A Comparative Study of University of Wisconsin-Stout Freshmen and Senior Education Major's Computing and Internet Technology Skills / Knowledge and Associated Learning Experiences

by

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Abstract

A study comparing University of Wisconsin-Stout freshmen and senior education majors' computing and Internet technology skills/knowledge and associated learning experiences was conducted. Instruments used in this study included the IC³® Exam by Certiport, Inc. and the investigator's Computing and Internet Skills Learning Experiences survey. UW-Stout freshmen education majors participating in the study demonstrated poor computing and Internet technology skills/knowledge. UW-Stout senior education majors participating in the study demonstrated marginal computing and Internet technology skills/knowledge. Both UW-Stout freshmen and senior education major study participants identified evidence of poor formal and informal learning experiences to develop computing and Internet technology skills/knowledge in elementary school, middle school and high school. Senior education major participants indicated more instances of formal and informal learning experiences in post-secondary schooling and employment. Informal self-teaching methods to develop computing and Internet technology

skills/knowledge were more evident with UW-Stout senior education majors who participated in the study. Notable comparisons by class and major were conducted after initial analysis showing the impact of specific formal and informal learning experiences. Recommendations to improve UW-Stout education majors computing and Internet technology skills/knowledge follow Robin Kay's *Evaluating Strategies Used to Incorporate Technology into Preservice Education* (2006).

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> *So I will restore to you the years that the swarming locust has eaten, the crawling locust, the consuming locust, and the chewing locust, My great army which I sent among you. You shall eat in plenty and be satisfied, and praise the name of the LORD your God, Who has dealt wondrously with you; and My people shall never be put to shame (Joel 2:25-26. New King James Version of the Holy Bible).*

Table of Contents

List of Tables

Chapter I: Introduction

Senator James Huff Stout had the vision of an education that prepared young people of the late 19th and early 20th Centuries with the general subjects of History, English, Science and Mathematics, and with "…that which best equips a young person for practical life work; that best fits… to earn a living and contribute to the demands of society; that gives… the greatest usefulness and encourages the highest and best citizenship" (Agnew, 1990, p. 18). During James Huff Stout's time, those things that prepared young people for practical life work, the earning of a living, contributing to the demands of society and useful citizenship were skills needed in industrial, agricultural and domestic settings.

The majority of the 20th Century and the beginning of the 21st Century has seen a variety of forces that have changed what skills are needed by Americans to get practical life work, earn a living, contribute to society and be best citizens. These forces include global competition and the continuously changing nature of work; what the work is, where the work is and the number of times the work will change in a person's lifetime (Commission on Behavioral and Social Sciences and Education, 1999). Technological innovation has historically been identified as a driving force of this change (Hendricks & Sterry, 1999). Specifically, the computer (Pease, 2000) has been a significant invention and driver of change during the late 20th and early 21st Centuries (Parshall, 1998).

Changing Nature of Work

Computing and Internet technologies (U.S. Department of Labor, 2000) have changed the nature of work and occupations that would allow a person to earn a living. While reading, writing and arithmetic are vital basic foundations that all persons should possess; computing and

Internet technology skills/knowledge are now essential in a world whose economies become more information-based (Brown, 2003).

From an international perspective, a study conducted by the Organisation for Economic Development and Cooperation (OEDC) found that nearly every industry identified required their employees to use computing and Internet technology skills/knowledge in some form. Data on the use of computing and Internet technology skills/knowledge was gathered and analyzed from the European Union, the United States, Canada and Australia. The study data was gathered from computing and Internet technology producing sectors, from previous studies focused on the use of computing and Internet technology skills/knowledge identified through infrastructure investments, the measurement approach of identifying the diffusion of computing and Internet technology skills/knowledge based on actual use and comparison of other workplace studies used to identify the use of computing and Internet technologies. The study found that computing and Internet technology skills/knowledge were either the focus of the identified industries or substantially supported the functions within the given industry (Organisation for Economic Co-operation and Development, 2004).

In the United States, a number of research interests have identified computing and Internet technology skills/knowledge importance in the workplace. In a report by The Conference Board, "…the world's preeminent business membership and research organization…known for the Consumer Confidence Index and the Leading Economic Indicators" (The Conference Board, 2007, ¶. 1), 25 workplace education programs were asked to identify key workplace skills. One area identified was the improved ability to use computing and Internet technology skills/knowledge (Bloom & Lafleur, 1999). The Secretary's Commission on Achieving Necessary Skills (SCANS) 2000 report identified five necessary competencies of 21st

Century workers. One of the competency areas focused directly on computing and Internet technology skills/knowledge (U.S. Department of Labor, 1991).

