literacy in the teacher education program. Learning strategies, such as reflection on student teachers' microteaching, were evaluated. Investigating the status of student competencies and the use of technology will help in the design of technology curriculum in the teacher education program. In summary, I examined the ICT literacy and dispositions of pre-service teachers at two stages in their teacher education program, e.g. the teacher candidates' ICT competencies and dispositions before and as they exited the program through these research questions.

Limitations and Assumptions

One of the limitations of self-efficacy research is that it provides measures of one's own perceptions rather than actual competencies. An assumption here is that findings may reflect a tendency that males might be overconfident toward their ICT competencies and females might be under-confident toward their ICT competences. Or, findings may be biased because different populations (e.g. males versus females) tend to self-assess differently. Another limitation in this study is that it was not possible to trace individual student progress in performance with ICT because the demographic item for student identification was not included in all of the instruments.

Given that no stand-alone technology course is required for all students in our teacher education programs, the Faculty of Education generally subscribes to an integration model for ICT. Individual experiences of ICT vary widely depending on subject-area or grade-level focus, and depending on the focus of individual instructors. The unevenness of instruction with ICT constitutes a limitation of the setting for the research.

Setting

The research site for this study was the Faculty of Education at the University of British Columbia (UBC), a large institution in Vancouver with 35,000 students and situated within a densely populated region rich with a diversity of ethnic cultures and languages. This linguistic and ethnic diversity brings challenges to the learning and use of ICT, particularly where immigration is highest and the population is by consequence, most diverse.

Demographically, the students in this research were diverse across a range of categories. For example, in 2003, about 24% of the students represented racial minorities (e.g., Afro-Canadians, Arab-Canadians, Asian-Canadians, First Nations, Indo-Canadians and Latin-Canadians). In 2001 and 2003, a majority of students were between twenty and forty years old, and a few were fifty to sixty years old. The majority of students were female (69% and 73% in 2001 and 2003 respectively). About 83% of elementary program students were female in each year; distribution in the secondary program was more balanced, with an average of 56% females in both years.

The teacher education program at UBC prepares teachers to teach in the K-12 system. The programs range from one to two years and include both theoretical coursework and practical experiences in schools (Table 1). The 12-month elementary option provides preparation for teaching in elementary schools (Grades K to 7); the 12-month Middle Years Option provides preparation for teaching 10-14 year olds in grades 6 through 9; the 12-month secondary option provides preparation to teach one or two subjects to youth in grades 8 through 12 (Table 1). The 2-year Elementary Option provides preparation for teaching in the elementary classroom (Grades K to 7), with specific preparation in one of six areas:

1. Early Childhood/Primary
2. English as an Additional Language
3. Humanities
4. Mathematics and Science
5. Special Education
6. The Expressive Arts in Education

Graduates of the Bachelor Education Program are qualified to apply for certification to teach in the province of British Columbia and also for certification to teach in other provinces and other countries (Teacher Education Office, 2006).

Applicants to the teacher education program must have met the academic requirements including a 4-year Bachelor of Arts or Science or its equivalent, majoring in a teachable subject prior to admission to the program. For example, a minimum of 90 credits must be in subject areas from Arts (humanities and social sciences), Visual and Performing Arts, Science, Music or Human Kinetics. These 90 credits may be presented as a completed 3-year degree from an accredited university or as 90 credits of a 120-credit (4-year) degree. The total program requirements are 60-62 credits. The UBC teacher education program does not require all student teachers to enrol in technology courses, but provides various opportunities for integrating ICT across the curriculum. The secondary cohort in Technology Studies includes a nine-credit requirement in technology-specific courses and nine credits of electives in the same. All of the cohorts include the use of ICT in assignments for the professional courses.

Table 1. Teacher education program description (secondary option, 12 months)

Term/Course	Credit	Description
September-December		
EDUC 311 The Principles of Teaching	**4**	Introduction to principles and instructional procedures related to classroom management, instructional planning, and the assessment of learning as applicable across grade levels and subject matter fields.
EDUC 315 Pre-practicum Experience	**0**	Observation and instruction in educational settings.
EDUC 316 Communication Skills in Teaching	**3**	Study and practice of communication skills in educational settings. Candidates will be required to demonstrate satisfactory oral communication abilities.
EDUC 319 Orientation School Experience – Secondary	**0**	A two-week sequence of observations and instructional assignments in a selected secondary school.
EPSE 306 Education during the Adolescent Years	**2**	Developmental characteristics of persons from pre-school age through adulthood. Physical, social, cognitive, moral, and emotional growth of both normal and exceptional children in grades 8-12. The teacher's role in assisting such students to deal with major developmental issues and problems.
EPSE 317 Development and Exceptionality in the Regular Classroom	**3**	The teacher's role in dealing with major developmental and special educational issues and problems within the regular classroom program, including working with supportive services, parents, and communities. Designated sections will focus on early childhood, middle childhood, or adolescence.
EDST 314 Analysis of Education	**3**	Concepts, abilities, and procedures for assessing educational claims, policies, and practices.
Curriculum and Instruction Studies Course(s) related to first subject. Course(s) related to second subject	**4** **2-4**	Candidates preparing to teach only one subject will instead enroll in 2-4 credits of additional courses related to that subject
January - April		
EDUC 329 Extended Practicum - Secondary	**18**	A developmental program of teaching practice, normally in one B.C. secondary school. Candidates will teach the subjects for which they have been academically and pedagogically prepared. The assignment covers the full school term. Prerequisite: All requirements set for Term 1.
EDUC 420 School Organization in its Social Context	**2**	The organization and administration of schools, including issues in governance, finance, and community and professional control and influence.
May -August		
EPSE 423	**3**	Theories of learning and instruction; principles and practices in the assessment of classroom learning; special attention is given to

Learning, Measurement Teaching		research on motivation, retention, transfer, problem solving, and concept development.
LLED 301 Language Across the Curriculum in Multilingual Classrooms: Secondary	**4**	Understanding the demands of the language diversity of the classroom and of the subject areas within the secondary school curriculum. Analysis of oral and written language from various curriculum areas; implications for learning and instruction.
ONE of the following:		
EDST 425 Educational Anthropology	**3**	Selected concepts from educational anthropology for teachers. Comparative study of school and classroom culture, school teaching, and multicultural education.
EDST 426 History of Education	**3**	An examination of selected topics in the history of European, Canadian and American education and of the relationship between historical development and current educational policy.
EDST 427 Philosophy of Education	**3**	An introductory course in which consideration is given to the philosophical foundations of education and to the practical bearing of theory upon curriculum content and classroom practice in our schools.
EDST 428 Social Foundations of Education	**3**	An application of the social sciences to the study of education.
EDST 429 Educational Sociology	**3**	Selected theories of society and schooling applied to Canadian education.
Elective or prescribed courses	**9**	Related to major or concentrations selected in consultation with an advisor.

Students take most of their courses within their cohort throughout the year. Some of the cohorts are organized around a particular theme such as French Immersion/Core French, Early Literacy, Language Literacy, Fine Arts and Media, Problem Based Learning, Self Regulated Learning, and Community of Inquiry. Cohort practicum placements may also be in particular communities (Vancouver, Delta, Surrey, Richmond, North Vancouver, Langley, Burnaby, Chilliwack, or Coquitlam). The surveys under study were administered to the student teachers in the 12 month elementary and secondary programs.

Terminology

Case Study

Yin (1989) defines case study as an investigation of a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (p. 23).

Technology

Technology is defined as "any systematized practical knowledge, based on experimentation and/or scientific theory, which enhances the capacity of society to produce goods and services, and which is embodied in productive skills, organization, or machinery" (Ely, 1983, p. 2; quoted in Pinar et al., 2002, p. 705). If technology can be defined as human innovation in action, then technologically literate persons should be able to use, manage, and understand technology as justified by the situation (Dyrenfurth, 1991).

Digital Technology

Digital describes electronic technology that generates, transmits or stores, and processes data in terms of two states: 0 and 1 values or positive and non-positive values respectively. Each of these states of digits is referred to as a bit (binary digit), and a string of bits that a computer can address individually as a group is a byte (a unit of data that is eight bits long, a byte is the unit most computers use to represent text, image, sound, etc). Digital technologies include devices such as computers, digital camera, digital camcorder, scanner, television, audio and video player which produce digital products such as image, text, sound and games. Digital technologies include networks as well, which require human interaction to browse, programme and surf for information (Petrina & Feng, 2005).

Digital Literacy

Digital literacy is highly contested in the new media age (Kress, 2003) and indicates the ability to use digital technology, communication tools or networks to locate, evaluate, use, create and critique information. The term digital literacy has become synonymous with the concept of competence of encoding and decoding of a range of semiotics discourses.

Literacy, Critical Literacy vs. Functional Literacy

Literacy has long been recognized as an essential element of an individual's ability to read and write, but there is a current motion for changing definitions of literacy brought about by digital technology. Kress (2003) points out that the way in which lettered representation is being transformed and shaped by digital literacy.

Functional literacy is defined as developing the skills of reading, writing and numeracy. Critical literacy pertains to the analysis and critique of relationships among discourses, language, power, justice, and social practices. It empowers us with ways of questioning literacy by challenging the attitudes, values and beliefs that lie beneath the surface of written words and multimedia products.

ICT Literacy

The ETS defines ICT literacy as follows: ICT literacy is using digital technology, communication tools, and/or networks to access, manage, integrate, evaluate, and create information (ETS, 2004, p. 2). ICT literacy includes general literacy skills, critical thinking skills and problem solving skills (ETS, 2002). The ETS concluded that ICT literacy should include both cognitive skills and the application of technical skills and knowledge. Educators use "ICT" to refer to the convergence between information and communication technologies.

ICT competencies and literacies are used somewhat interchangeably in this study, assuming that both entail functional and critical action, feelings and thoughts.

The BC Ministry of Education (2004) outlined various ways in which ICT content could be delivered from Kindergarten to Grade 12. For example, according to the *Integrated Resource Package* 2003 and 2004 (IRP 2004), recommendations for Information and Communications Technology 11 and 12 include integrating ICT into all subject areas, and separate courses for Applied Digital Communications (ICTC 11 and 12), Digital Media Development (ICTM 11 and 12), Computer Information Systems (ICTS 11 and 12), Computer Programming (ICTP 11 and 12), and a Modular Survey Course (ICTX 11 and 12).

Multiliteracies

Multiliteracies focus on special cognitive, cultural, and social effects of representation rather than language alone since "the days when learning a single set of standards or skills to meet the ends of literacy are gone" (Cope and Kalantzis, 2000, p. 42). Multiliteracies include six design components in the meaning-making process: linguistic meaning, visual meaning, audio meaning, gestural meaning, spatial meaning, and multimodal patterns of meaning "that relate the first five modes of meaning to each other" (p. 42). Multiliteracies refer to two major dimensions of language use. One is the variability of meaning-making in different cultural, social or professional contexts. As English is becoming a global language, these differences are becoming ever more significant to our communication environment. The second dimension involves characteristics of emerging technologies. Meaning is multimodal, or is interwoven with written text and visual, audio, gestural and spatial patterns (Cope and Kalantzis, 2000; New London Group, 1996).

What Brings Me to This Study?

When I first settled down in Canada, my bank card got stuck in an ATM while I was trying to withdraw money. The event made me realize that I couldn't survive without English and ICT skills in this new land. I found ICT to be a new language, and perhaps a new language to most of us who want to flourish in this information era. As I started work on my Master of Arts degree in education at UBC, I found optimal conditions for language acquisition opened through the integration of ICT. I started my Ph.D. in 2002 in Technology Studies, a field traditionally dominated by men, and pushed myself to help others, in particular, women.

My research interest in this study was developed through interacting with ICT in the context of national and international conference participation and in teacher education under the supervision of my supervisors, committee members, and the academic community at UBC. A blending of qualitative and quantitative research approaches to the study enabled a description and interpretation of the data collected from both general teacher education cohorts and technology cohorts. Applying mixed methodologies in research demands that a researcher be capable of implementing both qualitative and quantitative approaches. I prepared myself to meet such challenges by taking courses in both qualitative and quantitative methodologies. I was fortunate to have opportunities to discuss the related issues with some of well-known methodologists in mixed-research methods while attending international conferences. I had opportunities to attend a qualitative research workshop directed by Dr. Norman Denzin and to talk to Dr. Jennifer Green about issues of mixed methods at the First International Congress of Qualitative Inquiry at University of Illinois at Urbana-Champaign, USA. At the Ninth International Literacy and Education Research

Network Conference on Learning in 2002 (organized by the New London Group), I was introduced to the concept of multiliteracies by Cope and Kalantzis. AERA 2004 reintroduced me to Gardner's multiple intelligences. My participation in AERA 2005 and the Technology Conference 2005 in Berkeley opened my eyes to research practices and theories of other teacher educators in the world. These, coupled with my Teaching Assistant (TA) and Graduate Research Assistant (GRA) duties in the UBC Teacher Education Program, led me to the evolution of my research project, which aimed to increase understanding of the practices of ICT literacy in teacher education programs.

Organization of the Dissertation

The organization of the dissertation is as follows. Chapter Two addresses curriculum theory, curriculum integration, technological literacy and multiliteracies, and functional literacy and critical literacy. Chapter Three explores the research methodologies and the rationales of the research design, including data collection, research site, and hypotheses. Chapter Four consists of data analyses and findings from quantitative approaches. Findings from qualitative approaches follow in Chapter Five. Conclusions and implications of this study complete Chapter Six.

The research design focused on an understanding of ICT literacy in teacher education. Multiple dimensions of ICT literacy were investigated with multiple methods to triangulate data and other resources. Hypotheses were tested to answer the three major research questions. An ICT competencies scale was generated and used as a dependent variable to measure gender differences, and pre-program and post-program differences. Correlations between access and ICT competencies, attitudes and ICT competencies, and frequency of

ICT use and ICT competencies were tested. A scale of attitudes toward ICT was used as an independent variable when compared with ICT competencies, and as a dependent variable on which to measure gender differences (See Figure 1 for a map of design).

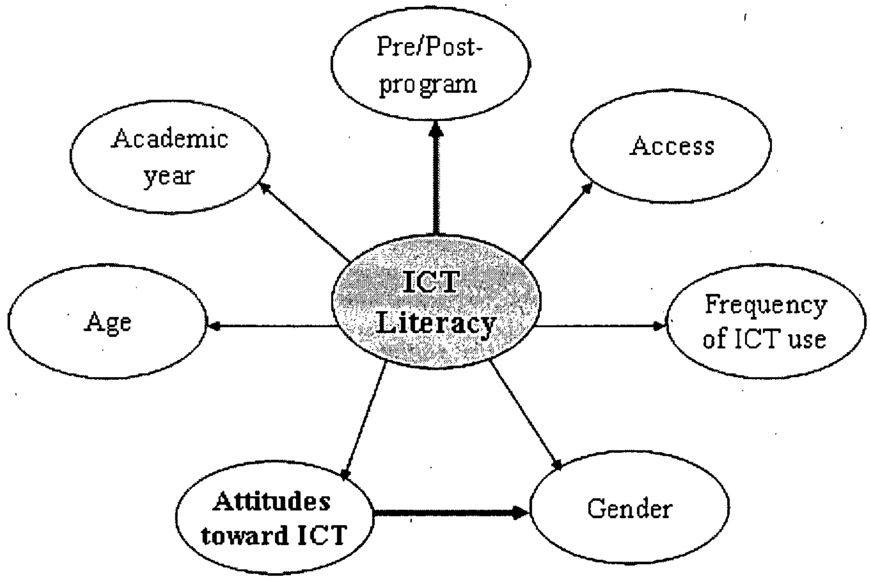


Figure 1. Map of research design

CHAPTER TWO
REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

Introduction

In this chapter, I explore the complex characteristics of ICT literacy in teacher education. Curriculum theory, curriculum integration, ICT literacy and multiliteracies create a theoretical framework for the study and are reviewed and discussed. I address the tension between functional literacy and critical literacy, gender, the digital divide, and related issues that educators and researchers have dealt with. I also explore issues and problems that have not been adequately addressed in the literature.

This chapter focuses on the following questions:

1. What is curriculum integration and why does it matter?
2. How is ICT literacy defined and why does it matter?
3. How is technological knowledge constructed in teacher education?
4. What components of ICT literacy are most important for student teachers?

The organization is as follows: (1) Philosophy of curriculum; (2) Curriculum design; (3) Curriculum integration; (4) ICT literacy; (5) Multiliteracies; (6) Pedagogy, and (7) Conclusions.

While my interest concerns the current **status** of learning and experiences with ICT in the teacher preparation program at UBC, I am also interested in what this status ought to be. The first time I came to Vancouver, I ventured from where I was located. I marked the street map and it was relatively easy to find my way around. Similarly, in order to understand the status of learning and experiences with technologies in teacher preparation programs in BC, it is necessary to begin with how curriculum and how ICT or technological literacy are defined, and why these definitions matter.

Understanding Curriculum Integration

I. What is Curriculum?

Philosophy addresses one's own point of view and the views of others. It deals with values clarification, beliefs and attitudes of researchers and participants, and helps conceive of frameworks for making decisions and acting on those decisions. Philosophy helps us clarify our beliefs and values: the way we observe the world around us, and the way we identify what is important to us. Philosophy also helps educators with foundations for organizing curriculum for schools. It helps them understand simple but important conceptions of goals, what subjects are of value, how students learn and develop their capabilities and knowledge, and what methods and materials are selected for use. Philosophy has played an important role in curriculum and teaching in the past, and will continue to be vital for making important decisions in the future (Ornstein & Hunkins, 1988).

The question "what is curriculum?" informs understandings of curriculum theory and curriculum integration. Curriculum is generally viewed as "an ugly, awkward, academic word" (Jackson, 1992a, p. 4); "mature scholars and beginning students alike have bemoaned the plethora of definitions" (Pinar, Reynolds & Slattery, 2002, p. 25). Jackson (1992a) and Pinar (2003) managed to list five curriculum definitions that spanned about fifty years:

1. A regular course of study or training at a school or university;

2. A specified course of study in a school or college to lead a person to a career; the whole body of courses offered in an educational institution, or by a department thereof by a definition in Webster's *New International Dictionary*, 2nd edition (Mish, Morse, Cilman & Copeland, 1997);
3. All of the experiences school students encounter under the guidance of teachers;
4. All learning opportunities provided by the school;
5. A plan or program for all experiences which the learner has under the guidance of the school (Jackson, 1992a).

Ornstein and Hunkins (1988) complained that it was frustrating and trivial to define curriculum because the curricularists could not agree on what curriculum was; each school had its own formal established curriculum. Their definitions of curriculum were:

1. A plan or a written document that consists of strategies for achieving objectives. This definition was initiated by Tyler (1949) and accepted by today's educators.
2. Experiences of a learner in school and outside of school when it is planned. This definition is rooted in Dewey's experience and education from the 1930s.
3. A system for dealing with people and the processes, or organization for carrying out the system.
4. A field of study including its own principles of knowledge or foundations.
5. Subjects such as mathematics, science, languages, etc.

Jackson (1992) and Ornstein and Hunkins (1988) paid attention to formal school courses along with unplanned, informal, and hidden curriculum, such as hidden and unstudied curriculum, unwritten and untaught curriculum, or the so called "out-of-school" curriculum in which students usually have more interest. For instance, students spend a lot of time with games after school and extra-curricular activities, such as Internet surfing, synchronous and asynchronous online chat with friends, and email communication.

Dictionary definitions of curriculum tend to be too simple and narrow. They are accurate but incomplete. The *Oxford English Reference Dictionary* (Pearsall & Trumble, 2002) defines curriculum as "the subjects that are studied or prescribed for study in a school" (p. 349) and the *Gage Canadian Dictionary* (1983) refers to curriculum as "1) The whole range of studies offered in a school, college, etc. or in a type of school: the university curriculum; 2) A program of studies leading to a particular degree, certificate, etc.: the curriculum of the Law School" (p. 290). The *Merriam-Webster Dictionary* (1997) offers an even simpler definition: "The courses offered by an educational institution" (p. 193). Educators have acknowledged that curriculum consists of more than just courses offered by institutions, or curricular activities designed for students to achieve specific objectives. Both Jackson (1992) and Ornstein and Hunkins (1988) included two significant common connotations: *experience* and *plan*, which are rooted in Ralph Tyler's *Eight Year Study* and John Dewey's *Experience and Education.*

Tyler (1949) concisely described his philosophy of curriculum in simple terms in his influential book, *Basic Principles of Curriculum and Instruction*. Tyler's philosophy is similar to current, popular points of view in many ways. He regarded education as "an active process" and outlined four basic principles in the development of curriculum:

1. Determining appropriate learning objectives;
2. Establishing useful learning experiences;
3. Organizing learning experiences to achieve a maximum effect;

4. Evaluating the curriculum and reform those aspects that did not prove to be effective.

This simplifies the curriculum process and has been a target of critique by numerous scholars (e.g., Pinar et al., 2002; Petrina, 2004).

II. Curriculum Theory

Curriculum theory has as many connotations as curriculum has definitions (e.g., McNeil, 1996; Pratt, 1994; Sowell, 1996). McNeil (1996) explained: “Curriculum theory is divided among traditionalists, scientists, and reconceptualists. A lack of common ground of professional action and responsibility is a course of concern” (p. 421). Sowell (1996) defines the conceptions of curriculum as follows: “Subject matter is emphasized in the cumulative tradition of organized knowledge; society and culture, in social relevance-reconstruction; and learners, in self-actualization” (p. 40). Generally accepted by educators, Eisner and Vallance (1974) suggest that curriculum theoretically forms around five philosophical dimensions: academic rationalism, cognitive processes, ICT, self-actualization, and social reconstruction. For better or worse, curriculum designs tend to be conceptually rooted in one or a combination of these dimensions (Hill, 1994; Petrina, 2004) (Figure 2).

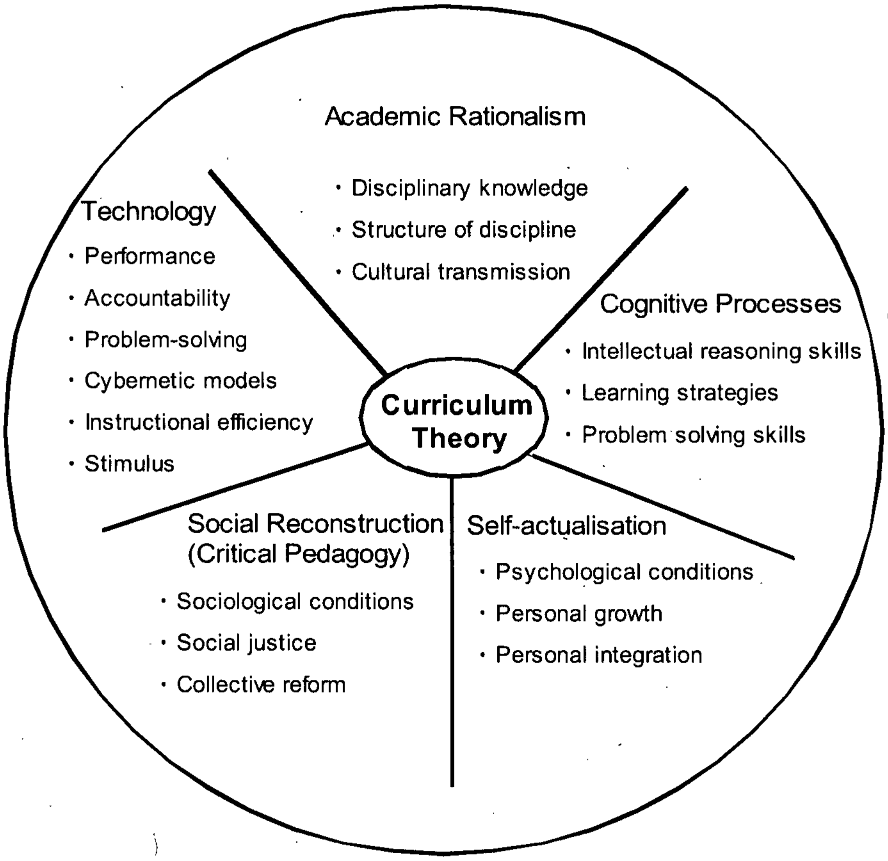


Figure 2. Curriculum theory (Eisner & Vallance, 1974)

I created this diagram (Figure 2) of curriculum theory based on interpretations of Eisner and Vallance. Academic rationalism is mainly concerned with disciplines, the forms of thought, and structures of disciplines, and cultural transmission in which students are educated to acquire intelligence and knowledge. Cognitive processes seek to develop cognitive skills that are applicable to a wide range of intellectual problems. Cognitive processes suggest that the greatest strength of schooling is in the development of intellectual abilities and cognitive skills, such as different learning styles and problem solving skills. Perspectives of self-actualization perceive education as an "integrative, synthesizing force, as a total experience responsible to the individual's needs for growth and personal integrity" (Eisner & Vallance, 1974, p. 10). Schooling is seen as a rich experience that helps the individual student's personal growth, self-discovery and self-satisfaction through social construction. The social reconstruction approach questions what is taught in school. Social reconstruction emphasizes the role of education and curriculum content within the social discourses. Social reconstructionists believe that learning is a social practice and that students should be cultivated to build a sense of responsibilities for the society. Educational ICT is understood as the development of a set of systematic techniques, and accompanying practical knowledge, for designing, testing, and operating schools as educational systems. Technology often plays a role as "educational engineering" (Gagne, 1974, p. 51) for the purpose of solving practical problems and is concerned about accountability, cybernetic models, stimulus, and systems analysis (Eisner & Vallance, 1974). Petrina (2004) argued that it is necessary to identify what knowledge is most important, and what technologies are selected, employed or purchased:

> Curriculum designs are negotiations in the politics of knowledge, identity and representation, and differ accordingly. They lend form to, and chart provisions for, the processes of learning and teaching and become concrete and operational at various stages of educational practice. The very nature of student experiences are shaped by the way we choose to design, or not design, curriculum. In other words, different curriculum designs provide varied qualities and powers of experiences and knowledge (p. 2).

Goodlad and Su (1992) summarized the traditional elements of curriculum design, including scope, continuity, sequence, and integration of curriculum.

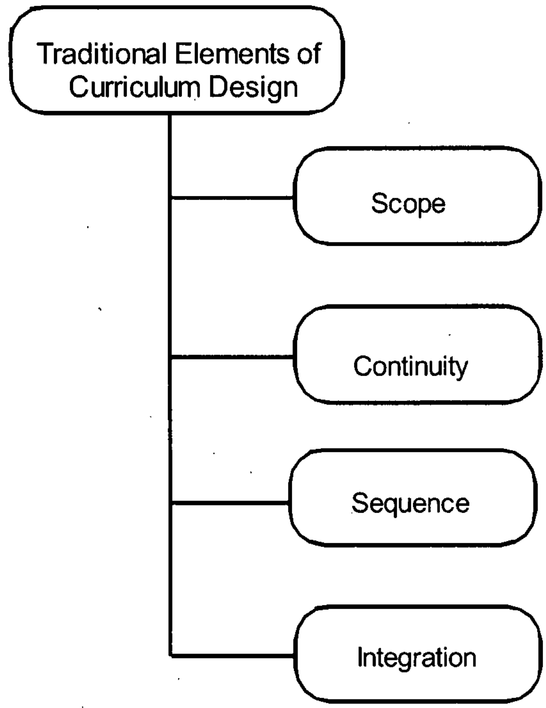


Figure 3. Traditional elements of curriculum design (Goodlad & Su, 1992)

Figure 3 was adapted from Goodlad and Su. As the figure indicates, scope refers to the horizontal range of the curriculum while continuity and sequence are the vertical development of the curriculum. In horizontal integration, integration is arranged across the disciplines. For example, interdisciplinary studies, cross-disciplines and complementary disciplines involve horizontal integration. In vertical integration, integration is arranged within the discipline. Teachers make links among the knowledge, skills, attitudes, and processes of one year with those of the previous and the next. Therefore, students are encouraged to integrate new understanding with their previous learning experiences. Sequence refers not only to the repetition of a skill (i.e. continuity), but also to depth, so each success lays foundation for a further one. Integration functions to interweave curricular principles of concepts, skills, and values and each of these reinforce the others (Goodlad & Su, 1992; Pinar et al., 2002). Pinar et al. Explained: "The location of ultimate integration" in the above curriculum design "is the individual student, a fact that led one wing of the field to study autobiography and biography to portray the individual's integration of curriculum experience" (p. 697).

This is an incomplete account of the minimal requirements of curriculum integration (Case, 1991, p. 221). Case argued that the jurisdictional levels of integration should be taken into account: state/provincial level, district or school level, and classroom level. For instance, state/provincial level integration deals with curriculum and program development; district and school levels concern the organizations of scheduling, course delivery, and teacher deployment and cooperation; at the classroom level, individual teachers are responsible for making lesson plans, carrying out units of study, and engaging students in activities. A curriculum often involves one act or one decision that proceeds to others. Some scholars argued that a curriculum in the schools should reflect a broad range of aesthetic and intellectual achievements (Hirst, 1974; Pinar et al., 2002). Their argument reflects the integration of curriculum.

III. Curriculum Integration

What is curriculum integration? Beane (1997) defined curriculum integration as "a curriculum design that is concerned with enhancing the possibilities for personal and social integration through the organization of curriculum around significant problems and issues, collaboratively identified by educators and young people, without regard for subject-area boundaries" (pp. x-xi). Curriculum integration is advocated not because it is easier for teachers, less costly, or more "efficient." It is, in many respects more difficult, complex and demanding, but it meets more adequately the diverse needs of students, particularly the needs of the adolescents, in their critical stage of life. Curriculum integration is not a new fashion, and most scholars suggest that John Dewey (1938, 1956) laid modern foundations for integration. Dewey's philosophy of education, known as pragmatism or instrumentalism, focused on learning-by-doing rather than traditional dogmatic teaching and rote learning. Dewey's philosophy had a profound influence on worldwide education. Dewey stressed that learning should focus on social problems and that education should help students understand and solve social problems. Learning should involve important experiences to prepare students for solving problems in society. In the 1930s, educators began practicing curriculum integration by directing students to solve problems in problem-centred classroom settings (Petrina, 2004). The practices of curriculum integration were generally curtailed due to World War II, and after decades of neglect, just like other educational conceptions that fade in and out, enthusiasm for curriculum integration appears to be returning. We are now in the midst of a new cycle in which it is urgent for educators to remove barriers to curriculum integration and promote greater integration than ever before. However, this worldwide zeal for curriculum integration is coupled with a considerable variety of opinions on what curriculum integration means and what kind of curricular organization it indicates (Jacobs, 1989; Coombs, 1991).

Educators and researchers (Gardner, 1993; Cope & Kalantzis, 2000; Yin, 1994) argued that putting things together cannot be counted as integrating them. An analogy of marbles and sculpture by Coombs (1991) provides a good explanation:

> Whereas fusing marbles together into a piece of sculpture integrates them, putting them together in a box does not. This suggests that when two or more things are integrated they are not simply a congeries of parts in some sort of conjunction. They form a new unity having a character that is different from the collection of parts (p. 2).

To recognize this value, educators need to perceive curriculum integration in such a way that a curriculum can be regarded as being integrated under the conditions of 1): The construct of integration has a feature different from the sum of its parts; 2): The new form of integration is represented to students as integral parts of the unified whole. For instance, physics is normally taught in the logic of integration between physics and mathematics. This example makes it possible to propose a hypothesis about the characteristics of integration: Any subject X can be taught in the logic of integration between subject X and subject Y. However, this hypothesis is only suggested by one example. It is not valid to make any generalization from only one example. It is possible to argue that the example is unique because mathematics is a unique domain. When mathematics is one of the domains to integrate, its form is unique. Based on this objection, we cannot make generalizations about integration. But we can argue that integration of two domains or among several domains always yields uniqueness because each domain is unique (Gibbons, 1979). For example, the integration of biology and chemistry is different from the integration of mathematics and physics. A corollary is that it is safe to argue that *integration between ICT and other subjects will provide unique learning experiences for students because ICT is a unique domain.*

Nesin and Lounsbury (1999) argued that the power of determining the centre of curriculum integration should be laid on the hands of the teachers' and the students. They are supposed to cooperatively determine a theme of curriculum integration. For instance, within the theme (see Figure 4) "The Future of Vancouver," students may look into the history of Vancouver to make predictions about its future. They may investigate the demographic distribution of population, races, cultures, languages, art, developing *ICT*, economy, business, agriculture, forestry, politics, history, etcetera. Activities involve knowledge from various content areas as students investigate and solve problems. They do not study individual subjects respectively; instead, they engage in activities that involve these subjects and other fields of knowledge (Figure 4).

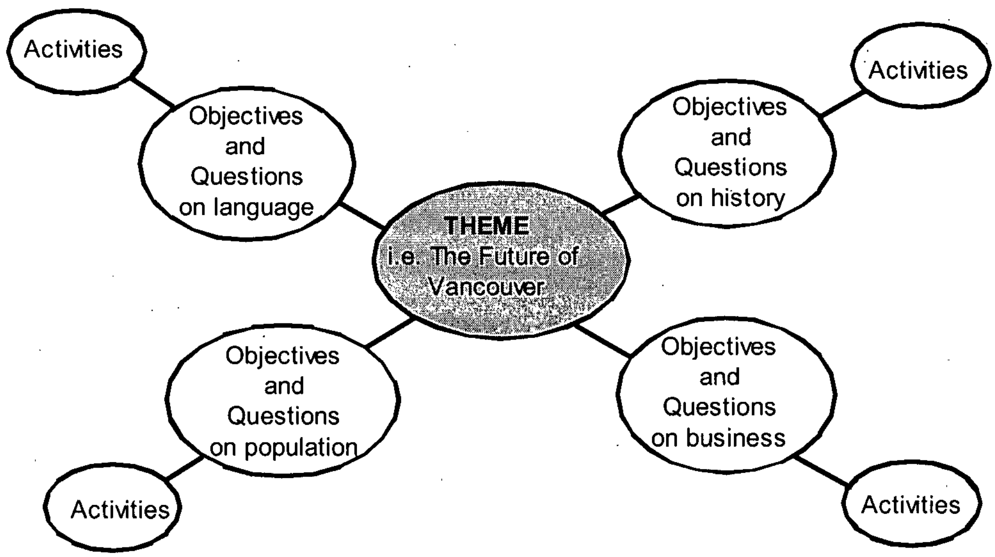


Figure 4. Curriculum integration (Nesin and Lounsury, 1999)

The theme can be substituted with any subject domain, integrating relevant knowledge and engaging students in related activities that increase their inspiration and curiosity. The process of selecting a theme may engage students' personal and social concerns. After the theme is determined, the teachers and students may work together in searching for information to answer the questions identified and they can figure out what activities may produce deeper understandings. For instance, taking the above theme as an example, in order to answer the questions on population knowledge of mathematics is required, and information of social studies is required for the questions of history. Sub-themes such as fishery, forestry, geography, and cultures can be brought in for making more accurate prediction and curriculum integration of chemistry, biology, physics, arts, etcetera and relevant activities should be organized and pursued.

Why should curriculum be integrated? Tyler noticed that "the effectiveness of curriculum organization in facilitating integration depends on the extent to which it aids the student in perceiving appropriate relationships" (Tyler, 1949, p. 105), thus indicating that curriculum integration is an approach or strategy, nor a goal (Case, 1991). The rationale for curriculum integration, from Dewey's point of view, is to cultivate active learning and increase student achievement in a democratic environment (Nesin and Lounsbury, 1999). Pratt (1994) is concerned that the knowledge students acquired in schools remains fragmented, isolated, and compartmentalized. Court (1991) stated in her report on the BC Tri-University Integration Project: "While there are a number of reasons why we want integration, the core reason is that we are distressed by many students' lack of interest in school, and we think integration may help solve this problem" (p. 1). Educators regarded curriculum integration as an unavoidable educational change (Case, 1991). Nesin and Lounsbury argued: "To maximize student learning and growth it is necessary to break away from the basic subject areas and the accompanying overuse of passive learning. Curriculum integration transcends many of barriers imposed by periods and subjects and engages students actively in meaningful learning activities" (Nesin and Lounsbury, 1999, p. 7). Case

(1991) summarized four reasons for curriculum integration: 1) Many phenomena cannot be fully understood from a single disciplinary perspective. For example, understanding Middle Eastern issues requires knowledge based on world and regional history, religious studies, and economics. The goal of integration for this reason is to enable students to understand the complexity of the phenomena; 2) Many students view subjects separately, so they have no clue how one subject contributes to an understanding another; 3) It is believed, from a fundamentally epistemological perspective, that knowledge is a seamless web and all knowledge is related. Integration empowers students to make connections among any pieces of information; 4) Efficiency is another reason for integration. Case believed that teaching two related aspects of the curriculum concurrently worked at least as well as teaching those aspects separately.

A curriculum organized in the traditional subjects is viewed by students as disconnected and dissociated from their interests and problems. Educators regard this sort of curriculum as a misrepresentation of knowledge and barrier to understanding curriculum. Philosopher Philip Phenix (1964) investigated questions of curriculum and content and found that the discipline-oriented curriculum merely included the use of materials and knowledge possessed by an authority in the disciplined community, but excluded meaningful discourses outside the discipline. Such organization of curriculum was discrete and incomplete. Pinar et al. (2002) argued that "curriculum must be organized in interdisciplinary ways, providing not only depth in the individual disciplines but also integration among them" (p. 170) (see also Petrina, 2004). Phenix (1994) also stressed: "A philosophy of the curriculum requires a mapping of the realms of meaning, one in which the various possibilities of significant experience are charted and the various domains of meaning are distinguished and correlated" (p. 6).

Therefore, curriculum is supposed to include the following: design in terms of themes, issues or problems that cut across traditional subjects; combinations of subjects so they are learned simultaneously; directing students' attention to connect to other subjects learned; and teaching various skills within a course devoted primarily to single components of knowledge. For instance, teaching critical thinking skills or communication skills in an English course (Coombs, 1991; Jacobs, 1989). If we look at one field, such as ICT, we see a remarkable degree of change over the last decade. Each area of the curriculum has the blessing and burden of growth. Curriculum designers are struggling not only with what should be taught but what can be eliminated from the curriculum (Jacobs, 1989).

Phenix (1964) emphasized the significance of integration for learning and derived six patterns from distinctive modes by educators and philosophers. The range covers six zones in general: 1) Symbolic learning of ordinary language, mathematics, and intuitive symbolic forms including gestures and rituals; 2) Empirical learning such as science and cultures; 3) Aesthetic learning experiences including music, visual arts, dance, and literature; 4) Personal knowledge (Polanyi, 1962); 5) Ethics pertaining to decision making; 6) Integrative learning of history, science, religion, and philosophy, etc.

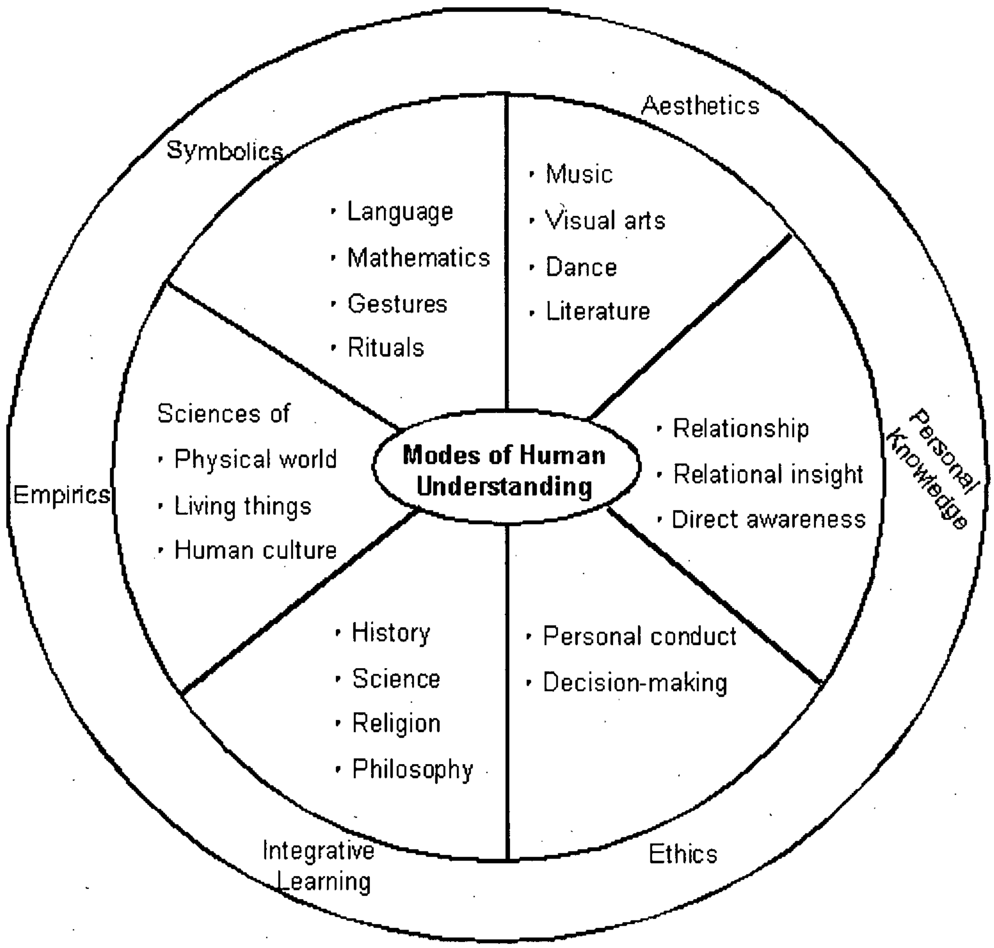


Figure 5. Patterns of integrative learning (Phenix, 1964)

Educators generally insist on the need for developing a balanced curriculum and acknowledge that curriculum is an "aesthetic and technological product" instead of adopting the "ugly" image (Tanner, 1971; Pinar et al., 2002). The "ugly" duck may yet become an elegant beautiful swan, decorated with velvet, balanced with strong wings to explore higher and broader in the sky. Educators put much effort to reconstructing the process of teaching-learning. They commonly suggest the traditional learning process of memorizing and reciting should be replaced in favour of understanding. However, some educators warn that integration of curriculum is not always a good idea. Just creating an activity to combine two subjects for the sake of integration, or ill-organized integration that asks students to do things that are meaningless, difficult, undoable, or do not have much educational value. Brophy and Alleman (1991) proposed two criteria for integration: "1) Activities should be educationally significant even if they did not include the integration feature; 2) Activities should foster, rather disrupt or destroy, accomplishment of major goals in each subject area" (p. 66). How do we implement curriculum integration to contribute to educational goals? What role does ICT play in integration?

ICTs in Teacher Education

As mentioned in Chapter 1, for better or worse, UBC's teacher education program does not require students to enrol in an ICT course. The program takes an integration of ICT across the curriculum approach to education. Educators generally recognize that the integration of ICT approach to curriculum requires a change in pedagogy (Brunner & Tally, 1999; Coombs, 1991; Court, 1991; Cooper and Hirtle, 1999; David, 1991; Wetzel et al., 2004). Formal teacher education programs in North America typically range from one to four years in duration and are offered as post-graduate certification programs, post-graduate degree programs, or full-degree programs. ICT are integrated in such programs in a number of ways: some institutions require students to enrol in ICT courses; some provide various opportunities for integrating across the curriculum while others offer a combination of the two. Wetzel, Wilhelm and Williams (2004) concluded that both ICT courses and integration models are effective if articulated and coordinated with each other. However, the value of ICT is limited if agreement—"a tool" or "if they are regarded as tools" that are interjected on an as-needed basis to aid with pedagogical tasks. The conception that "Technology is just a tool" fails to recognize that ICT constitutes and is constituted by particular contexts in which it is employed. The conception that "Technology is just a tool" also fails to acknowledge the changes ICT introduces into educational settings. Constructivist theories of learning, as addressed in a later section, regard ICT as an agent of change in both what is learned and how it is learned. There has been extensive research into collaborative and cooperative learning with ICT in which groups of students solve problems or complete learning tasks (Bruner and Bennet, 1997; Moseley and Higgins, 1999; Becker, 2000a; Mumtaz, 2000).

ICT radically change the ways in which information and knowledge are constructed (i.e., Bolter, 2001; Brunner, 1992; Logan, 1995). For example, Logan (1995) argued the computer is "not just a new medium of communication; rather, it is a radically new way to process and organize information and as such it represents a new form of languages" (p. 6). Brunner & Tally (1999) claimed that ICT is an expressive and creative medium and learning environment. Since teachers are expected to play an essential role in determining the use of learning technologies within their classrooms (Albion, 2001), it is essential that they are not only comfortable using ICT in their classroom but also able to engage with issues around, and dispositions toward, ICT in classrooms. McFarlane (1999) claimed that the role of the teacher is crucial to his or her success with ICT in teaching. Among many factors teachers face that influence their take-up of ICT, teacher factors far outweigh the institutional or school factors (Cuban, 2001; Veen, 1993). Although computers have been widely available in educational settings for well over two decades, the concern remains that teachers (in-service and pre-service) are neither confident nor competent users of digital technologies. Studies by Kerry

(2000) and Wetzel, Wilhelm and Williams (2004), for example, indicated that many practicing teachers thought they were unprepared to use ICT in their classrooms. Similarly, Watson (1997) found that many student teachers have low self-efficacy with learning ICT. These studies suggest that teacher education programs often fail to provide a structure through which teacher candidates can gain confidence and competence with ICT, and that this inadequacy limits the potential for meaningful use of ICT within educational settings (Watson, 1997).