To prepare for various careers or occupations, people have needed options that would allow them to get proper training or education. Computing and Internet technology skills/knowledge have created more options for people busy with family and work responsibilities through online course and online degree program offerings (Blake, Gibson, & Blackwell, 2005). With a computer and a connection to the Internet, students can enroll in online degree programs that exist at nearly every post-secondary school in the United States (Obringer, 2007).

Changing Access to Information

Another area impacted by the advances of computing and Internet technology skills/knowledge is libraries. Libraries are playing a significant role in providing credible information and digital resources by way of computing and Internet technology skills/knowledge. The "cybraries" (Rohland-Heinrich & Jensen, 2007, p. 11) or cyber-libraries are places on the Internet where people can go to access databases with numerous types of publications, library catalogs to find documents at a "brick-and-mortar" library building and general help for research and information seeking (Library Learning Center, 2007).

Changing Management of Finances and Transactions

Personal finance and electronic commerce are also areas impacted by computing and Internet technology skills/knowledge. Regarding personal finance, online management of monthly bills, checking and savings accounts (Westconsin Credit Union, 2007) and retirement funds (TIAA-CREF, 2007) are common practices. Electronic commerce (E-commerce) has continued to be the fastest growing element of the United States economy (U.S. Census Bureau, 2007). An example of E-commerce is eBay (eBay, 2007) that has over 200 million users' worldwide (Community Key, 2007).

Changing Social Interactions

Computing and Internet technology skills/knowledge have had an impact on the "…demands of our society" (Agnew, 1990, p. 18). Society is defined as "…an enduring and cooperating social group whose members have developed organized patterns of relationships through interaction with one another…a community, nation, or broad grouping of people having common traditions, institutions, and collective activities and interests" (Definition of Society, 2007, ¶. 3). Based on this definition, "relationships through interaction" and "community" have changed through various social networking websites like MySpace (MySpace.com, 2007) and Facebook (Facebook, 2007). A recent study by the National School Boards Association (NSBA) and Grunwald Associates LLC, found that 96% of U.S. students ages 9 to 17 that have Internet access use social-networking technology to connect with their peers (National School Boards Association, 2007).

Changing Participation in Politics

"Highest and Best Citizenship" (Agnew, 1990, p. 18) as identified by involvement in political processes has been impacted by computing and Internet technology skills/knowledge. The options that would allow a United States citizen to find information in an area of political interest have expanded beyond the traditional means of newspapers, television and radio. Websites of news agencies, political parties, election candidates, special interest groups and official government agencies are easily accessible on the Internet. In preparation for the 2008 Presidential election, New York Senator Hillary Rodham Clinton, eventual presidential election winner Illinois Senator Barack Obama and New Mexico Governor Bill Richardson all announced their intention to run for President by way of their political websites (Johnson, 2007). Information alone is only a part of today's computing and Internet technology skills/knowledge influenced political landscape. Interested citizens can actively participate in politically focused online forums of various types. A specific example of participation is with blogs. A blog is "…a web site that contains an online personal journal with reflections, comments, and often hyperlinks provided by the writer" (Definition of Blog, 2007, ¶. 1). Recent survey statistics by the Pew Internet and American Life Project (2007) state that 11 million Americans have created blogs and 32 million Americans regularly read blogs. Though somewhat counter to the independent voices of 4.8 million political bloggers, Presidential hopefuls John McCain and Hillary Rodham Clinton hired well-known political bloggers with the intent of influencing the political opinions of the blogger community to better position themselves for the 2008 election campaign (Calabresi, 2007).

The Designed World and Computing and Internet Technologies

Further examples of computing and Internet technology skills/knowledge, framed by the seven categories of the International Technology Education Association's (ITEA) "Designed World" are (2000):

- Medical technologies: Information and self-diagnosis of various health problems by way of websites like WebMD.com (WebMD, 2007).
- Agriculture and biotechnologies: Global Positioning Satellite (GPS) steering controls systems for farming equipment (Yancy, 2005).
- Energy and power technologies: The Home Energy Saver online energy audit tool that allows consumers to input home and energy consumption information into a

webpage and receive an instant report on how to best conserve energy and save money (Lawrence Berkeley National Laboratory, 2007).

- Information and communication technologies: Entertainment video and audio managed by applications like Apple iTunes (Apple Inc., 2007).
- Transportation technologies: Trip planning and driving directions for a trip through MapQuest.com (MapQuest, 2007).
- Manufacturing technologies: Prototyping of parts to be manufactured by way of Stereolithography. Essentially, a computer-aided design file is uploaded to the Stereolithography machine, which then creates a 3-D plastic model to be used for metal casting (Gibbs & Winkelmann, 2006).
- Construction technologies: Use of Intranets to supply employees of construction organizations with a wide-range of information from basic static information like company policy to dynamic information like project management and capturing lessons from previous construction projects (Ingirige & Sexton, 2007).

Established Standards

To meet the obvious previously mentioned demands of a world that uses computing and Internet technology skills/knowledge, various stakeholders have made statements through standards on how “young people” (Agnew, 1990, p. 18) should be prepared and what computing and Internet technology skills/knowledge they should be prepared to use.

According to the Partnership for 21st Century Skills, each child going to school should experience the core subjects, similar to general subjects during James Huff Stout’s time, and also be practiced in life skills, learning and thinking skills and finally; information and communication technology (ICT) skills which include computing and Internet technology skills/knowledge (The Partnership for 21st Century Skills, 2004).

Another private organization that has played an important role in the establishment of standards related to the use of computing and Internet technology skills/knowledge is the International Society for Technology in Education (ISTE). The ISTE's National Educational Technology Standards (NETS) Project is specifically focused on "…enabling stakeholders in Pre K-12 education to develop national standards for educational uses of technology that facilitate school improvement in the United States" (International Society for Technology in Education, 2007, ¶. 3).

In 1998, the State of Wisconsin's Department of Public Instruction (DPI) published the Wisconsin Model Academics Standards for Information and Technology Literacy. The Information and Technology Literacy standards were intended to help the educators in the State integrate their curriculum with the basic skills and knowledge sets needed to educate Wisconsin students to be successful students, workers, and citizens in a world experiencing an "…unprecedented explosion of information and knowledge" (Wisconsin Department of Public Instruction, 1998, p. 1).

The United States government, by way of the No Child Left Behind (NCLB) legislation (107th Congress of the United States, 2002), has also contributed to the standards discussion by way of the Enhancing Education Through Technology (EETT) Act of 2001. The main goals of this act are:

> …to improve student academic achievement through the use of technology in elementary schools and secondary schools …assist every student in crossing the digital divide by ensuring that every student is technologically literate by the time the student finishes the

> eighth grade and …encourage the effective integration of technology resources and systems with teacher training and curriculum development. (2002, p. 247-248)

Funding, Support and Education Initiatives

Besides the creation of various standards to address the knowledge and skills needed by "young people" (Agnew, 1990, p. 18) to use computing and Internet technology skills/knowledge, many ventures have been conceived, funded and implemented to provide appropriate infrastructure and training. The United States government has played a considerable role in helping schools address computing and Internet technology skills/knowledge needs. For example, the E-Rate program was established in 1997 by the Federal Communications Commission (FCC) in response to the Telecommunications Act of 1996. The goal of the E-Rate program is to provide affordable telecommunications services to schools and libraries that meet certain predetermined qualifications (Rivero, 2006). In other words, universal access to the Internet for schools and libraries is the primary focus of the E-Rate program. According to the Education and Library Networks Coalition (EdLiNC), from 1998 to 2005, $14,656,354,950 has been paid out to States and territories of the United States. Of this total funding amount, Wisconsin has received $192,988,880 and Minnesota has received $165,312,640 (2007).

State governments are playing a role by creating various options to acquire computing and Internet technologies. According to Mr. Tim Johnson, Technology Director and Principal in the Glenwood City Wisconsin school district, most direct funding in Wisconsin for computer and Internet technologies come from general revenue funds that are distributed for use within local school districts. Outside of general revenue funding, the Wisconsin Department of Public Instruction acts as a clearinghouse for various federal and private funding programs (T. Johnson, personal communication, August 22, 2007). For example, the Enhancing Education Through

Technology state block-grant program provides funding for computing and Internet technologies by way of federal funding associated with the NCLB Act of 2001 (107th Congress of the United States, 2002; Murray, 2005; Wisconsin Department of Public Instruction, 2007).