Dwyer et al. (1991) reported that their longitudinal research program identified an instructional evolution through which teachers made progress during the process of five years of ICT learning. This research program aimed at supporting teachers to learn to teach in a technology-rich context. The teachers were provided with software and hardware training, planning and sharing time, and peer observations. When the teachers entered the program, they grappled with technical problems and their attitudes and skills remained in this phase unchanged for a while until they moved to second phase, where they started using ICT in their classrooms. The teachers' attitudes changed and increased their self-confidence until they grasped some ICT skills. Finally, teachers developed new instructional patterns and ways of communicating with students and other teachers using technologies. Based on the literature, which suggests that student teachers' competencies or ICT literacies are good indicators of whether they successfully incorporate ICT in their teaching, the Faculty of Education designed a study to assess students' self-efficacy with ICT.

Technological Literacy and Multiliteracies

Emerging technologies bring new meaning and multi-dimensions to literacy. Technology makes curriculum integration possible in two dimensions: technology links one subject with another; technology is integrated into subjects. It is difficult to think of literacy without considering ICT literacy. Traditionally, the term "literacy" centred on knowledge of written language. Fundamentally, the dominant form of literacy is reading and writing— the *Oxford English Reference Dictionary* defines "literacy" as simply "the ability to read and write" (Pearsall & Trumble, 2002, p. 837). Canada's Adult Literacy Information Network (2003) notes that the term literacy "not only involves competence in reading and writing, but goes beyond this to include the critical and effective use of these in people's lives, and the use of language (oral and written) for all purposes" (www.nald.ca, 2003). This definition stresses critical thinking about what one reads and expands the term to include oral forms of literacy.

Educational theorist E.D. Hirsch (1987) defines literate people as those who share a body of knowledge that enables them to communicate with each other and make sense of the world around them. Hirsch argues that the goal of schooling should promote cultural literacy, no matter how elitist, to make people competent regardless of race, class or ethnicity in order to improve the quality of their lives. Yet Hirsch's notion of cultural literacy and oral communication is problematic when considering what literacy means for individuals with communication needs and significant cognitive impairments. Beukelman and Mirnenda (1998) caution that educators may not consider literacy as an educational end for certain individuals or those with cognitive limitations:

> If educators believe that reading does not begin until individuals have certain prerequisite skills, and if educators think of literacy as an "all or none" ability, they will not consider the potential for varying degrees of literacy learning by individuals with cognitive impairments. In truth, individuals with cognitive impairments can and should engage in the same emergent literacy activities as their peers without disabilities. We cannot overemphasize the importance of intensive exposure to literacy material in the early years (p. 361).

Indeed, literacy is a complex discourse involving the understanding and use of dominant symbol systems – alphabets, numbers, gesture, visual icons or audio means – for personal and community development. The nature of these components, and the demand for them, vary from one context to another. In an ICT society, literacy extends beyond the functional skills of reading, writing, speaking and listening to include multiliteracies such as visual, media and ICT literacy. These new forms of literacy focus on an individual's capacity and limitations to use and make critical judgments on information they encounter on daily base settings.

Kress (2003) argues that our current linguistic theories of literacy do not take into adequate account the multimodality of communication in the new media age: "a linguistic theory cannot provide a full account of what literacy does or is; language alone cannot give us access to the meaning of the multimodally constituted message" (p. 35). Kress explains how the emphases on writing and reading and other representational forms have evolved logically with multiliteracies (computers, CD-ROM, email, online discussions, cell phones, etc.). Multiliteracies are not meant to take the place of written text. Instead, Kress values written text as an opportunity to broaden how we view all texts ("in which the texts of high culture could be brought into conjunction with the banal texts of the everyday") and as a stimulus for rethinking how we educate for literacy: "Literacy and communication curricula rethought in this fashion offer an education in which creativity in different domains and at different levels of representation is well understood, in which both creativity and difference are seen as normal and as productive" (pp. 120-21).

In the early twenty-first century, literacy takes on a technological component. The word "technology" is derived from the Greek word *techne,* which means art, craft, or skill. Both Plato and Aristotle regarded *techne* as the systematic use of knowledge for intelligent human practice. Technology is not restricted to hardware. The development and application of hardware has been secondary to the broader dimensions and implications of technology. One contemporary educator defined technology as "any systematized practical knowledge, based on experimentation and/or scientific theory, which enhances the capacity of society to produce goods and services, and which is embodied in productive skills, organization, or machinery" (Ely, 1983, p. 2; quoted in Pinar et al., 2002, p. 705). Similarly, Wonacott (2001) and Dugger (2001) defined technology as follows: Technology includes all the modifications humans had made in the natural environment for their own purposes-inventions, innovations, and changes aimed to meet our wants and needs, to live longer and more productive lives. Such a broad definition of technology includes a spectrum of artefacts, ranging from the age-old (flint tools, wheels, levers) to the high-tech (computers, multimedia, biotechnologies). In short, if humans create it, it's technology. In this study, I refer to new technologies that educators use to enhance teaching and learning, such as digital technologies, media, ICT, etc. The ubiquity of technologies in everyday life, and the very rapid expansion of access, implies that it is not possible to think of teaching by ignoring social, cultural, and economic activity. Emerging technology introduces to teaching and learning a tremendous challenge.

It is understood that "advocacy for the goal of technological literacy originated from philosophically diverse quarters" (Lewis and Gagel, 1992, p.117), such as the scientific community, business, industry, and politicians. The concept of technological literacy does not have a stable meaning (Petrina, 2000). In early 1990s, technological literacy was interpreted broadly with a curriculum that included nuclear war, power generation, transportation, waste disposal, productivity, and social inequity. It was viewed as a complement of scientific literacy. The technologically literate person was supposed to understand the full range of considerations of people who produced new technology or controlled its use. Others argued that the curriculum should include "computer applications, industry processes, information system, logic, etc." (Lewis and Gagel, 1992. p. 117). Lewis and Gagel noted that "the study of technology is fundamental to the teaching of technological literacy" (p. 136) and suggested that the schools should carry out two responsibilities to achieve the goal of technological literacy: 1) articulate the disciplinary structure of technology; 2) provide for its authentic expression in the curriculum.

One useful way to think about ICT and technological literacy is to consider one of the characteristics of ICT as a component of dynamic change and its impact on education. Literacy is changing because the world is changing. Even within the field of technological literacy there are significant changes between the 1980s and the 21st century. In the 1980s, computer literacy dealt with programming, spreadsheets and databases, and mostly word processing. In the United States, the student-to-computer ratio was 38 to 1. Computer literacy was concentrated in labs and restricted to a very small percentage of population. Only one or two teachers— the very few computer teachers— had a chance to use ICT with students (Cuban, 2001). Only the computer literacy teachers had privileges to receive state training in the United States. While some of the educators talked about integrating ICT throughout the curriculum, it was merely to focus on computer literacy. Two unintended consequences of the requirement to integrate ICT throughout the curriculum in the 1980s militated against the success of integration: restrictions of the hardware and the technological training that the teachers received. It is difficult to integrate ICT without the ICT or the training (Fletcher, 2004).

Current technological literacy is quite different. The major difference is that today's technological literacy is about using ICT to learn as well as learning about ICT (Hirsch, 2001; Petrina, 2000; 2003). If ISTE's *NETS* (*National Educational Technology Standards for Students*) is used as a base, students will learn technological knowledge and skills by applying them. In grades pre-K to 2, students are expected to use digital resources such as digital cameras and create simple multimedia products with some help. In grades 3-5, they are expected to do more with multimedia, including using digital cameras and video to publish, write and communicate. Students are widely engaged in digital curriculum and activities. Technological literacy includes new digital curriculum in schools, such as animation, presentation, web page design, IMovie, CD, DVD, music MIDI, and other digital products of multimedia.

From an educationally philosophical point of view, Gardner's (1993) Theory of Multiple Intelligences has implications for teachers to apply ICT and to cater individual learning needs and different learning styles. Gardner used biographies to illustrate that each person has a range of intelligences. He argued that everyone is born with seven intelligences but develop different sets of capabilities, which means that each person has a unique set of intellectual strengths and weaknesses. Garner defined seven intelligences in 1993 (Figure 6) and later in 1999 added two more intelligences: naturalist intelligence, and spiritual intelligence or existential intelligence. He argued that all intelligences are equally important and they rarely operate independently. Educators recognize that the integration of a wide range of intelligences reflects multiple ways of knowing and successful integration of ICT into curriculum responds to students' distinct learning styles (Gabler and Schroeder, 2003; Petrina, 2003). Technologies, particularly multimedia, blend diverse types of media to facilitate different learning styles.

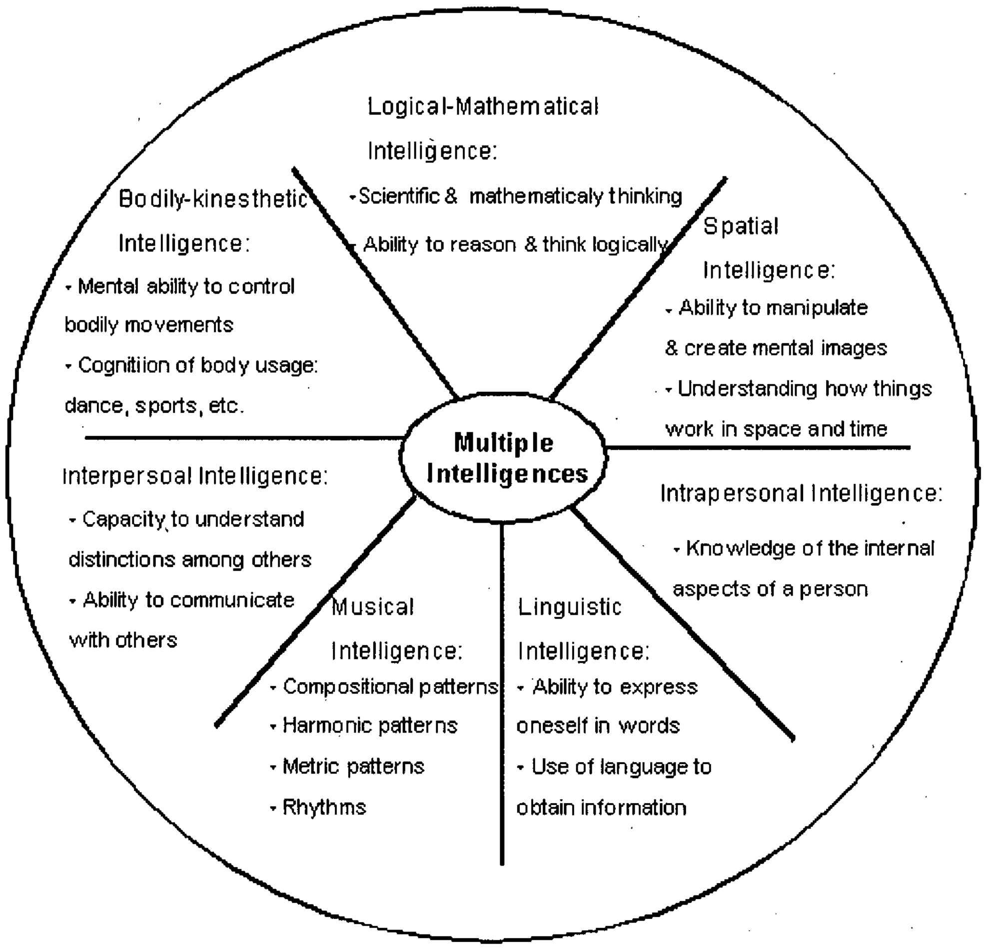


Figure 6. Multiple intelligences

I created Figure 6 based on my interpretations of Gardner's multiple intelligences and observed that the Theory of Multiple Intelligences had implications for classroom teaching with technologies. In line with Gardner's theory, the New London Group (1996) coined "multiliteracies" to include linguistic design, audio design, spatial design, visual design, and gestural design, providing a solution to problems that traditional educational systems overlooked.

"Multiliteracies" are designed to overcome limitations of traditional approaches. The New London Group[1] (1996) argues that the multiple linguistic and cultural diversities in our society are the core pragmatics of the working, learning, and private lives of students, and that the use of multiliteracies will empower students toward success. Multiliteracies focus on special cognitive, cultural, and social effects of representation rather than language alone since "the days when learning a single set of standards or skills to meet the ends of literacy are gone" (Cope and Kalantzis, 2000, p. 42).

Components of linguistic meanings include spoken and/or written language in the forms of monologue or dialogue or the interlocution of multi-participants; visual meaning deals with still or moving images, two or three dimensional representations plus interactive media. Spatial meaning consists of architecture buildings such as a classroom or lecture hall, but also with new technologies, which allow education to reach students beyond traditional geographic boundaries. Hyperspace provides unlimited space for communication and learning. Gesture can be represented in the form of icons and images by digital technologies. Gesture meaning includes patterns of gesture response and interaction, gesture as instruction

[1] In 1994 ten people met for a week in the small town of New London, in New Hampshire to consider the teaching of literacy, or rather the teaching of "Multiliteracies," a word which is intended to encapsulate the multiplicity of communications channels, the significant modes of "Meaning-Making" and the realities of increasing local diversity and global connectedness (Cope & Kalantzis, 2000).

and understanding, and gesture as expression of personality and feeling. Technologies play a very important role in representations of natural sounds and music. The uses of CD, DVD, MIDI, IMovie, and the Internet greatly develop audio design. For example, the use of a digital camcorder can monitor the appropriate learning behaviour in a demonstration of micro-teaching. The ICT allows pre-service teachers a platform for developing appropriate classroom teaching behaviours on video and it can provide a visual record from which to assess each pre-service teacher's gestures, eye contact, and pace. In this way, digital camcorders are considered helpful tools for reflection on learning and teaching behaviours. Multimodal patterns of meaning connect the above five modes and integrate them through multimedia. Two decades ago, the emphasis in computer literacy was on learning hardware and software applications. By contrast, students nowadays often use ICT to engage their minds with more creative multiliteracy learning activities.

Currently, information is presented and shared in a multimedia format although print is still in academic and non-academic spaces, such as in business, transportation, etc. Narratives, intercultural value differences, second language communication strategies, complex problems and their solutions can be shown through digital photos, video clips, music files, and graphics as well as text. Furthermore, using multimedia and creating multimedia products provide students opportunities to think in different ways and to link ideas in ways they normally would overlook with written texts (Fletcher, 2004). Multiliteracies describe the elements of design, not as rules, but as stimuli that represent a variety of different forms of meaning-making in relation to cultures, subcultures, and the aspects of an individual’s identity that these forms manifest. Each act of meaning making is a product of the design to yield new meaning as the redesigned meaning (The New London Group, 1996). The function of multimodal patterns can be described as below (Figure 7):

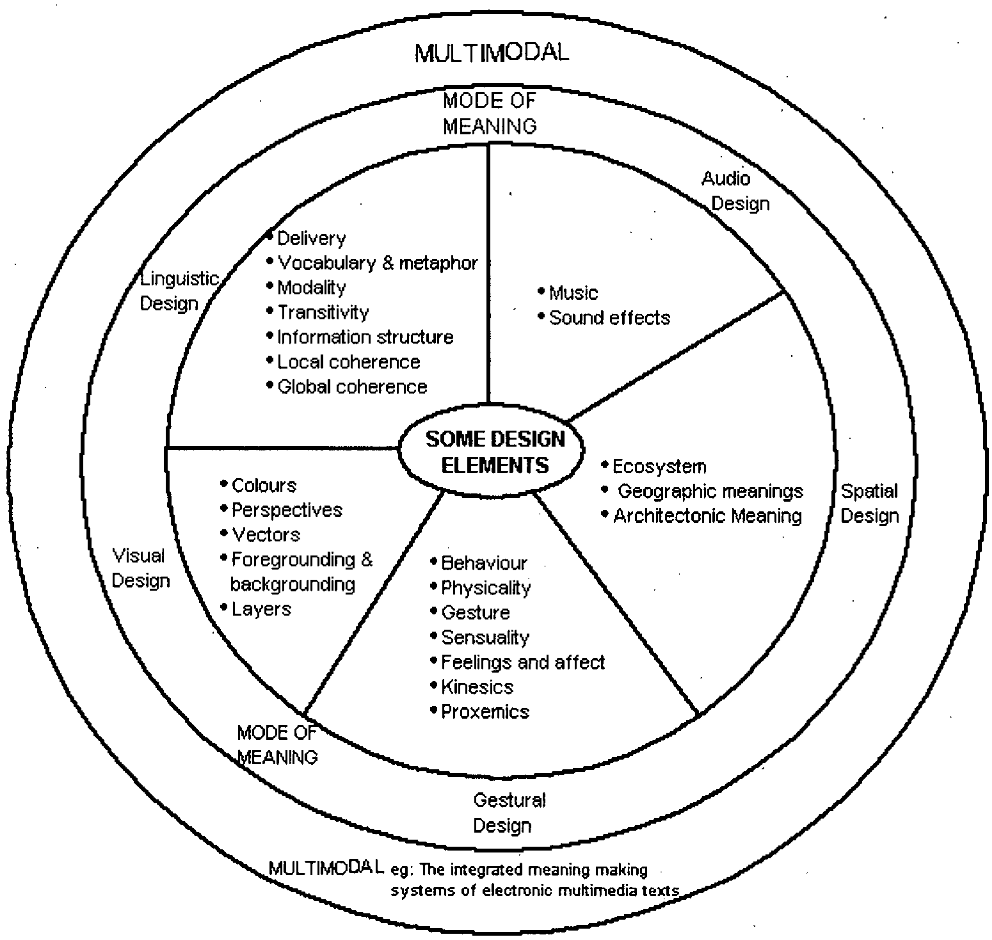


Figure 7. Map of multiliteracies (Cope & Kalantzis, 2000)

While multimodalities are consistent with Phenix's six patterns of interdisciplinary learning, the New London Group's multimodal meaning-making is more concrete and each pattern of the multimodal consists of elements which can be interwoven into others. For example, "kinesics" is the study of communication by means of gestures, facial expressions, etc., especially as they accompany speech. Cope and Kalantzis (2000) generalized four different definitions that multimodal patterns possess according to their attributes, contents, usage and inner logic in different dimensions:

Definition 1: Information medium: Multimedia are forms of technical instruments, a description of the characteristics of the focal machines themselves. Multimedia are employed channels of information transition and knowledge acquisition according to attributes.

Definition 2: Multimedia allow different forms of information to be stored and managed, in which the convergence of media is based on a common, digital medium of recording and representation. Convergence now means that the same machine—the computer installed with multimedia software—is capable of many things, from music to text, from visual to audio, from still images to moving pictures. Convergence also means that even those machines still used in one form of representation are increasingly developing the qualities of the multimedia computer.

Definition 3: Multimedia are defined in terms of their function to present forms and content holistically. In a practical sense, the development of multimedia has led to the integration of many formerly mysterious and separate forms merging into all-inclusive multimedia. Curriculum is presented to students as an aesthetic and technological product to assist them to accomplish the objectives of the subjects. This attribute of integration contributes to educational value.

Definition 4: Multimedia are defined in terms of inner logic, narrative structure, and the preference of the viewer, reader, or user. In this definition, two characteristic features of multimedia are regarded as important components: interactivity and the logic of hybridity

(Cope and Kalantzis, 2000). The term hybridity highlights the human's creativity through hybridity. People interact with each other, and with machines, within and between different modes of meaning, integrating modes across conventional boundaries.

Each of these definitions represents one dimension of the new multimedia. The multimodal is the most important of the modes of meaning-making, because it links all the other modes in a logic way that multimedia images relate to the linguistic to the visual and to the audio designs. In order to enhance literacy and learning with ICT, technological literacy is critical. Without ICT literacy, it is impossible to integrate ICT into curriculum studies. For instance, PowerPoint is popular presentation software. It helps teachers organize presentations clearly and professionally. It is easy to manipulate and add multimedia elements. However, without understanding basic applications, one can never learn the ropes of integrating this simple and convenient tool to create and modify a classroom presentation. Without knowing how to use web-based search engines, we can barely obtain what we are looking for and determine what content is appropriate.

The Rationale: Why It Matters?

Educators and teachers are seen as the designers of the learning process. However, research reveals the view that today's students are different from past generations and these differences provide both a challenge and an opportunity for the schools and teachers. About 31% of 100 million children and youth under 24 years old in the United States are minorities and each of these children may have different needs and particular learning styles. Canadian schools have a similar pattern: in particular in Vancouver, where about 65% of the school age students represent racial "minorities."

One theory is that today's students are "digital natives," born after 1982 and living in a world that is highly interactive and collaborative (Prensky, 2001; Himes, 2004). For this generation, ICT is not a tool, but an environment for communication, building relationships and community, researching, and learning. How can teachers today integrate *ICT* in a way that enhances learning, literacy, and outcomes in other subjects for the 21st century "digital natives"? Changes produce new ways of teaching and learning with words, new literacy, and new pedagogies. For example, new digital technologies and peripherals are rapidly proliferating. According to the Ipsos-Reid (2004) report, digital technologies have emerged into the mainstream of Canadian households. The 2003 Camera/Camcorder Digital Imaging survey reported that 20% of U.S. households owned digital cameras by the end of 2002, compared to 14% in 2001, at the increasing rate of 33% annually. Parallel growth was seen in peripherals and devices such as photo printers, ink cartridges, colour laser jet printers, CD/DVD burners and Web-cameras. The survey confirmed that the growth across Canada was following a similar pattern. Keeping track of new innovations in order to address the changing society is vital for literacy pedagogy in schools is a crucial. Finding our way around this changing world requires a new, multimodal literacy. How can educators recognize and respond to this change? Although a national movement with respect to ICT in teacher education in Canada has not been formally in place, the Canadian Association of Deans of Education recently began deliberations to establish the current state and possible future direction of ICT in teacher education nationwide (LaGrange and Foulkes, 2004; Canadian Association of Deans of Education, 2004). Teacher educators and researchers were called upon to prepare teachers to integrate ICT into curriculum.

Pedagogy: Technological Literacy

After curriculum has been designed and embodied in material form, what is "the curriculum?" One answer is that it is the experience of teaching and learning (Pinar et al., 2002, p. 744). The New London Group (1996) stated: "Any successful theory of pedagogy must be based on views about how the human mind works in society and classrooms, as well as about the nature of teaching and learning" (p. 18). The goal of curriculum is achieved through teaching and learning practices (Doyle, 1992; Pinar et al., 2002). Pedagogy or teaching is defined as the "how" of the schooling. In previous sections, the importance of learning experiences was stressed but pedagogical practices were not adequately addressed. Pedagogy consists of motivation, communication, feedback, and accessibility. Curriculum generally refers to what is to be taught while pedagogy pertains to how to teach. Pedagogy deals with the system of teaching and learning that links subject areas (disciplinary and interdisciplinary) with the supplementary support of ICT.

Goddard (2004) suggested that one of the challenges to ICT literacy in Canadian schools is to adjust pedagogical methods to the new technology as emerging technologies permeate our daily life. While no current theory in education has the "right answers" to technological pedagogy and no theories have defined what domains must always be integrated, educators suggest that considering ICT use in teacher education programs, as well as other professional courses, provides a useful starting point for elucidating those features of ICT and teaching practices that are specific to the setting and those that may have some relation to various contexts of technological literacy (The New London Group, 1996; Mitchell, 2001).

There are basically three major interdependent dimensions to technological literacy (see Figure 8):

- Knowledge
- Ways of thinking and acting
- Capabilities

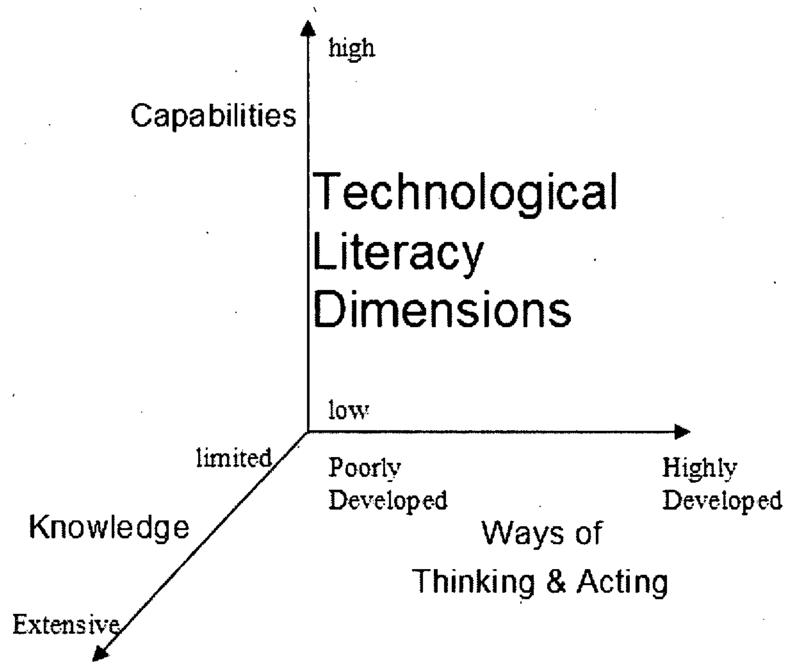


Figure 8. Dimensions of technological literacy (National Academy of Engineering, 2002)

A technologically literate person understands various components of ICT and is able to use ICT effectively in her or his work and studies or daily life. He or she is aware of technological issues and is able to make decisions and take action accordingly. These three dimensions of technology can be viewed as follows:

Knowledge— a technologically literate person may:

- Identify the ubiquity of technology in daily life and is willing to take advantage of its benefits and weigh its risks;
- Be aware of the ways technology affects humans; humans may or may not have control of technology;
- Be aware that ICT reflects values, such as equitable access or distribution creating haves and have-nots in culture and society;
- Realize that the use of ICT demands risks and may have unintended benefits or consequences.

Ways of thinking and acting— a technologically literate person may:

- Think of questions regarding the risks, benefits, and potentials of technologies;
- Seek information about new technologies and look for opportunities to adopt ICT applications;
- Engage in decision making in the use of ICT and development and take action in implementation. The ways of thinking about ICT include reflection on learning experiences, elucidation of background knowledge, critique of concepts and theories; the ways of acting with ICT consist of collaborative learning and communication between instructors and students, and among peers;
- Get involved in research. Through a variety of databases, surveys and web-based engine searches, they can quantify and qualify competency in accordance with standards and existing project goals and use the research findings to guide long-term institutional or local changes.

Capabilities— a technologically literate person may:

- Have a wide range of hands-on skills for ICT applications;
- Be able to solve basic technological problems at home, at work, and at school;
- Be able to transfer skills of one software application to another similar program;
- Be able to employ basic statistical concepts pertaining to probability and estimation to make appropriate evaluations of risks and benefits.

Each of the three-dimensions in the framework is connected with the others. Technological capability is simply the potential for efficient, practical, quality work in design (Petrina, 2000. p. 181). It is not likely that a person has technological capability but lacks a basic knowledge of the dimensions of ICT, or that a person who is aware of technological issues and thinks critically about the issues does not have some capabilities with ICT. These dimensions can be developed along a continuous growth of learning process from low to high, poorly developed to highly developed, or limited to extensive. Every individual has a unique combination of these dimensions that will dynamically change over time with training and practice.

When teacher candidates enter the program, each is at a different level of ICT knowledge and skills; their ways of thinking and acting are different their capabilities vary, and their learning styles and life experiences are different. It is challenging for teacher education programs to facilitate the teacher candidates' capabilities towards a shift from low to high and construct their knowledge to meet standards within, in some cases, one year. The teacher candidates' learning experiences greatly influence their future students' learning experiences: what they have learned and how they have learned it are powerful influences on what they are going to teach and how they are going to teach it.

Functional Literacy and Critical Literacy

According to the views of thousands of people consulted between fall 2001 and spring 2002 by the Ministry of Education, including parents, students, and teachers across British Columbia, the education system is not adequately preparing students for life beyond Grade 12. This is the tension between functional and critical literacy. Furthermore, there seems to be a tension between the instrumental use of ICT and the study of ICT, which further complicates the issue of functional and critical literacy of ICT.

In this contested milieu, critical literacy as one approach to pedagogy should be examined. The practice of organizing curriculum— activities, objectives, interests of students and teachers, technologies, values and the like— into a pedagogical form involves a series of political judgments (Petrina, 2004). Petrina (2000) proposed: "Where cultural text is the artificial representation of the world, and critical literacy an orientation toward transforming cultural practice, there are possibilities for a critical technological literacy figuring heavily in pedagogical practice" (p. 199).

Functional literacy is defined as developing the skills of reading, writing and numeracy. We are able to improve the quality of our life and society with these skills. But becoming literate, or developing a critical consciousness, is not a simple matter of learning how to read, speak, write and understand traditional words. Language is an important approach to representing cultures, but it is not limited to reading, speaking, and writing. Critical literacy does not confine its examination to "words-on-the-page" (Petrina, 2000). Critical literacy pertains to the analysis and critique of relationships among discourses, language, power, justice, and social practices. It empowers us with ways of questioning literacy by challenging the attitudes, values and beliefs that lie beneath the surface of written words and multimedia products. Through critical literacy, learners can obtain necessary personal experiences and theoretical foundations to constructively critique literacy, creatively expand and employ literacy, and gradually reconstruct their own literacy. This is also called transformative knowledge (Cope & Kalantzis, 2000; Petrina, 2000). Critical literacy and the transformation of knowledge require more than just "digital technology." It calls on critical pedagogy for a critical selection of and engagement with a variety of technologies to solve practical problems (Hill, 1998).

Experiential learning was theorized by Dewey and has also been associated with Vygotskian constructivist *activity theory*, in which a more-experienced person pulls the less-experienced forward. Similarly, Dewey theorized that curriculum begins with student experiences, which eventually had to be organized into reflective knowledge of the kind teachers possessed. As the starting point of a reflective process, Dewey asked: "What is the place and meaning of subject-matter and of organization within experience? How does subject-matter function? Is there anything inherent in experience which tends towards progressive organization of its contents?" (Dewey, 1938, p. 19).

Constructivism and Activity Theory

How can pre-service teacher education function in an active environment which demands problem solving skills and critical thinking? Constructivist pedagogy offers one of the answers to this dilemma. Constructivism is a critical way of building knowledge about self, school, daily life experience, and society practices through reflection and meaning making (Wonacott, 2001). Activity theory in general, and the "zone of proximal development" (ZPD) specifically, initiated by Vygotsky (1934, 1978), conclude that such zones exist when a less-skillful individual or student interacts with a more-advanced person or teacher, or is stimulated by an instrument, allowing the student to fulfill the task not possible when acting on her or his own. Activity theory suggests collaboration, social practice, and critical pedagogy. Russell (1995) defines activity theory in this way: "Activity theory analyzes human behavior and consciousness in terms of *activity systems*: goal-directed, historically situated, cooperative human interactions, such as a child's attempt to reach an out-of-reach toy, a job interview, a 'date,' a social club, a classroom, a discipline, a profession, an institution, a political movement, and so on. The activity system is the basic unit of analysis for both cultural and individual psychological and social processes. Activity systems are historically developed, mediated by tools, dialectically structured, analyzed as the relationship of participants and tools, and changed through *zones of proximal development*" (pp. 54-55).

Learning takes place within ZPD, an optimal challenge level that is neither too difficult nor too easy and meaningful to the learner. The "zone of proximal development" is a range in which a student can perform a task with help, means the development of languages, cognition, social practice, and knowledge (see Figure 9).

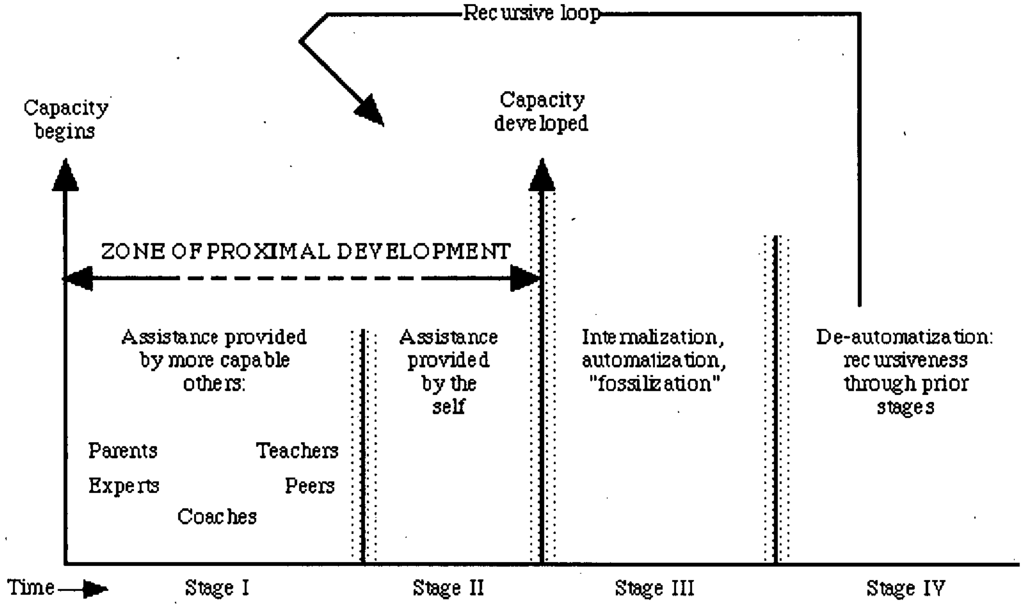


Figure 9. Four-stage model of ZPD (Tharp & Gallimore, 1988)

Vygotsky believed that learning is a dynamic process of social practice. Such development lies in two levels: internal and external levels. A person can make learning happen at certain internal level, but he/she will do it better with external assistance. External assistance includes the discursive environment such as tools being used and people providing support. New technologies provide external stimuli for a student to interact with others. Some research has shown evidence of the use of ICT as a catalyst empowered classroom teachers to play a role in shifting toward more constructivist pedagogy. Windschitl and Sahl (2002) documented their two-year study to examine how middle school teachers learned to use ICT in a computer program and then empowered them to integrate technologies into classroom teaching. This was mediated by their interrelated beliefs about learners in their school, about the concept of "good teaching" in the discourse of the institutional culture, and about the role of ICT in students' lives. The study indicated that ICT itself did not motivate teachers' movement toward constructivist instruction; rather, the previous dissatisfaction with teacher-centered practices made the teachers take action to transform the classroom activities through collaborative student work and project-based learning with ICT. Web-based projects for social construction involve enhancing literacy in its broadest sense, expanding sources of information, improving communication with others and developing critical thinking. Web-based projects provide a way to promote an effective model for cognition on the basis of communications and discussions in an authentic online environment (Guo, 2005).

Gender differences and ICT

Gender is a particular concern given that a large majority of pre-service teachers are females. Researchers (Clarke & Chambers, 1989; Fish, Cross & Sanders, 1986; Lockheed 1985; Singh, 1995; Ware & Stuck, 1985; Watson, 1997) observe that young children believe that ICT is the domain of males. Betz and Hackett (1981, 1983) reported that college male students held similar efficacy beliefs for traditional male occupations whereas female students had high efficacy beliefs for positions traditionally held by women but low self-efficacy for positions traditionally held by men. Research consistently showed that boys were more likely to be engaged in extracurricular activities with computers, to use a computer at home and play computer games. It also indicated that the stereotypical male images of computing magazines (Ware & Stuck, 1985) acted as deterrents for female involvement in technologies.

Some researchers argue that initial concerns over a digital divide along gender lines and equity initiatives to promote ICT use among women and other so-called disenfranchised groups were premature (Compaine, 2001, Fogg, 2005). Measures of access such as Internet use tend to overlook the nature and extent of barriers and conditions for particular learners. Hence, qualitative analyses of *how* disenfranchised individuals use ICT complement quantitative analyses of *who* use ICT. A Canadian examination of ICT use in school settings, for example, revealed that although "white males and females report relatively similar levels of use, males tend to use computers in more diverse ways, such as programming, using graphics and spreadsheet programs and desktop publishing" (Looker & Thiessen, 2003). Similarly, Bryson et al. (2003) found that enrolments of males and females in secondary school courses requiring sophisticated use of computers, such as programming— uses of computers that are more likely to lead to careers and positions of leadership in computer technology— is severely skewed, with males comprising between 79% and 90% of the student population in senior-level *ICT* courses. These numbers are nearly identical to enrolment patterns observed in such courses in the late 1980's. Gender and ICT interact in complex ways but in the aggregate females are much less likely to participate in ICT courses, careers and leadership (Withers, 2000). Fenwick (2004) showed that gender inequity persists both in access to and experience of learning opportunities with ICT. To be sure, any analysis of who controls Internet publishing (that is, who is in the business of maintaining servers, publishing web materials, designing interfaces, and so on) would reveal that a significant gender gap remains. As has been the case with the rise of most communication technologies, from print through television, males are the primary adopters and tend to control the content and format of information diffused through various media irrespective of how audiences change through time (Faulkner, 2001; Graff, 1995; Liff & Shepherd, 2004).

In approaching the question of gender differences and ICT in teacher education, then, the following premises were accepted: 1) there remains a digital divide along gender lines; 2) that divide is socially constructed (i.e., not biological); 3) as future educators, pre-service teachers are ideally situated to assist in the matter of contradicting gender-biased perceptions of ICT. Clearly women are not the only group that may face barriers to ICT.

Age and ICT Literacy: Digital Natives and Digital Immigrants

In addition to gender differences in ICT, the generation digital divide is another issue associated with ICT literacy. Previous research provided limited findings regarding the relationship between age and ICT literacy. There is an assumption that young people have more advanced ICT competences than that of elders. One of the objectives of this study was to investigate the age demographic distributions of pre-service teachers in the teacher education programs and their ICT literacy and skills. Another objective was aimed to explore the trend of ICT literacy through age divisions.

As mentioned earlier, according to Prensky (2001, 2001a, 2001b), students born in the 1980s are called the "e-generation" or "digital natives" because they speak a digital language and spend a great deal of time with computers, cell phones, MP3 players, video games and the Internet. Those who were born before the 1980s are called "digital immigrants". This metaphor of native speakers and immigrants illustrates the generation gap between young students and elders, including the teachers of young students. There are concerns about issues of ICT literacy due to this digital phenomenon. Is ICT literacy necessary to digital natives (it is believed that digital skills are inherent among digital natives)? If so, who will teach the digital natives? Is it a challenge for digital immigrants to teach digital natives and is there a need to change the ways traditional teachers teach? Digital immigrants are struggling to learn a second language — a new digital language— to educate digital natives. Prensky (2001a, 2001b), however, claimed that no matter how hard the digital immigrants try, they are not able to close the Immigrants/Natives divide because the digital natives' brain structures may differ from previous generations.

Prensky (2001a) described in detail: "Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, emails, the Internet, cell phones and instant messages are integral parts of their lives" (p. 1). Digital natives prefer parallel processing and multi tasking and regard games as "serious" work. Compared to young people, those who are older and were not born in the digital world reveal their immigrant status through a "Digital Immigrant accent" that becomes obvious in a number of ways—printing out an attachment document to edit it rather than editing it online, making a phone call to check if "you have got my email", for example (Prensky, 2001a). Editing online vs. in print simply allows one to view the document from a different perspective and thus to see errors not seen before. Yong people, in my experience as an English teacher, don't do much "serious" editing—online or off. This has not changed with the so-called digital native generation.

However, critical educators and parents (US Today, 2005) are concerned that "digital native is a misleading and deceptive title that encourages overconfidence. There are many things these kids accept and expect because of the ICT that has surrounded them since birth. In that way I see the point of the name. I just worry too many people are assuming these kids have skills that they clearly lack."

Similarly, Karsten and Roth (1998) reported, "Surprisingly, however, exposure to computer information systems at the high school or community college level was found to have little significant impact on student computer literacy" (p. 15). In general, some preliminary research (Brock et al, 1992; Karsten & Roth, 1998) found that the digital natives failed to demonstrate levels of computer literacy that were equivalent to students who had completed a course in computer literacy. Additional research is necessary to characterize the relationship between computer experience and ICT literacy. Research on differences in ICT literacy between digital natives and digital immigrants may provide a better understanding of this characteristic.

Moreover, VanSlyke (2003) argued that the human brain does not physically change, as Prensky claimed, based on stimulation it receives from the outside— that exposure to digital technologies doesn't change brain structures and that it doesn't guarantee higher level of ICT literacy. What matters is that educators who are so-called "digital immigrants" try to understand the emerging cultures brought up by digital natives, to narrow the digital generation gap and to change their way of teaching to meet the learning needs of new generations. Since ICT is a foreign language, as Prensky agreed, the author of this study argues that ICT can be acquired in a similar fashion to the way foreign languages are acquired. Prensky's statement that digital immigrants' endeavours in ICT literacy are in vain may discourage people, who are older than 25 years old, from trying to acquire ICT literacy. Further, learning is a social practice (Vygotsky, 1934, 1978; Cope & Kalantzis, 2000), as is ICT literacy.

For example, I myself must be a "digital immigrant." But I became comfortable with digital technologies and built my expertise in ICT literacy through my dedication and different ways of learning. I had never seen a digital camcorder until a few years ago. But I was determined to have a good command of this emerging technology and practiced it in many ways. I carried a digital camcorder and filmed the events I participated in and created CDs/DVDs: Conference presentations, graduation ceremonies, trips of sightseeing to Stanley Park, Grouse Mountain, Victoria, etc. I then taught digital natives how to use digital technologies. With the same strategies, I acquired ICT literacy and worked as a Webmaster for a few big organizations. I was asked to address both the digital natives and immigrants in the organizations about how to maintain a website. According to my observations and experiences, digital natives and digital immigrants were learning equally well but in different ways. I also have observed that many people in their 50's and 60's have no problem editing online. Prensky's statement on digital immigrants may prove to be an arbitrary generalization or provisional hypothesis.

Attitudes toward ICT

Given that there is an established correlation between attitudes and behaviour (Ajzen, 1988; Shrigley, 1990), it follows that student teachers' attitudes toward technologies may influence their behaviours and activities to study and use of ICT. Collins (1991) reported that self-efficacy beliefs were better predictors of career interests than their substantial abilities in communication and other quantitative skills. Consistent with this theory, Bandura (1986) found that higher self-efficacy beliefs were open to more diverse consideration of career options and higher levels of interest in careers (p. 432). When pre-service teachers enter teacher education program with different levels of experiences and abilities with ICT, teacher educators should be aware of incoming attitudes and needs. Some might feel ICT was completely foreign while others might have a wide range of experiences using computers and other emerging technologies and that the prior experiences were the predictors of student attitudes. Researchers (Koohang, 1987, 1989; Loyd & Gressard, 1986; Hunt & Bohlin, 1993; Pepper, 1999) found the that the significance to teacher educators was that those students who believed ICT literacy was vital for living in today's society held positive attitudes toward ICT; however, many did not perceive that they needed a good command of ICT for their future profession and they generally had negative attitudes toward ICT.

Based on findings that experience with ICT affects teacher attitudes, researchers sought the factors that might influence students' attitudes. Savenye (1993) found that participation in the course of ICT literacy improved the student attitudes toward computers and their use. Pre-service teachers reduced the level of anxiety and had more confidence, and therefore they valued ICT more as compared to the beginning of the course.

Similarly, many researchers found that attitudes and learning behaviours were correlated. For example, findings from Watson's (1997) research showed that many student teachers had negative attitudes towards ICT. Student teachers with different levels of ICT had different attitudes: the novice students appeared to have been the most negative while the more experienced were the most positive toward the learning potential provided by technologies. Moseley and Higgins (1999) found that teachers who successfully made use of ICT in classroom teaching had positive rather negative attitudes toward ICT. Kellenberger's research (1996) revealed that pre-service teachers developed positive attitudes toward ICT after training with technologies in their teacher preparation program. The factors that affected pre-service teachers' self-concept of their competency with ICT included hands-on experience with ICT and constructivist approaches in course work with technologies.

However, research revealed gender differences in students' attitudes toward academic performances. Stables and Stables (1995) noted although female students performed better than males, female students lacked confidence in science. This phenomenon may exist in ICT literacy. Makrakis (1993) observed that females as a group in general were as able as males in learning about computers but that they experienced more personal difficulties. A female would feel that everyone else seemed to know a lot more about computers than herself and it took longer for her to become confident in ICT while a male was more likely to enjoy the fun and pleasure of using computers. Generally, measures of attitudes toward ICT are psychologically-based and overlook the social construction of these attitudes (Herek, 2000). Ability, gender, race, and social status play important roles in how students and teachers perceive and relate to ICT. This is not to indicate that a homogenous consensus or divergence of attitudes forms around one's age, ethnicity, gender, and so on. Rather, a complex range of social factors constitute attitudes toward ICT. Research on the digital divide suggests that attitudes toward ICT are primarily mediated by social factors such as gender and socioeconomic status (Brosnan, 1998a; Bryson et al., 2003; Crombie & Armstrong, 1999; Fenwick, 2004).