Another example of State government support of computing and Internet technology skills/knowledge initiatives comes from the State of Pennsylvania. Led by Governor Ed Rendell, the State funded the ‘Classrooms of the Future’ initiative. The goal of this program was to provide each Pennsylvania high school student with a laptop computer in classrooms supplied with multimedia technology access for teachers and students (Ascione, 2006a).

Private organizations made up of concerned citizens are also working to address access to computing and Internet technologies. WiscNet, a nonprofit membership-based Internet service provider established in 1989, provides affordable access to the Internet and computer network support services for education and government organizations in the State of Wisconsin (Nykl, 2003). Computers for Youth is another nonprofit organization that was established in 1999 with the mission to provide computers, Internet connections, software and training to low income families in primarily urban neighborhoods in cities around the United States (Ba, Tally, & Tsikalas, 2002).

Philanthropic organizations also contribute to computing and Internet technology skills/knowledge access. The Bill and Melinda Gates Foundation created a grant program called Opportunity Online. The main focus of this program is “…to help the 40 percent of U.S. public libraries still struggling to provide reliable technology services for people with no other access to computers and the Internet” (2007, ¶.3).

Computer hardware and software manufacturers are also contributing to computing and Internet technology skills/knowledge access and initiatives. Since 2002, Dell Computer has collaborated with school districts in the United States and Canada in a program known as Dell Techknow. Techknow provides computer technology training for low-income and underserved middle school students. Once the students complete the program, they are rewarded with their own computer. Over 17,000 students from 60 participating school districts in the United States and Canada have completed the 40-hour course (Dell Inc., 2006).

Apple Computer has contributed to computing and Internet technology skills/knowledge access initiatives through the formation of an online social network for educators called Apple Learning Interchange. Apple Learning Interchange is a free service that provides K-12 and post-secondary educators a place to share curriculum ideas, display student projects, share research and communicate on relevant issues associated with education (Apple Inc., 2006).

Emphasis on computing and Internet technology skills/knowledge has become a normal part of many post-secondary schools in the United States by way of initiatives that provide computers, associated computer peripherals and networking infrastructure to students and faculty (Cutshall, Changchit, & Elwood, 2006). In the fall of 2002, The University of Wisconsin-Stout (UW-Stout) became the first Wisconsin state university to require all incoming freshmen to lease a laptop computer (The e-Scholar Program, 2006; Process Monitoring Results, n.d.). Along with Apple and Hewlett-Packard laptop computers, UW-Stout students are also given access to wired and wireless Internet, various software applications including the Microsoft Office Suite and Adobe Creative Suite, a course management system (CMS) named Desire to Learn (D2L) (Learn@UW-Stout, 2007), an online administrative system called Access Stout (Access Stout, 2007), software training via Lynda.com online (Lynda.com tutorials @ UW-Stout, 2006), campus technical support through Ask 5000 (Ask 5000, 2007) and access to numerous information sources by way of the UW-Stout Library Learning Center (Library Learning Center, 2007).

Accessibility Studies

Accessibly studies show the improved condition of American public school's computing and Internet technology infrastructures. In a report issued by the Institute of Education Sciences (IES), in 2003 almost 100% of United States public schools had connection to the Internet. The same study indicated that the student-to-computer ratio was 4.4 to 1 (Parsad & Jones, 2005). In a more recent report issued by the IES, use of both computers and the Internet were widespread from nursery school to 12th grade. In nursery school, 66% of children used computers while 23% of the same children used the Internet. In 12th grade, 97% of students used computers and 79% reported using the Internet. This particular study also investigated the impact of a number of factors including socio-economic, race/ethnicity, education, family and gender. In summary, access to computing and Internet technologies for all persons surveyed was significantly high (Chapman & DeBell, 2006).

Considering the statistics by the IES, it could be assumed that schools in the United States have the proper computer and Internet technologies to prepare their students for life in the 21st Century. However, this assumption may not consider all components necessary for students to use computing and Internet technology skills/knowledge. While access to computing and Internet technologies is nearly universal in American public schools, there is growing evidence indicating poor computing and Internet technology skills/knowledge.

Skill Studies

Studies have been conducted to measure the computing and Internet technology skills/knowledge of college students. Overall, the findings of the following example studies indicated less than satisfactory results. Chapter Two Literature Review will examine additional studies that measured the computing and Internet technology skills/knowledge of undergraduate college students.

During a pilot study of a newly developed computer literacy test that would allow exception from a required computer literacy course, students at Indiana University of Pennsylvania were found to have poor computing and Internet technology skills/knowledge. Out of the 170 Indiana University of Pennsylvania students who took the computer literacy test, only nine of them (5%) met the exception requirement (Pierce, Lloyd, & Solak, 2001).

A larger scale pilot study of a computer literacy test was implemented within the Robinson College of Business at Georgia State University. Results from the initial use of the computer literacy test found that 28% of Computer Information Systems graduate students and 51% of Computer Information Systems undergraduate students failed the test (McDonald, 2004).

A study by Clariana and Wallace (2005) found that 64% of incoming freshmen business students failed to test out of a required computer literacy course. Preliminary findings from Educational Testing Service's (ETS) newly created iSkills™ Assessment, which measures elements of computing and Internet technology skills/knowledge show that undergraduate students were only able to earn one-half of the possible points on the assessment (Educational Testing Service, 2007).

When considering the idea of "digital divide", it would seem that access to computing and Internet technologies is not the issue (Vail, 2003). The "divide" is turning out to be the development of skills and knowledge to use computing and Internet technologies. Current assumptions are that college students of today are a part of the "digital generation" and have little or no need for computing and Internet technology skills/knowledge training. The result is that many students who are a part of the “digital generation” have poor computing and Internet technology skills/knowledge including those students preparing to be teachers. With current and future teachers, poor computing and Internet technology skills/knowledge are problematic because they perpetuate poor skills in their students. In the article, *Next Generation Divide,* Karen Smith, Executive Director of TechCorps, a New York city based non-profit organization that helps schools with computer technology, states "…no matter how good access or equipment is, until teachers know how to use it [computing and Internet technology skills/knowledge] …the infusion of technology into teaching and learning will be limited” (p. 25).

Computing and Internet Technology Skills/Knowledge of Current Teaching Professionals

The question may be asked, “Will current education majors learn the needed computing and Internet technology skills/knowledge before they graduate and start their teaching careers?” The answer would seem to be “no” given the results of past studies and the investigator’s observations. What about current teaching professionals? Studies indicate that current teaching professionals are not prepared to use computing and Internet technology skills/knowledge. According to a 2002 survey conducted by the Wisconsin Educational Network Collaboration Committee (WENCC), building principals in 1,016 Wisconsin public schools identified and ranked needs related to their school’s use of instructional technologies. The top two areas of greatest need were identified as professional development and training for teachers (58%) to use instructional technologies, which includes computing and Internet technology skills/knowledge, and the integration (52%) of instructional technologies into existing curriculum (Wisconsin Department of Public Instruction, 2002). Further evidence comes from an investigation based on the No Child Left Behind goal that American students would be technologically literate by the end of 8^{th} grade. The investigation points to a problem with the computing and Internet technology skills/knowledge of current teaching professionals. It finds most states are not consistent in identifying what makes a student literate in computing and Internet technology skills/knowledge. An informal investigation by eSchool News concluded that:

> Nearly four years after [No Child Left Behind] was first implemented, states appear to be all over the map in terms of ensuring the technology proficiency of their students…the federal government does not currently track which states have taken which steps to meet the law's goals. (Ascione, 2006b, p. 1)

Investigator's Observations

Over the past 13 years, it has been the observation of the investigator that the computing and Internet technology skills/knowledge of the general student population at UW-Stout is poor. Approximately 35% to 50% of students enrolled in information and communication technology-based courses demonstrated basic computing and Internet technology skills/knowledge. For example, when considering the basic software applications that are found in a productivity software suite such as Microsoft Office, approximately 65% to 85% of students could demonstrate basic competence with the use of both word processing and presentation software. However, when considering spreadsheet and database applications, only 5% to 15% could demonstrate basic competence. Observations of students' basic computer operation, approximately 65% to 85% of students understood how to install and uninstall software, use a secondary storage device such as a Compact Disk (CD) or a Flash storage drive, use input devices like a keyboard, use output devices like printers, create folders for management of files, remove files by using the trash/recycling bin and properly start up and shut down their computers. Only 5% to 15% of the students could demonstrate understanding the difference between RAM memory and hard drive storage capacity, the process of connecting various input and output devices such as Liquid Crystal Display (LCD) projectors and scanners, the criteria for making a decision in purchasing a computer, running regular maintenance processes and making basic adjustments to elements of the computer operating system. Observations of students' skills associated with the use of the Internet technologies indicates approximately 65% to 85% of students could demonstrate the basic use of a web browser, find basic information through a search engine, download various Internet files, use basic email programs and interact with family and friends through any of the available social network applications. Only 5% to 15% of the students could demonstrate a basic understanding of how the Internet works, the criteria to consider when choosing an Internet service provider, how to connect to a network to gain Internet access and legal and ethical considerations related to proper use of email and other Internet technologies.