Although digital technologies have become increasingly available for a decade and some teacher educators have expected their students to arrive at university with basic competencies in learning technologies, research has consistently shown that this has not been the case for many students nor has this been the students' perception of their own competence in learning ICT over the last decade (Kellenberger, 1996; Watson, 1997; Wetzel, Wilhelm & Williams, 2004). Well prepared teacher candidates are one of the keys to K-12 student use of ICT in the classroom. However, only one-third of the graduating student teachers in the United States perceived themselves as prepared to teach ICT applications. This finding was based on a survey of 89% of all pre-service teacher education programs that provided some form of ICT education in the United States. Two-thirds of all in-service teachers felt that they were not at all prepared to use ICT in classroom teaching (Kerry, 2000; Wetzel, et al., 2004). Findings from Watson's (1997) research showed that many student teachers had low self-efficacy with learning ICT and negative attitudes towards ICT. Similarly, student teachers with different levels of ICT had different self-efficacy: the novice students appeared to have been the most negative while the more experienced were the most positive toward the potential provided by technologies. Lack of self-efficacy is expressed as perceived inability to satisfy course requirements with ICT. As Mumtaz (2000) pointed out:

> The implications of the studies are that teachers' theories about teaching are central in influencing teachers to use ICT in their teaching. Even if teachers are provided with up-to-date *ICT* and supportive networks, they may not be enthusiastic enough to use it in the classroom. Teachers need to be given the evidence that ICT can make their lessons more interesting, easier, more fun for their pupils, more enjoyable and more motivating. (p. 338)

Further discussions on the issue of attitudes towards ICT and ICT literacy can be found in Chapter Four through statistical procedures and in Chapter Five through qualitative approaches.

Conclusion

I would like to tie the "what" and the "how" of technological literacy back to the foreground of curriculum theory with which I began this chapter. This paper presented a philosophy of curriculum, which develops around five orientations: academic rationalism, cognitive approach, self-actualizations, social reconstructionism, and curriculum technology. Curriculum design plays an important role in carrying out an institution's mission and determining the significance of experiences and activities the institution should emphasize. Curriculum integration is assumed to be, when organized appropriately for enhancing teaching and learning, an approach to inspire student enthusiasm in learning and a component to solve practical problems in society. Based on the argument that integration between two domains or among several domains is possible to produce unique outcomes, I propose that ICT, one of the domains in curriculum theory, integrated into other domains or other subjects will provide unique learning experiences and enhance learning outcomes. For example, language learners might have unique learning experiences to improve their writing skills and communication skills by online communication and discussions; pre-service teachers might have unique learning experiences to observe their teaching behaviors and to improve their teaching strategies by integrating a technology, such as video recordings and the activities of watching and reflecting their video recordings, into practice teaching.

However, curriculum integration in general, and ICT integration specifically, requires the study of ICT (i.e. ICT literacy, and multiliteracies).

> Educators are urged to grapple with the implications of an 'explosion in knowledge, coupled with powerful new communication and information processing technologies' and, thereby, to promote widespread 'technological literacy'. Arguments that enthusiastically promote the widespread implementation of educational computing typically predict that these technologies will (a) facilitate and transform teaching processes, and (b) promote significant positive gains, both academic and vocational, for students (Castell, Bryson & Jenson, 2001. p. 114).

Curriculum integration with the use of ICT involves enhancing student learning in academic settings. ICT empowers students to learn in ways not otherwise possible. Effective integration of ICT is achieved when decision makers, educators, and students are able to select technologies to help them develop their technological competencies, analyze and synthesize the information they obtain with ICT, and present it professionally. ICT should become an integral part of how pedagogy functions. Technological pedagogy, specifically critical pedagogy, and critical literacy that is associated with constructivism, are inviting further investigation of their educational values. As Willis et al. (1996) point out, more case studies are necessary to assess innovations in the use of ICT that have been carried out for years.

Although the process of learning to integrate ICT into educational settings takes time and this learning is not unprecedented, teachers have adopted new technologies that have changed the way they illustrate ideas and interest students (Ropp, 1997). Ropp demonstrated in her dissertation research that learning to use ICT in educational settings creates a unique situation and experiences for learners:

> As with all environments, networked computers have particular affordances and constraints. Currently, most computer interfaces assume interactions with a single individual who controls the mouse, keyboard and menu selections or commands. Learning to work with such individualistic interfaces typically requires hands-on experiences and most learners would work alone for the majority of these experiences over the course of three-year program. This kind of environment assumes that a learner who knows how to be self-directed and independent will be more successful that one who is dependent on structured guidance. Independent learning settings do, however, offer the learner more choices and control over the process and pace of learning. (p. 11)

Sandholtz el al. (1997) reported that the teachers changed various components of the teaching unit, such as standards, tasks, interactions, situations, and assessment by implementing new technology in classrooms. The teachers wanted students to become proficient with ICT and to learn to access information from a variety of sources, including CD-ROMs and websites. Students completed many unique tasks— from doing research to producing final products using computers, videos, and learning software. The integration of ICT into curriculum also prompted the teachers to use a more constructivist approach to teaching, which met the different learning styles and interests.

CHAPTER THREE
RESEARCH METHODOLOGY

Introduction

In this chapter I address methodological issues of qualitative and quantitative methods and then elaborate on the methods used in my research. There exists a tension between qualitative and quantitative approaches. Quantitative critics often question the validity of qualitative research and vice versa. I argue that qualitative and quantitative methods are compatible within a research project, and describe my effort of blending qualitative and quantitative approaches in this research. Mixed methods were helpful in collecting and interpreting data, and in revealing characteristics of the ICT curriculum in the teacher education program at the University of British Columbia. These methods also helped capture expressions of student teachers in two cohorts within the program.

Dean (2003) claimed that there are few well-designed research studies with sufficient data available for educators to make remarkable policy decisions. The majority of research reviewed by Dean was contradictory due to common methodological flaws. Dean (2003) found few claims in ICT education that were well researched or evidenced; most were marked by misinterpretations of data or the lack of a rigorous research design. How can I ensure that my research is valid, reliable and trustworthy? How can I design a research study that yields convincing answers to the research questions? Good research design assists a researcher to obtain usable findings and a well-organized research design tends to bring a valid research to successful closure.

Research Design

In an attempt to investigate and understand **the status of the ICT curriculum in use and effective use of ICT** in teacher education at UBC, I blended qualitative and quantitative approaches within case study research. A case study typically focuses on a single case or multiple, comparable cases (Yin, 1994). Yin (1983, 1989, 1994) explains that a case study includes direct or indirect detailed observations and other sources of both qualitative and quantitative evidence to explore a complex social situation. In addition, "Case studies can be based… entirely on quantitative evidence" (Yin, 1989, p. 25). Denzin and Lincoln argue (1994) that no single source has a complete advantage over others; rather, they might be complementary and could be used to blur certain boundaries. Thus a case study should use as many sources as are relevant to the study. The rationale for using multiple sources of data is the triangulation of evidence: triangulation increases the validity of data analysis (Yin, 1983, 1989, 1994; Denzin, 1978; Denzin and Lincoln, 1994).

Similarly, Thomas (2003) defines a case study as an exploration of a case over time through detailed, in-depth data collection involving multiple sources of information rich in context. Thomas explains (2003) the aim of a single case study is not to represent the world, but to represent the case itself. Case study also includes a comparative form of the similarities and differences between two or more cases in a discourse. My case study consisted of a description of the practices pertaining to ICT literacy in teacher education programs. There is a need to research the ICT curriculum in teacher education and teaching practices to try to understand the gaps, if any, between teacher education and teaching. The purpose of this case study is to investigate the status in learning and practices in teacher education programs and to explore theoretical aspects such program effects, gender and the generation digital divide.

The greatest advantage of case study methodology is that it allows me, as a researcher, to display the uniqueness of the particular program I am studying. I believe every person, group, organization or event is significantly unique. Case study research distinguishes itself from other research methodologies in its attention to details. So case study research is a suitable vehicle for illustrating that uniqueness (Thomas, 2003). However, I also was aware of the limitation of case study, as it is risky to draw generalizations from one case. So my concern with my study related to: How might my research be validly presented to a broader audience? Can this risk of limitation be reduced if more than one case is studied to identify similarities and differences between the cases? Or can more confidence be placed in conclusions drawn from perspectives of different research methodologies?

Research Methods

The site for the research is ICT practices in the teacher education program at the University of British Columbia (see Chapter One). As stated earlier, this study applies qualitative and quantitative methods. Quantitative approaches provide measurable factors in a wide range of sampling but reflect only the effects of variables operationalized in the research design. By contrast, qualitative approaches offer rich and in-depth description of multi-dimensional perspectives and values, but do not allow for confident generalization from data. Arguably, a merger of the two approaches complements the features and disadvantages of each other. By definition, each approach is applicable to certain kinds of questions but not to other kinds. Adopting one methodology but rejecting another in a research project may embellish only one side of the argument. For instance, employing qualitative approaches but excluding quantitative methods will provide rich and in-depth analysis but will miss the possibility of generalization. Similarly, applying rigorous quantitative approaches exclusively will offer explanations and predictions of specific aspects of phenomena but may fail to provide an in-depth analysis. In addition, some research projects don't fit precisely into one category or the other, qualitative or quantitative. For multiple perspectives, an ideal solution is to use both qualitative and quantitative data to present both sides of the coin.

Methodologists have gradually become aware of the flaws and shortcoming of mono-method design, and of ways of reducing threats to the validity of research results. For instance, Brewer and Hunter (1989) describe mono-methods as "a diversity of imperfection" and call upon researchers to compensate for particular faults and imperfections by drawing on mixed methods and paradigms.

Denzin and Lincoln (1994) define a paradigm as a basic set of beliefs that guide research directions. A paradigm includes three components: epistemology, ontology, and methodology. Epistemology concerns how we know the world; ontology explores attributes of reality and existence; methodology focuses on how we gain knowledge about the world. I drew a diagram to represent my interpretations of Denzin and Lincoln's classification of the research paradigm, which draws attention to the implications of epistemology and ontology on research methodology (Figure 10):

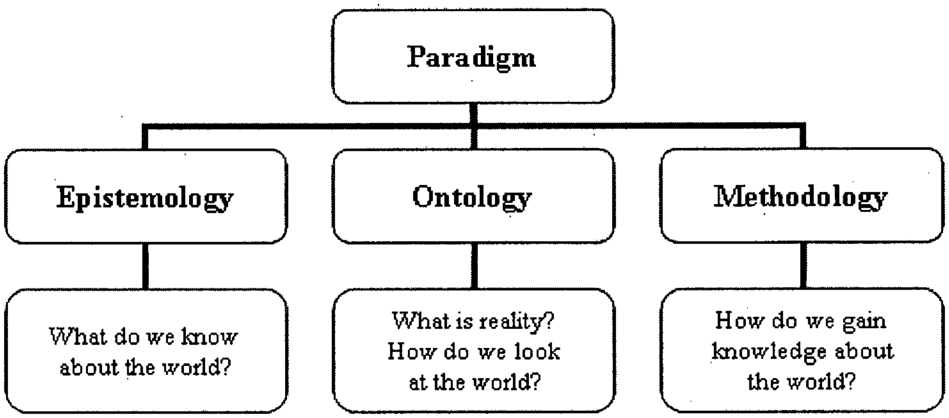
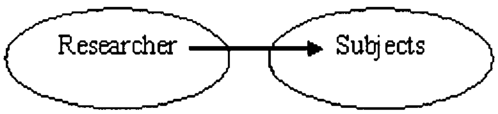
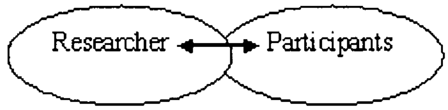


Figure 10. Paradigm components

Considering the implications of paradigmatic conceptions of research methodology under the quantitative research paradigm, researchers determine what is going to be done and carry out the research plan. The subjects of the research do not usually get involved in either making the plan or carrying out the plan. There is not much interaction between the researchers and the researched. By contrast, qualitative research paradigms are characterized by continuous interaction between the researcher and the researched; the researched are not only subjects of the research, but also participants. Qualitative researchers intend to represent, through observations and interviews, the participants' point of view on a particular issue or event. Sipe and Constable (1996) have diagrammed the conceptions of each of the paradigms in a manner that highlights the distinctive features between the paradigms of quantitative research and qualitative research (Table 2).

Table 2. A chart of quantitative and qualitative paradigms (Sipe & Constable, 1996)

Positivist	**Interpretivist**
	
Reality is objective and "found	Reality is subjective and constructed
Discourse is structured and transparent, reflecting reality	Discourse is dialogic and creates reality
What is true? What can we know?	What is heuristic? What can we understand?
Knowing the world	Understanding the world
Communication as transmission	**Communication as negotiation**

Applying Sipe and Constable's diagram, Thomas (2003), and Guba and Lincoln (1994) agree that qualitative approaches are generally supported by the interpretivist paradigm wherein qualitative researchers interpret the world as a reality that is socially constructed, complex and dynamic. By contrast, quantitative methods are generally supported by structural function and scientific paradigms which regard the world as a reality constituted by observable and measurable facts.

Since qualitative and quantitative researchers view the nature of the world differently, they draw on different methods and procedures to examine and measure the participants/subjects under study. While controversy and debate about reality continue between the two research groups, it does not follow that the quantitative researchers never use interviews or the qualitative researchers never use surveys and statistics. Currently, more educators and researchers developed mixed-method research designs that embrace both qualitative and quantitative methods within a single study. Greene

(1994) defines mixed-method designs as those that include at least one quantitative method (designed to collect numbers as data) and one qualitative method (designed to collect words as data).

Campbell and Fiske (1959) propose using multiple methods to study a research problem. Denzin (1978) supports the proposal by using the mathematic term *triangulation* to advocate multi-method designs. The term *triangulation* originates from Geometry, in which two points and their angles are used to determine the unknown distance to a third point. This approach to geometric analysis is analogously applied to study social phenomenon by converging data sources. Triangulation is defined as a designed use of multiple methods "with offsetting or counteracting biases, in investigation of the same phenomenon in order to strengthen the validity of inquiry results" (Greene, Caracelli, & Graham, 1989, pp. 256). For example, I needed information on *ICT* standards established in other Canadian universities that offer teacher education programs and I browsed through the links and sub-links of a website in a certain teacher education institute but could not find the information I needed. However, I found implications for ICT education in teacher education in the file "Students in Today's Schools," listing ICT standards for Grade 6 to Grade 12 students. Reasoning teachers must reach a higher standard than their students, I was able to draw from this information to inform my research question on ICT standards for teachers. Similarly, when the ICT standards for a teacher education program in an institute are not available through web survey, the ICT products and information technology in computer labs or administration standards for teacher education programs, including hardware, software, and networks that address teacher training, can be used as a source of triangulation data.

These examples illustrate how required information can be obtained through triangulation.

Denzin (1978) recommended the following types of triangulation:

- Data triangulation: use a diversity of data sources in a study;
- Investigator triangulation: use several researchers with different methodology orientations in a research project;
- Theory triangulation: use multiple methods of analysis to interpret the research results;
- Methodological triangulation: use multiple methods to study an identified problem.

Campbell (1957) and Denzin (1978) have contributed to the use of multiple methods in research. Researchers nowadays often see qualitative and quantitative approaches as complementary rather than antagonistic (e.g., Thomas, 2003; Tashakkori and Teddlie, 1998) and they don't believe either quantitative or qualitative approaches contribute a superior appraisal. On the contrary, because the differences between the two methods reflect different perspectives from people and reveal a diversity of aspects of the events or actions, a combination of the two approaches often complements the features of each. Thomas believes that both qualitative and quantitative methods can be used effectively in the same research project. He points out that **the rationale** should not be whether one method is superior to another but rather that the significance of the method employed can produce convincing answers to questions in the study under investigation.

As a consequence, in the last decade educational researchers have seen a strong shift in methods and approaches to practice on integrated research designs that blend qualitative and quantitative methods. This shift, known as the mixed methods movement, has been labelled "the third wave of research methodology" (Tashakkori, Teddlie and Greene, 2004). Many researchers agree that qualitative and quantitative approaches have common fundamental values of the research, including "belief in the value-ladenness of inquiry, belief in the theory-ladenness of facts, belief that reality is multiple and constructed, and belief in the fallibility of knowledge" (Tashakkori and Teddlie, 1998, p. 13). Greene, Caracelli and Graham (1989) argue that "all methods have inherent biases and limitations, so use of only one method to assess a given phenomenon will inevitably yield biased and limited results. However, when one or more methods that have offsetting biases are used to assess a given phenomenon, and the results of these methods converge or corroborate one another, then the validity of inquiry findings is enhanced" (p. 256). Through an analysis of 57 mixed-method studies Greene and her colleagues (1989) identify five purposes of these studies:

- Triangulation: seeking for logic results from a blending of methods;
- Complementary: seeking enhancement and correspondence of results from different aspects of a phenomenon;
- Development: Using the first result of the method helps develop the use of the second method;
- Initiation: finding contradictive results from one method with those from another;
- Expansion: Expanding the range and scope of inquiry by converging methods for different inquiry components.

Greene's triangulation theory agrees with Denzin's (1978). Methodological triangulation involves the use of two or more data collection strategies, such as using survey, statistics, and interviews coupled with observations as methods of data collection. Data triangulation refers to the use of a variety of data sampling techniques. A combination of objective and alternative measures as data sources is an effective method of data triangulation. Consistency of results across data sources would suggest that the research findings are reliable. When multiple data analysis and interpretations are in agreement, it lends credibility to findings.

Given the above, a researcher using both mixed methods must be competent in both quantitative and qualitative methods. It is complex to make design choices among diverse types of mixed methods. Quantitative-dominant with less qualitative-dominant mixed method designs are defined as quantitative/qualitative methods, wherein qualitative methods are weighted less equally in a single study, or vice versa. With equal and parallel design, both quantitative and qualitative approaches are used equally to understand and interpret the reality under study (Tashakkori and Teddlie, 1998). In sequential mixed approach, the researcher conducts a quantitative phase and then proceeds with qualitative one, or vice versa (Figure 11).

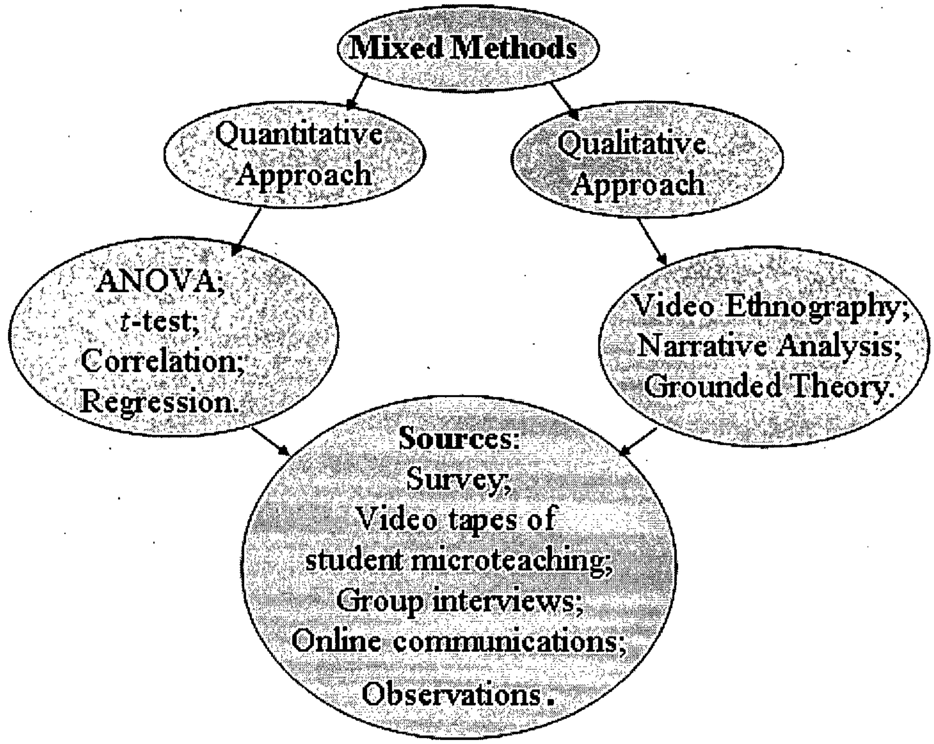


Figure 11. Design of mixed research methods

My research methodology was based on sequential mixed design. Sequential mixed designs allow the researcher to present a thorough analysis of quantitative data sources and then use the results to design a subsequent qualitative phase of the study. I started with a quantitative approach to bring up the main issues and concerns in ICT literacy in teacher education and followed up with in-depth qualitative analyses of interviews, student survey comments, video tapes of student microteaching, online communications, classroom observations and student teachers' work with ICT.

Validity

In general, validity pertains to the nature of a variable being measured by a test or set of operations or instruments (Ghiselli, Campbell and Zedeck, 1981). The American Psychological Association, American Educational Research Association, and National Council on Standards for Educational and Psychological Tests (1974) officially define validity as "the appropriateness of inferences from test scores or other forms of assessment" (p.25). Ghiselli, Campbell and Zedeck (1981) explain that the validity of measurement means different things to different people as the degree of validity of a measure directly ties to the extent to which "it is appropriate for answering specific questions" (p. 266). Validity can be divided into three categories: content validity, criterion-related validity and construct validity.

Ghiselli et al. (1981) refer to content validity as based on professional judgment. Content validity addresses the content of an instrument, in which the instrument is a representative sample of the content of the objectives or specifications it was designed to measure. The experts are often asked to make judgments about the levels of the test items to match the test objectives or specifications. Concurrent validity is a type of criterion-related validity. Concurrent validity stresses the correlation of an instrument validated with some well-recognized outside measures of the same objects or specifications. In concurrent validity, scores on one variable are used to estimate scores on another, both variables measuring the present properties of the individual who takes the tests (Ghiselli, Campbell and Zedeck, 1981). For instance, if we are interested in measuring English proficiency and intend to determine the validity of a new test for matriculation English to be administered in China, the group of testers who developed the test might decide to administer their new test and the TOEFL, regarded as a standardized test, to a large group of students and calculate the degree of correlation between the well recognized test and the new test. As both tests are administered at about the same time, this kind of criterion-related validity is also called concurrent validity. Another type of criterion-related validity is predictive validity. For example: the correlation between the two variables, GRE (Graduate Record Examination) and GPA (grade point average) after two years of graduate study. The correlation between these two variables represents the degree to which the GRE predicts academic achievement as measured by two years of GPA in graduate school.

However, one challenge in ICT literacy measurement, unlike the English language tests, is that so far, there is no consensus on what a standardized ICT test should cover, so in this study, relatively compatible tests were not administered together with the survey instruments to calculate the degree of correlation between the related tests. The ETS Scale of ICT literacy, developed after data were collected for this study, was introduced to address the problem. The survey instruments in this research were developed and rooted in previous research studies and theories that focused on ICT literacy (Gibson and Nocente, 1998; Scheffler and Logan, 1999; ISTE's NETS, 2003).

Self-efficacy is defined as the belief in one's ability to perform successfully a certain task (Moroz and Nash, 1997). Research suggests that self-efficacy has a certain amount of convergent construct validity and divergent construct validity. Convergent validity means that different measures of the same trait should be highly inter-correlated. Divergent validity implies that an instrument must not correlate too closely with similar but distinct concept or traits (Moroz and Nash, 1997). While convergent validity concerns the correlation between measures of the same construct or trait, divergent validity reflects the correlations of two traits measured with the same method. Correlation between two methods designed to measure the same trait, convergent validity, should be substantially higher than the correlation between two traits when they are measured with the same method, divergent validity, because "correlation should be a function of similarity in substantive content, not similarity in measurement method" (Ghiselli, Campbell and Zedeck, 1981, p. 476).

Brown (1996) defines a construct as an attribute, proficiency, ability, skill, or competency that the human brain possesses. For instance, overall English language proficiency is a construct. Namely, construct validity is often seen in experimental demonstration that an instrument is developed to measure the construct it claims to be measuring. Such measuring could take the form of a differential-groups study in which the performances on the same instrument are compared for two groups: one with the construct and another without the construct. If the group with the construct performs significantly better than the other without the construct, the result of the comparison can be said to support the construct validity of the instrument (Brown, 1996). In circumstances when such experimental methods for controlled groups are not conducted, an alternative strategy called intervention study serves well for the trustworthiness of construct validity. In an intervention study, after a group is measured weak in the construct using the instrument, the construct is taught and measured again. If a significant difference is found between the pretest and posttest, the difference lends evidence to the construct validity.

Regardless of how construct validity is defined, there is no single best way to address it. In most cases, construct validity should be demonstrated from a number of perspectives. Whereas the more strategies used to demonstrate the validity of an instrument, the more confidence users have in the construct validity, the evidence provided by those strategies is convincing.

Self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1994). Self-efficacy is a major construct and is commonly used in research and in educational settings for student placement, evaluation of programs and curriculum design. Self-efficacy is a valid predictor for academic performances when students are able to picture themselves succeeding in challenging tasks and making an effort to fulfill the task. When self-efficacy is interpreted through cognitive frameworks (Vygotsky, 1978; Mohan, 1986; Bandura, 1993, 1997; Bandura et al., 2003), cognition can be seen as a process of social interaction. Since ordinary social life is often strewn with difficulties, impediments, adversities, failures, setbacks, frustrations, and inequities, the acquisition of knowledge and competencies usually requires perseverant effort. Therefore, it takes human resilience of self-efficacy to overcome the numerous impediments to significant accomplishments. Positive self-efficacy of capability raises motivation in ways that enable people to get the most out of their talents. Knowledge of one's own cognitive capabilities is also an important facet of metacognition, which is defined as "knowledge and cognition about cognitive phenomena" (Flavell, 1979, p. 906).

Considerable research suggests that self-efficacy plays an influential role in career choice and development (Kuncel et al., 2005; Flavell, 1979; Bandura et al., 2003). Self-efficacy predicts academic grades, the range of career options considered, and persistence and success in chosen fields (Bandura, 1997; Betz & Hackett, 1981, 1983). Researchers have long recognized certain general competencies and learning skills, such as the ability to regulate and monitor one's own learning, learn independently and collaboratively, and solve problems in the learning process (Moroz & Nash, 1997; Guo, 2005; Scott, 2004). Possession of such skills is a prerequisite for both academic success and the continuous acquisition of knowledge over the lifetime learning process. An essential feature of "this model of knowledge acquisition is the operation of these learning skills as both independent (predictor) and dependent (criterion or indicator) variables" (Scott, 2004, p.2).

ICT self-efficacy, therefore, possesses the essential components of self-efficacy as applied to the domain of ICT learning (Ropp, 1997, p. 26). Several studies have investigated the relationship of self-efficacy to learning and academic achievement (Harrison & Rainer, 1992; Moroz & Nash, 1997; Ropp, 1997; Kuncel et al., 2005). Moroz and Nash's (1997) research on 216 graduate education students lent support to previous research (Murphy, Coover and Owen, 1989) that the amount of experience a student had with computers could influence his or her evaluation of computer self-efficacy. It ascertained that Computer Self-efficacy (CSE) was measuring the same construct to a similar degree for high or low computer users (Moroz and Nash, 1997). Moroz and Nash claimed that CSE was suitable for use in research and the construct validity under study of CSE was convincing.

However, there are threats to construct validity (Brown 1996, pp. 188-192): environments of the test administration, administration procedures, inappropriate attitudes of examiners, scoring procedures and test construction or quality of test items, inadequate numbers of test items, poor item writing, lack of pilot testing, lack of item analysis procedures, lack of reliability studies and lack of validity analysis.

For example, a recent report from Kuncel, Crede and Thomas (2005) suggested that self-reported grades should be used with caution. Findings from Kuncel et al. based on a sample of 60,926 subjects, implied that self-reported grades had less construct validity than educators and researchers believed: Although the self-reported grades reflected the actual grades for students with a high grade point average, self-reported grades were unlikely to represent the actual scores for students with low GPA and low ability. These findings may generalize to self-report of other accomplishments, including computer self-efficacy, and its construct validity. They are all problems that could be rectified by using well-designed research methods. Therefore, triangulation was applied in this research: first, data triangulation — diverse sources of data were used; second, methodological triangulation was employed to analyze and interpret the research results. Furthermore, I had been involved in several research projects of ICT literacy within the faculty, which enabled me to work with several researchers with different methodological orientations and perspectives.

I. Instrument Description

The first section of the instrument (see Appendix A) involves demographic items to obtain knowledge about and information on student distributions of age, gender, program, region, and digital access. This section generated demographic information addressing where student teachers learned computer skills before they entered the teacher education program.

The second section was based on items of ICT competencies common to the pre-tests and post-tests. All items were positively worded and an individuals' self-efficacy was calculated by summing item responses. High scores indicated a high degree of confidence in one's capability to use ICT. Responses were converted to a 4-point scale (1-4). Scores of 1, 2, 3 and 4 correspond to "None," "low," "medium," and "high" ability. Responses to leaving the choice blank was assigned zero. This section provided information on the status of the student teachers' ICT literacy. As mentioned earlier, ICT literacy refers to critical understandings and functional applications of technological skills and knowledge. In this study, "skill" and competency were used to refer to the knowledge and ability that enable the student teachers effectively perform with ICT, and to indicate the ability that the student teachers had to effectively perform with ICT.

The third section of the instrument asked student teachers about their learning activities with technologies during the program at UBC. Analysing data in this section provided information about how knowledge of ICT was constructed. The fourth section was designed to ask the student teachers to assess their attitudes and dispositions towards ICT, and changes in the attitudes and beliefs between the beginning and end of the program. Findings from this data source revealed distinct and interesting trends related to students' attitudes, beliefs and dispositions toward ICT literacy and the changes in students' attitudes over the course of their teacher education program.

In addition to the items of the survey, although students were allowed to write their comments on ICT literacy, a majority of the student teachers did not provide written comments. The response rate for the comment section varied across surveys: About 21% of the respondents wrote comments in the 2001 pre-program survey and 6% in the 2002 post- program survey; about 11% of the respondents provided written comments in the 2003 pre-program and 23% in the 2004 post- program survey.

II. Instrument Design

While educators pay much attention to the cognitive domain, Tyler (1973), along with others, argued for growing awareness of the need for schools to pay more attention to the affective domain when developing learning goals and objectives. Tyler postulated as to why affective learning had not been systematically designed as part of curricula. One of the reasons was that the majority of educators assumed affective aspects like feelings, attitudes, self-efficacy, interests, values and beliefs were not the concerns of the school, but rather the business of the home or church. Another reason was that the affective domain was regarded as natural growth of the cognitive domain and should not be addressed separately during the learning process.

As the cognitive domain received growing attention, the affective domain drew more attention from researchers (Bandura, 1986, 1989) and educators (Bloom 1976, Gable 1986; Gable & Wolf, 1993). It is now recognized that the interaction between overlapping cognitive and affective domains during the instructional process affect both cognitive and affective outcomes, which result in changes of feelings about subject matter (attitudes), feelings of personal worth and success (self-efficacy), motivation to become engaged in various learning activities (interests), and personal standards (values). Gable and Wolf (1993) argue that self-efficacy is a very popular and powerful construct, "which has been shown to be causally linked to several types of outcome behaviors in both school and corporate settings" (p. 5).

Since Renis Likert (1932) invented a measurement method to quantify affective data in 1932 (i.e., Likert Scale), this method has been widely used in surveys. The participants respond to items that range from "strongly disagree" to "strongly agree." Hopkins and Stanley (1981) view Likert scales as very flexible and reliable. Strengths of the Likert Scale include the following characteristics in general: (1) it forces a participant to give a clear positive or negative answer; (2) it produces items suitable for rapid response and analysis; (3) may save time compared to interviews and other inventories; and (4) participants can be reached through the use of in-class questionnaires in the schools. In addition, Knezed and Christensen (1996) reported that Likert-type self-report instruments are high on reliability and validity with stable measurement properties. Other researchers reported that self-rating instruments have been shown to have a high degree of reliability (Kuncel et al., 2005). Nevertheless, there are weaknesses in the Likert-type instrument. For instance, Hopkins and Stanley (1981) found problems in affective measurement: (1) self-deception; (2) semantic and interpretive barriers; and (3) criterion inadequacy. Self-report instruments also tend to be more sensitive to the subjective distress of the participants. Furthermore, the use of a self-rating scale may be influenced by variables like gender, cultural, and linguistic variables. For instance, as noted earlier, males may be more confident in their ICT competencies and self-rate higher than females.

The UBC ICT instrument was designed and developed in the affective domain as defined by Gable and Wolf (1993), based on a review of the literature in ICT and a review of earlier instruments. Conceptual definitions were developed for basic ICT competencies, use of ICT activities during coursework or practicum, and attitudes and perspectives on the role of information technologies in teaching and learning processes. The Faculty Technology Committee, under the direction of Dr. Gaalen Erickson, initially designed the *UBC Scale of ICT Literacy in Teacher Education (UBC ICT LITE Scale)* to evaluate pre-service teachers' competencies, knowledge and dispositions related to ICT. The Committee consulted various instrument patterns: computer literacy, self-efficacy and self-evaluation instruments, requirements of ICT skills for teachers in ISTE's (International Society for Technology in Education) *NETS* (National Educational Technology Standards, 2001), Scheffler and Logan's (1999) rank ordering of computer competencies for teachers, Gibson and Nocente's (1998) survey of Faculty of Education students at the University of Alberta, and our local experiences with ICT. There were four sections in each of the instruments: demography, ICT competencies, frequency of use ICT and the student teachers' attitudes toward technologies.

The instrument for each of the four years was developed with similar constructs. A committee of a wide range of experts in ICT, science, language and mathematics in the Faculty of Education participated in the design of the instrument and determined that the conceptual definitions for ICT categories demonstrated "comprehensiveness of theory and adequacy of sampling from the content universe" (Gable, 1986, p. 73). Based on the literature review, examination of previous ICT questionnaires and the conceptual definitions, statements were developed representing attitudes and competencies related to ICT. To establish content validity, the committee of experts examined each item for correspondence to a priori categories developed by the researchers (Gibson and Nocente, 1998; Woodrow, 1991). Each item in every section of the instruments was discussed fully in the committee before it was put into use. Items that were judged to be vague or difficult to interpret were modified and then retested until all items were interpreted as intended. A measurement specialist also reviewed the instrument to ensure that conventions in test construction were followed (Bartosh, Dobson, Erickson, Guo, Mayer-Smith, Petrina, & Stanley-Wilson, 2005).

One of the intents of this project was to assess students' ICT competencies and students' attitudes toward ICT, and changes in the ICT competencies and attitudes and beliefs between the beginning and end of the program. Based on a review of the literature in ICT and a review of earlier instruments, conceptual definitions were developed for basic ICT competencies, use of ICT activities during coursework and practicum, and attitudes and perspectives on the role of ICT in teaching and learning processes.

The 2001 instrument contained 71 items, including five demographic items. The post-program instrument for 2002 repeated most of the items in 2001 dealing with ICT competencies and dispositions and added 16 Likert items dealing with the frequency of ICT activities experienced in courses and on practicum. The pre-program instrument for 2003 almost duplicated the 2001 instrument with a few changes to items that did not adequately discriminate. The 2002 version consisted of 68 items, including five demographic items and was modified due to further feedback from the participants. One demographic item (i.e., student number) in the 2001 instrument for student identification was not included in the instruments for the 2002-2004 surveys. This made it impossible to trace individual student progress in performance with ICT.

To ensure that the directions and items were interpreted as intended, a readability assessment was conducted. Statements that were identified as vague or difficult to interpret were reworded and then retested until all items were interpreted as intended. In both pre- and post- program surveys of 2001-2002 the attitudinal section consisted of 14 Likert items dealing with attitudes toward ICT literacy. In 2003 and 2004 surveys, the instrument was further modified because it became increasingly clear to the researchers on the committee, that the original instrument did not provide much discrimination index between respondents, e.g., the degree of difference between the number of responses for high-scoring and low-scoring individuals. Each year, students entering the teacher education program have demonstrated increased knowledge and experience with ICT.

For the 2004 post-program survey, the Survey Committee of the Faculty of Education revised the 2002 instrument by combining some of the "ICT activity" items and rewriting the section of "disposition" items. Again, the aim of the revision was to delete some of the items that did not discriminate and to introduce new "knowledge" items informed by critical theories of ICT literacy. The committee intended to create an instrument balancing a dominance of items emphasizing "what can or did this student do or expect to do *with* ICT" with items addressing "what does this student know *about* certain aspects of ICT". Changes included the addition of included five new Likert items dealing with gender and mulitcultural attitudes toward ICT and four items dealing with ICT policy. These items were intended to help assess the students' knowledge about ICT and open a conversation on this aspect of ICT literacy.

III. Description of Scales

From items common to the instruments, two major scales were created in this study. To compare students' pre- and post-program ICT competencies, an *ICT Competency Scale* (TCScale) was created. To measure the students' attitudes toward ICT, attitudinal scales (ATT) were created. The scales were used for inferential statistics, to draw inferences from sample to population. The inferences drawn from this study are confined to the population of the student teachers in UBC teacher education programs from 2001 to 2004 cohorts. In addition, this study reflects phenomena that occur within a certain period of time, limiting inferential predictions for circumstances in the future.

The TCScale was a consolidation of the basic and multimedia scales. The TCScale was derived from eight Likert items on basic computer competencies and five Likert items on multimedia competencies. The items were converted to a point-based scale ranging from 1 to 4. Item scores of 1, 2, 3 and 4 corresponded to none, low, medium, and high levels of competencies. Therefore, scores were summed to give an indicator ranging from 0 to 52 on the total 13 items of the scale (0-32 on the basic computer competencies and 0-20 on the multimedia competencies). Statistical analyses (i.e., *t*-test, ANOVA, Post Hoc, Correlation and Multiple Regression) were used to test differences in student ICT competencies between pre and post-program surveys and their demographic distributions such as age, gender, and program. The alpha level, or the probability level of error, was set at 0.05.

The *UBC ICT LITE* Instrument for the Pre-Program Survey 2001 contained 71 items (Appendix A):

- 10 items for demographic information with the first item asking student teachers' students number;
- 28 items for self-efficacy of ICT competencies, with ranging from none to high degree;
- 16 Likert items asking the student teachers how frequently they expected to use technologies, ranging from "never" to "daily";
- 3 categorical items asking information of student teachers' access to technologies;
- 14 Likert items dealing with dispositions toward ICT in education;

The Post-Program *UBC ICT LITE* Instrument for 2002 consisted of the following items (68 items):

- 5 items for demographic information;
- 23 Likert items for self-evaluation of ICT competencies, ranging from "None" to "High" degree;
- 18 Likert items on the frequent use of technologies during their course work at UBC and during their practicum, ranging from "never" to "daily";
- 8 Likert items on the frequency the student teachers asked their students to use technologies during their practicum, ranging from "never" to "daily";
- 14 Likert items dealing with attitudes toward ICT literacy.

The Pre-Program *UBC ICT LITE* Instrument for 2003 contained 66 items:

- 10 items for demographic information;

- 27 Likert items on ICT competences ranging from "None" to "High" degree;
- 15 Likert items ranking the importance of these skills, ranging from not important to very important;
- 4 categorical items asking information of student teachers' access to technologies;
- 10 Likert items dealing with attitudes toward ICT literacy, ranging from "none" to "high" degree.

The Post-Program *UBC ICT LITE* Instrument for 2004 contained 53 items:

- 4 items for demographic information;
- 13 Likert items on ICT competencies ranging from "None" to "High" degree;
- 15 Likert items on the frequent use of technologies during their course work at UBC and during their practicum, ranging from "never" to "daily";
- 8 Likert items on the frequency the student teachers asked their students to use technologies during their practicum, ranging from "never" to "daily";
- 13 Likert items dealing with attitudes toward ICT literacy, ranging from "none" to "high" degree.

Table 3 displays the analysis results for internal consistency among items on the sections of ICT competencies that generated the TCScale. The alpha reliability coefficient was .90 for 28 items in the Pre-Program Survey 2001 and .94 for 23 items in the Post-Program Survey 2002, .93 for 27 items in the Pre-Program Survey 2003 and .96 for 13 items in the Post-Program Survey 2004.

Table 3. The reliability analysis of TCScale for the instruments (2001-2004)

	Year			
	2001	2002	2003	2004
Items	28	23	27	13
Number of Cases	819	512	770	523
Alpha	.90	.94	.93	.96

Based on the 13 items in the Post-Program Survey 2004, a TCScale with a range from 0 to 52 was generated from the common content of the items in each of the previous three surveys. The TCScale was used to measure the students' self-efficacy of their ICT competencies from the surveys between 2001 and 2004. The items included in the TCScale and their corresponding numbers on the instrument form each year are listed in Table 4.

Table 4. TCScale and the corresponding numbers on the instruments for each year

Items	2004	2003	2002	2001
Use a scanner to create a digital image	5	16	11	17
Create or modify a database document	6	12	7	13
Make a backup copy of a computer file	7	13	8	14
Create a folder or directory	8	14	9	15
Copy a file from one disk to another	9	15	10	16
Create or modify a spreadsheet document	10	11	6	12
Use a digital camera to create an image on a computer	11	17	12	18
Place an image or graphic into a document	12	18	13	19
Create a presentation e.g: Powerpoint or SlideShow	13	19	14	20
Make a web bookmark or favorite	14	20	15	23
Do an advanced search with AND and OR operators	15	21	16	26
Download files to your computer	16	22	17	27
Create or record your own music using a computer	17	23	18	28

Similarly, an attitudinal scale (ATT) was generated to measure gender differences in attitudes toward ICT by year. The Pre-Program Survey 2001, Post-Program Survey 2002 and Pre-Program Survey 2003 included the same items in the attitude sections (items 58 to 71 in the Pre-Program Survey 2001; items 55 to 68 in the Post-Program Survey 2002; items 57 to 66 in the Pre-Program Survey 2003) but the items for the attitudinal section in the Post-Program Survey 2004 differed from those in the previous years. Three items in Table 5, "It's not really important for teachers to know how to use ICT," "I think that there is too much emphasis on using ICT in the classroom" and "I do not plan to use ICT in my future classroom" were worded in a negative direction with the higher numerical value indicating negative attitudes. So these items were converted to be consistent with other items in positive direction. The attitudinal scale (ATT), ranging from 0 to 56, was created from 14 attitude items in the Pre-Program Survey 2001 and the Post-Program Survey 2002 with an alpha value of reliability of coefficients .80. Each Likert item was coded into a numeric value: 0 =

Don't know, 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree. Similarly, the attitude scale for the Pre-Program Survey 2003, with a range from 0 to 40, was created with an alpha value of reliability coefficients .78.

Items from which the attitudinal scales (ATT) were derived for the years 2001-2003 are listed below (Table 5):

Table 5. Attitudinal scale (ATT) and the corresponding numbers for items on the instrument in each year

Items	Directions	2001	2002	2003
I am interested in learning more about how to use technology in the classroom.	+	58	55	
I would like to teach computer skills in my future classroom.	+	59	56	
The use of technology promotes student-centered learning.	+	60	57	
I would like to use educational software in my classroom.	+	61	58	57
I understand the ethical issues involved in using technology in the classroom.	+	62	59	58
It's not really important for teachers to know how to use technology.	–	63	60	
Integrating the use of technology across subject areas maximizes student learning.	+	64	61	59
I think that there is too much emphasis on using technology in the classroom.	–	65	62	60
I feel competent to use technology in my classroom in a meaningful manner.	+	66	63	61
I would like to use the Internet as an instructional resource.	+	67	64	62
New technology have a positive effect in transforming instruction.	+	68	65	63
I do not plan to use technology in my future classroom.	–	69	66	64
I would like to use technology for assessment and evaluation in my classroom.	+	70	67	65
I would like to use multimedia to explore different ways to represent concepts.	+	71	68	66

The Post-Program Survey 2004 included 10 Likert items dealing with attitudes toward ICT in gender and education, and ICT policy. As these attitude items were not comparable with the previous three surveys, I was not able to make comparisons across the four attitudinal sections. Nevertheless, special attention was paid to the attitudinal section in the Post-Program Survey 2004: Both quantitative and qualitative data from the Post-Program Survey 2004 were examined in hypothesis VI (see below) and Chapter Five.

Subscales

Three sub-TCScales were generated for the Pre-Program Surveys 2001 and 2003, and Post-Program Survey 2002 respectively (Table 6). The sub-scales for access, and frequency of ICT uses were generated for each year respectively. The sub-TCScale for the Pre-Program Survey 2001 (TCPR1) ranging from 0 to 112 was counted from 28 Likert items (item 11 to 38) related to ICT competencies in the second subsection of the Pre-Program Survey 2001, and the alpha value of reliability coefficients was .93. Student teachers were asked to respond to items extending from basic computer skills such as "create or modify a word processing document" to advanced ICT competences such as "create a web page on the World Wide Web." Each Likert item was coded into a numeric value: 1 = "None," 2 = "Low," 3 = "Medium," 4 = "High." The same coding system was used for the other two sub-TCScales Post-Program Survey 2002 (TCPS2) and Pre-Program 2003 (TCPR3). [The TCScale for general hypothesis tests was generated from 13 items in the Post-Program Survey 2004 and was used to measure ICT competencies for the Post-Program Survey 2004 (see Table 4 above)].

Table 6. Sub-TCScale for the Pre-Program Survey 2001(TCPR1)

☛ *If you do not use computers at all, please go to Question 39.*

Please indicate your degree of current competence for each of the activities listed below:
Choose "Avoid" if you would try to avoid this task if possible. Choose "Low" if you feel uncertain about doing the task. Choose "Medium" if you would attempt the task but are unsure of your competence. Choose "High" if you feel sure and able to complete the task.

	Don't know	Avoid	Low	Medium	High
11. Create or modify a word processing document.					
12. Create or modify a spreadsheet document.					
13. Create or modify a database document.					
14. Make a backup copy of a computer file.					
15. Create a folder or directory.					
16. Copy a file from one disk to another.					
17. Use a scanner to create a digital image.					
18. Use a digital camera to create an image on a computer.					
19. Place an image or graphic into a document.					
20. Create a presentation, e.g. PowerPoint or SlideShow.					
21. Send or receive an e-mail message.					
22. Open or send an attachment with an e-mail message.					
23. Make a web bookmark or favorite.					
24. Use a search engine such as AltaVista, Google, or Yahoo.					
25. Use information from the web for a project or assignment.					
26. Do an advanced search with AND and OR operators.					
27. Download music files to your computer.					
28. Create or record your own music using a computer.					
29. Burn a music CD.					
30. Use an FTP program to upload files.					
31. Install an application program onto a computer.					
32. Save or use an image from a web page.					
33. Modify an image or graphic with the computer.					
34. Use advanced WP features such as tables or templates.					
35. Create a chart or graph with a spreadsheet program.					
36. Download a plug-in for your browser.					
37. Participate in an online discussion or newsgroup.					
38. Create a web page on the World Wide Web.					

The sub-TCScale for the Post-Program Survey 2002 (Table 7) ranging from 0 to 92, was computed from 23 Likert items (item 6 to 28) on ICT competencies and the alpha value of reliability coefficients was .94. The item contents for both the Pre-Program Survey 2001 and Post-Program Survey 2002 were similar. Five items on ICT competencies in the Pre-Program Survey 2001 (Table 6) were not included in the Post-Program Survey 2002: #11 "Create or modify a word processing document," #21 "Send or receive an e–mail message," #22 "Open or send an attachment with an e-mail message," #24 "Use a search engine such as

Ata Vista, Google, or Yahoo," and #25 "Use information from the web for project or assignment."

Table 7. Sub-TCScale for the Post-Program Survey 2002 (TCPS2)

Please indicate your degree of comfort and current competence for each of the activities listed below: Choose "None" if you would try to avoid this task if possible. Choose "Low" if you feel uncomfortable and uncertain about doing the task. Choose "Medium" if you would attempt the task but are unsure of your competence. Choose "High" if you feel sure and able to complete the task.

	None	Low	Medium	High
6. Create or modify a spreadsheet document.	○	○	○	○
7. Create or modify a database document.	○	○	○	○
8. Make a backup copy of a computer file.	○	○	○	○
9. Create a folder or directory.	○	○	○	○
10. Copy a file from one disk to another.	○	○	○	○
11. Use a scanner to create a digital image.	○	○	○	○
12. Use a digital camera to create an image on a computer.	○	○	○	○
13. Place an image or graphic into a document.	○	○	○	○
14. Create a presentation, e.g. PowerPoint or SlideShow.	○	○	○	○
15. Make a web bookmark or favorite.	○	○	○	○
16. Do an advanced search with AND and OR operators.	○	○	○	○
17. Download music files to your computer.	○	○	○	○
18. Create or record your own music using a computer.	○	○	○	○
19. Burn a music CD.	○	○	○	○
20. Use an FTP program to upload files.	○	○	○	○
21. Install an application program onto a computer.	○	○	○	○
22. Save or use an image from a web page.	○	○	○	○
23. Modify an image or graphic with the computer.	○	○	○	○
24. Use advanced WP features such as tables or templates.	○	○	○	○
25. Create a chart or graph with a spreadsheet program.	○	○	○	○
26. Download a plug-in for your browser.	○	○	○	○
27. Participate in an on-line discussion or newsgroup.	○	○	○	○
28. Create a web page on the World Wide Web.	○	○	○	○

The sub-TCScale for the Pre-Program Survey 2003 (TCPR3) (Table 8) was generated from 27 Likert items (11 to 37), ranging from 0 to 108 on ICT competencies and the alpha value of reliability coefficients was .93. The items on ICT competencies for the Pre-Program Survey were basically the same as those in the Pre-Program Survey 2001 except that one item was dropped off (#11: "Create of modify a word processing document").

Table 8. Sub-TCScale for the Pre-Program Survey 2003 (TCPR3)

Please indicate your degree of current competence for each of the activities listed. Choose "None" if you have no knowledge of , or experience with, this task. Choose "Low" if you have some limited experience with the task, but are unsure of your ability to complete it unassisted. Choose "Medium" if you feel reasonably sure of your ability to complete this task. Choose "High" if you are sure of your ability to complete this task to the point that you could teach it to someone else.

11. Create or modify a spreadsheet document.	None	Low	Medium	High
12. Create or modify a database document.	None	Low	Medium	High
13. Make a backup copy of a computer file.	None	Low	Medium	High
14. Create a folder or directory.	None	Low	Medium	High
15. Copy a file from one disk to another.	None	Low	Medium	High
16. Use a scanner to create a digital image.	None	Low	Medium	High
17. Use a digital camera to create an image on a computer.	None	Low	Medium	High
18. Place an image or graphic into a document.	None	Low	Medium	High
19. Create a presentation e.g.: PowerPoint or SlideShow.	None	Low	Medium	High
20. Make a web bookmark or favorite.	None	Low	Medium	High
21. Do an advanced search with AND and OR operators.	None	Low	Medium	High
22. Download files to your computer.	None	Low	Medium	High
23. Create or record your own music using a computer.	None	Low	Medium	High
24. Burn a CD.	None	Low	Medium	High
25. Use an FTP program to upload files.	None	Low	Medium	High
26. Install an application or program onto a computer.	None	Low	Medium	High
27. Save or use an image from a web page.	None	Low	Medium	High
28. Modify an image or graphic with the computer.	None	Low	Medium	High
29. Use advanced word processing features such as tables.	None	Low	Medium	High
30. Create a chart or graph with a spreadsheet program.	None	Low	Medium	High
31. Download a plug-in for your browser.	None	Low	Medium	High
32. Participate in an on-line discussion or newsgroup.	None	Low	Medium	High
33. Create and upload a web page on the World Wide Web.	None	Low	Medium	High
34. Create or modify a word processing document.	None	Low	Medium	High
35. Send or recieve an e-mail message with an attachment.	None	Low	Medium	High
36. Use a search engine such as Google, Alta Vista or Yahoo.	None	Low	Medium	High
37. Use information from the web for a project or assignment.	None	Low	Medium	High

In the Pre-Program Surveys 2001 and 2003, student teachers were asked to provide their information about the levels of their access to ICT sources before they entered the teacher education program. An access scale (ACC1) was created from items 7 to 10 in the first section of the Pre-Program Survey 2001, ranging from 0 to 11 and its alpha value of reliability coefficients was .83. Items dealing with access in 2001 included "do you have ready access to a computer at your residence?" "Do you have a printer with this computer?"

"Do you have web access on this computer?" and "Where did you learn your computer skills?" The pre-service teachers were asked to check all the main sources for the four items. Responses to "No" or "Have None" in each of the items were not counted. The others were assigned with numerical values. For example, in item 7 "Do you have ready access to a computer at your residence", "No" was assigned a numerical value 0, each of the other sources was coded to 1 and then cumulated to three. Responses to each of all the access sources from item 7 to 10 were cumulated to a total of 11 scores (Table 9).

Table 9. ACC1 scale for the Pre-Program Survey 2001

7. Do you have ready access to a computer at your residence? No ( ) Mac ( ) Windows ( ) Other ( )
8. Do you have a printer with this computer? No ( ) Yes ( )
9. Do you have web access on this computer? No ( ) Yes ( )
10. Where did you learn your computer skills? (Check all the main sources.) Have none ( ) Self-taught ( ) High School ( ) University ( ) Friends/relatives ( ) Workplace ( ) Other ( )

An access scale (ACC3) was created from items 6 to 10 in the first section of the Pre-Program Survey 2003, ranging from 0 to 17 and its alpha value of reliability coefficients was .86. The coding system for ACC3 was the same as that of ACC1. In the Pre-Program Survey 2003, more sources were included and questionnaires were more specific, for example, "Linux" in item 6, "Desktop" and "Laptop" in item 7, "High-speed wire-Telus/Shaw", "High-speed wireless", "Dial-up" in item 8. All the main sources were counted. Some items were valued with more than one scored. However, item 8 was valued for one score because it was likely an individual would have only one home Internet connection (Table 10).

Table 10. ACC3 scale for the Pre-Program Survey 2003

6. What computer operating system do you have at home? None ◯ Mac ◯ Windows ◯ Linux ◯ Other ◯
7. What kind of computer do you have? None ◯ Desktop ◯ Laptop ◯
8. What is your home internet connectivity? None ◯ High-speed wire-Telus/Shaw ◯ High-speed wireless ◯ Dial-up ◯
9. Where do you most frequently access the internet?
home ◯ university ◯ internet cafe ◯ library ◯ friend's house ◯
10. Where did you learn your computer skills? (check all the main sources)
Have none ◯ Self-taught ◯ High school ◯ University ◯ Workplace ◯ Friends/Relatives ◯ other ◯

The Post-Program Instrument 2002 and 2004 dropped the access section but added frequency of ICT uses during the university course work and practicum. A frequency of ICT use scale (UA2) was created from 18 items (item 29 to 46, see Table 7a), ranging from 0 to 72, in the third section of the Post-Program Survey 2002 dealing with the frequency of ICT use during university course work. Each item in the column "during coursework" was coded: 1 = never, 2 = a few times, 3 = weekly, 4 = daily. The values of reliability coefficients were .82 for UA02 in 2002.

Similarly, a frequency of ICT use scale (UB2) was created for the Post-Program Survey 2002 dealing with the frequency of ICT use during practicum. The range and coding system of UB2 scale were the same as those of UA2 (Table 11).

Table 11. UA2 & UB2 scales for the Post-Program Survey 2002

Please make two judgments concerning each of the activities below: (1) the frequency of use during your university coursework, and (2) the frequency of use during your practica.
As part of your teacher-education program, how frequently did you:

	During coursework					During practicum				
	N/A	Never	A few times	Weekly	Daily	N/A	Never	A few times	Weekly	Daily
29. Create new graphics or images using graphics software.	○	○	○	○	○	○	○	○	○	○
30. Create a chart or graph with spreadsheet software.	○	○	○	○	○	○	○	○	○	○
31. Create a document with database software.	○	○	○	○	○	○	○	○	○	○
32. Make your own file storage or music CD.	○	○	○	○	○	○	○	○	○	○
33. Use the computer to make lesson plans and worksheets.	○	○	○	○	○	○	○	○	○	○
34. Use the internet to obtain teaching resources.	○	○	○	○	○	○	○	○	○	○
35. Create a lesson or unit plan that incorporated subject matter software.	○	○	○	○	○	○	○	○	○	○
36. Use simulation software to introduce or teach content information.	○	○	○	○	○	○	○	○	○	○
37. Create web pages as part of a lesson or unit.	○	○	○	○	○	○	○	○	○	○
38. Use presentation software such as PowerPoint or Slideshow.	○	○	○	○	○	○	○	○	○	○
39. Use multimedia software with animation, sound, graphics, and/or video.	○	○	○	○	○	○	○	○	○	○
40. Use software to maintain student grades.	○	○	○	○	○	○	○	○	○	○
41. Introduce a new approach to technology to your school advisor.	○	○	○	○	○	○	○	○	○	○
42. Use e-mail to communicate with your faculty advisor.	○	○	○	○	○	○	○	○	○	○
43. Use e-mail to communicate with your school advisor.	○	○	○	○	○	○	○	○	○	○
44. Use e-mail to communicate with your students or their parents.	○	○	○	○	○	○	○	○	○	○
45. Participate in online forums, chat rooms, or discussion groups.	○	○	○	○	○	○	○	○	○	○
46. Participate in a school or district technology workshop.	○	○	○	○	○	○	○	○	○	○

The same procedure was used to produce subscales of frequency of ICT uses for the Post-Program Survey 2004. Items in the Post-Program Survey 2004 were slightly different from those of the previous ones. Items 18 to 32 in the third section asked student teachers to make an evaluation of "the frequency of use during your university course work" and "the frequency of use during your practicum." Subscales for frequency of ICT uses (UA4, UB4) by student teachers in university and during practicum were derived from 15 items in column A and B respectively, ranging from 0 to 60 (Table 12). “N/A” was coded “0”.

Table 12. ICT use scales (UA4, UB4) for the Post-Program Survey 2004

Please make two judgements concerning each of the activities below: (1) the frequency of use during your university course work, and (2) the frequency of use during your practica.

As part of your teacher-education program, how frequently did you:	During Coursework					During Practicum				
	N/A	Never	A few times	Weekly	Daily	N/A	Never	A few times	Weekly	Daily
18. Create new graphics or images using graphics software?	○	○	○	○	○	○	○	○	○	○
19. Create a chart or graph with spreadsheet software?	○	○	○	○	○	○	○	○	○	○
20. Burn a CD?	○	○	○	○	○	○	○	○	○	○
21. Use the internet to obtain teaching resources?	○	○	○	○	○	○	○	○	○	○
22. Create lessons that incorporate subject-specific software?	○	○	○	○	○	○	○	○	○	○
23. Create lessons that incorporate simulation software?	○	○	○	○	○	○	○	○	○	○
24. Create lessons using presentation software (e.g., PowerPoint)?	○	○	○	○	○	○	○	○	○	○
25. Create lessons incorporating student use of digital video, graphics or sound editors?	○	○	○	○	○	○	○	○	○	○
26. Use software to maintain student grades?	○	○	○	○	○	○	○	○	○	○
27. Introduce a new approach to technology to your school or faculty advisor?	○	○	○	○	○	○	○	○	○	○
28. Use email to communicate with your faculty advisor?	○	○	○	○	○	○	○	○	○	○
29. Use email to communicate with your school advisor?	○	○	○	○	○	○	○	○	○	○
30. Use email to communicate with your students or their parents?	○	○	○	○	○	○	○	○	○	○
31. Participate in on-line discussions related to your education program?	○	○	○	○	○	○	○	○	○	○
32. Participate in a school or district technology workshop?	○	○	○	○	○	○	○	○	○	○

The Post-Program Survey 2002 and 2004 were comprised of the same items asking student teachers to respond to how often they had their students use ICT during practicum. A subscale for frequency of student ICT use scale (UC) was generated from 8 items from 47 to 54 in the Post-Program 2002 (33 to 40 in the Post-Program Survey 2004), ranging from 0 to 40. Each item was coded: 1 = never, 2 = a few times, 3 = weekly, 4 = daily (Table 13).

Table 13. Student ICT use (UC) scale for the Post-Program Surveys 2002 and 2004

During your practicum, how frequently did you have your students:

	Never	A few times	Weekly	Daily
47. Use word processing programs to complete written work.	○	○	○	○
48. Use the internet for research.	○	○	○	○
49. Use multimedia software with animation, sound, graphics, and/or video	○	○	○	○
50. Use presentation software such as PowerPoint or Slideshow.	○	○	○	○
51. Create web pages.	○	○	○	○
52. Use educational CD-ROMs.	○	○	○	○
53. Use e-mail to correspond with other schools.	○	○	○	○
54. Participate in on-line interactive projects with other schools (excluding e-mail).	○	○	○	○

In the Post-Program Survey 2004, items 28a to 32b asked student teachers to place a value on their online communication activities during university coursework and practicum. These items were grouped and generated as a subscale "online communication" (ONLINE) (Table 14) with a range from 0 to 40 (0 = N/A, 1 = none, 2 = a few times, 3 = weekly, 4 = daily). Scores in column A and B were added from items 28a and 28b "use email to communicate with your faculty advisor during coursework," and "use email to communicate with your faculty advisor during practicum"; 29a and 29b "use email to communicate with your school advisor during coursework" and "during practicum"; 30a and 30b "use email to communicate with your students or their parents during coursework" and "during practicum"; 31a and 31b "participate in online discussions related to your education program during coursework" and "during practicum"; down to 32a and 32b "Participate in a school or district ICT workshop."

Table 14. Communication scale (ONLINE) for the Post-Program Survey 2004

As part of your teacher-education program, how frequently did you:	During Coursework					During Practicum				
	N/A	Never	A few times	Weekly	Daily	N/A	Never	A few times	Weekly	Daily
28. Use email to communicate with your faculty advisor?	○	○	○	○	○	○	○	○	○	○
29. Use email to communicate with your school advisor?	○	○	○	○	○	○	○	○	○	○
30. Use email to communicate with your students or their parents?	○	○	○	○	○	○	○	○	○	○
31. Participate in on-line discussions related to your education program?	○	○	○	○	○	○	○	○	○	○
32. Participate in a school or district technology workshop?	○	○	○	○	○	○	○	○	○	○

An attitudinal subscale (ATT4) was generated by grouping general attitude items #45 "online courses improve the learning process and outcomes for students who unsuccessful in traditional educational systems," and #49 "Internet access at home is essential to education for North American school-age students." This attitudinal subscale also included items related to gender attitudes toward ICTs: item #43 "females have less access to information technology within the school environment than do males", #44 "the World Wide Web advances gender and racial equity", #46 "males are more comfortable using information technology than are females", #48 "females are less likely to use information technology while teaching than males", and #52 "males are less concerned with the implications of information technology than are females" in the Post-Program Survey 2004. The Likert responses to the above items "strongly disagree", "disagree", "agree", and "strongly agree" were converted to a point-based scale (1 - 4), coded 1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree. These items were grouped as a dependent variable ranging from 0 to 24 with reliability coefficient (reliability = .629, $p < .01$).

Table 15. The attitudinal subscale (ATT4) for the Post-Program Survey 2004

Indicate your level of agreement with the following statements:	Strongly Disagree	Disagree	Agree	Strongly Agree
41. My practicum school provided teachers with adequate means to use information technology in instruction.	○	○	○	○
42. My practicum school provided teachers with adequate means to use information technology for professional development.	○	○	○	○
43. Female students have less access to information technology within the school environment than do male students.	○	○	○	○
44. The World Wide Web advances gender and racial equity.	○	○	○	○
45. Online courses improve the learning process and outcomes for students who are unsuccessful in traditional educational systems.	○	○	○	○
46. Males are more comfortable using information technology than are females.	○	○	○	○
47. Online distance education courses reduce employment opportunities for teachers.	○	○	○	○
48. Females are less likely to use information technology while teaching than males.	○	○	○	○
49. Internet access at home is essential to education for North American school-age students.	○	○	○	○
50. Teachers should advocate less corporate involvement related to information technology in schools.	○	○	○	○
51. Significant electronic game playing (i.e., 2 hrs+ per day) promotes hyperactive, aggressive behaviour.	○	○	○	○
52. Males are less concerned with the implications of information technology than are females.	○	○	○	○

IV. Variables (As used for Each Hypothesis)

In conjunction with the research questions, the following variables were used for hypothesis testing.

Dependent variables:

1) ICT competences: The TCScale (basic TCScale and multimedia TCScale) (Table 4) was used to measure general ICT competencies in Hypotheses I, II, III (testing the effects of program, gender and academic year), VI (interaction testing of program, gender and academic year), VII (testing of age and ICT literacy), VIII (interaction of age and ICT competencies), IV (testing of digital divide and ICT competencies), and X (interaction of digital divide and ICT competencies);

2) Attitudes toward ICT: The ATT Scale (Table 5) was used to measure gender differences in attitudes toward ICT in Hypothesis VI (testing of gender and attitudes toward ICT).

3) Subscales:

- TCPR1: The subscale TCPR1 (ICT scores for the Pre-Program Survey 2001) (Table 6) was used as a dependent variable to test Hypothesis VI;
- TCPS2: The subscale TCPS2 (ICT scores for the Post-Program Survey 2002) (Table 7) was used as a dependent variable to test Hypothesis VI;
- TCPR3: The subscale TCPRE3 (ICT scores for the Pre-Program Survey 2003) (Table 8) was used as a dependent variable to test Hypothesis VI;
- ACC1 (student teachers' access to ICT in the Pre-Program Survey 2001): The subscale ACC1 (Table 9) was used as a variable to test Hypothesis XI.
- ACC3 (student teachers' access to ICT in the Pre-Program Survey 2001): The subscale ACC3 (Table 10) was used as a variable to test Hypothesis XI.
- UA2 (frequency of ICT use during university coursework for the Post-Program Survey 2002) and UB2 (frequency of ICT use during practicum for the Post-Program 2002): The subscales UA2 and UB2 (Table 11) were used as variables to test Hypothesis XII.
- UA4 (frequency of ICT use during university coursework for the Post-Program 2004) and UB4 (frequency of ICT use during practicum for the Post-Program 2004): The subscales UA4 and UB4 (Table 12) were used as variables to test Hypothesis XII.

- UC2/4 (frequency of ICT use the student teachers had their students during their practicum for the Post-Program 2002 and 2004). The subscale UC2/4 (Table 13) was used to test Hypothesis XII.
- Communication scale (ONLINE): The subscale ONLINE (Table 14) was used as a dependent variable to test Hypothesis V_2;
- ATT4 (attitudinal scale for the Post-Program Survey 2004) (Table 15) was and used as a variable to test Hypothesis XI: access to, and attitudes toward ICT.

Independent variables:

1) Gender: Male was coded 1, female 2;
2) Program: pre-program was coded 1 (the Pre-Program Surveys 2001 and 2003); post-program was coded 2 (the Post-Program Surveys 2002 and 2004);
3) Age: in Hypothesis VIII, age group 20 to 24 years old was coded to 1, 25 to 29 to 2, 30 to 40 to 3, over 40 to 4, N/A (no age information available) to 5; in Hypothesis IX, age group 20 to 29 years old was coded 1, over 30 years old was coded 2;
4) Academic year: the independent variable academic year was combined the Pre-Program Survey 2001 and Post-Program Survey 2002, the Pre-Program Survey 2003 and the Post-Program Survey 2004. Academic year 2001-2002 was coded 1; academic year 2003- 2004 2.

The alpha Level was set at the 0.05 level, meaning that I was willing to risk being wrong 5% of the time when I rejected H_0.

Procedure and Participants

Wiersma (1986) defines research as "a systematic process of collecting and analysing information (data) for some purpose" (p. 7). According to Wiersma, the procedures of qualitative approaches and quantitative approaches are similar. They both originate in identifying problems and complete the research with conclusions. There are basically five stages in qualitative research method:

1. Identifying the problems by obtaining related knowledge of the research under study;
2. Reviewing information. This refers to gathering information about how others have approached or dealt with similar problems. The research literature is the source of such information;
3. Collecting data. This process requires good design to avoid haphazard or ad hoc manner in data collection;
4. Analysing data. The digital technology such as video and audio data makes possible new ways of creating, processing and analysing data;
5. Drawing conclusions. The conclusions are based on the data and the analysis.

The procedure of quantitative research is mainly designed in the following phases:

1. Theories and hypotheses. The researcher is aware that something requires attention, feels the need to solve the problem and prepares to respond to the calling of the need;
2. Developing/Applying a research design. This phase requires to develop preliminary design before the research project;

3. Developing measures of concepts. Accuracy and reliability underpin the measures of concepts;
4. Collecting/Analysing data: The growth of the Internet has made new ways of collecting web survey data and questionnaire survey data;
5. Testing hypotheses/Testing theories. This phase is the ongoing application of the design. After data are gathered and analysed, theories and hypotheses may be tested and revised or discarded;
6. Explaining results/drawing conclusions. This phase is similar to the final phase of qualitative research procedure.

Thus, qualitative and quantitative approaches and procedures are similar and can be conducted simultaneously or sequentially. Although it is necessary to carry out the process of research design in relative order, some phases may overlap.

Data Collection and Analysis

I emphasized depicting the phases of data collection and analysis with both qualitative and quantitative procedures, instead of going over each phase redundantly. Data were gathered on a cross-sectional basis. The participants were from different groups each year, which allowed me to examine trends and patterns of ICT literacy. Questionnaires (*UBC ICT LITE* Instrument) were administered to a large number of pre-service teachers in teacher education at UBC. Between 2001 and 2004:

- 897 responded to the 2001 pre-program survey;
- 615 responded to the 2002 post-program survey;
- 828 responded to the 2003 pre-program survey;

- 554 responded to the 2004 post-program survey.

Statistical Package for the Social Sciences (SPSS) was used to generate descriptive statistics and test hypotheses. Data analysis focused on the relationships between the student teachers' demographic distributions, such as age, gender, program, conceptions, etc., and their ICT literacy (e.g. skills to create a word document, EXCEL or PowerPoint applications, and their abilities to work with peripherals such as scanners, digital cameras and digital camcorders). Qualitative approaches, such as interviews and class observations, helped, when necessary, fill gaps that the survey questionnaires were unable to address.

Data collection and analysis included three phases:

- **First phase**: Pre- and post-program surveys were administered to student teachers in two academic years (2001-2002 academic year and 2003-2004 academic year) of UBC's teacher education program to obtain a quantitative overview of ICT competencies.
- **Second phase**: Research hypotheses were tested and survey data were analysed.
- **Third phase**: Data from observations of technology studies in the 2003-2004 and 2004-2005 cohorts, data from online communication, individual and group interviews with volunteers from the UBC 2003-2004 and 2004-2005 teacher education cohorts were pooled. Videotapes of student teachers' microteaching were evaluated for evidence of pedagogical usefulness. Student teachers' survey comments were examined to find their expectations and perspectives on the program.

- **Fourth phase**: Qualitative analysis of the data, discussions and conclusion.

One of the persistent threats to survey research lies in the possibility of a non-response rate. The validity of survey research relies on the response rate, representing the percentage of respondents returning the questionnaire *and* the quality of response or the completeness of the data. The response rate for the Pre-Program Surveys 2001 and 2003 was 92% and 87% respectively. The response rate for the Post-Program Surveys 2002 and 2004 was 65% and 58% respectively. Compared to the Pre-Program 2001, we lost 262 participants in the Post-Program Survey 2002 and the attrition rate was 30%. In the Post-Program Survey 2004, we lost 274 participants and the attrition rate was 33%.

The **first phase** of the research began in September 2001, when the Pre-Program *UBC ICT LITE* instrument was administered by a Faculty of Education Technology Committee. As indicated, committee members included educators in the field of teacher education and measurement and technology specialists. The committee members discussed the survey items intensively and revised the multiple drafts of the survey instrument before it was administered. The post-program instrument was administered at the end of the 2001-2002 academic year. The pre- and post-program *UBC ICT LITE* instrument was administered in 2003-2004 as well.

During the **second phase** of the research, after data collection from the two years of the survey, data and information from these surveys allowed me to reveal distinct and interesting trends related to students' attitudes, beliefs and dispositions toward ICT literacy and the changes in students' attitudes over the course of their teacher education program. To analyze the differences between pre- and post-program surveys, a series of statistical analyses (i.e., the *t*-test, analysis of variance (ANOVA), correlation, multiple regressions) were employed. The *t*-test, ANOVA and regression analysis are mathematically equivalent and would yield identical results.

The *t*-test assessed whether the means of two gender groups were *statistically* different from each other in specific multimedia skills. The *t*-test helped judge the difference between the means of male and female student teachers relative to the spread or variability of their scores. The formula for the t-test is a ratio:

The value of t = difference between group means/variability of groups

However, the *t*-test was not adequate for multiple paired comparisons of variables with more than two levels. ANOVA tests were employed to put all the data into one value (F) and yield *one P* value for the null hypotheses. ANOVA was used to assess the differences between pairs or combinations of means with more than two levels for the nominal variable, for instance, age groups with 5 levels in this study. I will provide additional descriptions in terms of the details of the ANOVA tests in the hypothesis section below.

Correlation was used to denote associations between variables: ICT competencies and other variables, such as access (ACC1, ACC3), and attitudes (ATT). The degree of association was measured by Pearson's correlation coefficient, denoted by r. The correlation coefficient was measured on a scale that varied from + 1 through 0 to – 1, a measure of linear association. Complete absence of correlation is represented by 0.

Correlation describes the strength of an association between two variables, and is completely symmetrical. For example, the correlation between ICT competencies and attitudes was the same as the correlation between attitudes and ICT competencies. However, if the two variables were related it meant that when one changed by a certain amount the other changed on an average by a certain amount. If y represents the dependent variable ICT competencies and x the independent variable ICT use, this relationship could be described as the regression of y on x and its *regression equation* can be written as follows:

$$\hat{Y} = a + bX_1 + bX_2$$

Where:

$\hat{Y}$ is the dependent variable, or a predictor

"a" is the intercept

"b" is the slope or regression coefficient

X is the independent variable

A regression equation expresses the relationship between two (or more) variables algebraically. It indicates the nature of the relationship between two (or more) variables. In particular, it indicates the extent to which some variables are associated with others, or the degree to which some variables could predict others. The multiple regression correlation coefficient, R^2, is a measure of the proportion of variability explained by the regression (linear relationship) in a sample of paired data. R-Square is also called the coefficient of determination. Like correlation coefficient, it is a number between 0 and 1 and a value close to 0 suggests a poor model.

The **third phase** of the research involved collecting observation and interview data. Observations and interviews were used to provide an in-depth analysis of teacher education technology curriculum and effective use of technology on practicum. Hence, I conducted multilevel research in which data were collected quantitatively at one level and qualitative at another. I used student comments from the 2003 and 2004 post-program surveys along with teacher cohort observations and interviews to acquire meaningful and understandable qualitative representations. The informants were allowed to speak freely about their experiences of learning and teaching with technologies and I recorded the interviews verbatim.

The **fourth phase**, the last phase of the research design, involved qualitative analyses of the data. Several methods were used to analyse the qualitative data. One was Labov's narrative analysis framework (please refer to "Narrative and Grounded Theory" section below and Chapter Five for details). The effort to understand narrative is amenable to a formal framework, particularly in the basic definition of narrative as the choice of specific inquiry to report past events (Labov, 1997). The interpretation of narrative is different from other analysis methods. While Gee (1991) created a framework that focuses on the coherence and content of a narrative by presenting stanzas in lines, the narrator's feelings and evaluation cannot be fully revealed by Gee's framework. On the other hand, with Labov's framework, although the whole picture of a narrator's perspectives and values related to the content can be represented in a concise pattern, the coherence of the event is not well presented. According to Labov's framework, narratives have formal properties and each has a function. Labov's framework consists of six common elements: abstract (summary), orientation (time, place, situation, and participants), complicating action (sequence of events), evaluation (significance and meaning of the action, attitude of the narrator), resolution (what finally happened), and coda (returns the perspective to the present). With these structures, an interviewee constructs a narrative from a primary experience and interprets the significance of events (Riessman, 1993). The data of the individual and group interviews with volunteers from the UBC teacher education cohort for technology studies were analysed by Labov's structural analysis approach to highlight the relation among the significant elements of observations and the interview interpretation.

Hypothesis Tests

Setting up and testing hypotheses are central to statistical inference. In order to formulate such a test, hypotheses are put forward, in the form of argument. Hypotheses were tested through accepting or rejecting a null hypothesis or an alternative hypothesis. A 2 x 2 x 2 (gender x program x academic year) factorial ANOVA (analysis of variance) was designed to test hypotheses on gender, program, and academic year effects, in addition to the combined effect/interaction of these factors. A factorial ANOVA is an ANOVA with two or more factors (two or more independent variables). Factorial designs are symbolized with a shorthand notation such as "2 x 2" (read as two by two) or "3 x 6" (three by six) where the first number refers to the number of levels of the first factor; the second number is the number of levels of second factor. Factorial designs allow for the analysis of the multiple factors and multiple interactions of multiple factors where the interaction refers to the joint effect of two or more factors on a dependent variable. The factorial ANOVA design was used to yield the results of the effects of gender, program and academic year on ICT competencies in general, where the first number "2" refers to the number of levels the program effect (1 = pre-program, 2 = post-program) and the second number "2" refers to two levels of the gender effect (1 = male, 2 = female). The third number "2" refers to two levels of the academic year effect (1 = academic year 2001-2002, 2 = academic year 2003-2004).

Several analyses were conducted in this design. First, I wanted to assess **Research Question One**: "Are there differences between pre- and post-program perceptions of ICT competencies?" This question addresses whether the program had a significant effect (e.g. main effects of program), independent of the gender effects and year effect. In this research question, I was interested in assessing whether the experience of the program had a statistically significant difference in ICT competencies. Second, I wanted to assess **Research Question Two**: "Are there gender differences in pre-service teachers' perceptions of, and attitudes toward, ICT competencies?" This question addresses whether gender had a significant effect (e.g. main effects of gender) without considering the program and academic year effects. In addition, I intended to assess whether the academic year (i.e., 2001-02 vs. 2003-04) had a significant effect (e.g. main effects of academic year). Simultaneously, I intended to examine if there were interaction effects among main effects of gender, program, and academic year.

Following the general Factorial ANOVA tests, correlation and multiple regression analyses were conducted to test hypotheses to address research question three: "How did the student teachers perceive their progress in ICT competency?" This question addresses the effects of student teachers' attitudes and perceptions toward, and self-efficacy of, ICT competencies.

Table 16. Description of Hypotheses

Research questions	Hypothesis	Methods	Variabes	
			Dependent	Independennt
1. Are there differences between pre- & post-program perceptions of ICT competencies?	I. Test of program	Factorial ANOVA 2 x 2 x 2	TCScale	Pre-/Post-Programs gender, year
	III. Test of year	2 x 2 x 2	TCScale	year 01-02, 03-04 gender, Pre-/Post-Pro.
	IV.Inter.of program, gender & year	2 x 2 x 2	TCScale	Pre-/Post-Programs, gender, year
	VII.Test of age	Factorial ANOVA 2 x 5	TCScale	Pre-/Post-Programs, age groups: 20-24, 25-29, 30-40, over 40, N/A.
	VIII.Inter.of age & program	2 x 5	TCScale	Pre-/Post-Programs, age groups: 20-24, 25-29, 30-40, over 40, N/A.
	IX.Test of the digital divide	Factorial ANOVA 2 x 2	TCScale	Pre-/Post-Programs, age groups:20-29, over 30.
	X.Inter.of program & digital divide	2 x 2	TCScale	Pre-/Post-Programs, age groups: 20-29 over 30.
2. Are there gender differences in student teachers' attitudes toward ICT competencies?	II. Test of gender & program	Factorial ANOVA 2 x 2 x 2	TCScale	gender, year, Pre-/Post-Programs
	IV.Inter.of program, gender & year	2 x 2 x 2	TCScale	Pre-/Post-Programs, gender, year
	V_1 & V_2. Test of gender & ICT use	Two-tailed t-test	Specific skills, ONLINE	male, female
	VI.Test of attitudes to ICT by gender	One way ANOVA	ATT	male, female
3. How do student teachers perceive their progress in ICT competencies?	XI. Test of access, attitudes to ICT ICT literacy	Correlation	TCPR1, ACC1, ATT	
			TCPR3, ACC3, ATT	
			TCSale ATT4	
		Regression (stepwise)	TCPR1	ACC1, ATT
			TCPR3	ACC3, ATT
	XII.Test of frequency of ICT use and ICTs	Correlation	TCPS2, UA2, UB2, UC2;	
			TCPS4, UA4, UB4, UC4.	
		Regression (stepwise)	TCPS2	UA2, UB2, UC2
			TCPS4	UA4, UB4, UC4

Hypotheses I to IV focused on research questions one and two by investigating the program effects, gender effects, and academic effects on the ICT scores of student teachers to obtain an overall picture of the program. Hypotheses V to X focused on specific areas of gender, age, the digital divide, and ICT competencies. Hypothesis XI and XII focused on research question three, examining the correlations among access to ICT, attitudes toward ICT, and ICT competencies in the Pre-Program Surveys 2001 and 2003 and the relationship among ICT use in various educational settings, attitude change, and ICT competencies in the Post-Program Surveys 2002 and 2004. The Alpha level was set at .05 for the hypothesis tests from I to X, and .01 for Hypotheses XI and XII. To avoid to making a type I error, in which a true null hypothesis is incorrectly rejected, and type II errors, in which a false null hypothesis is not rejected, a small p-value or a large p-value were not employed. The smaller the p-value is, the more convincing the rejection of the null hypothesis or vice versa.

Different methods were applied to test the hypotheses. Ghiselli et al. (1981) emphasized that "correlation between two methods designed to measure the same trait should be substantially higher than the correlation between two traits when they are measured with the same method" (p. 286).

Overall Tests

Hypothesis I. Pre-/Post-Program testing

H_0: $\mu_{pre} = \mu_{post}$

H_1: $\mu_{pre} \neq \mu_{post}$

Where:

H_0 = the null hypothesis

μ_{pre} = the mean ICT scores of the Pre-Program Surveys

μ_{post} = the mean ICT scores of the Post-Program Surveys

H_1 = the alternative hypothesis

Formulation of the null hypothesis is a vital step in statistical testing. When a null hypothesis is formed, it is always in contrast to an implicit *alternative hypothesis*, which is accepted if the observed data values are sufficiently improbable under the null hypothesis. The null hypothesis (H_0) postulated that the ICT scores of the Pre-Program Surveys were equal to that of the Post-Program Surveys. The alternative hypothesis (H_1) postulated that the ICT scores of the Post-Program Surveys were not equal to that of the Pre-Program Surveys.

Hypothesis II. Gender testing

H_0: $\mu_m = \mu_f$

H_1: $\mu_m \neq \mu_f$

Where:

μ_m = the mean ICT scores of male student teachers

μ_f = the mean ICT scores of female student teachers

According to previous research (Bryson et al., 2003, Clarke & Chambers, 1989), females scored lower than males in technology courses and performance. The second research question (see Chapter One) asks whether there was a statistically significant difference between male and female student teachers' ICT literacy. Hypothesis II tested gender effects on ICT scores between males and females in the teacher education program. The dependent variable was the same as in Hypothesis I, ICT scale, and the independent variable was gender coded: 1=male and 2=female, N = 2310 (males = 698, females = 1827). The null hypothesis (H_0) postulated that ICT scores for males were equal to those for females. The alternative hypothesis (H_1) postulated that the ICT scores of males were different from those of females.

Hypothesis III. Program testing by academic year

H_0: $\mu_{y1} = \mu_{y2}$

H_1: $\mu_{y1} \neq \mu_{y2}$

Where:

μ_{y1} = the mean ICT scores of academic year 2001-2002

μ_{y2} = the mean ICT scores of academic year 2003-2004

The intent for Hypothesis III was to examine patterns of ICT literacy and therefore to predict any trend of ICT literacy. Hypothesis I examined the differences, if any, in ICT between pre-program and post-program stages. Hypothesis II investigated the gender differences in ICT competencies. Hypothesis III compared the mean ICT scores for academic year one (academic year 2001-2002, N =1329) with that for academic year two (academic year 2003-2004, N = 960). The null hypothesis H_0: $\mu_{y1} = \mu_{y2}$ postulated the mean ICT scores for academic year one was equal to that for academic year two. The alternative hypothesis H_1: $\mu_{y1} \neq \mu_{y2}$ postulated the mean ICT scores for academic year one was different from that for academic year two. The TCScale was used as dependent variable, as in Hypotheses I and II, and the independent variable was academic year coded: 1 = academic year 2001- 2002, 2 = academic year 2003- 2004. These three sets of hypotheses were tested for 2001-2002 and 2003-2004 academic years respectively to ascertain the consistency of the findings and also to examine a trend for ICT literacy.

Hypothesis IV. Interaction testing

H_0: All $(\mu_{mpre} - \mu_{f\,pre} - \mu_{mpost} - \mu_{fpost}) = 0$

H_1: All $(\mu_{mpre} - \mu_{f\,pre} - \mu_{mpost} - \mu_{fpost}) \neq 0$

Where:

μ_{mpre} = the mean ICT scores for male student teachers in the Pre-Program Surveys

$\mu_{f\,pre}$ = the mean ICT scores for female student teachers in the Pre-Program Surveys

μ_{mpost} = the mean ICT scores for male student teachers in the Post-Program Surveys

μ_{fpost} = the mean ICT scores for female student teachers in the Post-Program Surveys

The null hypothesis H_0: All $(\mu_{mpre} - \mu_{f\,pre} - \mu_{mpost} - \mu_{fpost}) = 0$ postulated there was no interaction of gender effect and program effect with ICT literacy across the 2001 to 2004 surveys. The alterative hypothesis H_1: All $(\mu_{mpre} - \mu_{f\,pre} - \mu_{mpost} - \mu_{fpost}) \neq 0$ postulated an interaction effect. Interaction is a situation in which the effect of one factor depends upon another factor. Factorial ANOVA was used to analyse the factors and the interaction between the factors to assess whether the factors, gender and program, interact with each other to affect scores on the dependent variable (ICT scores). If the difference of the ICT scores between the two levels of program (or the intervals between the pre-program and post-program) depends on gender, an interaction of program and gender exists. If the difference between the pre-program and post-program were the same for females and males, then there should be no interaction. In addition, an exploratory factorial ANOVA was conducted, which also included program and age effects to determine if there were main effects and interactive effects of the program.

Hypotheses I, II, III and IV were performed simultaneously with factorial ANOVA. The same analysis also provided results of tests for interaction of gender, pre-/post-program and academic year. For these four hypothesis tests, the dependent variable was TCScale (see Table 4); the independent variables were: program with two levels [1 = pre-program (2001, 2003), N=1568; and 2 = post-program (2002, 2004), N = 1053] for Hypothesis I; gender with two levels (1 = male, 2 = female) for Hypothesis II; academic year with two levels (1 = academic year 2001-2002, 2 = academic year 2003-2004) for Hypothesis III; all the data involved in the three hypotheses, TCScale, program, gender, and academic year, were collapsed for Hypothesis V interaction (see Table 16).

Hypotheses V_1 and V_2. Testing gender and multimedia use

$H_0: \mu_m = \mu_f$

$H_1: \mu_m \neq \mu_f$

Communicating with ideational function, interpersonal function, and textual function (Carey & Guo, 2003; Guo, 2005; Halliday, 1973; Halliday & Mattiessen, 1999), online participants could explore the ICT schemata and promote interpersonal appreciation, awareness, and ICT literacy in an authentic language environment. Language was viewed as a transparent medium. White (1985) pointed out, "Writing and reading are exercises for the whole mind, including its most creative and imaginative faculties" (p. 32). As Brown (1994) stated, "theories of communicative competence emphasize the importance of interaction as human beings use language in various contexts to 'negotiate' meaning, or simply stated, to get one idea out of your head and into the head of another person and vice versa" (p.159). Feeling comfortable in communicating online would greatly increase the speed of reaching the online community. Also, actively engaged participation in communication greatly enhanced the opportunity of using the technologies to express ideas, feelings and values; therefore, the online users' ICT competencies could be significantly improved.

It was hypothesized that, by the end of the teacher education program, there would be no statistically significant difference in multimedia competencies between males and females. It was assumed that both male and female student teachers had equal opportunities and access to multimedia at UBC. Hypothesis V_1 investigated the student teachers' self-evaluation on ICT competencies in both the Pre-Program Survey 2003 and Post-Program Survey 2004. Each item that the TCScale was derived from (Table 4) in the multimedia subset of the surveys was used as a dependent variable with a range from 1 to 3 and gender was an independent variable coded 1 = male, 2 = female.

A two-tailed *t*-test was run with the alpha level at .01 to test hypothesis V_1. Two-tailed *t*-tests are frequently used when there is no basis to assume that there may be a significant difference between the groups of variables whereas a one-tailed t-test is used when there is some basis (e.g. previous experimental observation) to predict the direction of the difference, e.g. expectation of a significant difference between the groups. Previous experimental observation was not available for this study, so two-tailed *t*-test was applied.

Each item in this subset of the Post-Program Survey 2004 was tested against this hypothesis to identify if there existed a gender difference in any of the specific multimedia skills such as creating a database, spreadsheet or presentation document, making a web bookmark or favourite, recording music using a computer and so on.

Then, hypothesis V_2 examined if there were gender differences in online communication. The purpose of testing hypothesis V_2 was to draw a conclusion from all the differences observed from the hypothesis tests. Considering that the range of each item of the dependent variable was small (some items had a range from 1 to 3), which might affect the results of the tests, items on the same topic were grouped as a dependent variable to test hypothesis V_2. Gender was an independent variable as in Hypothesis V_1, the subscale ONLINE (online communication) (Table 14) used as a dependent variable to test Hypothesis V_2 with one way ANOVA.