Out of the UW-Stout student population observed by the investigator, approximately 50% of students with poor computing and Internet technology skills/knowledge are UW-Stout education majors. Since future educators play a significant role in the instruction and modeling of computing and Internet technology skills/knowledge for their students, further study of computing and Internet technology skills/knowledge of education majors at UW-Stout was warranted.

Statement of the Problem

Past observations of UW-Stout freshmen education majors indicate poor computing and Internet technology skills/knowledge. Various faculty and staff have observed UW-Stout freshmen education majors struggle with computing and Internet technology skills/knowledge. UW-Stout freshmen education majors have not had learning experiences that would support their ability to use computing and Internet technology skills/knowledge.

UW-Stout senior education majors may also have poor computing and Internet technology skills/knowledge. Faculty and staff have observed UW-Stout senior education majors struggling with the computing and Internet technology skills/knowledge throughout their undergraduate experience at UW-Stout. The investigator believes UW-Stout senior education majors have not had learning experiences that support their computing and Internet technology skills/knowledge and may be insufficiently prepared to model, teach and utilize computing and Internet technology skills/knowledge as future educators.

Purpose of the Study

The purpose of this study was to measure and compare the computing and Internet technology skills/knowledge and associated learning experiences of freshmen and senior education majors at the University of Wisconsin-Stout. The results of this study may help UW-Stout's School of Education development/revise curriculum to better prepare preservice teachers to use and model computing and Internet technology skills/knowledge as future educators.

Objectives of Study

This study addressed the following objectives:

1. Measure the computing and Internet technology skills/knowledge of UW-Stout freshmen education majors.
2. Measure the computing and Internet technology skills/knowledge of UW-Stout senior education majors.
3. Identify the learning experiences of UW-Stout freshmen education majors in relationship to development of computing and Internet technology skills/knowledge.
4. Identify the learning experiences of UW-Stout senior education majors in relationship to development of computing and Internet technology skills/knowledge.

5. Compare the measured computing and Internet technology skills/knowledge of UW-Stout freshmen and UW-Stout senior education majors.
6. Compare the identified learning experiences of UW-Stout freshmen education majors and UW-Stout senior education majors associated with the development of computing and Internet technology skills/knowledge.

Significance of Study

The analysis of computing and Internet technology skills/knowledge and related learning experiences of UW-Stout freshmen education majors and UW-Stout senior education majors were significant for two reasons. The conclusions identified the extent to which UW-Stout freshmen education majors and UW-Stout senior education majors were proficient in computing and Internet technology skills/knowledge.

1. UW-Stout education majors need computing and Internet technology skills/knowledge to function as university students. By identifying computing and Internet technology skills/knowledge and the associated learning experiences, the UW-Stout School of Education can adjust current curriculum and practice to give their students a better university experience with computing and Internet technology skills/knowledge.
2. UW-Stout education majors need computing and Internet technology skills/knowledge to function as 21st Century education professionals. By identifying computing and Internet technology skills/knowledge and the associated learning experiences of UW-Stout freshmen and senior education majors, the UW-Stout School of Education can adjust current curriculum and practice to prepare their

students to properly use, model and teach computing and Internet technology skills/knowledge.

Assumptions of the Study

There were six assumptions in this study:

- UW-Stout freshmen and senior education majors participating in this study gave their best effort on the data collection instruments used to measure computing and Internet technology skills/knowledge and related learning experiences.
- UW-Stout freshmen and senior education majors had enough computing skills to complete the computer-based performance assessment used in this study: IC³® Exam.
- UW-Stout School of Education administrators and program directors are interested in the results of this study and will revise undergraduate curriculum to serve their student's computing and Internet technology skills/knowledge learning needs.
- There is a relative homogeneity in participant's demonstrated computing and Internet technology skills/knowledge.
- Computer platform preference (Macintosh or PC) will not affect participant responses.
- Individual computing and Internet technology skills/knowledge and other outside factors may not be accounted.