Hypothesis VI. Testing gender and attitudes toward ICT

H_0: $att_m = att_f$

H_1: $att_m \neq att_f$

Where:

att_m = the mean ATT scores for male student teachers

att_f = the mean ATT scores for female student teachers

It was hypothesized that attitudes toward ICT were related to ICT competencies. As a corollary, it was arguable that there was a difference in attitudes toward ICT if there was a gender difference in ICT competencies. The null hypothesis H_0: $att_m = att_f$ postulated that there was no difference between male and female student teachers. The alternative hypothesis H_1: $att_m \neq att_f$ postulated there was a statistically significant difference between male and female student teachers' perceptions of ICT. A one-way ANOVA was used to test if male and female student teachers perceived ICT differently. The attitudinal scales (ATT) (Table 5) by year (2001, 2002 and 2003 respectively) were used as a dependent variable by year, and gender (Male = 1, Female = 2) as an independent variable. As the Post-Program Survey 2004 included a different set of items in the attitudinal section from the previous three years and they were not comparable, separate analyses were conducted to the attitudinal section in 2004 and both quantitative and qualitative data from the Post-Program Survey 2004 were examined.

Further tests on each item included in the attitudinal scales for each year were conducted with ANOVA to identify specific items that consistently showed significant gender differences. Each of the items was used as a dependent variable ranging from 0 to 4, gender as an independent variable. One-way ANOVA was applied to test Hypothesis VI.

Age Testings

Hypotheses VII_1 and VII_2. Age testing

H_0: There is no difference in mean ICT score among the five age groups.

H_1: At least one mean ICT score in one age group is different from those of other four groups.

Hypothesis VII examined another dimension of demographic distribution, the ICT distribution for different age groups. This test addressed the teacher education program's effect on pre-service teachers' ICT literacy in different age groups. As explained in Chapter two, young students, born in 1980s and after 1990s, are called "native speakers" of the digital language of computers, video games and the Internet, while those who are older are called digital immigrants (Prensky, 2001). It was hypothesized that there might be statistical difference among the age groups, e.g. the ICT scores for the age group 20 to 24 might be higher than those of the other age groups 25 to 29, 30 to 40, over 40 and N/A group (no age information available). Two phases were involved testing Hypothesis VII_1 with two steps : first step in Hypothesis VII_1 included five age groups in the independent variable with N/A group and second step comprised four age groups without the N/A as independent variable.

Missing or invalid data such as N/A (information not available) are generally too common to ignore. Survey respondents might have refused to answer certain questions. It is useful to distinguish between those who refused to give information about their ages and those who gave information about their ages. So level 5 N/A was included to examine the differences. In test two of hypothesis VII_1, the categorical variable level 5 N/A was taken out to run the hypothesis again to examine if there was any difference among the other four independent categories (1 = age group 20 to 24, 2=age group 25 to 29, 3=age group 30 to 40, 4=age group over 40). The dependent variable TCScale, ranging from 0 to 39, was used as a measure for ICT scores in Hypothesis I, II, III, and IV.

If a significant F-value was obtained in Hypothesis VII_1, Hypothesis VII_2 would proceed with a Post Hoc test. While an F-value would tell whether the smallest and largest means were significant different from each other, post hoc tests would provide comparisons of age groups. The most widely used Post hoc test is Tukey, which is experimental-based. Again, since my data were not experimental, I chose Scheffe, among other Post Hoc methods such as Bonferroni, Sidak, Tukey, Duncan, etc, to examine all possible linear combinations of age group means, not just pairwise comparisons. Scheffe runs simultaneous joint pairwise comparisons for all possible pairwise combinations of means.

Factorial ANOVA was applied for Hypothesis VII_1 and Post Hoc (Scheffe) was run to compare the mean scores of the age groups by testing Hypothesis VII_2 with the alpha level .05. One objective was to examine if there were main effects of the independent variable program (1 = pre-program, 2 = post-program) and the age effects on the ICT scores measured by the dependent variable TCScale.

A conclusion might be cautiously drawn on results of these tests to determine if the group of student teachers who did not provide age information were different from those who provided age information. A sample was drawn from 2003-2004 academic year survey.

Hypothesis VIII. Interaction of age, pre and post-program and TCScale

H_0: $(\mu_{pre} - \mu_{post})(\mu_{group1} - \mu_{group2} - \mu_{group3} - \mu_{group4} - \mu_{group5}) = 0$

H_1: $(\mu_{pre} - \mu_{post})(\mu_{group1} - \mu_{group2} - \mu_{group3} - \mu_{group4} - \mu_{group5}) \neq 0$

Where:

μ_{group1} = the mean TCScale for the age group 20 to24

μ_{group2} = the mean TCScale for the age group 25 to 29

μ_{group3} = the mean TCScale for the age group 30 to 40

μ_{group4} = the mean TCScale for the age group over 40

μ_{group5} = the mean TCScale for the group without age information (N/A)

The null hypothesis postulated that there was no interaction of age effect and program effect on ICT literacy in 2003-2004 academic year surveys while the alterative hypothesis postulated that there was an interaction. If the difference of the mean TCScale between the two levels of pre-program and post-program depended on any level of the five categories of age, an interaction would exist by program and by age. If the difference between the pre-program and post-program mean TCScale would be the same for all five levels of the factor age, then there should be no interaction. If there were no main effects of either program or age, then there were no interactions involving these variables, indicating the patterns by program and by age were similar to the patterns previously described in the overall analysis. A factorial ANOVA 2 x 5 (program by age) was run to compare the mean scores of these groups based on Hypothesis VIII. Both the dependent variable and independent variable were the same as in Hypothesis VII.

Demographically, the vast majority of students were between twenty and forty years old, but ages ranged upwards from fifty to sixty in 2001 and 2003. The majority of students were female (69% and 73% in 2001 and 2003 respectively).

Hypothesis IX. The Digital divide

H_0: $\mu_{dn} = \mu_{di}$

H_1: $\mu_{dn} \neq \mu_{di}$

Where:

μ_{dn} = the mean ICT score measured by TCScale for the age group 20 to 29

μ_{di} = the mean ICT score measured by TCScale for the age group 30 to over 40

Hypothesis IX was conceived to test if there was any difference in ICT score for the digital natives and digital immigrants. In this set of hypothesis, the null hypothesis postulated that the digital immigrants had the same ICT skills as the digital natives while the alterative hypothesis H_1 postulated that there was a difference between the digital natives and the digital immigrants in ICT competencies. A 2 x 2 factorial ANOVA test was designed, with a dichotomous division of age and age was one independent variable. Age group was divided according to the digital Native/Immigrant divide as independent variable (1 = age groups 20 to 24 and 25 to 29, 2 = age groups 30 to 40 and over 40). According to the birthday divide, the digital natives included age groups 20 to 29, and the digital immigrants included age groups 30 to 40 and over 40. The dependent variable ICT scale and alpha level were the same as in other hypotheses.

Hypothesis X. Interaction of age (digital divide), pre and post-program and ICT scores

H_0: $(\mu_{pre} - \mu_{post})(\mu_{dn} - \mu_{di}) = 0$

H_1: $(\mu_{pre} - \mu_{post})(\mu_{dn} - \mu_{di}) \neq 0$

Hypothesis X was designed to examine if an interaction existed between program and age. This test would confirm if the results of hypothesis X and hypothesis VIII were consistent.

Attitude Tests and Regression Hypotheses

Hypotheses were tested to find if there was a connection between pre-service teachers' attitudes toward ICT and their self-efficacy of ICT competencies, and if there were relations between frequency of ICT use and their perceptions of ICT competencies. Student teachers' attitudes were measured on a continuous scale. It was hypothesized that their attitudes towards ICT might be related to their ICT literacy and competencies.

Hypothesis XI. Access, attitudes toward ICT and ICT literacy

H_0: $\mu_{acc} - \mu_{att} - \mu_{ict} = 0$

H_1: $\mu_{acc} - \mu_{acc} - \mu_{ict} \neq 0$

The null hypothesis H_0 stated that access and attitude towards ICT did not affect the student teachers' performance on ICT. The alternative hypothesis H_1 argued that access and attitudes made a difference in performance and that positive attitudes towards ICT increased ICT scores and competences.

It was hypothesized that the accessibility of technology and the frequent use of technologies during course work and during practicum increased ICT competencies. Given that the pre-test scores were not affected by the program, both pre-program 2001 and 2003 surveys were examined to test the correlations between accessibility of technologies, attitudes toward ICT and ICT competencies. Since ANOVA tests were conducted on age, gender, program and ICTs, and in order to avoid redundant analysis, these variables were not included in the correlation tests. Petrina (2000) claimed that ICT capability was the potential for efficient, practical, quality work in design (Petrina, 2000. p. 181). It is not likely that a person is ICT literate but lacks knowledge of technology. Technology capabilities could be developed along a continuous growth of learning from low to high, novice to expert, and poorly developed to highly developed, or limited to extensive dimensions. Every individual has a unique combination of potential that dynamically change over time with training and practice.

Hypothesis XI was tested with multiple regressions to identify predictors of ICT competencies in the year 2001 and 2003. As mentioned earlier, regression produces conditional predictions among variable under study. Multiple regression employs more than one independent X variable to predict the value of the Y variable. Multiple independent x variables, such as access (ACC1, created in Table 9; ACC3, Table 10), attitudinal scales (ATT, Table 5), UA2 and UB2 (Table 11), UA4 and UB4 (Table 12), and UC (Table 13) were used as predictors to predict dependent variable y, including sub-TCScales, TCPR1 (Table 6), TCPS2 (Table 7), TCPR3 (Table 8), and TCScale (Table 4) in Hypotheses XI and XII respectively.

Frequent Use and ICT Scores: Correlation Tests

Hypothesis XII. Frequent use of technologies and ICTs:

H_0: Correlation between frequent use of technologies and ICT = 0

H_1: Correlation between frequent use of technologies and ICT ≠ 0

In hypothesis XI, the null hypothesis (Correlation between frequent use of technologies and ICT competencies = 0) stated that there was no correlation between the two variables of frequency of technology use and ICT competencies, while the alterative hypothesis (Correlation between frequency of ICT use and ICT competencies ≠ 0) stated that the frequency of ICT use and ICT competencies were related to each other. What was the relationship among ICT competencies and integration with technologies during university course work and during practicum? Mitchell (2001) argued that more access to and more practice with technologies increases ICT competencies. Given that post-scores might be more valid for correlation tests for the student teachers who had equal access to technologies and facilities during the program, I designed a test for correlation of ICT competencies across the post-program surveys 2002 and 2004: 1) the frequency of technology use by the student teachers during their course work at UBC; 2) the frequency of technology use by the student teachers during their practicum, and 3) the frequency the student teachers asked their students to work with ICT at practicum schools. Pearson Correlation was conducted to analyse relationships among variables TCScale, UA2, UB2, UA4, UB4, and UC. Items from 18 to 32 in the Post-Program Survey 2004 (see Appendix A) were used as a dependent variable. The p-value was set at .01 (2-tailed). If there was no relationship among the variables, the correlation would equal zero. If the findings claimed that there was a relationship among the variables, then a frequency of technology use and integration of technology into course work and practicum may be one of the solutions to enhance ICT literacy.

Ethnographic Approaches to Qualitative Data

While statistical analysis was the dominant approach in this study, an ethnographic approach was employed for detailed qualitative data collection. A major difference between ethnography and other research approaches is the depth and intimacy of ethnography. Another difference is that any information, including interviews, comments by people, and observations, can be used as data in ethnographic research (Machin, 2002). The researcher in ethnographic approach is closely and personally involved with the research participants in the natural context of their activities.

The researcher observed, listened to, and did all of this in the settings where the action took place. An ethnographic approach was applied to interpret and describe the qualitative data gleaned from the teacher candidates. Data sources included group interview, teacher candidates' microteaching, online communication and observations.

Video Ethnography

Microteaching has become a widely known technique in teacher education and educational research (Allen & Ryan, 1969). Technologies and new multimedia have provided more opportunities for both teacher educators and teacher candidates to observe and monitor microteaching. Not using technology in the classroom could deprive students of access to valuable information, ideas and tools for knowledge construction and sharing (Gabler & Schroeder, 2003). Gabler and Schroeder stress that successful classroom integration of technology depends on a larger context that involves the pedagogical settings, for instance, teacher versus student centred and other conditions including the Internet accessibility, hardware and software availability.

The participants included all of the 48 teacher candidates, M = 40 and F = 8, in the technology cohort in the teacher education program of UBC in 2003. All the videotapes of the students' microteaching were examined and three of them were collected (with consent and ethics approval). Five teacher candidates participated voluntarily in the group interview after their practicum. Interviews were taped, transcribed, and then interpreted and described in an ethnographic approach. The teacher candidates completed two microteaching sessions in a term. The first one lasted six minutes and second one lasted ten minutes. These data provided a rich description of the technology curriculum in teacher education. The data also illustrated what the student teachers had done with technology in their practicum.

Narrative Analysis and Grounded Theory

Data from interviews, course assignments and online communications were analysed using Labov's framework of narrative analysis and grounded theory. A narrative of personal experience is a recount of a sequence of events that the narrator attempts to convey simply and seriously as an important experience in the lives of participants. The narrative analysis of experience introduced by Labov includes abstract, orientation, complication action, and coda. Abstract is an initial clause in a narrative that begins the sequence of the recount of the narrative; An orientation offers information on the time, place of the events, the participants and their initial behaviours of the narrative; complicating action is a sequential report in response to a potential question such as "what happened next"; a resolution/coda is an ending report which brings the narrative to the time of speaking, with a preclusion of a potential question, "and what happened then?" With Labov's methodology, the social discourse of the narrative can have a better representation of the cause and effect of an event. The sociolinguistic components of Labov's framework reveal what happened, why it happened, what happened next, and how the narrator thought when the event occurred and the narrator's reflections on the event or past experience afterwards. According to Labov (1997), experience narratives have been drawing attention in many academic and literacy disciplines. Labov put evaluation as an important component of narrative analysis. As speakers gain the ability to evaluate their experience, what the narrator feels or senses in the narrative in the form of negatives, comparatives, modals and futures therefore can be read as a form of evaluation. Analysis of narrator's evaluation is important because it reflects a more accurate interpretation of the narrative. Therefore, I included evaluation in the framework of interview analysis to yield an enriched, elaborated understanding of the complex phenomenon of ICT literacy.

Grounded theory was applied to systematically analyse data from WebCT communication of pre-service language teachers for an inductive discovery. I initially identified three main topics to be examined:

1. What attitudes did pre-service language teachers hold toward information technology?
2. How did pre-service language teachers use technologies to enhance second language acquisition (SLA) in practicum schools?

3. What attitudes did pre-service language teachers hold toward information technology after the course work and practicum?

I integrated the different sources of data collected and then eliminated redundant results by a method of constant comparison of the data. The constant comparison is inductive in that the analysis shifts from specific information to a broader, more inclusive conclusion (Strauss & Corbin, 1990). The above methods were the main approaches combined with quantitative and qualitative methodologies to satisfy my research objectives: survey results provided measurable factors; discourse analysis offered a meaningful knowledge structure, including being (the identities), doing (the practices), and sensing (the evaluation), within the examined field; narrative analysis and grounded theory represented a rich and in-depth description of interviews.

Conclusion

In this chapter, I introduced the methods adopted for my research. A blending of qualitative and quantitative research approaches to the study was employed, including inferential analysis and interpretive analysis of the characteristics of ICT literacy in the teacher education program at the University of British Columbia. I proposed 12 hypotheses to investigate three major research questions dealing with program effects and ICT, gender effects and ICT and attitudinal dispositions and ICT. Data collection and analysis included questionnaires, interviews, and class observations. Questionnaires were used to gather data by sampling responses from a wide range of participants. Interview data yielded additional information regarding the respondents' feelings and opinions. The participants of this research were invited to give opinions on teacher education and their expectations and to comment on uses of technology in the curriculum. I described why they were chosen and how these methods were used in my research to represent different aspects of the case study.

Combining qualitative and quantitative approaches allowed me, as a researcher, to have reflexive responsibilities to examine my own practices in this dissertation research. Quantitative data provided measurable factors in a wide range of sampling but was not able to reflect the effects of variables not included in the research design. Qualitative data offered a rich and in-depth description of perspectives and values from points of views from multi-dimensions and multi-layers. A merger of the two approaches complements the features and disadvantages of each other to yield reliable research results and convincing findings. The dataset of this research, however, does not deal with factors such as ethnicity or socioeconomic status in teacher education. As indicated, a stand-alone technology course is *not* required for all students in our teacher education program, and the Faculty of Education generally subscribes to an integration model for ICT. Individual experiences of ICT vary widely depending on subject-area or grade-level focus, and depending on the focus of individual instructors.

CHAPTER FOUR
QUANTITATIVE ANALYSIS AND FINDINGS

Introduction

This chapter presents quantitative findings from both descriptive and inferential analyses of hypothesis tests. Descriptive analyses include preliminary explorations of student demographics phenomena, such as gender, pre/post program performances, and student perceptions of their competencies with basic and multimedia technologies. Findings from inferential analyses provide information to draw conclusions about ICT literacy from the period of time under investigation. This chapter focuses on findings related to gender, the digital divide and predictors of ICT literacy in teacher education.

Data Analysis with Quantitative Approach

Findings Related to Research Questions One and Two

Hypotheses I to VI were conducted to investigate the **first two major research questions**: "Are there differences between pre- and post-program perceptions of ICT competencies?" and "Are there gender differences in pre-service teachers' views of, and attitudes toward, ICT competencies?" Factorial ANOVA involving the procedure of GLM General Linear Model (GLM) was used. Factorial ANOVA tests each of several factor effects simultaneously on the dependent variable. Although it is not fatal for ANOVA tests to fail to meet the assumption of homogeneity of sizes, I also managed to create equal sample sizes and large sample sizes to test the hypotheses and to confirm the results yielded from the tests I conducted and reported in this document.

A Levene test was used for the homogeneity of variances across samples before the ANOVA tests. The Levene test was an alternative to the Bartlett test, which is more commonly used by statisticians. However, the Bartlett test is known to be sensitive to non-normality while Levene test is less sensitive to non-normality than the Bartlett test. The dataset in this study was not a perfect normal distribution (Figure 12), with less than 68% of the observations falling within a standard deviation (SD = 9.85) of the mean (mean = 24.32, Figure 12), and the sampling distribution was less symmetrical, so a Levene test, instead of Bartlett test, was applied to verify the equality of the two variances. When the Levene test was significant ($P < .05$), the two variances were significantly different. When it was not significant ($P > .05$), the two variances were not significantly different; that is, the two variances were approximately equal. The Levene test showed that the normality was acceptable. The ANOVA tests proceeded under the condition that the significance of the Levene test for the model was above .05 ($F = .049, p = .986$, Figure 12).

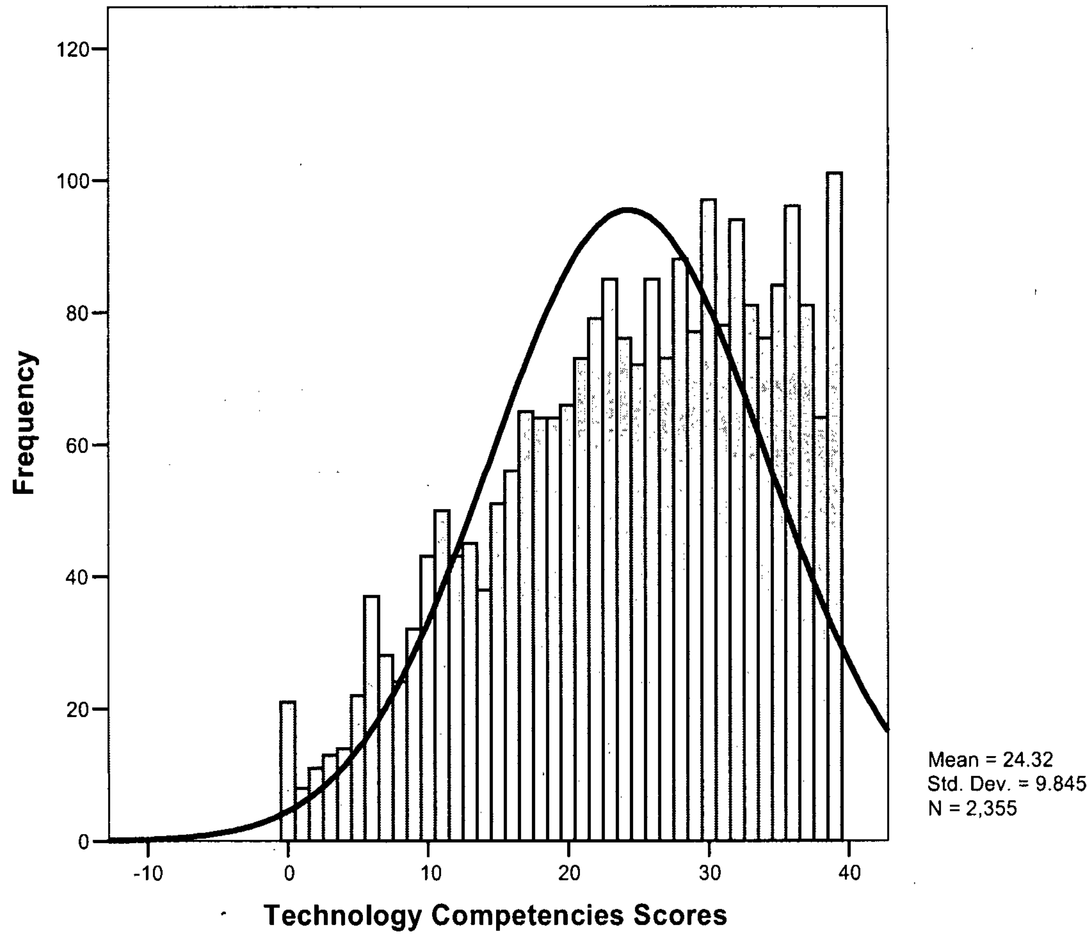


Figure 12. Data distribution from 2001 to 2004

Hypotheses I to III: Testing effects of program, gender and academic year

The initial analysis was to carry out a 2 x 2 x 2 factorial ANOVA to test for ***program effects***, ***gender effects*** and ***academic year effects*** by combining the pre- and post-program data for each of the two academic years that the surveys were administered (2001-2002 and 2003-2004). Because of the large differences in the numbers of female versus male respondents, a set of tests were subsequently run with generated random samples of equal size for females and males to see if the results of these latter tests were consistent with those of the initial 2 x 2 x 2 factorial ANOVA tests (see appendix B). The results of testing for hypotheses (I-IV) were displayed in Table 17 and Table 18. Hypothesis I tested changes in the student teachers' self-efficacy of ICT competencies between the beginning and end of the program.

Table 17. The ICT mean scores by program, gender and year (2001- 2004)

Dependent Variable: Technology Competencies Scores

Program	Year	Gender	Mean	Std. Deviation	N
Preprogram	2001-2002 academic year	male	25.23	9.962	228
		female	19.23	9.457	576
		Total	20.93	9.972	804
	2003-2004 academic year	male	25.08	9.892	190
		female	21.24	9.585	547
		Total	22.23	9.803	737
	Total	male	25.16	9.919	418
		female	20.21	9.568	1123
		Total	21.55	9.910	1541
Postprogram	2001-2002 academic year	male	29.31	9.154	143
		female	25.49	8.595	382
		Total	26.54	8.906	525
	2003-2004 academic year	male	29.39	8.900	67
		female	26.73	8.493	156
		Total	27.53	8.684	223
	Total	male	29.34	9.052	210
		female	25.85	8.576	538
		Total	26.83	8.846	748
Total	2001-2002 academic year	male	26.81	9.849	371
		female	21.73	9.622	958
		Total	23.14	9.947	1329
	2003-2004 academic year	male	26.20	9.811	257
		female	22.46	9.623	703
		Total	23.46	9.810	960
	Total	male	26.56	9.830	628
		female	22.04	9.626	1661
		Total	23.28	9.888	2289

Table 17 presented the distribution frequency of ICT scores for the pre- and post-program survey through 2001 to 2004. As seen from Table 17, 2,289 student teachers responded to the surveys with nearly three times more female student teachers than males (Pre-program: M = 418, F = 1123; post-program: M = 210, F = 538). Both male and female student teachers increased their ICT self-efficacy scores in post-programs. The post-program ICT mean scores in the 2002 survey for male student teachers was 4.08 (29.31-25.23), higher than that of the pre-program 2001 and the mean scores for female student teachers was 6.26 (25.49-19.23), higher than that of the pre-program. Female student teachers entered the program with lower scores than that of males. As indicated from Table 5, the gender gap in pre-program 2001 was 6 (25.23-19.23) and 3.86 (29.31-25.45) in post-program 2002. The gap was narrower in the following year. The difference in ICT scores between males and females in the pre-program 2003 survey was 3.84 (25.08-21.24), favouring males; this gap slightly decreased to 3.54 (29.34-25.85) in the post-program survey, still favouring males. The gender gap was around four points in pre-program 2003 and 2.5 in post-program 2004. Findings from the analysis of the initial 2 x 2 x 2 (program by gender by academic year) factorial ANOVA revealed a statistically significant difference in ICT scores between pre-program and post-program, favouring the post-program (see Table 18).

Table 18. The effects of gender, year and program on ICT scores (2001- 2004)

Dependent Variable: Technology Competencies Scores

Source	df	F	Sig.
Gender	1	69.142	.000
AcYear	1	2.601	.107
Program	1	105.376	.000
Gender* AcYear	1	2.871	.090
Gender* Program	1	2.945	.086
AcYear * Program	1	.078	.780
Gender* AcYear* Program	1	.260	.610
Error	2281		
Total	2289		

The effects of the program were measured by the pre-post tests. The *F* value for "the Program Effect" was: $F\ (1, 2281) = 105.376, p < .01$, favouring the post-program. The *F* value for gender effects was: $F\ (1, 2281) = 69.142, p < .01$. There was a statistically significant difference in ICT scores between male and female student teachers, favouring the males. The *F* value for academic year was: $F\ (1, 2281) = 2.601, p = .107$. There was no statistically significant difference in ICT scores between the academic year 2001-2002 and the year 2003-2004, indicating that the academic years were in the similar pattern of ICT literacy. Among the three effects of program, gender and academic year, the first main effect was program, e.g. the duration of the program; the second main effect was gender.

Hypothesis IV: Interaction Testing

As seen from Figure 13, the distribution of the scores on the pre/post-program surveys was approximately parallel and indicated that the student teachers had a higher mean ICT scores at the end of the program. There was no statistically significant interaction of gender effects and program effects and academic year effects (a combination of academic year 2001 and 2002, and 2003 and 2004) on ICT scores. The F value for interaction of gender and academic year effects was: $F(1, 2281) = 2.871, p = .090$; the F value for interaction of gender and pre/post program effects was: $F(1, 2281) = 2.945, p = .086$; the F value for interaction of academic year and pre/post program effects was: $F(1, 2281) = .078, p = .780$; the F value for interaction of gender, academic year and pre/post program effects was: $F(1, 2281) = .260, p = .610$. None of the interactions was statistically significant in either of the academic years, which indicated that the differences between pre-program and post-program in ICT competencies were the same for both male and female student teachers, the differences between in ICT competencies for academic years remained the same for male and female student teachers (Table 18, Figure 13, Figure 14). The non-significant interactions between gender and academic year, gender and program, academic year and program, and the non-significant interactions among gender, program and academic year indicated that the program and academic year did not favour one gender or disfavour another. Feng (1996) had similar findings with his research, and claimed non-significant interaction indicated that the differences in dependent variable between the duration of the times under study were the same for the different levels of the same variable.

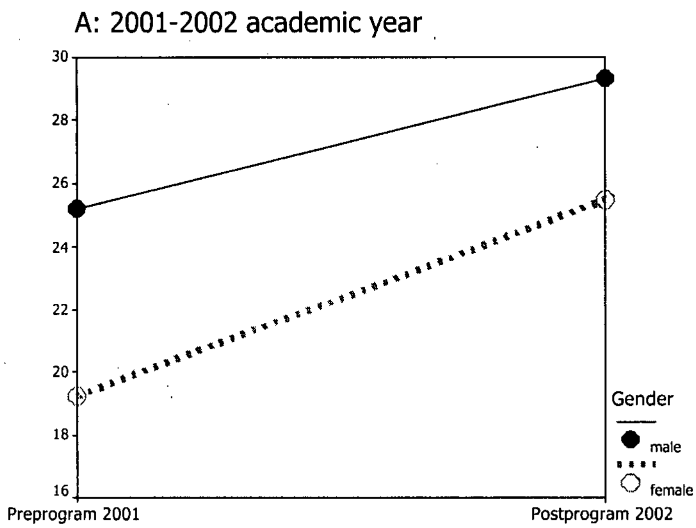


Figure 13. The interaction between gender and program (2001- 2002) on ICT scores

As Figure 14 indicates, there was no statistically significant interaction of gender effects and program effects on ICT scores in the academic year of 2003-2004 cohorts.

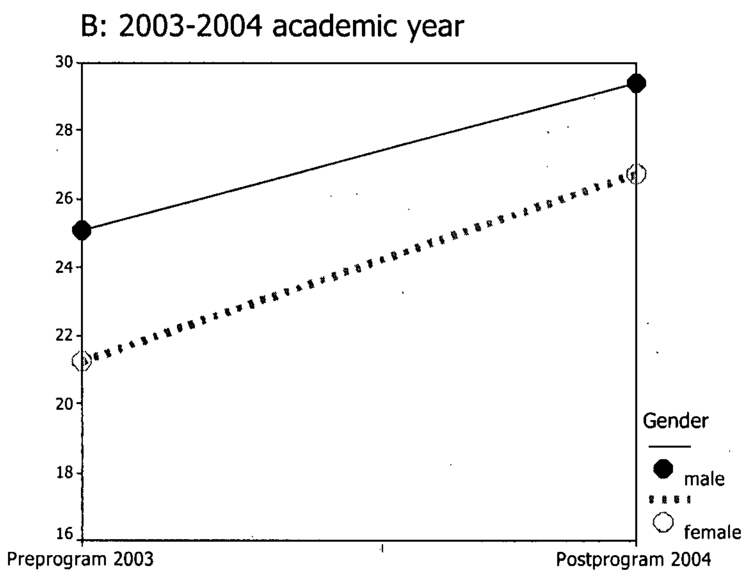


Figure 14. The interaction between gender and program (2003- 2004) on ICT scores

Figure 13 and 14 also suggest that both academic years shared a similar pattern in ICT literacy in the teacher education program. This pattern was consistent with the findings from tests by year (see appendix B): The gender gap in ICT skills was narrower at the end of the program, but the increase of females' rating of their ICT competencies was not enough to offset the difference between the gender gap at the start of their programs.

Since the pattern of ICT literacy between academic years was consistent, I collapsed the two academic cohorts and focused on gender and program effects. A 2 x 2 factorial ANOVA was designed to test for ***program effects*** and ***gender effects*** by combining the pre- and post-program surveys from 2001 to 2004. The F value for gender effect was: $F(1, 2306) = 84.409, p < .01$. There was a statistically significant difference in ICT scores between male and female student teachers, favouring the males. The F value for "the program effect" variable was: $F(1, 2306) = 110.416, p < .01$, favouring the post-program. There was a statistically significant difference in ICT scores between the Pre-Program and Post-Program Surveys (Table 19).

Table 19. The effects of gender and program on ICT scores (2001- 2004)

Dependent Variable: Technology Competencies Scores

Source	df	F	Sig.
Gender	1	84.409	.000
Program	1	110.416	.000
Gender*Program	1	2.289	.130
Error	2306		
Total	2310		

There were no interactions involving the independent variables gender and program, The F value for interaction of gender and program effects was: $F(1, 2306) = 2.289, p = .130$, which indicated that the ICT scores did not depend on a level of a variable, e.g. the differences in dependent variable ICT competencies between male and female student teachers remained basically the same in the Pre-Program Survey as that in the Post-Program Survey. This result was consistent with that of the previous tests on interactions of gender and program and academic year which indicated that the student teachers' self-efficacy of ICT competencies did not depend on a level of academic year, meaning their differences in ICT competencies were the same for both academic years under study.

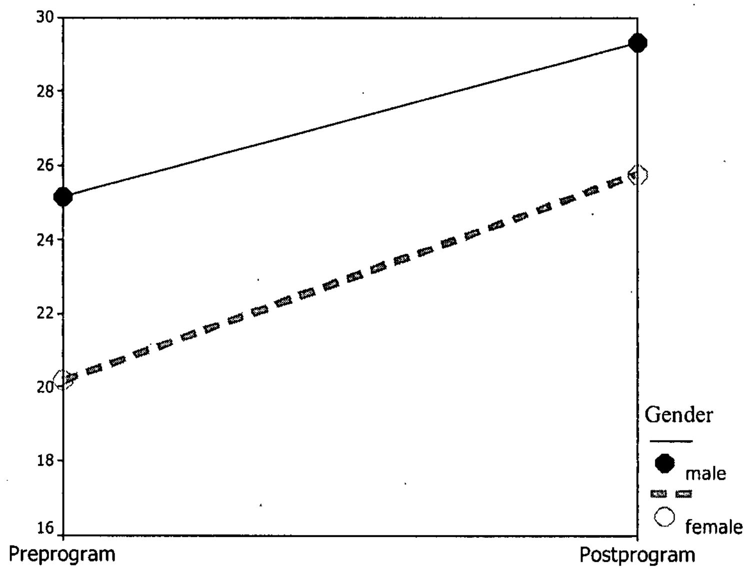


Figure 15. The interaction between gender and program (2001- 2004) on ICT scores

One way ANOVA was designed to test the gender differences in ICT competencies for both the Pre-Program Surveys (2001, 2003) and the Post-Program Surveys (2002, 2004) respectively. Findings showed that there was a statistically significant in ICT competencies between males and females, $F(1, 804) = 19.93$, p = .001, for the Pre-Program Survey 2001, $F(1, 737) = 26.68$, $p = .001$, for the Pre-Program Survey 2003; $F(1, 580) = 18.18$, $p = .001$, for the Post-Program Survey 2002, and $F(1, 242) = 5.35, p = .02$ for the Post-Program Survey 2004 (Table 20).

Table 20. ANOVA summary from 2001 to 2004

Technology Competencies Scores

Year		2001	2002	2003	2004
Male	Mean	25.23	29.31	25.08	29.31
	SD	9.96	9.15	9.89	8.75
Female	Mean	19.23	25.49	21.24	26.56
	SD	9.46	8.59	9.58	8.55
df		1, 804	1, 580	1,737	1, 242
F value		19.93	18.18	26.68	5.35
P value (Sig.)		0.001	0.001	0.001	0.02

Women arrived with much lower skills but improved during the program. The gender gap in the pre-program ICT scores for both the Pre-Program Surveys (2001, 2003) was larger than that in the Post-Program Surveys (2002, 2004), but the change was not statistically significant.

Hypothesis V_1 and V_2: Testing gender and multimedia use:

Hypothesis V_1 predicted that student teachers who rated themselves as more competent would report having more experience in using multimedia. For example, using a scanner to manipulate digital imagines is considered a specific skill. Although female student teachers arrived with lower skills than their male peers in using a scanner, it was assumed that female student teachers would catch up to the males in this specific skill during the program, assuming equal access to a scanner. Hypothesis V_1 tested 13 specific skills from item 5 to item 17 by gender in the Post-Program Survey 2004 (see Table 5).

For the individual items, normality was acceptable. However, Levence tests were not satisfactory for each of the individual items. Three items (#8 Create a folder or directory, #9 Copy a file from one disc to another, and #16 download files to your computer) had F values less than .05, which meant that ANOVA tests could not proceed. Consequently, it was preferable to use *t*-test as a common analysis for all the individual items. Test values under equal variances assumed were reported for the ten items with Levene test values above .05; test values under equal variances not assumed were reported for the three items with Levene test values below .05.

Table 21. The *t*-test on specific skills by gender (2004)

	t-test for Equality of Means				
				95% Confidence Interval of the Difference	
	t-value	Mean Difference	Sig. (2-tailed)	Lower	Upper
5. Use a scanner to create a digital image.	.908	.12	.431	-.183	.427
6.Create or modify a database document.	.921	.14	.358	-.164	.452
7.Make a backup copy of a computer file.	2.129	.25	.034	.019	.484
8.Create a folder or directory.	1.890	.21	.060	-.009	.432
9.Copy a file from one disk to another.	1.880	.21	.061	-.010	.433
10.Create/modify a spreadsheet document.	2.557	.37	.011	.086	.662
11.Use a digital camera to create an image on a computer.	1.847	.28	.088	-.042	.596
12. Place an image into a document.	.849	.11	.397	-.149	.376
13. Create Powerpoint or Slideshow.	2.245	.32	.026	.040	.606
14. Make a web bookmark or favorite.	1.012	.12	.313	-.118	.367
15. Do an advanced search with AND/OR operator.	1.268	.16	.206	-.088	.407
16. Download files to your computer.	1.588	.15	.114	-.036	.339
17. Create or record your own digital music.	.648	.11	.518	-.220	.435

Table 21 indicates that the gender gap was statistically significant for 3 of the 13 items, but diminished in most specific skills, such as item 5 "use a scanner to create a digital image" [$t(240) = .908, p = .431$], 6 "creating or modifying a database document" [$t(239) = .921, p = .328$], item 11 "using a digital camera to create an image on a computer" [$t(237) = 1.711, p = .088$], item 12 "placing an image or graphic into a document" [$t(241) = .849, p = .397$], item 14 "making a web bookmark or favourite" [$t(240) = 1.012, p = .313$], item 15 "doing an advanced search with AND and OR operators" [$t(238) = 1.268, p = .206$], item 16 "downloading files to a computer" [$t(240) = 1.588, p = .114$], item 17 "creating or recording one's own music using a computer" [$t(240) = .648, p = .518$]. All the values of the confidence intervals of these items included a zero, with one end of the interval negative and the other positive, indicating the results were not significant. However, the gender gap existed, favoring male student teachers in these skills: item 7 "make a backup copy of a computer file" [$t(239) = 2.129, p = .034$], 10 "creating or modifying a spreadsheet document" [$t(239) = 2.557, p = .011$], and item 13 "creating a presentation PowerPoint or Slideshow" [$t(241) = 2.245, p = .026$]. The values of the confidence intervals of these items did not include zero, with two ends of the intervals positive, and the significant value $p < .05$.

Compared with the Pre-Program Survey 2003, the Post-Program Survey 2004 had a fewer items that showed statistically significant gender differences. While there were 3 of 13 items in the Post-Program Survey 2004 were statistically gender differences (in bold, Table 22), there were 12 of 13 items in the Pre-Program Survey 2003 showed statistically significant gender differences (in italic, Table 22).

Table 22. The *t*-test summary comparison of specific ICT competencies (2003 and 2004)

Item	Year	Gender	Mean	SD	*t* value	df	*p* value
Scanner	2003	Male	2.69	1.19	3.95	1, 813	*0.001*
		Female	2.33	1.15			
	2004	Male	2.78	1.12	0.91	1, 238	0.43
		Female	2.66	1.09			
Database	2003	Male	2.21	0.94	2.64	1, 812	*0.01*
		Female	2.01	0.95			
	2004	Male	2.64	1.09	0.92	1, 239	0.36
		Female	2.5	1.13			
Backup	2003	Male	3.39	0.87	6.01	1, 813	*0.001*
		Female	2.95	1			
	2004	Male	3.6	0.81	2.13	1, 240	**0.03**
		Female	3.35	0.86			
Folder	2003	Male	3.36	0.93	2.78	1, 816	*0.01*
		Female	3.15	0.96			
	2004	Male	3.65	0.72	1.89	1, 237	0.6
		Female	3.44	0.83			
Copy a File	2003	Male	3.47	0.87	4.26	1, 817	*0.001*
		Female	3.14	1			
	2004	Male	3.71	0.68	1.88	1, 239	0.61
		Female	3.5	0.84			
Excel	2003	Male	2.66	1.03	3.31	1, 815	*0.001*
		Female	2.39	1			
	2004	Male	3.17	1	2.56	1, 237	**0.01**
		Female	2.79	1.06			
Digital Camera	2003	Male	2.52	1.23	4.14	1, 816	*0.001*
		Female	2.14	1.14			
	2004	Male	3	1.14	1.85	1, 239	0.09
		Female	2.72	1.56			
Image/ Graphic	2003	Male	2.93	1.07	3.51	1, 816	*0.001*
		Female	2.62	1.1			
	2004	Male	3.34	0.94	0.85	1, 238	0.4
		Female	3.23	0.97			
Presentation	2003	Male	2.47	1.16	4.17	1, 813	*0.001*
		Female	2.1	1.11			
	2004	Male	3.29	0.94	2.25	1, 236	**0.026**
		Female	2.96	1.07			
Bookmark	2003	Male	3.41	0.98	2.61	1, 816	*0.009*
		Female	3.2	1.08			
	2004	Male	3.29	0.8	1.01	1, 236	0.31
		Female	2.96	0.9			
Search	2003	Male	3.08	1	1.67	1, 817	0.95
		Female	2.94	1.01			
	2004	Male	3.41	0.8	1.31	1, 239	0.19
		Female	3.25	0.9			
Download	2003	Male	3.41	0.81	3.6	1, 817	*0.001*
		Female	3.16	0.9			
	2004	Male	3.68	0.62	1.59	1, 238	0.11
		Female	3.53	0.7			
Record Music	2003	Male	2.73	1.23	5.65	1, 818	*0.001*
		Female	2.18	1.67			
	2004	Male	2.62	1.2	0.65	1, 239	0.52
		Female	2.51	1.18			

Hypothesis V_2 tested another aspect of the ICT competencies: online activities. Findings from the Levene test illustrated that the significance value p was above .05 for ten items and below .05 for three, so Hypothesis V_2 proceeded with a t-test. A two-tailed t-test at .05 was run against Hypothesis V_2 with dependent variable ONLINE (derived from Table 14) and independent variable gender (1 = male, 2 = female). The confidence interval included zero, with one end of the interval negative (-1.849), and the other positive (.512), which indicted that the results were not significant. The gender effect on online communication was not statistically significant different in the Post-Program Survey 2004, [$t(238)= -1.116, p = .265$].

The overall descriptive analysis found similar patterns for the pre-program surveys in 2001 and 2003. Students arrived with high levels of basic ICT competencies but lower levels of competencies in multimedia technologies. The TCScale scale combined eight items, dealing with basic technology skills, with five items dealing with the use of multimedia. The eight basic items were meant to investigate the students' self-efficacy of their ICT competences, this includes daily basic use of technologies for, and common in, classroom teaching (e.g., making a backup copy of a document file, creating or modifying an Excel document, creating a PowerPoint presentation and modifying a word document). In the pre-program survey, students rated themselves with high levels of competencies for modifying word processing documents (96% and 93% for the Pre-Program Surveys 2001 and 2003), creating an Excel document (60% and 47% for the Post-Program Surveys 2001 and 2003), creating a chart or graph (56% and 51%), using database software (35% and 33%), and creating a presentation (e.g., PowerPoint) (34% and 40%). The items on basic skills also included items to investigate student teachers' information fluency, a knowledge construct recognized by information experts (e.g., Committee on Information Technology Literacy, 1999). Librarians and information scientists identified skills for browsing and Boolean searches (database searches), downloading and installing applications, emailing and exchanging information through online discussions as basic survival skills in academic world. In 2001 and 2003, 93% of the student teachers reported they had medium or high skill levels in using email to exchange information and to attach documents. The majority of the student teachers felt comfortable using research engines to access information, and 97% of student teachers self evaluated medium or high skill levels in information fluency. However, only 38% had confidence in manipulating digital images, including skills in downloading or managing images from the Internet for their course work. The majority of student teachers were adept at downloading document files (56% in 2001 compared to 80% in 2003), but only a small percentage of student teachers were able to download MP3 files and digital music.

The five multimedia items prompted the student teachers to rate their competencies with peripherals such as digital cameras, media burners and scanners, indicating a certain level of skills in audio and image manipulations and applications. A considerably small percentage of student teachers (e.g., 12% in 2003) rated high skill levels in using multimedia and manipulating images. Students reported similar skill levels for manipulating audio files and creating music. In 2003, for example, 23% reported that they could manipulate audio files and burn a CD. Nearly three times as many students reported medium or high skill levels in downloading files than uploading files via a File Transfer Protocol (FTP) application. About 25% of the students in both 2001 and 2003 felt moderately or highly skilled in creating a web page and FTPing it to a server. On the pre-program survey, the students were prompted to place a value on basic ICT they anticipated using in the teacher education program— their ratings corresponded to their skills. Most anticipated using word processing and presentation software most often (from the Pre-Program Survey 2001) or placed the highest values on these skills (from the Pre-Program Survey 2003). Low percentages expected using multimedia (the Pre-Program Survey 2001) and placed relatively low values on these skills (the Pre-Program Survey 2003).

Hypothesis VI: Testing gender and attitudes toward ICT

Hypothesis VI examined if male and female student teachers perceived ICT differently. A one way ANOVA was run to test Hypothesis VI with the attitudinal scale (ATT, Table 5 a dependent variable by year and gender (1 = Male, 2 = Female) as an independent variable. Findings showed that there were statistically significant differences in both the Pre-Program Surveys 2001 and 2003 but not in both the Post-Program Surveys 2002 and 2004. The Post-Program Survey 2004 had a different set of items in the attitudinal section and a separate analysis was conducted. The results showed the same pattern as that in the Post-Program Survey 2002. Table 23 suggested there were statistically significant gender differences in attitudes toward ICT in both pre-program surveys, favouring males. The F value for gender effect on attitudes in 2001 was: $F(1, 853) = 10.154, p < .01$; The F value for gender effect on attitudes in 2002 was: $F(1, 526) = .002, p = .965$; The F value for gender effect on attitudes in 2003 was: $F(1, 812) = 4.174, p = .041$. Similarly, an analysis was conducted on the attitudinal items in the Post-Program Survey 2004 and no statistically significant gender differences were found in the results of the general test on attitudes toward ICT: $F(1, 238) = 238, p = .662$ (Table 23).

Table 23. Summary of gender and attitudes toward ICT (2001-2004)

ATTITUDE

	df	F	Sig.
2001 pre-program	(1, 853)	10.154	0.001
2002 post-program	(1, 526)	0.002	0.965
2003 pre-program	(1, 812)	4.174	0.041
2004 Post-Program	(1, 238)	0.191	0.662

The results of the analysis indicated that there was a statistically significant difference between male and female student teachers in attitudes toward ICT, indicating male student teachers had more positive attitudes toward ICT in the Pre-Program Surveys 2001 and 2003. No statistically significant gender difference in attitudes toward ICT was found in the Post-Program Surveys 2002 and 2004.

A detailed test was run to examine the attitudes to toward ICT and each item in Table 5 was used as a dependent variable and gender as an independent variable to test Hypothesis VI with One Way ANOVA. I found four patterns of dispositions toward ICT through further analyses of these individual items (Table 24):

- **Pattern A)** One item showed consistently statistically significant differences in all the surveys of three years: "I feel competent to use technology in my classroom in a meaningful manner", [2001: $F(1, 853) = 23.036, p < .01$, favouring males; 2002: $F(1, 521) = 9.099, p = .003$, favouring males; 2003: $F(1, 812) = 10.732, p = .001$, favouring males].
- **Pattern B)** One item found statistically significant gender differences in the pre-program 2001 and 2003 surveys, but not significantly different in post-program 2002: "I think that there is too much emphasis on using technology in the classroom" [2001:

$F(1, 853) = 8.455, p = .004$, favouring males; 2003: $F(1, 812) = 7.282, p = .007$, favouring males; but no statistical significantly difference shown in 2002].

- **Pattern C)** Five items indicated no statistically significant gender differences in the years under examination: "I am interested in learning more about how to use technology in the classroom" (not included in 2003), "I would like to teach computer skills in my future classroom"(not included in 2003), "The use of technology promotes student-centered learning" (not included in 2003), "I would like to use educational software in my classroom", "I would like to use multimedia to explore different ways to represent concepts."
- **Pattern D)** Three items indicated statistically significant gender differences in the 2001 survey, but not statistically significant gender differences in the 2002 and 2003 surveys: "I understand the ethical issues involved in using technology in the classroom" [2001: $F(1, 853) = 8.822, p = .003$, favouring males, but the statistical significant difference was not found in 2002 and 2003], "Integrating the use of technology across subject areas maximizes student learning" [2001: $F(1, 853) = 6.319$, $p = .012$, favouring males, but the statistical significant difference disappeared in 2002 and 2003], "New technology have a positive effect in transforming instruction" [2001: $F(1, 853) = 7.480, p = .006$, favouring males, but the statistically significant difference disappeared in 2002 and 2003].

However, the specific one-by-one item tests indicated that nine items showed no statistically significant gender difference but one item was exceptional: "Online courses improved the learning process and outcomes of students who are unsuccessful in traditional educational systems" with a mean score for male student teachers 2.43 and a mean score for female student teachers 2.78, $F(1, 213) = 15.355$, $p < .01$, favouring female student teachers. Female student teachers had more positive attitudes toward online courses and their impact on the learning process. Tests on Hypothesis V had similar findings, indicating that no evidence showed significant gender differences on online communication and discussions. Qualitative analyses are reported in Chapter five to interpret the pre-service teachers' open-ended comments in the 2004 survey.

Table 24. Gender and changes of attitudes toward ICT by year

Items	2001	2002	2003
I would like to use educational software in my classroom.	61	58	57
F	1.347	.511	.070
Sig.	.246	.475	.792
I understand the ethical issues involved in using technology in the classroom.	62	59	58
F	8.821	1.530	.390
Sig.	.003	.217	.533
It's not really important for teachers to know how to use technology.	63	60	
F	3.41	3.809	
Sig.	.065	.052	
Integrating the use of technology across subject areas maximizes student learning.	64	61	59
F	6.319	.603	.514
Sig.	.012	.438	.474
I think that there is too much emphasis on using technology in the classroom.	65	62	60
F	8.455	3.079	7.282
Sig.	.004	.080	.007
I feel competent to use technology in my classroom in a meaningful manner.	66	63	61
F	23.036	9.099	10.732
Sig.	.000	.003	.001
I would like to use the Internet as an instructional resource.	67	64	62
F	11.438	.145	.000
Sig.	.001	.704	.991
New technology have a positive effect in transforming instruction.	68	65	63
F	7.480	.291	.695
Sig.	.006	.590	.405
I do not plan to use technology in my future classroom.	69	66	64
F	.120	1.788	.428
Sig.	.729	.182	.513
I would like to use technology for assessment and evaluation in my classroom.	70	67	65
F	8.712	.194	2.248
Sig.	.003	.660	.134
I would like to use multimedia to explore different ways to represent concepts.	71	68	66
F	2.088	2.581	2.078
Sig.	.149	.109	.150

Hypothesis VII$_1$ and VII$_2$. Testing age and ICT literacy:

Figure 16 displays the age distribution of 2,583 valid cases of pre-service teachers who responded to the surveys from 2001 to 2004. The age group 20 to 24 accounted for 46.3% (1195 students) of the respondents; the age group 25 to 29 accounted for 37% (955 students); 10% (259 students) of the respondents reported ages 30 to 40 and 3.2% (83 students) reported ages over 40. About 3.5% (91 students) of the survey respondents did not provide age information.

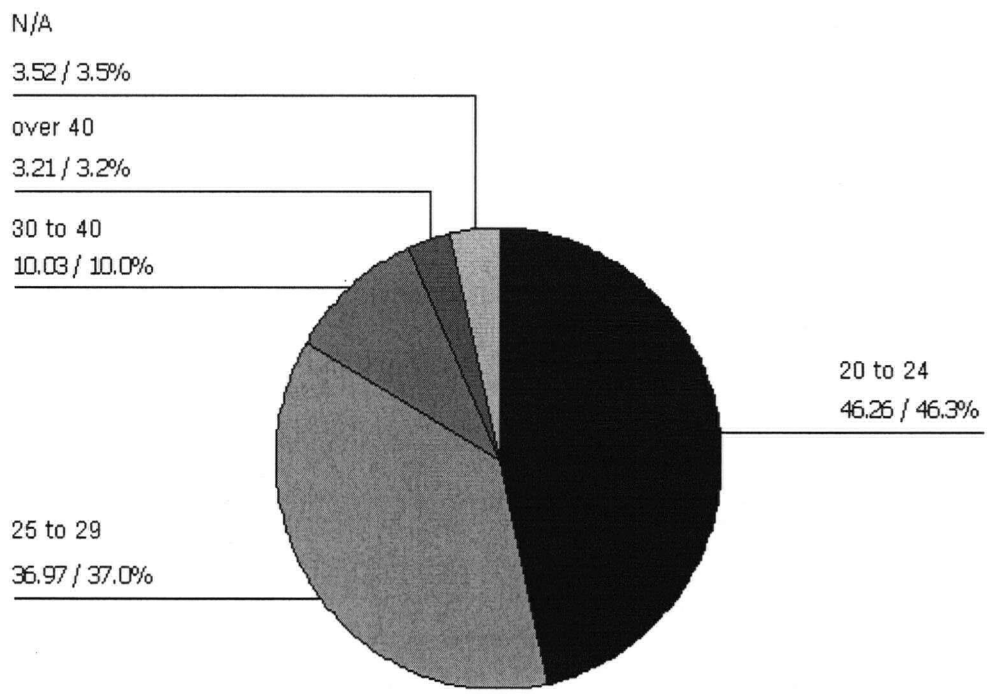


Figure 16. Age distributions of student teachers (2001 - 2004)

Descriptive statistics showed that three age groups 20 to 24, 25 to 29 and 30 to 40 entered the program with similar levels of ICT, favouring the group 30 to 40, and exited the program about five points higher than the scores when they entered the program. The age group over 40 had scores close to that of the younger age groups for both the pre-program and post-program surveys.

The 2 x 5 factorial ANOVA test was designed to assess the potential effects of age and program on student teachers' ICT scores. Findings indicated that there was no statistical difference between the four age groups (e.g. age groups 20 to 24, 25 to 29, 30 to 40, and over 40) on ICT competencies. The age group 30 to 40 had the highest mean scores with an entering score of 23 and an existing score of 28; the mean score for the age group 20 to 24 had mean score 22 for pre-program and 27.7 for post-program; the age group 25 to 29 had 21 for pre-program and 27 for post-program; and the age group over 40 had 20 for pre-program and 25 for post-program; the N/A group had 30 for pre-program and 22 for post-program. The age group 25 to 29 had the highest increase (6 points) compared with other groups and the age group over 40 ranked second in the positive direction. The sample was from the surveys of 2001-2002 and 2003-2004 cohorts. There were no data for the age group over 50 for 2001-2002 cohorts, and there were 16 cases over 50 in the 2003-2004 cohorts so they were combined with the age group over 40 (Table 25).

Table 25. The ICT scores by age and by year (2001- 2004)

Dependent Variable: Technology Competencies Scores

Age	Pre/Post	Mean	Std. Deviation	N
20 to 24	Preprogram	22.05	9.492	772
	Postprogram	27.68	7.941	423
	Total	24.04	9.366	1195
25 to 29	Preprogram	21.20	10.116	523
	Postprogram	27.24	9.057	432
	Total	23.93	10.105	955
30 to 40	Preprogram	22.36	10.427	146
	Postprogram	28.35	9.009	113
	Total	24.97	10.255	259
Over 40	Preprogram	19.94	10.596	49
	Postprogram	25.09	10.282	34
	Total	22.05	10.712	83
N/A	Preprogram	17.04	10.958	55
	Postprogram	21.89	10.698	36
	Total	18.96	11.056	91
Total	Preprogram	21.55	9.926	1545
	Postprogram	27.28	8.781	1038
	Total	23.85	9.889	2583

According to a 2 x 5 Factorial ANOVA test, there was a statistically significant difference between the age groups. The F value for age effect was: $F(4, 2573) = 8.167, p < .05$ (Table 26). There was a statistically significant difference in ICT competencies between pre-program and pos-program surveys, $F(4, 2573) = 71.947, p < .001$. The Post-Program scores (27.28) were significantly higher than the Pre-Program scores (21.55). The results of pre/post program effects were consistent with the previous tests by gender (see Table 26).

Table 26. The effects of age and teacher education program on ICT scores (2001 - 2004)

Dependent Variable: Technology Competencies Scores

Source	df	F	Sig.
Age	4	8.167	.000
Pre/Post-program	1	71.941	.000
Age * Pre/Post	4	.146	.965
Error	2573		
Total	2583		

Findings from the analysis of a 2 x 5 (program effect by age effect) factorial ANOVA test indicated that there was a statistically significant difference in ICT scores between the five age groups. One of the reasons for the statistical significance in age effect might be the involvement of the N/A (the group without age information) and the other four groups.

Post Hoc Scheffe test (on Table 26 in 2 x 5 Factorial ANOVA) was run to compare the mean scores among the five age groups to test Hypothesis VII_2 with the alpha level .05. Scheffe was chosen, among other Post Hoc methods such as Bonferroni, Sidak, Tukey, Duncan, etc, to examine all possible linear combinations of group means. As mentioned earlier, Scheffe test could perform simultaneous joint pairwise comparisons for all possible combinations of means and examine the five age groups for the group means and provide *F* Value. According to the Post Hoc test, the largest group different means were between the age group 30 to 40 and the N/A group (6.02). There were statistically significant differences in ICT competencies among the N/A group and the groups 20 to 24, 25 to 29, 30 to 40, but no evidence that there were statistically significant differences among other groups (see Table 27).

Table 27. Post hoc test on multiple comparisons of age group means (2001 to 2004)

Dependent Variable: Technology Competencies Scores
Scheffe

(I) age	(J) age	Mean Difference (I-J)	Std. Error	Sig.
20 to 24	20 to 24			
	25 to 29	.12	.410	.999
	30 to 40	-.93	.647	.724
	Over 40	2.00	1.071	.482
	N/A	5.09*	1.026	.000
25 to 29	20 to 24	-.12	.410	.999
	25 to 29			
	30 to 40	-1.05	.661	.645
	Over 40	1.88	1.080	.553
	N/A	4.97*	1.035	.000
30 to 40	20 to 24	.93	.647	.724
	25 to 29	1.05	.661	.645
	30 to 40			
	Over 40	2.92	1.190	.197
	N/A	6.02*	1.150	.000
Over 40	20 to 24	-2.00	1.071	.482
	25 to 29	-1.88	1.080	.553
	30 to 40	-2.92	1.190	.197
	Over 40			
	N/A	3.09	1.432	.324
N/A	20 to 24	-5.09*	1.026	.000
	25 to 29	-4.97*	1.035	.000
	30 to 40	-6.02*	1.150	.000
	Over 40	-3.09	1.432	.324
	N/A			

Based on observed means.

*. The mean difference is significant at the .05 level.

Hypothesis VIII. Interaction of age and ICT scores

The distribution of the scores on the pre/post-program surveys was parallel, which indicated that all the groups of student teachers had higher ICT scores at the end of the programs. There was no statistically significant interaction of age effects and program effects on ICT scores, indicating the differences in ICT between pre-program and post-program remained the same for all the age groups. In other words, the program did not favour one age group or disfavour another group. The F value for interaction of age and pre/post program effects was: F (4, 2573) = .146, p = .965 (Table 26, Figure 17).

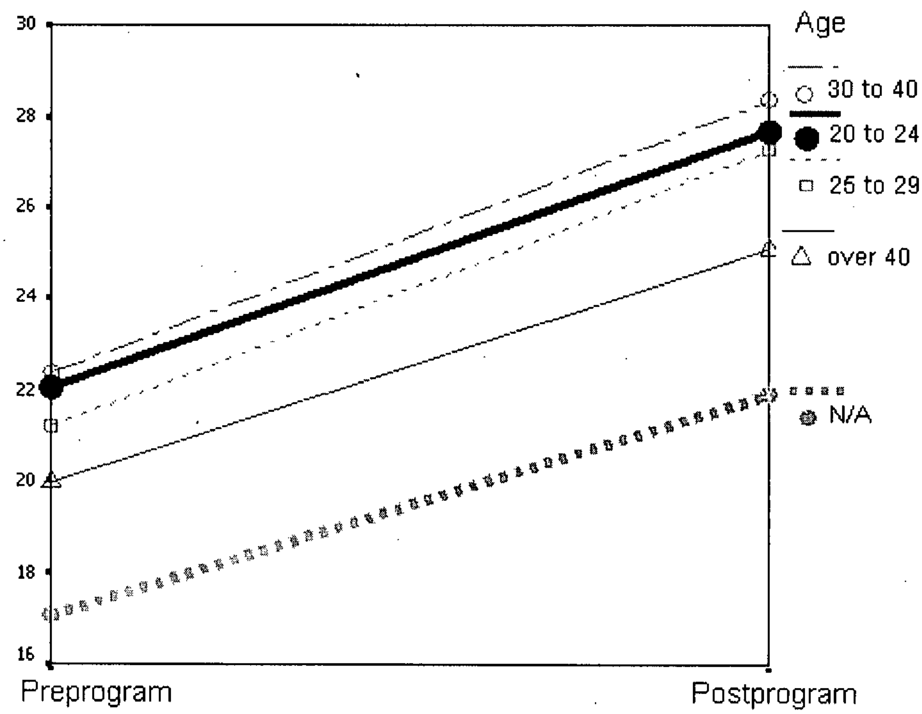


Figure 17. The interaction between age and program on ICT scores (2001 - 2004)

Findings showed that there was a significant difference among age groups when the N/A group was included. But a non-significant difference among age groups was found when the N/A data were not included. A Post hoc test was conducted to explore the detailed descriptions of mean comparisons by age. As seen from Table 26, a statistically significant difference was found among the N/A group and the other three age groups (20 to 24, 25 to 29, and 30 to 40), while no significant differences were found among the other age groups.

Hypothesis IX testing of the digital divide:

Prensky's conception of the digital divide assumes that the younger student teachers would have higher competences than their peers who were older. So in the second round test, equal random sample sizes were drawn by age groups to test Hypothesis IX. The TCScale was used as a dependent variable to measure the ICT scores and age was an independent variable with two levels. After the data N/A group were dropped from the dataset, age groups were divided into two categories with a dichotomous division of age, 1 = age 20 to 29 (N = 297, M = 147, F = 150), 2 = age over 30 (N = 297, M = 147, F = 150), reflecting Prensky's theory of a digital native and digital immigrant divide. Given that a previous study (Guo, et al., 2005) found that the ICT score for males was statistically significant higher than that of females, an equal randomized sample was drawn from 36% of female students to match the male dataset.

The F value for "the Program Effect" variable was: $F(1, 590) = 38.924, p < 0.01$, which was consistently significant with the previous findings. The F value for age effect was: $F(1, 590) = .156, p = .693$, which indicated non-significant difference among the age groups of 20 to 24, 25 to 29, 30 to 40 and over 40 (Table 28).

Table 28. The effects of age and program on ICT scores (without N/A group 2001-2004)

Dependent Variable: Technology Competencies Scores

Source	df	F	Sig.
Program effect	1	38.924	.000
Age effect	1	.156	.693
Program* Age	1	.054	.816
Error	590		
Total	594		

Results of program effects in tests for Hypothesis IX were consistent with the results of Hypothesis VIII in terms of program effects: There was a statistically significant difference in ICT scores between the pre-program and post-program surveys, favouring the post-program. The F value for "the program effect" variable was: $F\,(1, 590) = 38.92, p < .01$. The F value for age effect was: $F\,(1, 590) = .156, p > .05$ (Table 28), which indicated that there was no statistically significant difference in ICT scores between the digital native and digital immigrant age groups (Figure 18).

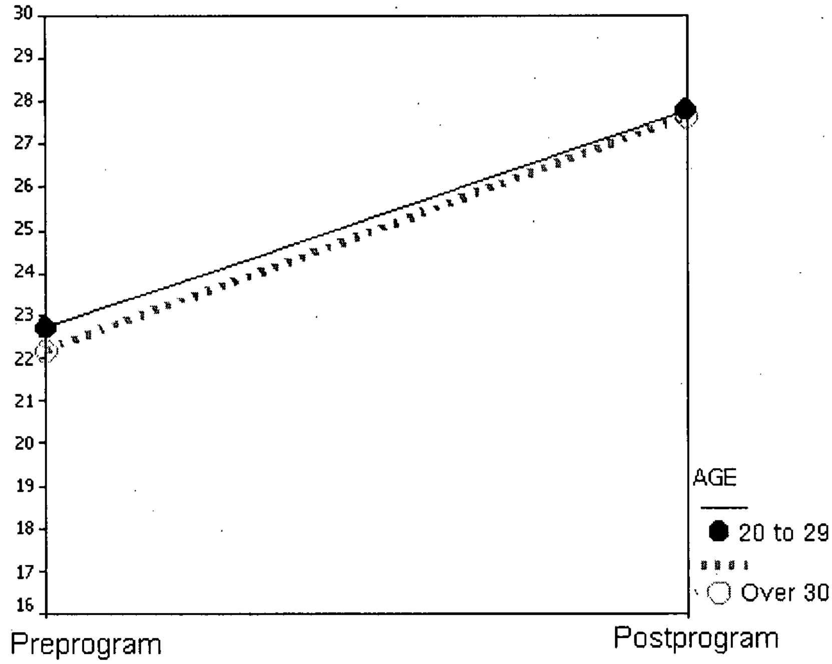


Figure 18. The interaction between age and program effects (2001- 2004)

Overall, there was a difference in ICT competencies between age groups in both program years, but the findings were not consistent with Prensky's claim that people of older ages would have lower average ICT competencies than younger ages.

Hypothesis X testing of interaction of age (digital divide), pre and post-program and ICT scores

As seen from Table 26, there was no statistically significant interaction between age and program effects in the tests for the dichotomous division of age: $F(1, 590) = .054$, $p = .816$. The ANOVA tests were also conducted with a randomized sampling of equal sizes by year 2001, 2002, 2003, and 2004. Findings from those analyses were similar to the pattern presented in Figure 18, which indicated no statistically significant difference between the digital native group and digital immigrant group with equal sample sizes. The overall test with the whole dataset of 2001 to 2004 was included to test Hypothesis IX and the results were the same as that presented in Table 26 and Figure 18.

Findings Related to Major Research Question Three

A further study was conducted and focused on the third research question and intended to determine if there was a correlation between age, gender and the attitudes toward ICTs in pre-program 2003 and post-program 2004; as well, these analyses were meant to determine if the factors such as age, gender or attitudes toward technologies were predictors of ICT literacy in teacher education programs. Some qualitative studies (Guo, 2006) showed pre-service teachers' attitudes towards technologies changed as they became convinced that technologies could play an important role in enhancing student learning, motivation and outcomes. These changes were due to particular opportunities of actively participating in interesting online activities and of using digital technologies during the course of the program. This quantitative study examined if the findings of the survey data on pre-service teachers' attitudes toward ICT were consistent with the claims of qualitative studies.

Hypothesis XI: access to, and attitudes toward, ICT

Hypothesis XI and XII focused on research question three "**How do the student teachers perceive their progress in ICT competency**." As indicated previously, my intent of these investigations was to investigate if the factors, including age, gender, frequency of ICT use, and students' attitudes had an impact on student teachers' ICT literacy. The previous analyses examined the effects of age, gender, year and program. So the following analyses focused on examining whether other variables such as access, attitudes, and frequency of ICT use had relationship with ICT competencies. I first looked at the Pre-Program Surveys 2001 and 2003 for the correlations of attitudes and ICT competencies combined with access and then looked at the Post-Program Surveys 2002 and 2004 for frequency of ICT use, including the frequency of ICT use during university course work, the frequency of ICT use during their practicum, and the frequency of ICT use the student teachers had their students work with technologies during their practicum, and ICT competencies combined with attitudes toward ICT.

It is assumed that attitudes toward ICT and ICT literacy were correlated. Hypothesis XI and XII examined if any of the factors access, attitudes toward ICT, and frequency of ICT use were predictors of ICT literacy in pre-program surveys. First, the student prior learning experiences with ICT were investigated and this information was grouped along with other related items to yield the subcategory "access" for further study. Item 10 in the demographic subsection of both pre-program surveys 2001 and 2003 asked student teachers "where did you learn your computer skills?" This item was meant to obtain information on prior learning experiences with ICT. Student teachers were permitted to check all seven main sources listed: have none, self-taught, high school, university, friends/relatives, workplace, and other. Student responses to this question in both years were similar (Bartosh et al., 2005):

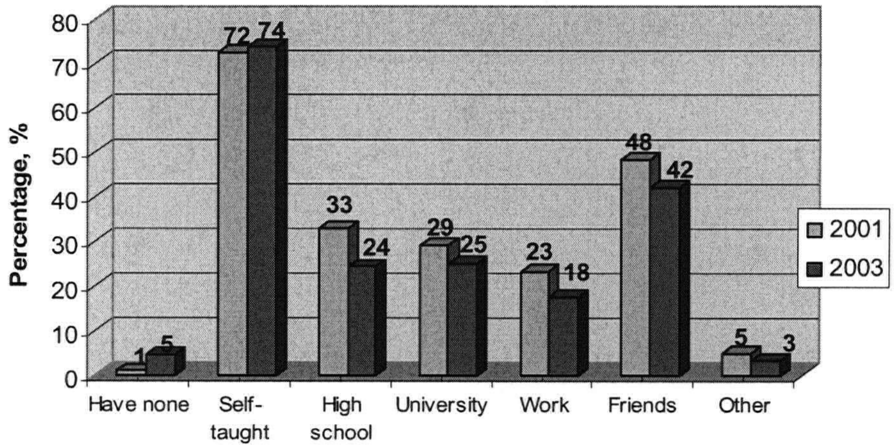


Figure 19. Student teachers' self-efficacy on ICT in pre-program

Figure 19 showed the distribution of responses to item 10. Self-taught was rated the highest of the seven sources of ICT literacy: more than half of the student teachers indicated that they taught themselves about computers; 634 and 610 in 2001 and 2003 respectively reported that they were self-taught; 10 students reported they "had no ICT competences"(e.g. the ability to things well or effectively with technologies) and 5 students rated themselves as having no skills (e.g. knowledge and ability to do things well with technologies). Learning from high school and university was ranked third and fourth.

Multiple regression was used to examine the relationship between the dependent variable ICT competencies and a set of independent variables, including ATT (Table 5), ACC1 (Table 9), ACC3 (Table 10) in Hypothesis XI. The tests were conducted with two tails at an alpha level of .01. As mentioned earlier, a two-tailed significance level tests null hypothesis in which the direction of an effect is not specified in advance. It was hypothesized that the student teachers' attitudes towards ICT and their access might be related to their ICT literacy and competencies. Pearson'·correlation was used to measure how the variables, including ICT scores, access and attitudes, were related. Pearson's correlation measures the linear association between two variables. Values of the correlation coefficient range from -1 to 1. The sign of the coefficient indicated the direction of the relationship and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. The attitude scale was the same as that in Hypothesis VI and it was used as a dependent variable. The sub-TCScale TCPR1 (Table 6), access scale ACC1 (Table 9) and attitudinal scale ATT (Table 5) were used to test Hypothesis XI.

Pearson Correlation test in Table 29 indicates that there was a statistically significant association between TCPR1 (ICT competencies) and ATT (attitudes toward ICT): $r = .366, p < .01$. Analysis of Pearson correlations between TCPR1 and ACC1 (access) showed a correlation existed between the two variables: $r = .290, p < .01$. The correlation between ACC1 and ATT was also statistically significant: $r = .142, p < .01$. This means all the associations were statistically significant different (Table 29).

Table 29. Correlations of access and attitudes and ICT in 2001

		TCPR1	ATT	ACC1
Pearson Correlation	TCPR1	1.000	.366	.290
	ATT	.366	1.000	.142
	ACC1	.290	.142	1.000
Sig. (1-tailed)	TCPR1	.	.000	.000
	ATT	.000	.	.000
	ACC1	.000	.000	.
N	TCPR1	869	869	869
	ATT	869	869	869
	ACC1	869	869	869

I used both backwards and stepwise sequential analyses to compare the contributions of each independent variable and the results from the stepwise sequential analyses were presented. The stepwise sequential analysis arranges the results in the order of the correlations between the dependent variable and the independent variables from the smallest to the largest. Therefore, it was easy to tell which variable was the most powerful one. In backward selection procedure, all variables are entered into equation and then sequentially removed. The variable remaining in the equation with the smallest partial correlation is considered next. The procedure terminates when there are no variables in the equation that satisfy the removal criteria. At each step in stepwise sequential analysis, the independent variable not in the equation which has the smallest *F* value is entered. Variables are removed if the *F* value becomes sufficiently large. The method terminates when no more variables are eligible for inclusion or removal.

The linear regression results in Table 28 showed that the *t* value for ATT was statistically significant different from zero, $t\ (869) = 10.740, p < .01$, indicating that the variables ICT competencies and attitude were related and ICT competencies varied with attitudes. ICT competencies increase or decrease with the increase or decrease of attitudes toward ICT. Similarly, the slope value for the variable ACC1 was statistically significant different, $t(873) = 7.853, p < .01$, indicating that ICT competencies and access were related and ICT competencies varied with access. ICT competencies increased or decreased with the increase or decrease of access. The analysis of stepwise sequential regression showed that the independent variable was a stronger predictor of ICT competencies (Table 30).

Table 30. Regression of access and attitudes and ICT in 2001

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	13.981	4.027		3.472	.001
	ATT	1.021	.095	.332	10.740	.000
	ACC1	4.064	.518	.242	7.853	.000

a. Dependent Variable: TCPR1

According to the regression equation:

$\hat{Y} = a + bX$

$\hat{Y} = 13.98 + .332x_1 + .242x_2$

Where:

$\hat{Y}$ = TCPR1 (predictor ICT competencies scores)

X_1 = attitudinal scores (ATT)

X_2 = access scores (ACC1)

The sub-TCScale TCPR3 (ranging from 0 to 81, Table 8), access scale ACC3 (Table 10) and attitudinal scale ATT (Table 5) were used to test Hypothesis XI for the Pre-Program Survey 2003. The attitudinal scale was the same as that for Hypothesis VI. As seen from Table 29, there was a statistically significant correlation between ICT competencies and attitude in 2003: $r = .380, p < .01$; analysis of Pearson correlations between ICT competencies and access showed a correlation existed between the two variables: $r = .177, p < .01$. However, the correlation between access and attitudes was not statistically significant: $r = .062, p = .075$ (Table 31).

Table 31. Correlations of access and attitudes and ICT competencies in 2003

		ICT	ATTITUDE	ACCESS
ICT	Pearson Correlation	1	.380	.177
	Sig. (2-tailed)	.	.000	.000
	N	828	823	828
ATTITUDE	Pearson Correlation	.380	1	.062
	Sig. (2-tailed)	.000	.	.075
	N	823	823	823
ACCESS	Pearson Correlation	.177	.062	1
	Sig. (2-tailed)	.000	.075	.
	N	828	823	828

The linear regression results in Table 32 for pre-program 2003 had the same pattern as that in Table 30 for 2001. The analysis from stepwise procedure showed that the slope value for attitude had statistically significant difference from zero, t (823) = 11.598, $p < .01$, indicating that the variable ICT competencies and attitude were related and ICT competencies varied with attitudes. ICT competencies increased or decreased with the increase or decrease of attitudes. Similarly, the slope value for the variable access showed a statistically significant difference from zero, $t(828) = 4.761, p < .01$, indicating that ICT competencies and access were significantly related and ICT competencies varied with access. ICT competencies increased or decreased with the increase or decrease of access (Table 32).

Table 32. Regression of access and attitudes and ICT in 2003

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	16.015	2.647		6.050	.000
	ATT	1.061	.091	.370	11.598	.000
	ACC3	1.225	.257	.152	4.761	.000

a. Dependent Variable: TCPR3

The regression equation could be expressed as:

$\hat{Y} = 16.015 + .37x_1 + .152x_2$

However, findings showed there was no statistical evidence to support a relationship between attitude and ICT competencies in 2004: $r = .005, p = .902$. This may indicate that the student teachers rated higher for their attitude scores in the 2004 survey or may be due to the different items between the 2004 and the 2003 surveys. Or this might indicate that generally their attitudes towards ICT had changed during the course of the program. More in-depth interpretations of attitudes and gender issues were addressed in Chapter Five, which contains qualitative analyses.

Table 33. Correlation of attitudes and ICT competencies in 2004

Correlations

		TCScale	ATT4
TCScale	Pearson Correlation	1	.005
	Sig. (2-tailed)		.902
	N	554	540
ATT4	Pearson Correlation	.005	1
	Sig. (2-tailed)	.902	
	N	540	540

Like the results of the stepwise regression for the Pre-Program Survey 2001 (Table 30), the analysis of stepwise sequential regression showed that the independent variable was a stronger predictor of ICT competencies in the Pre-Program Survey 2003. The regression summary showed that there existed statistically significant relationships among the variables attitudes, access and ICT competencies: $r = .438$, R Square = .192, $F(2, 866) = 102.602$, $p < .01$ for the Pre-Program Survey 2001; $r = .409$, R Square = .167, $F(, 820) = 83.34$, $p < .01$, which indicated that all the variables attitudinal scales and access scales had strong relationships with the dependent variable ICT scores, measured by TCPR1 and TCPR3 for both the Pre-Program Surveys (2001, 2003) (Table 34).

Table 34. Regression summary of the Pre-Program Surveys 2001 & 2003

ANOVA						
Model: year		R	R Square	df	F	Sig.
Pre-Program.2001	Regression			2	102.602	0.001
	Residual			866		
	Total	0.438	0.192	868		
Pre-Program 2003	Regression			2	82.34	0.001
	Residual			820		
	Total	0.409	0.167	822		
a	Predictors: (Constant), ACC1, ATT					
b	Dependent Variable: TCPR1					

The stepwise regression sequential analyses for both the pre-program surveys 2001 and 2003 in table 35 and 36 indicated that ATT (attitudes) was the most powerful predictor and ACC (the level of access to technologies) the second powerful predictor of the dependent variable technology competencies (TCPR1 and TCPR3). In the pre-program survey 2001, the value of R was .366 when the variable ATT was entered. The value of R increased to .438 when a second variable ACC1 was added, which meant that the variable ACC1 was also a good predictor of ICT competencies in the pre-program survey 2001 (Table 35).

Table 35. Model summary for the Pre-Program Surveys 2001

(stepwise regression)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.438[a]	.192	.190	21.401
2	.366[b]	.134	.133	22.137

a. Predictors: (Constant), ATT, ACC1

b. Predictors: (Constant), ATT

Compared to the pre-program survey 2001, the independent variable ATT remained the most powerful predictor of ICT competencies in the pre-program survey 2003. The value of *R* was .380 when the variable ATT was entered. The value of *R* increased to .409 when a second variable ACC3 was added. The *R* Square increased from .144 to .167 when ACC3 was added, which meant that ACC3 was also a good predictor of ICT competencies in the pre-program survey 2003 (Table 36).

Table 36. Model summary for the Pre-Program Surveys 2003

(stepwise regression)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.409[a]	.167	.165	12.571
2	.380[b]	.144	.143	12.735

a. Predictors: (Constant), ATT, ACC3

b. Predictors: (Constant), ATT

Hypothesis XII testing of correlation on frequent use of technology and ICT skills

The purpose of this set of tests was to gain an understanding of the construct of technological knowledge and pedagogical applications in teacher education. In the teacher education program, student teachers had varied access to ICT and the post-program surveys did not include the access items but focused on items dealing with frequency of ICT use. The frequency of ICT use as an operation of learning skills and the attitudes toward ICT as beliefs functioned as both independent (predictor) and dependent (criterion or indicator, also in Hypothesis VI) variables in regression tests. In Hypothesis XII, the variables included subscale TCPS2 (derived from Table 7), TCScale (Table 4), ATT4 (derived from Table 15), UA2 and UB2 (Table 11), UA4 and UB4 (Table 12), and UC2/4 (Table 13). Pearson correlation and multiple regressions (stepwise and backward) were used to test Hypothesis XII, the last hypothesis of this study.

As seen from Table 32, the values of Pearson correlations of the four variables in 2002 were: 1) $r = .272$ for correlation of ICT competencies and frequency of use during university course work, $p < .01$; 2) $r = .334$ for ICT competencies and the frequency of use during practicum, $p < .001$; 3) $r = .496$ for ICT competencies and students' frequency of use in practicum schools. The correlation between frequency of ICT use and ICT competencies was statistically significant. There existed statistically significant correlations between use at university and practicum schools, and the use between the student teachers and their students. The strongest correlation was between the UA2 and UB2 (.697), meaning that the frequency of ICT use by student teachers during their course work and during practicum was strongly related. The higher frequency of ICT use during course work increased the frequency of use in practicum. The other meaningful significant associations were UC2 and UA2 (r =.338, p <

.001), UC2 and UB2 ($r = .327, p < .001$), which indicated that the student teachers' ICT use during the university course work and during practicum were statistically related their students' frequency of ICT use (Table 37).

Table 37. The correlations between ICT use and ICT competencies in 2002

Correlations

		TCPS2	UA2	UB2	UC2
TCPS2	Pearson Correlation	1	.334*	.469*	.250*
	Sig. (2-tailed)		.000	.000	.000
	N	512	347	349	458
UA2	Pearson Correlation	.334*	1	.697*	.338*
	Sig. (2-tailed)	.000		.000	.000
	N	347	385	345	373
UB2	Pearson Correlation	.469*	.697*	1	.327*
	Sig. (2-tailed)	.000	.000		.000
	N	349	345	385	372
UC2	Pearson Correlation	.250*	.338*	.327*	1
	Sig. (2-tailed)	.000	.000	.000	
	N	458	373	372	529

As seen from Table 38, the pattern of correlations in 2004 was similar to that of 2002. Pearson correlations of the four variables in 2004 were: 1) $r = .258$ for ICT competencies and UA4 (frequency of use during university course work), $p < .01$; 2) $r = .420$ for ICT competencies and UB4 (frequency of use during practicum), $p < .01$; 3) $r = .218$ for ICT competencies and UC4 (frequency of ICT use by the students of the teacher candidates in practicum). The correlation between frequency of ICT use and ICT competencies was statistically significant. There existed a statistically significant correlation between the use at university and practicum schools, and the use between the student teachers and their students. In post-program 2004, the strongest correlation remained between the variables UA4 and

UB4 (.590), indicating those who acquired higher ICT competencies had a tendency of using the skills and knowledge at practicum schools. The correlation between UC4 and UB4 was also high (.511), which indicated that the student teachers who had higher frequency of ICT use during the practicum also had high frequency of asking and encouraging their students to use ICT (Table 38).

Table 38. The correlation between ICT use and ICT competencies in 2004

Correlations

		TCScale	UA4	UB4	UC4
TCScale	Pearson Correlation	1	.258*	.420*	.218*
	Sig. (2-tailed)		.000	.000	.000
	N	554	551	550	543
UA4	Pearson Correlation	.258*	1	.590*	.286*
	Sig. (2-tailed)	.000		.000	.000
	N	551	551	550	543
UB4	Pearson Correlation	.420*	.590*	1	.511*
	Sig. (2-tailed)	.000	.000		.000
	N	550	550	550	542
UC4	Pearson Correlation	.218*	.286*	.511*	1
	Sig. (2-tailed)	.000	.000	.000	
	N	543	543	542	543

The regression summary for Hypothesis XII showed that there existed statistically significant relationships between the variables under examination: $r = .474$, R Square = .224, $F(1, 306) = 88.569, p < .01$ for the Post-Program Survey 2002; $r = .464$, R Square = .215, $F(1, 540) = 147.763, p < .01$. This indicated that all the variables UA, UB and UC had strong relationships with the dependent variable ICT scores, measured by TCPS2 and TCScale for both the Post-Program Surveys 2002 and 2004 (Table 39).

Table 39. Regression summary of the Post-Program Surveys 2002 & 2004

ANOVA

Model: year		R	R Square	df	F	Sig.
Post-Program 2002	Regression			1	88.569	0.001
	Residual			306		
	Total	0.474	0.224	307		
Post-Program 2004	Regression			1	147.763	0.001
	Residual			540		
	Total	0.464	0.215	541		

a Predictors: (Constant), UA,UB,UC

b Dependent Variable: TCScale

The stepwise regression sequential analyses for both the post-program surveys 2002 and 2004 in table 40 and 41 indicated that UB2 and UB4 (ICT use during practicum) was the most powerful predictor of the dependent variable technology competencies (TCPR2 and TCScale). In the post-program survey 2002, the value of *R* was .474 when the variable UB2 was entered, the value of *R* remained the same when a second variable UC2 (the frequency the student teachers asked their students to use ICT during their practicum at schools) and then a third variable UA2 (the frequency of ICT use during university course work) were entered. The multiple *R* did not increase when the other variables were added. Adding UA2 and UC2 did not produce a better explained model, which meant that the independent variable UB2 was the most powerful predictor of ICT competencies in the post-program survey 2002 (Table 40).

Table 40. Model summary for the Post-Program Surveys 2002

(stepwise regression)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.474[a]	.225	.217	14.160
2	.474[b]	.225	.220	14.137
3	.474[c]	.224	.222	14.117

a. Predictors: (Constant), UC2, UA2, UB2

b. Predictors: (Constant), UC2, UB2

c. Predictors: (Constant), UB2

Compared to the post-program survey 2002, the independent variable UB4 remained the most powerful predictor of ICT competencies in the post-program survey 2004. The value of R was .464 when the variable UB4 was entered. The value of multiple R did not increase when a second variable UA4 was added. Adding another variable UC4 did not benefit the value of the multiple R either (Table 41). This model explained about 22% of the variability in the outcome.

Table 41. Model summary for the Post-Program Surveys 2004

(stepwise regression)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.465[a]	.216	.212	7.589
2	.464[b]	.216	.213	7.584
3	.464[c]	.215	.213	7.581

a. Predictors: (Constant), UC4, UA4, UB4

b. Predictors: (Constant), UA4, UB4

c. Predictors: (Constant), UB4

Conclusion

This chapter reports on the quantitative aspects of the research design and focuses on findings from the analyses of 12 hypotheses underpinned by the research questions. Examining the differences in ICT competencies included a straightforward purpose of determining if the student teachers had increased their self-efficacy of ICT competencies during the program. Overall, tests were run with the entire data set from the 2001 to 2004 surveys to examine assumptions underlying the study and to obtain a descriptive picture of the survey respondents. Samples of equal size were randomly drawn to test the hypotheses. Two of the null hypotheses retained (interaction testing, age and ICT literacy testing) and nine alternative hypotheses remained tenable. Results from the ANOVA tests, regressions, *t*-tests and Correlations provided the following significant findings (Table 42):

Table 42. Summary of Quantitative Findings

Research questions	Hypothesis	Tests	Variabes: Dependent	Variabes: Independennt	Sinificance: Y/N	Sinificance: Test values
1. Are there differences between pre- & post-program perceptions of ICT competencies?	I. Test of program	Main effects **2 x 2** x 2	**TCScale**	**Pre-/Post-Programs gender**, year	Yes	$F = 105.38$, $p < .05$ Table 18
	III. Test of academc year	Main effects 2 x 2 x 2	**TCScale**	**Pre-/Post-Programs year**, gender	No	$F = 2.601$, $p = .107$ Table 18
	IV.Inter.of program, gender & year	Interaction **2 x 2 x 2**	**TCScale**	**Pre-/Post-Programs, gender, year**	No	$F = .26$, $p = .61$ Table 18
	VII.Test of age	Main effects **2 x 5**	**TCScale**	**Pre-/Post-Programs, age groups: 20-24, 25-29, 30-40, over 40, N/A.**	Yes	$F = 8.17$, $p < .05$ Table 26
	VIII.Inter.of age & program	Interaction **2 x 5**	**TCScale**	**Pre-/Post-Programs, age groups: 20-24, 25-29, 30-40, over 40, N/A.**	No	$F = .15$, $p = .97$ Table 26
	IX.Test of the digital divide	Main effects **2 x 2**	**TCScale**	**Pre-/Post-Programs, age groups:20-29, over 30.**	No	$F = .16$, $p = .69$ Table 28
	X.Inter.of program & digital divide	Interaction **2 x 2**	**TCScale**	**Pre-/Post-Programs, age groups: 20-29 over 30.**	No	$F = .05$, $p = .82$ Table 28
2. Are there gender differences in student teachers' attitudes toward ICT competencies?	II. Test of gender & program	Main effects **2 x 2** x 2	**TCScale**	**gender**, year, **Pre-/Post-Programs**	Yes	$F = 69.14$, $P < .05$ Table 18
	IV.Inter.of program, gender & year	Interaction **2 x 2 x 2**	**TCScale**	**Pre-/Post-Programs, gender, year**	No	$F = .26$, $p = .61$ Table 18
	V_1 & V_2. Test of gender & ICT use	*t*-test	**Specific skills, ONLINE**	**gender**		Table 21, 22
	VI.Test of attitudes to ICT by gender	One way ANOVA	**ATT**	**gender**		Table 24
3. How do student teachers perceive their progress in ICT competencies?	XI. Test of access, attitudes to ICT ICT literacy	Correlation	**TCPR1, ACC1, ATT**			Table 29
			TCPR3, ACC3, ATT			Table 31
			TCScale	**ATT4**		Table 33
		Regression (stepwise)	**TCPR1**	**ACC1, ATT**		Table 30, 34
			TCPR3	**ACC3, ATT**		Table 32, 34
	XII.Test of frequency of ICT use and ICT	Correlation	**TCPS2, UA2, UB2, UC2;**			Table 37
			TCPS4, UA4, UB4, UC4.			Table 38
		Regression (stepwise)	**TCPS2**	**UA2, UB2, UC2**		Table 39, 40, 41
			TCPS4	**UA4, UB4, UC4**		Table 39, 40, 41

First, there were statistically significant differences in ICT competencies for teacher candidates between pre-program and post-program intervals. This indicated that over the duration of the program the teacher candidate self-efficacy of ICT competencies improved. However, some precautions need to be addressed regarding this finding and a couple of factors should be taken into consideration: A) The variable under examination was actually time between the program intervals, not the program, which differs from references to the "elementary program," "middle years program" and "secondary program;" B) the range of factors that conceivably affected the changes was not adequately controlled during the study. For example, students who were less confident with their competencies might have dropped out of the survey or might have not provided valid information while others might have sought technical support outside of the program to increase their competencies and confidence.