Limitations of Study

Limitations of this study included:

- Results of this study were focused only on UW-Stout education majors.
- The instrument used to measure computing and Internet technology skills/knowledge, the IC³® Exam, is a performance-based instrument. No data identifying perceived

computing and Internet technology skills/knowledge of study participants was collected.

- This study utilized a survey developed by the investigator. The instrument may have contained errors, misinterpretations, misstatements, or omissions not intended by the investigator. Every effort was made to develop a reliable and valid instrument.
- Because of the ever-changing nature of software applications, Microsoft's new version of the Office Suite 2007 may have interfered with the results of the Key Applications test (CNET.com, 2006).
- The process used to select study participants was not a random sample. A convenient sampling method was used to select study participants.
- Because of the limited number of IC³® Exams purchased, a representation of all UW-Stout School of Education undergraduate degree programs was not possible.
- A substantial time commitment was expected of the study participants. Because of this commitment, paying the participants for their time was paramount to assure enough participants in the study to run the statistical tests of significance.
- The IC³® Exam is computer-based. There was the possibility to experience technical issues that would interfere with the data collection process.

Definition of Terms

Common terms used in this study were defined as follows:

Computing and Internet Skills Learning Experiences survey. A survey used to identify how and where participants gained their current computing and Internet technology skills/knowledge. Focus on both formal and informal learning experiences.

Computing and Internet technologies. A wide variety of technologies associated with computers and the Internet including computer hardware, software and operating systems; various software applications; networks; and processes designed to find and evaluate information and to ethically and legally use computing and Internet resources at work, home and school.

Computing and Internet technology skills/knowledge. A wide variety of skills and knowledge associated with computers and associated Internet technologies including foundational understanding of computing including knowledge and use of computer hardware, software and operating systems; word processing, presentation and spreadsheet applications and common features of all software applications; basic knowledge of networks and the Internet, skills in specific applications such as electronic mail software, and web browsers, skills required to find and evaluate information, and an understanding of issues related to computing and the Internet being used at work, home and school including ergonomics, security, ethics, Internet "rules of the road" or "netiquette" (Exam Content Background, 2004, p.3; IC³® Test Objectives, 2007).

Computing and Internet technology skills/knowledge development across curriculum. See formally integrated learning experiences below.

Computing Fundamentals test. Part of the IC³® Exam. Measures skill/knowledge of computer hardware, computer software and operating systems.

Employment-based formal exclusively-focused training. Part of the Computing and Internet Skills Learning Experiences survey. Similar to "formal exclusively-focused learning experiences" but in the form of employment-based training to learn computing and Internet technology skills/knowledge.

Employment-based informal training. Part of Computing and Internet Skills Learning Experiences survey. Informal learning experiences that occur during employment. Example: Job shadowing for a new bank teller. An experienced bank teller demonstrates entering a transaction; the new bank teller observes and then practices the skill.

Formal exclusively-focused learning experiences. Part of the Computing and Internet Skills Learning Experiences survey. Formal exclusively-focused learning experiences refer to a courses/class where the focus is only on computing and Internet technology skills/knowledge.

Formally integrated learning experiences. Part of the Computing and Internet Skills Learning Experiences survey. Formally integrated learning experiences where computing and Internet technology skills/knowledge are integrated into the content of a course/class. Example: A statistics course where the skills in Microsoft Excel are learned. The course is about statistics; learning of Microsoft Excel is integrated.

IC^3® Certification. Credential that certifies an individual possesses foundational computing and Internet technology skills/knowledge.

IC^3® Exam. Performance-based assessment tool used to measure computing and Internet technology skills/knowledge. Commercially available assessment designed and developed by Certiport, Inc. (IC^3® Home, 2009).

Informal self-teaching methods. Part of the Computing and Internet Skills Learning Experiences survey. Self-teaching methods used to learn computing and Internet technology skills/knowledge. Examples include using online tutorials, asking a friend, using the help menu, etc.

Key Applications test. Part of the IC^3® Exam. Measures skills/knowledge of word processing, spreadsheet, presentation applications as well as common program functions.

Living Online test. Part of the IC³® Exam. Measures skills/knowledge of Internet, Networks, Electronic Mail and use of Computers and Society.