The gender gap in the 2003-04 cohorts was narrower, but the difference in the total sample remained statistically significant favouring the males. Research on the digital divide suggests that males have advantages (e.g, gender bias and norms in curriculum and instruction, socialization) with ICT that accrue over time (Bryson et al., 2003). On the other hand, the findings may reflect a tendency that in self-evaluations of ICT competencies, males might have been overconfident in their skills whereas females might have been under-confident in their ICT competences.

Second, there was a statistically significant difference between males and females in their perceptions of ICT competencies, favouring the male student teachers. Evidence indicated that female student teachers made greater progress in ICT literacy to reduce the gender gap. The gender gap still existed in favour of male student teachers. There were statistically significant gender differences in attitudes toward ICT in pre-program 2001 and 2003 surveys, favouring male student teachers. The gender difference was reduced in both post-program surveys and there was no statistically significant difference between male and female students toward ICT in the 2002 and 2004 post-program surveys. This can be interpreted that female student teachers' attitudes toward ICT changed as their confidence in ICT competences increased. However, all the results of ANOVA tests for three years indicated that there was a statistically significant difference between male and female student teachers toward the item "I feel competent in using technology in my classroom in a meaningful manner" included in the surveys (2001, 2002 and 2003), favouring males. One interpretation is that females had less confidence in their ICT competencies, even though they might have similar levels of ICT competencies as their male peers.

Third, there was statistically significant difference in attitudes toward ICT between males and females in the Pre-Program Surveys 2001 and 2003, but no evidence to show significant difference in attitudes toward ICT between males and females in the Post-Program Surveys 2002 and 2004. This study was based on the assumption that pre-service teachers' success in using technologies is partially dependent on their attitudes towards technologies.

The regression summary for Hypotheses XI and XII showed that the *R* Squares for all the four surveys were statistically significant, which indicated that there existed statistically significant relationships among the variables under examination, e.g., student perceptions of ICT competencies among attitudes, access, and frequency of ICT use during the university course work and during their practicum. The stepwise regression analyses showed that the strongest predictor for the Pre-Program Surveys were attitudes. The linear regression results indicated that the variable ICT competencies and attitudes were strongly related in the Pre-Program Surveys 2001 and 2003 and ICT competencies varied with attitudes. The strongest correlations were ICT competencies and frequency of ICT use during the university course work for both the Post-Program Surveys 2002 and 2004. Furthermore, findings showed there was a correlation between student teachers' ICT competencies and their students' frequency of use, suggesting that the student teachers may have made meaningful connections between what they had obtained and pedagogy in practicum. The strongest correlations were consistently between variables UA2 and UB2 in the Post-Program Survey 2002 (.697, Table 33) and UA4 and UB4 in the Post-Program Survey 2004 (.590, Table 34) , meaning that the frequency of ICT use by student teachers during their course work and during practicum was strongly related.

There was no statistically significant difference among the different age groups. This finding did not agree with Prensky's claims for digital natives and digital immigrants.

CHAPTER FIVE
QUALITATIVE ANALYSIS AND FINDINGS

Introduction

Chapter Four dealt with three research questions from the perspectives of quantitative analyses while Chapter Five provides subtle details for major research questions regarding how ICT skills were constructed and integrated into teacher preparation. This chapter presents the findings from qualitative analyses and interpretations of data in the order of: 1) student comments on open-ended survey response sections; 2) observations of microteaching; 3) group interviews; and 4) online communication.

In this chapter, I focus on qualitative data directly related to the statistical analyses in Chapter Four. In addition, I include a triangulation of data and reported observations of microteaching in technology cohorts from 2003 to 2005, group interviews with student teachers in technology cohort in summer 2004, and online communication and discussions from second language student teachers in 2004. Multiple qualitative approaches, including ethnographic approaches, grounded theory and Labov's narrative analysis, were applied for interpretations of the rich, qualitative data. Qualitative findings in this chapter inform the research questions with in-depth interpretations of ICT literacy in the program, descriptive examples of the uses of ICT, and applications of multiliteracies in teacher education.

Data Analysis and Findings

Data source A: Survey comments

The student comments on open-ended survey responses directly related to the statistical analyses in Chapter four. This section analyses qualitative data dealing with attitudes toward ICT literacy, attitudes toward their progress in ICT, and attitudes toward gender issues in ICT collected through the student written responses to the 2004 survey.

Attitudes toward ICT literacy

In addition to the Likert items of the survey, students were asked to provide comments on their attitudes toward ICT. My interpretation focused on the open-ended comments in this section. In the last section of each instrument, student teachers were asked to "imagine yourself as a new teacher, indicate the degree to which you agree the following statement." Each statement concerned attitudes toward ICT. The 2001 survey included 15 items and the 2003 survey included 10 attitudinal items. The 2002 survey consisted of 14 items and the 2004 instrument consisted of 13 items asking student teachers to rate their attitudes toward ICT. To ensure that the directions and items were interpreted as intended, a readability assessment was conducted by a research committee representing the target population (e.g., student teachers). Items that were judged to be vague or difficult to interpret were reworded and then retested. The alpha value for the reliability coefficient in this section was .60 for 2004 and .80 for the other three surveys respectively. In Chapter Four, quantitative analyses found that attitudes were significantly related to ICT literacy in 2001, 2003, and 2002, but not in 2004. I paid close attention to student comments in the 2004 survey to find out why the attitudinal pattern differed from those of other years.

Most student teachers held positive attitudes toward ICT. They realized that *"technology is everywhere in the world. If we don't properly prepare our students, they will be left behind"* (2002 survey). Some proposed a stronger focus on technology use in the teacher education program: *"A mandatory course needs to be offered in order to be able to use this technology as it would be very beneficial in teaching."*

On the other hand, some showed negative attitudes toward ICT and said there was too much emphasis on information technology in this program. One student teacher complained: *"We are poorly served by this emphasis because it does not reflect the reality of public schools in BC so we are encouraged to waste time developing skills and techniques that are impossible to use in the schools. Why?"*

Although many respondents showed interest in using ICT, believing that ICT should be a part of the teacher education program, and agreeing that ICT played an important role in education, some felt it was difficult to learn how to use ICT: *"I hardly know anything about technology. I'm sure It's a good tool if you know how to use it. But for me it's just a lot of extra work so I do without it"* (2004).

Some complained that computers malfunctioned or were often broken during practicum and, since the problems were never fixed, they couldn't rely on the technologies. They believed that traditional methods were more reliable than technological pedagogies. Similar comments were found in 2002. Pre-service teachers showed their frustrations with ICT and expressed strong feelings: *"I hate computers, I never rely on them."*

"I would like to become adept at using technology but find it too overwhelming and am slow at learning the steps in using software."

"I found that although I wanted to use some of the technologies available in my school during my practicum, more often than not monitors for viewing/teaching computer technology were broken...Headache!"

One student listed a few reasons why using technologies was a *"headache"*, including no technical support available when needed during the practicum. So he or she had to turn to traditional methods over the use of technology. This student always printed slideshows as overhead transparencies in case PowerPoint presentations did not work. Many negative attitudes toward ICT were directed toward the reliability of technologies, the lack of a command of necessary skills and the lack of technical support. Another student teacher said he or she did not rely heavily on technology during practicum for fear of excluding the students who did not have Internet access at home due to lower socio-economic status.

There also existed confusion over the concept of ICT literacy. A few students suggested that the use of technology was just a trend that too many teachers were willing to follow just like a *"pendulum swing."* However, some student teachers made strong statements: *"teacher education graduates should be forced to learn the latest technology"* and *"Technology is not only a tool, but it is also another resource students can use in learning and understanding curriculum."*

Attitudes toward their progress in ICT

Although it was evident from the findings in Chapter Four that student teachers had improved their ICT competencies, they did not show, in their open-ended responses, any satisfaction with their progress in ICT. Most of the student teachers held negative attitudes to their progress. Some of them claimed they had no knowledge of ICT by the end of the program and some of stated that they obtained ICT by themselves, but not from the program. Some responses showed that student teachers did seek opportunities, such as workshops and course work, for learning how to use technologies.

Comments like *"I hardly know anything about technology" (2004 survey) can be considered as a way of showing dissatisfaction."* The following statements showed that the coursework and workshops did not cater to the students' interest: *"Any of the knowledge I gained about learning technology was done on my own. I did not receive any additional education on technology during my practicum or coursework"* (2004 survey).

"I took a workshop for learning how to create web pages (downstairs in the Education Computer Lab) and it was incredibly boring. I felt like I wasted two hours of my time and learned not that much. Expectations of the workshop should have been more clear."

Even though some skills were acquired from coursework, one student claimed, these technology skills *"were not at all relevant to my teachable subjects. I found the website design classes an absolute waste of time."* Students had preferences for certain skills that they wanted to obtain and this makes curriculum and instruction in ICT challenging.

Attitudes toward gender and ICT

Items 41 to 53 in the 2004 survey were designed to elicit student teachers' attitudes toward gender issues in ICT. Generally, neither female nor male student teachers seemed aware of the extent of the issues raised. Some explained that they did not want to agree or disagree with a statement when they were not given any information on this issue. Most of the comments on gender issues in ICT were negative. Some of the student teachers critiqued the questions as "bad" or "ridiculous" to answer. Instead of responding to the survey items, many student teachers made comments on items. For example, a respondent wrote: *"#44 is a strange question— difficult to answer"* (2004 Survey).

Item 44 is a relatively simple statement, *"The World Wide Web advances gender and racial equity,"* and was meant to measure student teachers' attitudes toward gender and racial issues in ICT. More than 10 comments had strong descriptors such as *"bad"*, *"bizarre"*, or *"inappropriate"* to express their feelings about this question and some other questions dealing with gender issues in ICT.

For instance, one student observed, *"I found some of the questions drew too frequently on gender assumptions about technology use which I found inappropriate"* (2004 survey). Some students wrote sarcastically: *"Put a little effort into creating a decent questionnaire. I feel that the questions you are asking cannot be replied to by education students who have just and only completed a 13 – week practicum"* (2004 survey).

Some students expressed opinions indicating that student teachers did not have an interest in gender issues or they did not like to make a judgement on statements for which they did not have enough knowledge. *"I don't appreciate the gender related/segregated/sexist questions. How do I know if online education courses decrease employment opportunities for teachers?"* Responses like these indicated that the student teachers did not have informed concepts of gender and ICT. One of the students gave a precise explanation: *"Without reading studies on these statements it is difficult to form an opinion."*

Table 43. Summary of data source A with Labov's evaluation approach

Attitudes toward ICT	**Attitudes toward their progress**	**Attitudes toward gender and ICT**
ICT is: *Great!!!* *Very beneficial & valuable;* *An important tool.*	**Learned ICT:** *By self-teaching;* *From friends;* *Not from UBC class instruction.*	Primarily critical
Headache: *Memory problems;* *Always breaking down.* *"I hate computers."*	**Discouraging:** *Wasted time;* *Boring;* *Not related to teachable subjects;* *A lot of extra work.*	**Dislike:** *Bad questions;* *Absurd, bizarre;* *Inappropriate, strange;* *Impossible to answer.*
We need: *More equipment;* *Budget for technology;* *More training in ICT.* *Loan equipment for practicum.*	**We need:** *More hands-on skills;* *A stronger focus on ICT;* *Integration technology into curriculum and high school classroom.*	*Do not appreciate this kind of question: Offensive.*

Labov's approach to evaluation was applied to summarize the student teachers' attitudes: What did they say, how did they feel, and what did they need? As suggested in Table 43, student teachers had intentions to learn how to use technologies but ignored the issues related to ICT literacy. What they needed most was to solve the immediate problems. Some expected to borrow AV equipment and laptops for extended periods of time during the 13-week practicum and others hoped that more of a budget would be available for equipment and computer labs in practicum schools.

Technology integration:

Selected comments such as the following from the post-program survey (May 2004) suggest that learning technology should be fully integrated, or required as a course, in the program. Students generally believed that the use of technology in teaching is beneficial and that a stronger focus on ICT in the teacher education program is mandatory. There was an interest in integrating technologies into curriculum, but some of the student teachers acknowledged the hit-or-miss approach of integration. In 2001 and 2003 respectively, 66% and 73% of the students agreed that there should be an ICT course requirement in their program. Students who offered comments on this qualified their preferences with cautions about an already overloaded curriculum. Some noticed that the students in the practicum schools had more sophisticated ICT literacy than the student teachers. They felt they were "digital immigrants." The following quotations express their sentiment:

"I think there needs to be a stronger focus on technology use in the teacher education program. The students I teach are extremely adept at using technology that I am completely unfamiliar with (i.e., website creation)."

"Learning technology should be fully integrated in the teaching curriculum and student teachers' practicum" (2004 survey). Some student teachers acknowledged the importance of integrating ICT into curriculum and instruction, but felt unconfident about how to do it. Comments like the following were common: *"It would be nice if there was a course/workshop that taught students in the teacher education programs how to use film, web design, PowerPoint, etc. A lot of us don't use these because we don't know how"* (2004 survey). Student teachers also noticed the need for ICT literacy for young students at school. One of the student teachers made comments about students (2004 survey): *"During my*

practicum, I found the majority of my students had familiarity with the information technology but they were definitely less aware of the reliability of websites."

While some of the teacher candidates celebrated their successful use of technologies on their practicum, others were concerned about the availability of technologies in schools. They experienced frustration due to insufficient equipment in practicum schools. A student teacher wrote in the 2004 survey: *"I think that computer-related technologies are essential to incorporate into the high school classroom... I feel my practicum school fell far short of supplying adequate technology options and equipment. Also, the B.Ed. program at UBC failed to prepare or even inform its students of relevant technology options in the classroom. This is one major area that needs improvement in this program, especially in science, and would help make the program more relevant and practical."*

Comments like this indicated that ICT was not only associated with the practices of literacy but also related to economics, policy, administration, and many other social issues and perspectives, which need further research. Participants in the interview expressed that they were looking forward to getting involved in the changing process the new technologies facilitated. Some recommended that it was necessary to explore the conditions of technology access at the practicum schools before the practicum. Therefore, strategies and action could be taken to solve the problems during the practicum to assure the connection between the learning of technology in the programs and technology use during practicum.

Data source B: Observations of Microteaching

The purpose of collecting videotape data of microteaching was to gain an in-depth understanding of how student teachers integrated technologies into subjects they were going to teach on practicum and in the future. Qualitative techniques were applied to investigate the following research questions:

1. How did the teacher candidates engage with ICT in their microteaching?
2. How did ICT facilitate reflection on learning and teaching?

Analyses of videotapes from selected student teachers in the technology cohorts in 2003 (M = 40, F = 8), 2004 (M = 29, F = 2) and in 2005 (M = 29, F = 5) documented progress the teacher candidates made in their microteaching. In order to reduce the complexities involved in teaching, the student teachers were asked to demonstrate two short lessons for 6-10 minutes, which they would teach in front of a group consisting of 8-10 peers and a supervisor during the first course they encountered in the teacher education program. Each of the teacher candidates was assigned to plan a microteaching lesson for a subject that he or she would be teaching during practicum. At the end of each microteaching session, the presenter received immediate oral and written feedback from his or her supervisor and peers. The feedback generally included four areas: Vocal skills (projection, volume, articulation and enunciation, pace); Non verbal cues (contact with audience sustained, eye contact, scanning, positioning, facial expression, gestures); Interpretation skills (content clear, phrasing, rhythm, pitch variety, emphasis); Questioning (appropriate level, varied level, pause, redirect, open questions, delay the question).

Each microteaching session was recorded onto the presenter's videotape. The use of digital camcorders or VHS helped students to reflect on their microteaching and be aware of their strength and weaknesses that were otherwise impossible to visualize themselves. The student teachers watched each other's video recording in groups and analysed their microteaching. They became aware of their eye contact, their gestures, body position in the classroom, their voices and paces in the microteaching by watching their video recordings. Therefore, they could design their gestures and modify their voices and paces for the next microteaching.

Student teachers made observations of their own microteaching and critiqued their own performances. For example, a student teacher received comments from his observers but he did not agree with them. However, he was convinced by his video. After watching his video he wrote: *"On my comment sheet I kept getting people stating that my presentation was good but I have to get rid of my "uuuuhhh's". I didn't agree until I saw the recording but after watching myself I agree that it is something I need to work on."*

He decided to make improvements on his microteaching and tried to get rid of the habit of mumbling "uuuhhhs". He found positive results when he watched the second video of his microteaching: *"I feel like this presentation was another step forward. ...my "uhhs" have not yet disappeared completely (they are way better than last time) but over all, this demo was an improvement on the last one."*

Another student teacher made valuable comments on how he looked by comparing how he dressed differently in two of his microteaching. He reflected on his first microteaching after he watched his tape recording: *"When I watched the video tape, I was aware of several problems. First of all, I did not look like a teacher. I was wearing my khaki shorts and an old work t-shirt. This made me look very unprofessional."*

He dressed up for his second microteaching and felt very comfortable when he delivered his presentation. After watching the second video of his second microteaching, he wrote: *"I feel I've made a very important stride in being professional. I was dressed up. I smiled and demanded attention. I spoke with a clear and professional voice. This* *demonstration was a far cry from my first. In the first one, I was dressed in khaki shorts and t-shirt and I looked like a 'regular Joe' off the street. ...In this one, I looked great. The professionalism alone made my demonstration twice as good as the first."*

Viewing their own teaching behaviours allowed student teachers to become aware of their strengths and weaknesses and helped them develop professionally. Videotapes of the students reflected that each performed much better in the second microteaching than in the first. About 75% of the teacher candidates delivered PowerPoint presentations in the first microteaching, but 100% of the teacher candidates presented with PowerPoint in the second microteaching. Progress was evident, after applying the model of multiliteracies (Cope & Kalantzis, 2000):

- Linguistic design: The PowerPoint texts were more concise and precise;
- Audio design: Most presenters spoke clearly and loud enough to be heard,
- Visual design: The images were rich in colours and coherent with the contents;
- Gestural design: Their classroom behaviours looked professional and more confident;
- Spatial design: The student teachers made good use of the classroom space to present their knowledge and themselves as professionals.

The teacher candidates applied multimedia to analyse and synthesize their teaching subjects and gave evaluation to their own work and their peers. They also organized their microteaching with conceptual structures and hierarchies. They created digital products such as drawings, graphics, images and IMovies to be embedded in the PowerPoint presentations to help express their ideas and teaching contents. Class observations revealed that the products of multimedia suggested gender identities. For example, in the PowerPoint presentations, male students retrieved images and their presentation contents most likely dealt with various artifacts. On the contrary, the female student teachers manipulated images of animals and birds, beauty of nature, people and social justice. And the female student teachers' digital products were more colourful, softer and more personal.

The student teachers made progress in microteaching with PowerPoint presentation. They combined visual design, audio design, gestural design in their microteachings. This study illustrated the advantages of the pedagogy of integrating multiliteracies into microteaching in an authentic teaching environment:

- Hands-on experience with technologies
- Learning through multiliteracies
- Student creativity and communication

In addition, employing multimedia in microteaching provided student teachers an opportunity to reflect on their performances and therefore make improvement possible. They could focus on one teaching skill in each microteaching and also were aware of many other skills by watching their peers' videotapes of microteachings. At the same time, the teacher candidates could develop an interest in ethnographic study of their own teaching practices.

In general, their knowledge construction had transformed from the application level to the higher levels of analysis, synthesis and evaluation in the second microteaching compared to the first one. The student teachers presented themselves as more professional and more confident and brought multimedia products into the second microteaching in a meaningful way. Although there was a difference in presentation skills between male and female student teachers in post-program 2004 survey, no difference was identified from the qualitative data regarding the presentation skills. However, the female student teachers in technology cohorts accounted very small portion (8 out of 40 in 2003, 2 out of 31 in 2004) whereas the majority of student teachers in other cohorts were females.

Observations also revealed that technology brings about risk, some of which can be predictable and some cannot. For instance, some of the student teachers were excited about working on their video projects and tried to download their videos to the computers before the instruction sessions on videos were completed. Some managed to download the footage they shot successfully and some did not. One of the problems was that the procedure of working on digital technologies was not properly organized: A camera was set to "on" before it was connected to a computer, and this caused damage to the Firewire port on the digital camera. Another problem was that some of the videotapes were not in good condition and the computer could not read the information. However, it was predicted that the student teachers might encounter problems in saving movie files so this issue was reinforced during the instruction and student teachers were aware of saving movie files and other documents. It was also predicted that the student teachers would have problems dealing with audio files. So the instructors were prepared to work with the students to solve the problems in manipulating different music files the students selected to insert into the Movies. Cooperation and sharing of knowledge and information was evident when student teachers were working for their digital projects.

Data source C: Group Interview

The group interview was conducted at the end of the program in July 2004, after the student candidates returned from their practicum. It was intended to lend a rich and in-depth qualitative texture to the large research project dominated by quantitative analysis. It was hoped that the group interview would capture candidates' experiences as they completed their practicum in different schools. It provided information on how multi-literacy was practiced in the school-based settings. Five teacher candidates participated in the interview, M = 3, F = 2. This interview was designed to invite the participants to give voice to their course experiences and practicum experiences with respect to ICT literacy. All the participants responded that they were comfortable using technology in classroom settings and they felt that it was a good phenomenon for learning technology in the course work.

Interview analysis revealed the various challenges student teachers faced in their use of technology during their practicum. The interview also reflected the pedagogical use of multi-literacy in classroom teaching during teacher candidates' practicum. Quotations were selected from the interview to represent the diverse perspectives and experiences of the teacher candidates. The teacher candidates who were able to use technology in practicum stated that they felt happy. One of the female teacher candidates said *"I felt very happy going in there and presenting through a PowerPoint projector into a seminar room— like instruction in classroom. I knew that teachers would never imagine doing that and I think it gave some of the students an exposure to multimedia technology— like PowerPoint, very effective, you know. For me to be able to take that class and understand how to use PowerPoint was a tremendous benefit to me."*

However, some of them were not able to use multimedia in their practicum because the software and hardware were not available in the schools. One of the candidates reported that she could not use PowerPoint presentation to deliver her Java lessons during the practicum because a projector was not available in that school. But she helped fix the technical problems in the school because the technicians did not have the necessary technology skills. She also mentioned if she was hired she would invest her own money to purchase the equipment for teaching if necessary.

According to the interviews conducted during the summer in 2004, the use of technology in the classroom in practicum schools had positive impact on teaching and learning. The supervising teachers and students encouraged student teachers when they applied technologies in classroom teaching practices. However, some student teachers reported that there was a severe problem of computer accessibility at practicum schools. For example, they did not have the chance to use presentation software because there was no projector in the classroom or they could not access other software because there was no computer in the classroom. There was a disconnection between the learning of technology in the teacher education programs and the use of technology in practicum schools due to the lack of digital technology accessibility. This finding is consistent with the findings from analyses of Hypothesis IX, indicating that ICT competencies and access were correlated and ICT competencies varied with access. ICT competencies increase or decrease with the increase or decrease of access.

Data source D: Second language teachers' attitudes towards ICT

The purpose of collecting the data and conducting this investigation was to examine if the student teachers' attitudes changed after they had experiences in the environments with ICT. There were a total of 38 female student teachers in two second language education classes evenly divided between in-service and pre-serve teachers. Both the face-to-face components and the online component of the mixed-mode courses were held in a computer lab. Data collection and analyses were based on classroom observations, questionnaires, interviews, and narrative inquiry. These second-language teachers planned to teach one or more of French, Spanish, German, Mandarin, or Japanese as second languages in secondary schools. Grounded theory was applied to systematically analyse data.

At the beginning of the course, most students held negative attitudes toward ICT and hesitated in using it. Students were given instruction in the use of WebCT electronic bulletin boards and search engines for finding language teaching resources, and also given lists of appropriate websites in addition to assigned readings. The students were required to use the WebCT online bulletin board to discuss each of the assigned chapters and their in-class presentations as well as their autobiographies on language/culture/identity. These activities were designed to help the student teachers to collaborate in developing their personal philosophy of language acquisition/teaching. In the first classes the students greeted each other online and then posted their autobiographies to reflect their languages, culture, identity, and pedagogical development and acquisition from childhood to the present. The construction of their autobiographical narrative was designed to facilitate student awareness of their own individual exposure to teaching methodologies and contribute to the understanding of their formation of their language/culture/identity and to help them develop a personal theory of second language acquisition and their preferred teaching methodology. The posting of this autobiography and subsequent online discussion was also found to facilitate the formation of an online community as well (Carey & Guo, 2003). Soon after the student teachers were familiar with the computer lab environment and their use of the WebCT electronic forum for discussing their language identity autobiographies, the professor informed the students how to form student groups for each of the several languages to be taught by the teachers:

After today's lab experience I think you can see how you could form a group of colleagues who teach a common second language that could continue to collaborate and help each other by finding online language teaching resources throughout this course that you can use for the teaching of your particular language. This resource group will be very useful to you and you can continue to find and evaluate teaching resources throughout the coming year of teaching starting in September.

I. Group Work

Each language group was encouraged to collaborate and pool pedagogical resources found on the Internet for their particular language teaching and post these on the bulletin board so the student teachers could efficiently build a collection of language teaching resources. The following samples of the data indicate that the student teachers in each particular language group were excited about the useful resources that they found from the Internet as they told their peers to search and explore these resource treasures for teaching.

Spanish: "*Hola. There are a ton of great webquest activities that would be soooooo easy to use in the classroom. The best part is that they are self- run. That means less prep time for us. Also, when you go into Vivisimo, there are several sights that have online tests for students, which would be great review for tests. Check them out. Hopefully the grades in Spanish will pick up.*"

Mandarin: "*let's get together virtually one day and find some more useful websites for teaching. They are really helpful.*"

French: "*look for my homepage on this thing for awesome links!*"

German: "*Do you think online activities like that would be useful in your German class? Would students in core German enjoy the opportunity to try to communicate simple messages in German?*"

"I think using bulletin board is very useful, you can encourage students to have very simple chat or communication with each other."

Some student teachers found that using the discussion forum was an ideal method for teaching listening and speaking to ESL learners. In most ESL classroom settings, an ESL student in a class of 15 students might have a chance to speak English at most five minutes in a class section. The teachers do not have enough time to help students correct pronunciation problems. WebCT allowed teachers' instructions to be accessible to a wider audience and provided convenient conditions for teachers to diagnose students' grammar problems. It also offered opportunities for students to identify their own grammar problems, to relieve speaking anxiety, and to provide limitless space and time to practice. Furthermore, it had implications for developing learner-centred curriculum and activities and providing convenient tests online.

Students appreciated the empowering use of the internet to find resources for their particular language and their particular program. This also demonstrated their change of attitude from neutral or negative to strongly positive towards the use of technology for teaching second languages. Through group work, the student teachers not only found academic support from each other, but also built their strength in technology skills and developed their relationships. Some of the online participants even expressed how they were eager to maintain their online community and keep in touch after the course was completed.

II. Online Cooperation

The WebCT Bulletin Board not only provides a way to encourage organized collaboration in the online community, but also allows the participants to support each other whenever there is a need. For example, one of the classmates found that a peer was absent from classroom instruction. She posted a message to offer help: *"because you were away today you missed a bit of stuff... We learned about different search engines for finding teaching tools. Come to me to get a copy of the handout we got today."* Messages like this were commonly posted by students to help other students who occasionally missed the F2F classroom instruction.

The online discussion also provided a space for the professor and student teachers to exchange their interpretations of the text content covered in the classroom meetings. The following message from the professor gave an explanation of the conceptions by theorists in the fields of linguistics and socio-linguistics. It conveyed the professor's interpretations and also encouraged student teachers to develop their critical thinking skills and also invited further online discussions:

> The discussion on how collaboration can aid SLA is fascinating because it puts into practice the theoretical works of Piaget, Vygotsky and much of information processing. These chapters offer the potential for conducting SLA classes that could result in much more rapid SLA. However, they also point out that learning of anything requires active reflection, analyzing and critical thinking on the part of the students. How much time does the average student really spend on critical thinking? Critical thinking requires motivation, interest and concentrated effort. I hope you will "collaborate in a discussion on collaboration" on our electronic bulletin board so that you can judge personally how a BB could be so useful in promoting reflection, critical thinking and thereby learning in a second language. There are some great quotes in these chapters that are gems of learning and worthy of negotiated meaning oriented discussions. Hope to hear from you in the bulletin board.

The in-service and pre-service student teachers shared their learning experiences and teaching experiences. An in-service teacher realized the importance of applying different means to stimulate the students' interest in learning a language:

> We have been boring students to death with too much rote learning. It's no wonder so many students dislike SLA. I think that we can revitalize our SLA classes by making

> them more interesting for the students. And one of the best ways to do this is to provide them with the opportunity to really think about what they are learning through reflection, analysis, and critique.

Other students replied, indicating that technology provided a way for learners to learn in a relaxed environment:

> It is also really nice to have the time to think about what I am going to say prior to writing it and sending it - it takes the pressure off and means that I can say everything I want to say. It's also nice to think about what others have said and come back later to respond after I have had enough time to really reflect on it. The more I use (the online communication), the more worthwhile and interesting it is becoming for providing an opportunity for learning a second language.

A student teacher shared her experiences of using multimedia, CD-ROM, Webquests and games in the classroom in her practicum to help draw student attention to learning. She found the pedagogy of integration of ICT into teaching and learning particularly helpful for the students who did not have much motivation for learning. She reported that students were stimulated to learn with the assistance of multimedia:

> In my practicum I had opportunities to try using technology such as CDs in the classroom. As I became more comfortable with the class I tried using a Webquest that worked wonderfully. I completed my practicum with a game of Who Wants to be a Millionaire. Both of these exercises went over incredibly well proving that technology really captivates student attention. Even my poorest students completed the assignments on time and received good grades.

In summary, second language teachers were convinced that technology was worthwhile and important in helping enhance learning outcomes through their own learning experiences and their students' experiences with ICT. According to the framework on evaluation by Labov (1997), a summary of second language student teachers' experiences and comments on online communication was presented in Table 44.

Table 44. Summary of data source D

Use of Technologies to Enhance SLA	Attitudes toward Technologies after Course Work and Practicum
Students enjoyed doing the projects with technologies and they became more interested to look at other links which helped them to learn even more.	Technology helps motivate students and they felt connected with the target language.
Various German websites that were good for advanced learners and they provided much information about Germany such as music, food, holidays and cultures.	One interesting way for encouraging students to learn foreign language is through technology.
French teachers identified excellent French websites for learning French at different levels.	In their practicum they had some opportunities to use technology in classroom.
Students can learn French cultures in other countries through information technology.	Technologies can help: as students become more and more accustomed to working and playing on computers, teachers must find more ways to use technologies constructively.
Some websites provide opportunities for critical thinking as they offer small critiques of popular movies, games, and music that youth would be interested in.	As language teachers, they realized technology would provide many opportunities to experience the Chinese culture in many different ways.

Student teachers' perspectives were relevant to constructivism and activity theory (Vygosky, 1934, 1978). As noted earlier, Vygotsky stresses that leaning takes place within the "zone of proximal development" (ZPD). There is no single ZPD for individuals because the zone varies with culture, society, language, and experience. Vygotsky (1934) claims that the larger the zone, the better students will learn. Online communication created a large ZPD for student teachers to interact with each other intellectually. They brought their experiences to their practicum classrooms and found their students enjoyed learning in this way, as well.

Conclusion

This chapter addressed the *use* of learning technologies in teaching practices and provided examples. In order to prepare student teachers for their teaching practices in the classrooms, the respondents wished that the teacher education program assigned more time to various technology applications (e.g. how to use Excel, PowerPoint, Database programs, how to make web pages). Multiple methods were employed to analyse the rich data collected from the survey's open-ended comments, group interviews, tapes of student microteaching, direct observations and data of online communications to explore perceptions of the student teachers of their progress in ICT.

Student teachers entered the program with different levels of ICT competences. Their needs for technology course work varied: some needed individualized instruction and others needed peer tutoring/coaches. At the same time, teacher educators need to become aware of the pedagogical issues, technological limitations, ethics, equity and other issues related to the use of technology in education.

Data sources from survey comments reflected the student teachers' attitudes toward ICT, their progress, the program, gender issues, etc. that could not be seen in the Likert item analyses. There was a variety of attitudes toward ICT among the student teachers. While some student teachers expected a stronger emphasis on ICT in the teacher education program, a small portion of student teachers believed that they wasted their time in this program developing ICT skills that would be impossible for them to use in the schools of

BC. Some believed ICT and information resources played an important role in teacher education but technology courses should not replace basic core courses like classroom management and interaction between the students and instructor. A student teacher mentioned that he or she did not use ICT more often during practicum because of his or her intention of protecting lower-income students who did not have access to new technology. Those students with lower socio-economic status had little-to-no access to technologies at home, and they had little access to technologies at school.

Data sources from online communications reflected that pre-service teachers enjoyed completing projects with technologies and found that due to the collaboration and participatory learning they learned more than they expected. During their assignments they became more interested in looking at resources, which helped them to learn even more. The pre-service teachers became more enthusiastic about the possibilities of implementing their new knowledge and skills; however, the majority doubted they would be able to use this knowledge in their teaching positions. The primary obstacles they stated to implementing technology in their future classes included:

- The lack of computers in their schools when they did their practicum;
- The lack of positive attitudes towards technology expressed by their supervising teachers in the schools;
- The lack of emphasis on the importance of technology expressed by some of their professors in the teacher preparation program;
- Beliefs that ICT were incapable of providing a venue to foster human interaction and affective second language learning;

- Their belief that technology was competing with their specialization as teachers and that technology would displace their power and status as teachers;
- Their fear that their students would be more advanced in technology and technology would therefore undermine teachers' authority and ability to control their classes.

Because all the 38 participants in the second language education classes were female student teachers who provided the data via online communication, the interpretations of their perspectives and dispositions toward ICT were consistent with the findings from the statistical analyses in Chapter Four that female student teachers held more positive attitudes toward online communications by the end of the program.

Data sources from class observations illustrated various methods of integrating pedagogy and ICT into microteaching within an authentic teaching environment. Findings from this study showed that ICT in microteaching helped student teachers develop their teaching strategies and build confidence. The student teachers said that applications such as PowerPoint and digital camcorders were very helpful in enabling them to reflect on learning and teaching. Employing ICT in microteaching provided student teachers an opportunity to reflect on their performances. They could focus on one teaching skill in each microteaching session and become aware of many other skills by watching their videotapes of microteaching. At the same time, the teacher candidates developed an interest in the ethnographic study of their own teaching practices while reflecting on their microteaching.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

Significance of Outcomes

This case study entailed a statistical analysis of surveys administered to more than 2,000 pre-service teachers at UBC in two academic years and interpretations of qualitative data with a smaller sample of the participant group. Using both quantitative and qualitative approaches, I examined issues of age and ICT literacy, gender and ICT literacy, gender and attitudes toward ICT, frequency of use and ICT literacy, and program preparation and ICT literacy. Adopting triangulation (e.g. survey, direct observations, open-ended interviews) and multiple methods as recommended by Yin (1989, 1994), Denzin (1978), and Denzin and Lincoln (1994) to expand the depth of data gathering and increase the sources of information, this study provided an understanding of the complex characteristics of ICT literacy in teacher education at UBC. This study provided reliable data at an institutional level regarding the use of ICT in teacher preparation programs and an in-depth analysis of ICT literacies and practices of pre-service teachers.

This research helps us understand the complexity of ICT literacy in teacher education. This research also informs the assessment of technology curriculum and the debate over concentrating technology into a separate component of teacher education versus integrating technology into all curriculum studies. The findings will help educators gain a better understanding of how student teachers perceive ICT and how our teacher preparation programs can be updated to adopt an optimal technology curriculum and learning environment that will maximally benefit the educational system and student teachers in the teacher education program. In sum, the research findings contribute to practices and theories of ICT competencies and attitudes toward ICT in education, and can assist in formulating a vision for the role of ICT literacy in teacher education.

Major Findings

Four variations of a survey instrument were used to measure the following variables: access, attitudes toward ICT, frequency of use of ICT, and student teachers' ICT self-efficacy. The study entailed multiple sources of data, including questionnaires administered to more than 2,000 pre-service teachers at UBC in two academic years and ethnographic data from a smaller sample. Using both quantitative and qualitative approaches, I examined issues of age and ICT literacy, the relationship among access, attitudes towards ICT, frequency of use of ICT and ICT literacy, gender and ICT literacy, and program duration and ICT literacy. The three major research questions were answered through quantitative analyses and qualitative interpretations (Figure 20).

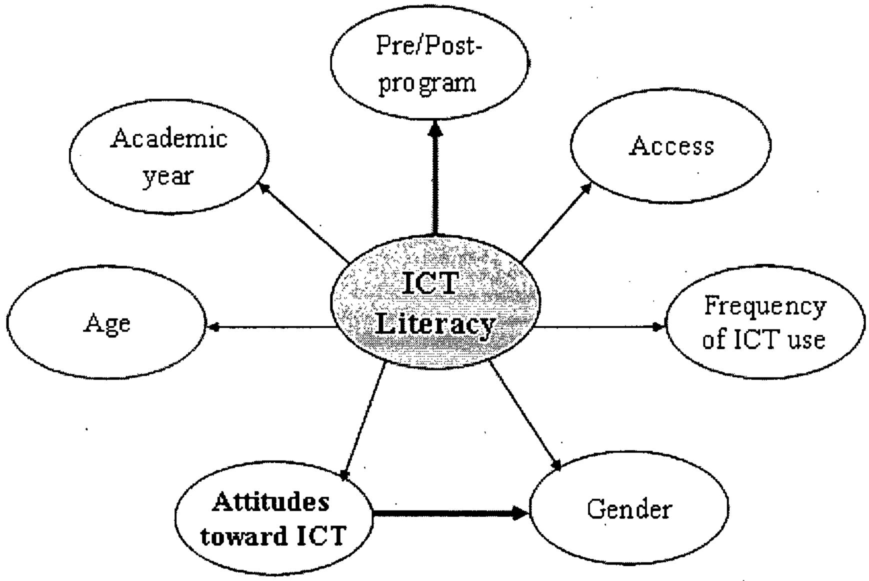


Figure 20. Summary of major findings

Figure 20 reiterates the research design. The following addresses the research design through major findings. Research question one: **Are there differences between pre- and post-program perceptions of ICT competencies**? Hypotheses one to eight were designed to investigate if there were differences in perceptions of ICT competencies between pre- and post-programs combined with other variables, including age, attitudes, and gender. All the results from the multiple tests with different independent variables, age, academic year, attitudes, pre/post-program and gender confirmed that there was a statistically significant difference in student teachers' perceptions of ICT competencies between pre- and post-program intervals. It was evident that over the duration of the program the teacher candidates perceived that they improved their perceptions of ICT competencies. The range of ICT scores reported in pre-program surveys confirmed that teacher candidates begin teacher education programs with a wide variety of perceptions of ICT competencies and skills. The students indicated that they obtained prior ICT competencies through self-teaching, friends, high school and university, workplace, or other channels. This diversity makes developing an appropriate technology curriculum particularly challenging. As mentioned in Chapter Four, however, factors that affected the differences were not actually under methodological control, such as confidence in ICT and anxiety. The student teachers' increase in their perceptions of ICT competencies may (or may not) have been related to factors such as instructional pedagogies, meaningful assignments with technologies, and collaboration with peers. It was mandatory in some of the course work that student teachers apply ICT skills to complete assignments and engage in communication. This encouraged the students to increase the frequency of use of ICT or seek ICT support to achieve success in their course work.

However, it was possible that some students who did not participate in the survey might have had less confidence with their ICT competencies. This study confirmed that access, attitudes toward ICT, and frequency of use of ICT made significant contributions to ICT competencies. An important finding in this study is that there was a significant correlation between student teachers' perceptions of ICT competencies and their students' frequency of use of technologies, an indicator that student teachers may have made meaningful connections between what they acquired through pedagogy on practicum.

Research question two: **Are there gender differences in pre-service teachers' views of, and attitudes toward, ICT competencies?** There existed a statistically significant difference between female and male student teachers' perceptions of ICT competencies. An overall descriptive analysis found similar patterns for the pre-program surveys in 2001 and 2003. Students arrived with high levels of basic ICT skills but lower levels of ICT skills. Males arrived in the program with a higher rating of their self-efficacy of ICT competency and exited the program with a higher self-efficacy mean score than females. Both males and females increased their scores as indicated by a comparison of the pre-program and post-program survey data. Although they arrived with lower perceptions of ICT competencies, the female student teachers made greater progress than their male peers. The gender gap in post-program perceptions of ICT competencies for both the 2002 and 2004 surveys was narrower than that in the pre-program surveys in 2001 and 2003. One of the reasons might be that some male student teachers were at the ceiling (e.g. upper values of the ICT competences scale) when they entered the education program and there was not much room for them to increase their scale value when they exited the program. This ceiling effect may not have affected female student teachers as it affected males. On the other hand, the findings may reflect a tendency that in self-evaluations of ICT competencies males might be overconfident in their skills whereas females might be under-confident in their ICT competences. Girls and women tend to have low confidence in their ICT literacy and this manifests itself in their attitudes toward technology (Beyer, Rynes, Perrault, Hay and Haller, 2003). These differences are often misinterpreted as "computer anxiety," "computerphobia," or "technophobia" (Brosnan, 1998b; Worthington and Zhao, 1999).

Generally speaking, this study showed that pre-service teachers' attitudes toward ICT changed. There were statistically significant gender differences in attitudes toward ICT in both pre-program surveys. Male student teachers had significantly different attitudes from females when they entered the program. One conclusion that may be drawn from this study is that attitudes can be changed through exposure to ICT and the development of competencies. There was not a significant difference in the post-program surveys, although female student teachers rated themselves significantly lower each year than males on the item "I feel competent to use technology in my classroom in a meaningful manner." This indicated that female student teachers were under-confident in ICT competencies. However, both male and female student teachers did not see gender as an issue for ICT literacy. Students reacted passionately to the items dealing with gender issues in ICT and some called these items "absurd," "gender," and "sexist," "inappropriate," "impossible to answer," "offensive," "strange," and "opinion, not fact based."

The quantitative analyses found that attitudes were significantly related to ICT literacy in 2001 and 2003, but not in 2002 and 2004. Qualitative studies of student comments on the 2004 survey were employed to gain an understanding of why the pattern in attitudes differed from that of other years. One of the reasons might be that the student teachers did not fully appreciate the attitude items in the 2004 survey. Some students stated that they were not aware of gender issues in ICT literacy or lacked adequate knowledge in this area to answer the questions. There was a certain dislike of ICT among some student teachers, a suspicion that they would not have a chance to use the ICT skills in classroom teaching once they exited from the program. Some student teachers did not perceive a need to integrate ICT into their curricula and suggested a focus on traditional teaching methods over integration of technology.

Research question three: **How do the student teachers perceive their progress in ICT competency?** Generally, the students' dispositions toward ICT on the pre- and post-program surveys were positive, a conclusion that can be cast as "technoethusiastic" or ideologically conservative. For example, on pre- and post-program surveys of 2001-2002 and 2003-2004, about 70% of the students agreed or strongly agreed with the statement that "new technologies have a positive effect in transforming instruction." First of all, it was certain from the quantitative analysis that student teachers had increased their ICT literacy, the variables ICT competencies and attitude were related, and ICT competencies varied with attitudes. ICT competencies increase or decrease with the increase or decrease of attitudes. However, in the open-ended responses the student teachers did not demonstrate satisfaction with their progress in ICT competencies. This can be interpreted as demonstrating that the student teachers had high expectations for the program.

Other resources of qualitative data showed consistency with the quantitative findings on student teachers' perceptions of ICT literacy. Findings from an ethnographic study of videotapes, class observations, and student reflections on their engagement with ICT showed most student teachers enjoyed using digital cameras to record their microteaching and to analyse their teaching styles. They found they made professional improvement through the pedagogy of technology integration. Watching their own video recording and analysing their microteaching required the student teachers to manipulate digital files, to download and edit their videotapes. They became aware of their strengths and weaknesses in microteaching by watching their video recordings. Therefore, they could make meaningful changes for the next microteaching session. Integrating ICT, such as digital cameras, PowerPoint and computer applications in microteaching gave student teachers an opportunity to reflect on their performances and therefore to make improvement possible. At the same time, the teacher candidates developed interests in studying their own teaching practices. In their presentations the student teachers used ICT as an expressive and creative medium and enjoyed using PowerPoint, digital technologies, and websites in their coursework. Interview interpretation also suggested that student teachers were excited to use PowerPoint on practicum. Some of the student teachers said in interviews that they were looking forward to using ICT to help their students.

Data from online communication examined the sub-questions focused on attitudes of teacher candidates in language. Analysis of the question "what attitudes did pre-service language teachers hold toward information technology" suggested that there existed fear and anxiety and that the student teachers had mixed feelings toward ICT at the beginning of the course. They used ICT to participate in online communication and build collaborative relationships during coursework. There was evidence that the student teachers changed their attitudes toward ICT when they were able to use and share resources and information to learn and teach languages.

On the contrary, some of the open-ended responses to the survey questions found that there was disappointment and frustration among the student teachers and some of them thought it was boring to learn how to use ICT. Some of them thought it was a waste of time to spend time learning ICT skills in the program. Some complained they did not receive any additional instruction about technology during their practicum or coursework at UBC.

In addition, this study examined the age demographic distributions of student teachers and their ICT competencies. There was no significant difference in ICT skills between age groups in both program years. The findings were *not* consistent with Prensky's prediction that people of older ages would have lower average ICT competencies than the younger students. There was no statistically significant difference among age groups when the variable "N/A" group was removed from the analysis. The findings showed that there was no statistically significant difference in student perceptions of ICT competencies between digital natives and digital immigrants. This finding was consistent with that of some preliminary studies by Brock et al. (1992) and Karsten and Roth (1998). This study implies that there is a need for ICT literacy for all students in different age groups, whether they are so-called digital natives or digital immigrants. Learning theories (Vygotsky, 1934, 1978; Cope & Kalantzis, 2000) and rapid developing technologies encourage life-long learning. "Basic literacy is still the gateway to truly being native in the digital environment" (US Today, 2005).

Class observations for three years revealed that female student teachers were under-represented in the technology cohorts, even in spite of the fact that the teacher education program at UBC was dominated by female student teachers (69% and 73% in 2001 and 2003 respectively). There were 20% (8 out of 48) female student teachers in the technology cohorts in 2002-2003 academic year, 6% (2 out of 31) in 2003-2004 and 15% (5 out of 34) in 2004-2005 academic year. Compared to the population of females in other cohorts of the teacher education program, their representation in technology cohorts was small.

Recommendations and Directions for Future Research

ICT is not only associated with practices of literacy but also relates to economics and many other social issues and perspectives that need further research. Vancouver is a densely populated region rich with a diversity of ethnic cultures and languages. This linguistic and ethnic diversity brings challenges to the use of technologies. In Vancouver, immigration is highest in BC and the population is in consequence most diverse. For example, about 24% of the student teachers in 2003 teacher education program represented racial minorities (e.g., Afro-Canadians, Arab-Canadians, Asian-Canadians, First Nations, Indo-Canadians and

Latin-Canadians). Further research is needed for an understanding of the effect of ethnicity on ICT literacy.

Previous research provided a limited understanding regarding the connection between the technology curriculum in teacher education and the practice of beginning teachers using technology in their classrooms. Little is known about the factors influencing beginning teachers' use of ICT in their classrooms, or about how they use ICT in instruction (Scheffler & Logan, 1999). As well, research suggests that there is a digital divide among technology users along the lines of age, ethnicity, gender, and socioeconomic status (Bryson et al., 2003; Wilhelm, 2000). As noted earlier, this claim was upheld in part in this research (e.g., males scored higher on competency ratings in pre-program surveys, although the divide was reduced but still significant in post-program surveys). Should we expect such imbalances among pre-service teachers to be further reduced or to increase when they enter the classroom setting where they are less likely to have support in their efforts to integrate ICT in teaching? Based on the analyses of the data and findings, in particular the gender differences in perceptions of ICT competencies, the relationship between student attitudes toward ICT and their perceptions of ICT competencies, the correlations between students' ICT uses on practicum and their perceptions of ICT competencies, directions for future research and teacher education curriculum and programs are indicated as following:

- To explore students' attitudes toward ICT literacy
  - Teacher educators may want to develop attitudes in the pre-service teachers that support ICT innovation

- To explore students' confidence in ICT competencies
  - Teacher educators may want to develop confidence in particular groups of pre-service teachers (e.g., women, older students, etc.)

- To explore social, group work with ICT use
    - Teacher educators may want to develop activities and projects that utilize social dynamics and group work
    - Peer tutoring in ICT is an especially helpful direction

- To explore technical support conditions for students on practicum
    - Teacher educators may want to establish technical support structures for student teachers' adoption of ICT while on practicum

- To explore what types of curriculum that challenge students at various ICT levels
    - Teacher educators may want to create curriculum that challenges students to develop and draw on ICT skills

Finally, there is a question with respect to how or whether ICT enhances learning (Cuban, 2001). It is important to consider how teachers' practices with ICT might be changing their pedagogies and, therefore, their students' learning experiences (Becker, 2000). Further research is needed to examine whether the ICT literacy student teachers acquire is a predictor of their students' frequent and appropriate use of ICT; a study of comparisons between student perceptions of their ICT competencies and their task performances in ICT skills to investigate whether there is a gap between student perceptions of their ICT competencies and their solid ICT skills (e.g., ETS test of ICT literacy) would be a very fruitful direction for research.

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APPENDIX A: Instruments

Pre-Program Survey 2001

1. UBC Student Number

Use an HB (or softer) pencil to write your UBC Student Number in the 8 boxes at the head of the columns to the left. Then, for each digit, fill in the corresponding circle in the column below it.

0 1 2 3 4 5 6 7 8 9

2. Age: 20-24 ( ) 25-29 ( ) 30-34 ( ) 35-40 ( ) over 40 ( )

3. Gender Male ( ) Female ( )

4. Program Elementary ( ) Middle ( ) Secondary ( ) NITEP ( ) Graduate ( )

5. Major or Cohort

Elementary 1-year program cohorts: (Select one)
CITE ( ) Delta ( ) ELP ( ) FAME ( ) French ( ) Langley ( ) PBL ( ) SRL ( ) Surrey ( ) Urban Diversity ( ) Intermediate Generalist ( ) Primary & Intermediate Generalist ( )

Elementary 2-year program concentrations: (Select one)
Early Childhood ( ) ESL ( ) Humanities ( ) Math & Sci ( ) Spec Ed ( ) Expressive Arts ( )

Middle Years program concentrations: (Select one)
Business Ed ( ) English ( ) Physical Ed ( ) Science ( ) Social Studies ( )

Secondary program cohorts: (Select one)
Humanities & Social Justice ( ) Langley ( ) Home Economics ( ) SIS ( ) Technology Studies Ed ( ) French Immersion ( ) SMART ( ) TIME ( )

Secondary program concentrations: (Select one)
Art ( ) French ( ) Bus Ed ( ) Comp Sci ( ) English ( ) ESL ( ) Phys Ed ( ) Tech Ed ( ) Math ( ) Home Ec ( ) Mod Lang ( ) Music ( ) Science ( ) Soc Studies ( ) Theatre ( )

6. Do you have a disability that affects or is affected by your use of technology? No ( ) Yes ( )
7. Do you have ready access to a computer at your residence? No ( ) Mac ( ) Windows ( ) Other ( )
8. Do you have a printer with this computer? No ( ) Yes ( )
9. Do you have web access on this computer? No ( ) Yes ( )
10. Where did you learn your computer skills? (Check all the main sources.) Have none ( ) Self-taught ( ) High School ( ) University ( ) Friends/relatives ( ) Workplace ( ) Other ( )

If you do not use computers at all, please go to Question 39.

Please indicate your degree of current competence for each of the activities listed below:
Choose "Avoid" if you would try to avoid this task if possible. Choose "Low" if you feel uncertain about doing the task. Choose "Medium" if you would attempt the task but are unsure of your competence. Choose "High" if you feel sure and able to complete the task.

	Don't know	Avoid	Low	Medium	High
11. Create or modify a word processing document.	( )	( )	( )	( )	( )
12. Create or modify a spreadsheet document.	( )	( )	( )	( )	( )
13. Create or modify a database document.	( )	( )	( )	( )	( )
14. Make a backup copy of a computer file.	( )	( )	( )	( )	( )
15. Create a folder or directory.	( )	( )	( )	( )	( )
16. Copy a file from one disk to another.	( )	( )	( )	( )	( )
17. Use a scanner to create a digital image.	( )	( )	( )	( )	( )
18. Use a digital camera to create an image on a computer.	( )	( )	( )	( )	( )
19. Place an image or graphic into a document.	( )	( )	( )	( )	( )
20. Create a presentation, e.g. PowerPoint or SlideShow.	( )	( )	( )	( )	( )
21. Send or receive an e-mail message.	( )	( )	( )	( )	( )
22. Open or send an attachment with an e-mail message.	( )	( )	( )	( )	( )
23. Make a web bookmark or favorite.	( )	( )	( )	( )	( )
24. Use a search engine such as AltaVista, Google, or Yahoo.	( )	( )	( )	( )	( )
25. Use information from the web for a project or assignment.	( )	( )	( )	( )	( )
26. Do an advanced search with AND and OR operators.	( )	( )	( )	( )	( )

Please indicate your degree of current competence for each of the activities listed below:

	Don't know	Avoid	Low	Medium	High
27. Download music files to your computer.					
28. Create or record your own music using a computer.					
29. Burn a music CD.					
30. Use an FTP program to upload files.					
31. Install an application program onto a computer.					
32. Save or use an image from a web page.					
33. Modify an image or graphic with the computer.					
34. Use advanced WP features such as tables or templates.					
35. Create a chart or graph with a spreadsheet program.					
36. Download a plug-in for your browser.					
37. Participate in an online discussion or newsgroup.					
38. Create a web page on the World Wide Web.					

As part of your teacher-education program, how frequently do you expect to:

	Don't know	Never	A few times	Weekly	Daily
39. Use a computer for university course work.					
40. Create a document with a word processor.					
41. Use advanced WP features such as tables or templates.					
42. Manipulate graphics or images with a computer.					
43. Create new graphics or images using graphics software.					
44. Create a chart or graph with spreadsheet software.					
45. Create a document with database software.					
46. Create a presentation with presentation software.					
47. Send or receive an e-mail message.					
48. Send or receive an e-mail attachment.					
49. Use a search engine to find useful information on the Web.					
50. Download a file from the Internet or the Web.					
51. Make your own file storage or music CD.					
52. Participate in an online discussion or bulletin board.					
53. Create a web page on the World Wide Web.					
54. Use computers as a regular part of instruction in your courses?					

55. Should there be a required course on computer use in the Teacher Education Program? No ○ Yes ○

56. Do you feel instructors teaching university courses should be competent computer users? No ○ Yes ○

57. As a student, to which of these services do you feel the university should provide ready access? (Check all that apply). computers ○ e-mail ○ basic software ○ computer lessons ○ printers ○ web access ○ specialist software ○ technical assistance ○

Imagine yourself as a new teacher; indicate the degree to which you agree with the following statements:

	Don't know	Strongly disagree	Disagree	Agree	Strongly agree
58. I am interested in learning more about how to use technology in the classroom.					
59. I would like to teach computer skills in my future classroom.					
60. The use of technology promotes student-centred learning.					
61. I would like to use educational software in my classroom.					
62. I understand the ethical issues involved in using technology in the classroom.					
63. It's not really important for teachers to know how to use technology.					
64. Integrating the use of technology across subject areas maximizes student learning.					
65. I think that there is too much emphasis on using technology in the classroom.					
66. I feel competent to use technology in my classroom in a meaningful manner.					
67. I would like to use the Internet as an instructional resource.					
68. New technologies have a positive effect in transforming instruction.					
69. I do not plan to use technology in my future classroom.					
70. I would like to use technology for assessment and evaluation in my classroom.					
71. I would like to use multimedia to explore different ways to represent concepts.					

I am going to write in the "Comments" section on the front page. No ○ Yes ○

Thank you for taking the time to complete this survey.

1. UBC Student Number

Use an HB (or softer, such as B) pencil to write your UBC Student Number in the 8 boxes at the head of the columns to the left. Then, for each digit, fill in the corresponding circle in the column below it.

0 ○○○○○○○○ 0
1 ○○○○○○○○ 1
2 ○○○○○○○○ 2
3 ○○○○○○○○ 3
4 ○○○○○○○○ 4
5 ○○○○○○○○ 5
6 ○○○○○○○○ 6
7 ○○○○○○○○ 7
8 ○○○○○○○○ 8
9 ○○○○○○○○ 9

2. **Age** 20-24 ○ 25-29 ○ 30-34 ○ 35-40 ○ over 40 ○

3. **Gender** Male ○ Female ○

4. **Program** Elementary ○ Middle ○ Secondary ○ NITEP ○ Graduate ○

5. Major or Cohort

Elementary 1-year program cohorts: (*Select one*)
CITE ○ Delta ○ ELP ○ FAME ○ French ○ Langley ○ PBL ○ SRL ○ Surrey ○
Urban Diversity ○ Intermediate Generalist ○ Primary & Intermediate Generalist ○

Elementary 2-year program concentrations: (*Select one*)
Early Childhood ○ ESL ○ Humanities ○ Math & Sci ○ Spec Ed ○ Expressive Arts ○

Middle Years program concentrations: (*Select one*)
Business Ed ○ English ○ Physical Ed ○ Science ○ Social Studies ○

Secondary program cohorts: (*Select one*)
Humanities & Social Justice ○ Langley ○ Home Economics ○ SIS ○
Technology Studies Ed ○ French Immersion ○ SMART ○ TIME ○

Secondary program concentrations: (*Select all that apply*)
Art ○ French ○ Bus Ed ○ Comp Sci ○ English ○ ESL ○ Phys Ed ○ Tech Ed ○
Math ○ Home Ec ○ Mod Lang ○ Music ○ Science Soc Studies ○ Theatre ○

Please indicate your degree of comfort and current competence for each of the activities listed below:
Choose "None" if you would try to avoid this task if possible. Choose "Low" if you feel uncomfortable and uncertain about doing the task. Choose "Medium" if you would attempt the task but are unsure of your competence. Choose "High" if you feel sure and able to complete the task.

	None	Low	Medium	High
6. Create or modify a spreadsheet document.	○	○	○	○
7. Create or modify a database document.	○	○	○	○
8. Make a backup copy of a computer file.	○	○	○	○
9. Create a folder or directory.	○	○	○	○
10. Copy a file from one disk to another.	○	○	○	○
11. Use a scanner to create a digital image.	○	○	○	○
12. Use a digital camera to create an image on a computer.	○	○	○	○
13. Place an image or graphic into a document.	○	○	○	○
14. Create a presentation, e.g. PowerPoint or SlideShow.	○	○	○	○
15. Make a web bookmark or favorite.	○	○	○	○
16. Do an advanced search with AND and OR operators.	○	○	○	○
17. Download music files to your computer.	○	○	○	○
18. Create or record your own music using a computer.	○	○	○	○
19. Burn a music CD.	○	○	○	○
20. Use an FTP program to upload files.	○	○	○	○
21. Install an application program onto a computer.	○	○	○	○
22. Save or use an image from a web page.	○	○	○	○
23. Modify an image or graphic with the computer.	○	○	○	○
24. Use advanced WP features such as tables or templates.	○	○	○	○
25. Create a chart or graph with a spreadsheet program.	○	○	○	○
26. Download a plug-in for your browser.	○	○	○	○
27. Participate in an on-line discussion or newsgroup.	○	○	○	○
28. Create a web page on the World Wide Web.	○	○	○	○

Please make two judgments concerning each of the activities below: (1) the frequency of use during your university coursework, and (2) the frequency of use during your practica.

As part of your teacher-education program, how frequently did you:

	During coursework					During practicum				
	N/A	Never	A few times	Weekly	Daily	N/A	Never	A few times	Weekly	Daily
29. Create new graphics or images using graphics software.	○	○	○	○	○	○	○	○	○	○
30. Create a chart or graph with spreadsheet software.	○	○	○	○	○	○	○	○	○	○
31. Create a document with database software.	○	○	○	○	○	○	○	○	○	○
32. Make your own file storage or music CD.	○	○	○	○	○	○	○	○	○	○
33. Use the computer to make lesson plans and worksheets.	○	○	○	○	○	○	○	○	○	○
34. Use the internet to obtain teaching resources.	○	○	○	○	○	○	○	○	○	○
35. Create a lesson or unit plan that incorporated subject matter software.	○	○	○	○	○	○	○	○	○	○
36. Use simulation software to introduce or teach content information.	○	○	○	○	○	○	○	○	○	○
37. Create web pages as part of a lesson or unit.	○	○	○	○	○	○	○	○	○	○
38. Use presentation software such as PowerPoint or Slideshow.	○	○	○	○	○	○	○	○	○	○
39. Use multimedia software with animation, sound, graphics, and/or video.	○	○	○	○	○	○	○	○	○	○
40. Use software to maintain student grades.	○	○	○	○	○	○	○	○	○	○
41. Introduce a new approach to technology to your school advisor.	○	○	○	○	○	○	○	○	○	○
42. Use e-mail to communicate with your faculty advisor.	○	○	○	○	○	○	○	○	○	○
43. Use e-mail to communicate with your school advisor.	○	○	○	○	○	○	○	○	○	○
44. Use e-mail to communicate with your students or their parents.	○	○	○	○	○	○	○	○	○	○
45. Participate in online forums, chat rooms, or discussion groups.	○	○	○	○	○	○	○	○	○	○
46. Participate in a school or district technology workshop.	○	○	○	○	○	○	○	○	○	○

During your practicum, how frequently did you have your students:

	Never	A few times	Weekly	Daily
47. Use word processing programs to complete written work.	○	○	○	○
48. Use the internet for research.	○	○	○	○
49. Use multimedia software with animation, sound, graphics, and/or video.	○	○	○	○
50. Use presentation software such as PowerPoint or Slideshow.	○	○	○	○
51. Create web pages.	○	○	○	○
52. Use educational CD-ROMs.	○	○	○	○
53. Use e-mail to correspond with other schools.	○	○	○	○
54. Participate in on-line interactive projects with other schools (excluding e-mail).	○	○	○	○

As a prospective new teacher, indicate the degree to which you agree with the following statements:

	Don't know	Strongly disagree	Disagree	Agree	Strongly agree
55. I am interested in learning more about how to use technology in the classroom.	○	○	○	○	○
56. I would like to teach computer skills in my future classroom.	○	○	○	○	○
57. The use of technology promotes student-centred learning.	○	○	○	○	○
58. I would like to use educational software in my classroom.	○	○	○	○	○
59. I understand the ethical issues involved in using technology in the classroom.	○	○	○	○	○
60. It's not really important for teachers to know how to use technology.	○	○	○	○	○
61. Integrating the use of technology across subject areas maximizes student learning.	○	○	○	○	○
62. I think that there is too much emphasis on using technology in the classroom.	○	○	○	○	○
63. I feel competent to use technology in my classroom in a meaningful manner.	○	○	○	○	○
64. I would like to use the Internet as an instructional resource.	○	○	○	○	○
65. New technologies have a positive effect in transforming instruction.	○	○	○	○	○
66. I do not plan to use technology in my future classroom.	○	○	○	○	○
67. I would like to use technology for assessment and evaluation in my classroom.	○	○	○	○	○
68. I would like to use multimedia to explore different ways to represent concepts.	○	○	○	○	○

Thank you for taking the time to complete this survey.

1. UBC Student Number

1	○	○	○	○	○	○	○	○	1
2	○	○	○	○	○	○	○	○	2
3	○	○	○	○	○	○	○	○	3
4	○	○	○	○	○	○	○	○	4
5	○	○	○	○	○	○	○	○	5
6	○	○	○	○	○	○	○	○	6
7	○	○	○	○	○	○	○	○	7
8	○	○	○	○	○	○	○	○	8
9	○	○	○	○	○	○	○	○	9
0	○	○	○	○	○	○	○	○	0

Pre-program Survey 0903

Using an HB or softer pencil, write your UBC Student Number in the 8 boxes at the head of the columns to the left. Then, for each digit, fill in the corresponding circle in the column below it.

2. **Age closest to** 20 ○ 30 ○ 40 ○ 50 ○

3. **Gender** Male ○ Female ○

4. **Program** Elementary ○ Middle ○ Secondary ○ NITEP ○

5. **Major or Cohort:** **Elementary 1-year program cohorts**(Select One)
CITE ○ Delta ○ ELP ○ FAME ○ French ○ WKTEP ○ PBL ○ SLR ○ Surrey ○
Primary & Intermediate Generalist ○

Elementary 2-year program cohorts (Select One) Diversity ○ Generalist 201,2,3 ○

Middle Years program concentrations (Select One)
Business Ed ○ English ○ Physical Ed ○ Science ○ Social Studies ○ Maths ○ Art ○

Secondary program cohorts (Select One)
Humanities & Social Justice ○ Langley ○ Home Economics ○ SISO ○ Math Integrated ○
Computer/Technologies Studies Ed ○ French Immersion ○ SMART ○ Time ○

Secondary program concentrations (Select One)
Art ○ French ○ Bus Ed ○ Comp Sci ○ Eng ○ ESL ○ Phys Ed ○ Tech Ed ○
Math ○ Home Ec ○ Mod Lang ○ Music ○ Science ○ Soc Studies ○ Theatre ○

6. **What computer operating system do you have at home?** None ○ Mac ○ Windows ○ Linux ○ Other ○
7. **What kind of computer do you have?** None ○ Desktop ○ Laptop ○
8. **What is your home internet connectivity?** None ○ High-speed wire-Telus/Shaw ○ High-speed wireless ○ Dial-up ○
9. **Where do you most frequently access the Internet?**
home ○ university ○ internet cafe ○ library ○ friend's house ○
10. **Where did you learn your computer skills?** (check all the main sources)
Have none ○ Self-taught ○ High school ○ University ○ Workplace ○ Friends/Relatives ○ other ○

Please indicate your degree of current competence for each of the activities listed. Choose "None" if you have no knowledge of, or experience with, this task. Choose "Low" if you have some limited experience with the task, but are unsure of your ability to complete it unassisted. Choose "Medium" if you feel reasonably sure of your ability to complete this task. Choose "High" if you are sure of your ability to complete this task to the point that you could teach it to someone else.

11. **Create or modify a spreadsheet document.**	None ○	Low ○	Medium ○	High ○
12. **Create or modify a database document.**	None ○	Low ○	Medium ○	High ○
13. **Make a backup copy of a computer file.**	None ○	Low ○	Medium ○	High ○
14. **Create a folder or directory.**	None ○	Low ○	Medium ○	High ○
15. **Copy a file from one disk to another.**	None ○	Low ○	Medium ○	High ○
16. **Use a scanner to create a digital image.**	None ○	Low ○	Medium ○	High ○
17. **Use a digital camera to create an image on a computer.**	None ○	Low ○	Medium ○	High ○
18. **Place an image or graphic into a document.**	None ○	Low ○	Medium ○	High ○
19. **Create a presentation e.g.: PowerPoint or SlideShow.**	None ○	Low ○	Medium ○	High ○
20. **Make a web bookmark or favorite.**	None ○	Low ○	Medium ○	High ○
21. **Do an advanced search with AND and OR operators.**	None ○	Low ○	Medium ○	High ○
22. **Download files to your computer.**	None ○	Low ○	Medium ○	High ○
23. **Create or record your own music using a computer.**	None ○	Low ○	Medium ○	High ○
24. **Burn a CD.**	None ○	Low ○	Medium ○	High ○

25. Use an FTP program to upload files.	None ○	Low ○	Medium ○	High ○
26. Install an application or program onto a computer.	None ○	Low ○	Medium ○	High ○
27. Save or use an image from a web page.	None ○	Low ○	Medium ○	High ○
28. Modify an image or graphic with the computer.	None ○	Low ○	Medium ○	High ○
29. Use advanced word processing features such as tables or templates.	None ○	Low ○	Medium ○	High ○
30. Create a chart or graph with a spreadsheet program.	None ○	Low ○	Medium ○	High ○
31. Download a plug-in for your browser.	None ○	Low ○	Medium ○	High ○
32. Participate in an on-line discussion or newsgroup.	None ○	Low ○	Medium ○	High ○
33. Create and upload a web page on the World Wide Web.	None ○	Low ○	Medium ○	High ○
34. Create or modify a word processing document.	None ○	Low ○	Medium ○	High ○
35. Send or recieve an e-mail message with an attachment.	None ○	Low ○	Medium ○	High ○
36. Use a search engine such as Google, Alta Vista or Yahoo.	None ○	Low ○	Medium ○	High ○
37. Use information from the web for a project or assignment.	None ○	Low ○	Medium ○	High ○

<u>How important do you think it is that you know or attain the following competencies in your teacher-education program?</u>	<u>Not Important</u>	<u>Somewhat Important</u>	Important	<u>Very Important</u>
38. Create a document with a word processor.	○	○	○	○
39. Use advanced word processing features such as tables or templates.	○	○	○	○
40. Create/manipulate graphics or images with a computer.	○	○	○	○
41. Create a chart or graph with spreadsheet software.	○	○	○	○
42. Create a document with database software.	○	○	○	○
43. Create a presentation with presentation software.	○	○	○	○
44. Conduct research using the library.	○	○	○	○
45. Conduct research using the Internet.	○	○	○	○
46. Send or receive e-mail with an attachment	○	○	○	○
47. Use a search engine to find useful information on the Web.	○	○	○	○
48. Download a file from the Internet or the Web.	○	○	○	○
49. Burn a CD .	○	○	○	○
50. Participate in an on-line discussion, forum, or bulletin board.	○	○	○	○
51. Create a web page and upload it to the World Wide Web.	○	○	○	○
52. Be able to integrate computers into your classroom lessons.	○	○	○	○

53. Should there be a required course on computer use in the Teacher Education Program? No ○ Yes ○

54. Should computers be integrated on a regular basis into course instruction? No ○ Yes ○

55. What sort of computer support would you find most helpful?

onsite help desk ○ remote help desk - phone/e-mail ○ peer tutorials ○ online tutorials ○ workshops ○

56. As a student, to which of these services do you feel the university should provide ready access (check all that apply)

computers ○ printers ○ e-mail ○ computer lessons ○ web access ○ technical assistance ○

basic software ○ specialist software ○

<u>As a prospective teacher, indicate your level of agreement with these sentences:</u>	<u>Don't Know</u>	<u>Strongly Disagree</u>	Disagree	<u>Agree</u>	<u>Strongly Agree</u>
57. I would like to use educational software in my classroom.	○	○	○	○	○
58. I understand the ethical issues involved in using technology in the classroom.	○	○	○	○	○
59. Integrating the use of technology across subjects maximizes student learning.	○	○	○	○	○
60. I think that there is too much emphasis on using technology in the classrooom.	○	○	○	○	○
61. I feel competent in using technology in my classroom in a meaningful manner.	○	○	○	○	○
62. I would like to use the Internet as an instructional resource.	○	○	○	○	○
63. New technologies have a positive effect in transforming instruction.	○	○	○	○	○
64. I do not plan to use technology in my future classroom.	○	○	○	○	○
65. I would like to use technology for assessment and evaluation in my classroom.	○	○	○	○	○
66. I would like to use multimedia to explore different ways to represent concepts.	○	○	○	○	○

I am going to write in the "Comments" section on the front page. No ○ Yes ○

Post-program Survey 2004

Using an HB or softer pencil, completely fill in the circle(s) that best represent your response to each question. If you change your mind, completely erase the incorrect response.

1. Age closest to 20 ◯ 30 ◯ 40 ◯ 50 ◯ **2. Gender** Male ◯ Female ◯

3. Program: Elementary ◯ Middle ◯ Secondary ◯ NITEP ◯

4. Major or Cohort:

a. Elementary 1-year program cohorts ***(Select One)***

CITE ◯ Delta ◯ ELP ◯ FAME ◯ French ◯ WKTEP ◯ PBL ◯

SRL ◯ Surrey ◯ TACT ◯ Primary & Intermediate Generalist ◯

b. Elementary 2-year program cohorts ***(Select One)*** Diversity ◯ Generalist 201,2,3 ◯

c. Middle Years program concentrations ***(Select One)***

Business Ed ◯ English ◯ Phys Ed ◯ Science ◯ Socials ◯ Maths ◯ Art ◯

d. Secondary program cohorts ***(Select One)***

Humanities & Social Justice ◯ Langley ◯ Home Ec ◯ SISO ◯ Math Integrated ◯

Computer/ Tech Studies Ed ◯ Fr. Immersion ◯ SMART ◯ Time ◯

e. Secondary program concentrations ***(Select up to two)***

Art ◯ French ◯ Bus Ed ◯ Comp Sc ◯ Eng ◯ ESL ◯ Phys Ed ◯ Tech Ed ◯

Maths ◯ Home Ec ◯ Mod Lang ◯ Music ◯ Sci ◯ Theatre ◯ Socials ◯

Please indicate your degree of current competence for each of the activities listed. Choose "None" if you have no knowledge of, or experience with, this task. Choose "Low" if you have some limited experience with the task, but are unsure of your ability to complete it unassisted. Choose "Medium" if you feel reasonably sure of your ability to complete this task. Choose "High" if you are sure of your ability to complete this task to the point that you could teach it to someone else.

	None	Low	Medium	High
5. Use a scanner to create a digital image.	◯	◯	◯	◯
6. Create or modify a database document.	◯	◯	◯	◯
7. Make a backup copy of a computer file.	◯	◯	◯	◯
8. Create a folder or directory.	◯	◯	◯	◯
9. Copy a file from one disk to another.	◯	◯	◯	◯
10. Create or modify a spreadsheet document.	◯	◯	◯	◯
11. Use a digital camera to create an image on a computer.	◯	◯	◯	◯
12. Place an image or graphic into a document.	◯	◯	◯	◯
13. Create a presentation e.g.: PowerPoint or SlideShow.	◯	◯	◯	◯
14. Make a web bookmark or favorite.	◯	◯	◯	◯
15. Do an advanced search with AND and OR operators.	◯	◯	◯	◯
16. Download files to your computer.	◯	◯	◯	◯
17. Create or record your own music using a computer.	◯	◯	◯	◯

Please make two judgements concerning each of the activities below: (1) the frequency of use during your university course work, and (2) the frequency of use during your practica.

As part of your teacher-education program, how frequently did you:	During Coursework					During Practicum				
	N/A	Never	A few times	Weekly	Daily	N/A	Never	A few times	Weekly	Daily
18. Create new graphics or images using graphics software?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
19. Create a chart or graph with spreadsheet software?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
20. Burn a CD?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
21. Use the internet to obtain teaching resources?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
22. Create lessons that incorporate subject-specific software?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
23. Create lessons that incorporate simulation software?	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Please continue on back →

As part of your teacher-education program, how frequently did you:	During Coursework N/A	Never	A few times	Weekly	Daily	During Practicum N/A	Never	A few times	Weekly	Daily
24. Create lessons using presentation software (e.g., PowerPoint)?	○	○	○	○	○	○	○	○	○	○
25. Create lessons incorporating student use of digital video, graphics or sound editors?	○	○	○	○	○	○	○	○	○	○
26. Use software to maintain student grades?	○	○	○	○	○	○	○	○	○	○
27. Introduce a new approach to technology to your school or faculty advisor?	○	○	○	○	○	○	○	○	○	○
28. Use email to communicate with your faculty advisor?	○	○	○	○	○	○	○	○	○	○
29. Use email to communicate with your school advisor?	○	○	○	○	○	○	○	○	○	○
30. Use email to communicate with your students or their parents?	○	○	○	○	○	○	○	○	○	○
31. Participate in on-line discussions related to your education program?	○	○	○	○	○	○	○	○	○	○
32. Participate in a school or district technology workshop?	○	○	○	○	○	○	○	○	○	○

As part of your practicum, how frequently did you have your students:	Never	A few times	Weekly	Daily
33. Use word processing programs to complete written work?	○	○	○	○
34. Use the Internet for research?	○	○	○	○
35. Use multimedia software with animation, sound, graphics and/or video?	○	○	○	○
36. Use presentation software such as PowerPoint or Slideshow?	○	○	○	○
37. Create web pages?	○	○	○	○
38. Use educational CD-ROMs?	○	○	○	○
39. Use email to correspond with other schools?	○	○	○	○
40. Participate in on-line interactive projects with other schools (excluding email)?	○	○	○	○
Indicate your level of agreement with the following statements:	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
41. My practicum school provided teachers with adequate means to use information technology in instruction.	○	○	○	○
42. My practicum school provided teachers with adequate means to use information technology for professional development.	○	○	○	○
43. Female students have less access to information technology within the school environment than do male students.	○	○	○	○
44. The World Wide Web advances gender and racial equity.	○	○	○	○
45. Online courses improve the learning process and outcomes for students who are unsuccessful in traditional educational systems.	○	○	○	○
46. Males are more comfortable using information technology than are females.	○	○	○	○
47. Online distance education courses reduce employment opportunities for teachers.	○	○	○	○
48. Females are less likely to use information technology while teaching than males.	○	○	○	○
49. Internet access at home is essential to education for North American school-age students.	○	○	○	○
50. Teachers should advocate less corporate involvement related to information technology in schools.	○	○	○	○
51. Significant electronic game playing (i.e., 2 hrs+ per day) promotes hyperactive, aggressive behaviour.	○	○	○	○
52. Males are less concerned with the implications of information technology than are females.	○	○	○	○
53. Information technologies are just tools.	○	○	○	○

Thank you for taking the time to complete this survey!

APPENDIX B: Supporting Analyses

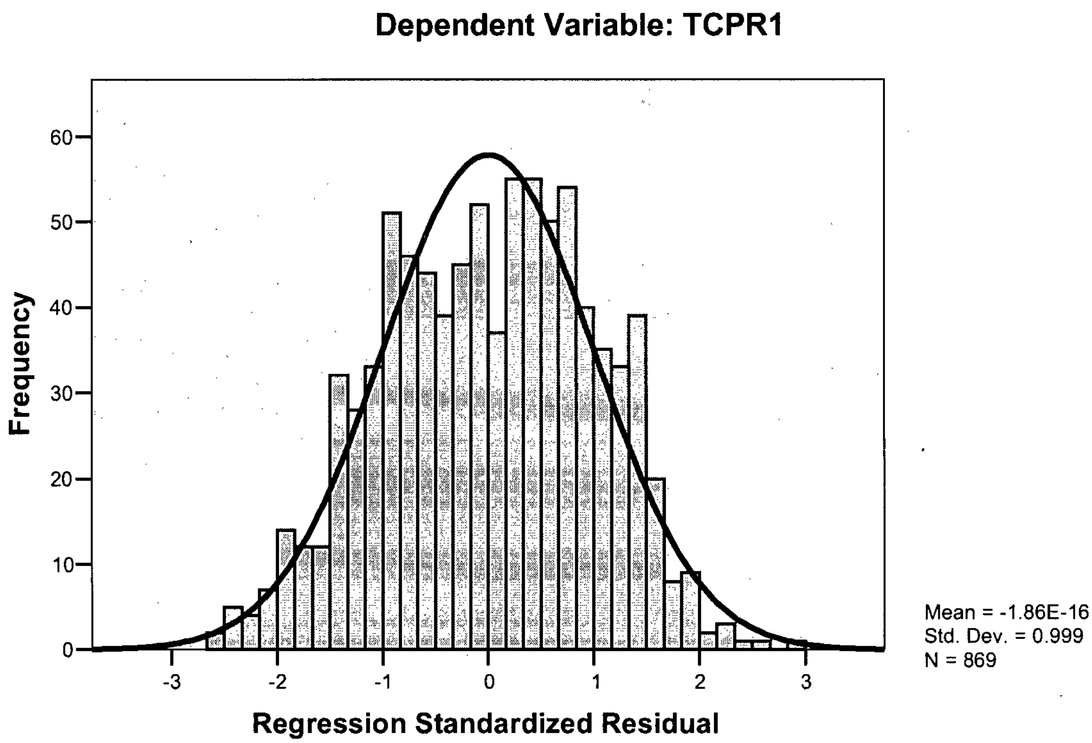

Figure 21. Regression standardized residual for pre-program survey 2001

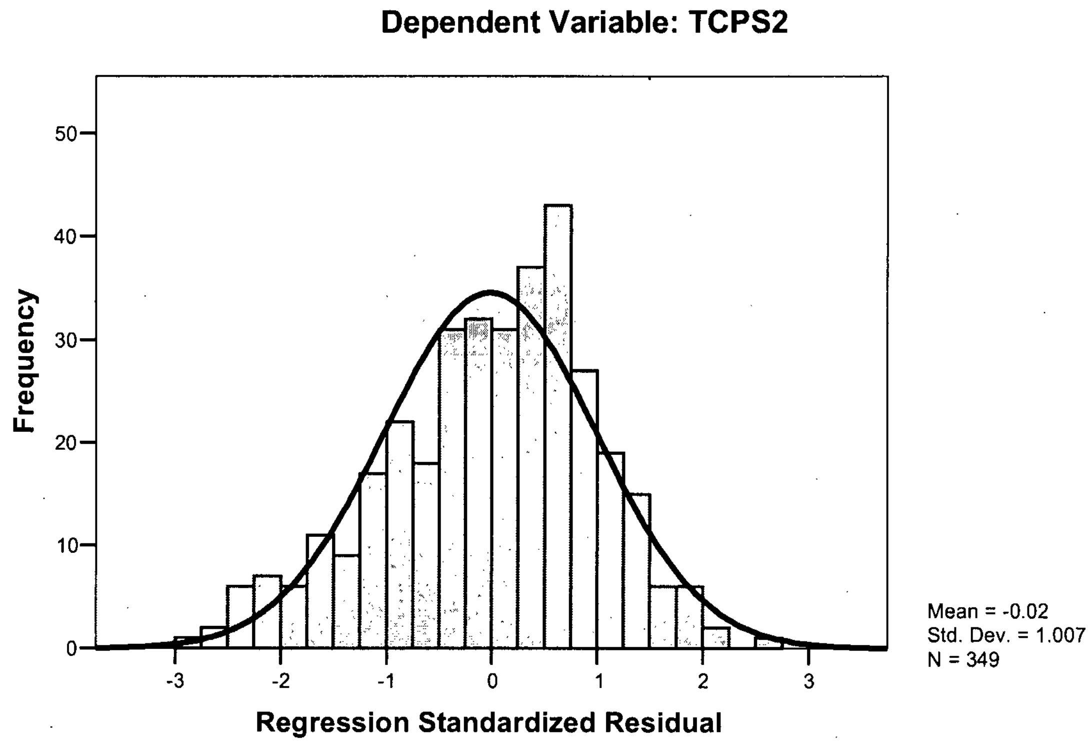

Figure 22. Regression standardized residual for post-program survey 2002

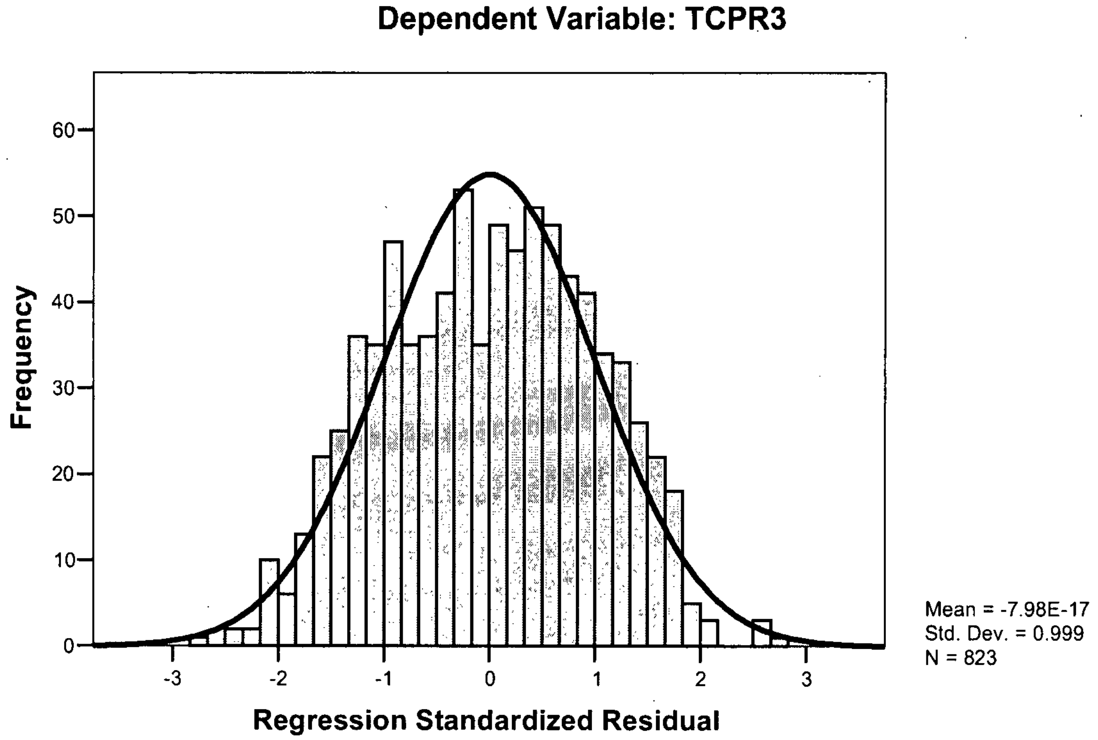

Figure 23. Regression standardized residual for pre-program survey 2003

Table 45. The effects of gender and program on ICT scores with equal sizes (2001-2004)

Dependent Variable: Technology Competencies Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5973.182[a]	3	1991.061	21.813	.000
Intercept	352628.474	1	352628.474	3863.236	.000
Pre/Post	2982.662	1	2982.662	32.677	.000
Gender	2725.612	1	2725.612	29.861	.000
Pre/Post * Gender	264.974	1	264.974	2.903	.089
Error	51389.520	563	91.278		
Total	411088.000	567			
Corrected Total	57362.702	566			

a. R Squared = .104 (Adjusted R Squared = .099)

Table 46. Gender differences in attitudes toward ICT in 2001

		df	F	Sig.
Q58	Between Groups	1	1.702	.192
	Within Groups	844		
	Total	845		
Q59	Between Groups	1	2.893	.089
	Within Groups	851		
	Total	852		
Q60	Between Groups	1	.924	.337
	Within Groups	846		
	Total	847		
Q61	Between Groups	1	1.347	:246
	Within Groups	840		
	Total	841		
Q62	Between Groups	1	8.821	.003
	Within Groups	844		
	Total	845		
Q63	Between Groups	1	3.406	.065
	Within Groups	841		
	Total	842		
Q64	Between Groups	1	6.319	.012
	Within Groups	841		
	Total	842		
Q65	Between Groups	1	8.455	.004
	Within Groups	849		
	Total	850		
Q66	Between Groups	1	23.036	.000
	Within Groups	845		
	Total	846		
Q67	Between Groups	1	11.438	.001
	Within Groups	846		
	Total	847		
Q68	Between Groups	1	7.480	.006
	Within Groups	835		
	Total	836		
Q69	Between Groups	1	.120	.729
	Within Groups	839		
	Total	840		
Q70	Between Groups	1	8.712	.003
	Within Groups	843		
	Total	844		
Q71	Between Groups	1	2.088	.149
	Within Groups	842		
	Total	843		

Table 47. Gender differences in attitudes toward ICT in 2002

		df	F	Sig.
Q55	Between Groups	1	4.245	.040
	Within Groups	525		
Q56	Between Groups	1	.647	.421
	Within Groups	522		
Q57	Between Groups	1	.872	.351
	Within Groups	522		
Q58	Between Groups	1	.511	.475
	Within Groups	524		
Q59	Between Groups	1	1.530	.217
	Within Groups	518		
Q60	Between Groups	1	3.809	.052
	Within Groups	519		
Q61	Between Groups	1	.603	.438
	Within Groups	518		
		519		
Q62	Between Groups	1	3.079	.080
	Within Groups	520		
Q63	Between Groups	1	9.099	.003
	Within Groups	521		
Q64	Between Groups	1	.145	.704
	Within Groups	523		
		524		
Q65	Between Groups	1	.291	.590
	Within Groups	514		
		515		
Q66	Between Groups	1	1.788	.182
	Within Groups	519		
		520		
Q67	Between Groups	1	.194	.660
	Within Groups	521		
Q68	Between Groups	1	2.581	.109
	Within Groups	523		

Table 48. Gender differences in attitudes toward ICT in 2003

		df	F	Sig.
Q57USE	Between Groups	1	.070	.792
	Within Groups	810		
Q58ETHIC	Between Groups	1	.390	.533
	Within Groups	810		
Q59INTEG	Between Groups	1	.514	.474
	Within Groups	808		
Q60EMPHA	Between Groups	1	7.282	.007
	Within Groups	799		
Q61CLASS	Between Groups	1	10.732	.001
	Within Groups	807		
Q62INTER	Between Groups	1	.000	.991
	Within Groups	804		
Q63INSTR	Between Groups	1	.695	.405
	Within Groups	775		
Q64NOPLA	Between Groups	1	.428	.513
	Within Groups	803		
Q65CLASS	Between Groups	1	2.248	.134
	Within Groups	804		
Q66MULTI	Between Groups	1	2.078	.150
	Within Groups	801		

Table 49. Gender differences in attitudes toward ICT in 2004

ANOVA

		df	F	Sig.
q41	Between Groups	1	.147	.702
	Within Groups	236		
q42	Between Groups	1	1.050	.307
	Within Groups	235		
q43	Between Groups	1	3.554	.061
	Within Groups	231		
		232		
q44	Between Groups	1	.512	.475
	Within Groups	208		
q45	Between Groups	1	15.355	.000
	Within Groups	213		
q46	Between Groups	1	.398	.529
	Within Groups	223		
q47recod	Between Groups	1	2.138	.145
	Within Groups	214		
q48	Between Groups	1	1.069	.302
	Within Groups	221		
q49	Between Groups	1	3.039	.083
	Within Groups	226		
q50recod	Between Groups	1	1.071	.302
	Within Groups	215		
q51recod	Between Groups	1	7.135	.008
	Within Groups	220		
q52	Between Groups	1	3.526	.062
	Within Groups	211		
		212		
q53	Between Groups	1	.557	.456
	Within Groups	222		