Personal learning strategies. Self-directed strategies to learn new computing and Internet technology skills/knowledge. Personal learning strategies are suggested as more effective and efficient than traditional training methods realizing the fast pace of computing and Internet technology innovations.

Preservice teachers. Undergraduate education majors preparing to become credentialed teachers.

Methodology

A comparative study of University of Wisconsin-Stout freshmen and senior education majors computing and Internet technology skills/knowledge and associated learning experiences. Instrumentation used in this study was Certiport's IC³® Exam and the investigator's Computing and Internet Skills Learning Experiences survey. Differences between the freshmen and senior education majors were analyzed using descriptive and comparative statistical tests of significance.

Two groups of participants containing 23 freshmen and 25 senior education majors were used in this study. Freshmen and senior study participants were selected from UW-Stout databases and emailed invitations to participate in the study. The email included information related to the purpose of the study, confidentially and the participation benefits including possible IC³® Certification and a cash payment of $20.00. Study participants were sent an email informing them of study particulars when they agree to participate.

Data collection for this study occurred during the fall 2008 semester. The Information Technology Management program's computer networking lab in Fryklund Hall was used for data gathering event. The computer-networking lab supported the data collection activities adequately.

The investigator facilitated the data gathering activities to control the data gathering process. The IC³® Exam requires an IC³® certified instructor to proctor its use because a study participant who passes the three tests that make up the IC³® Exam can gain IC³® Certification. The investigator is an IC³® certified instructor.

The time needed for the data-collection process was about 165 minutes. The data collection process went as follows:

1. Introduction. Welcome, overview of the study, review and signature of the confidentiality waiver and establishment of a Certiport user account used to document IC³® Exam results and coding for the data collection. Time: 15 minutes.
2. IC³® Exam. The three tests (Key Applications, Living Online and Computing Fundamentals) each have a time limit of 45 minutes. In this step, study participants were asked to select one of the lab computers and turn it on. Each lab computer had the IC³® Exam engine installed before the data gathering event. All study participants were asked to open Internet Explorer and login to their online Certiport user account. Each study participant was given three test vouchers. Once the voucher information was entered, the exam began. Time: 135 minutes.
3. Computing and Internet Skills Learning Experiences survey. A paper-based survey that identified the participant's past formal and informal learning experiences related to the development of computing and Internet technology skills/knowledge. This survey was given after the study participant completed the IC³® Exam. Time: 15 minutes.

4. After the data collection was completed, participants were required to fill out the "Payment of Human Subjects" form. After the form was completed, the participant received $20.00. Each participant was thanked for their participant in the study and dismissed.
5. All Computing and Internet Skills Learning Experiences surveys were securely stored.
6. All "Payment of Human Subjects" forms were hand-delivered to Ted Wenum in the UW-Stout Business Services office to account for payment to individual transactions as well as any unused payment to individual funds.

The data analysis of this study directly reflects the study objectives. Study objectives one through four used descriptive statistics including frequency counts, minimum, maximum, mean, standard deviation and variance. The Mann-Whitney U Test and the Chi-Square Test of Independence were used for the data analysis of study objective five. The Chi-Squared test was used for the data analysis of study objective six. Comparative analysis of notable undergraduate education degree programs used the Chi-Square Test of Independence and Kruskal-Wallis *H* Test.

Summary

The data from this study may provide information to the UW-Stout School of Education regarding degree program planning to prepare preservice teachers to integrate computing and Internet technology skills/knowledge in professional practice. A literature review reflecting and further developing upon the objectives of this study occurs in the next chapter.

Chapter II: Literature Review

This literature review focuses on computing and Internet technology skills/knowledge of preservice teachers measured by performance-based assessments, computing and Internet technology skills/knowledge of other post-secondary audiences measured by performance-based assessments and the learning experiences/strategies used to develop computing and Internet technology skills/knowledge for preservice teachers.

Perception vs. Performance to Assess Computing and Internet Technology Skills/Knowledge

Most studies measuring computing and Internet technology skills/knowledge of any particular group used data collection methodologies that were based upon self-assessment or perception of study participants (Brown, Dickson, Humphreys, McQuillan, & Smears, 2008; van Braak, 2004; Process Monitoring, 2009). Though some literature claims validity between self-assessment and actual performance (Hakkarainen, Ilomaki, & Lipponen, 2000; van Braak, 2004), most of the literature does not (Ballantine, McCourt Larres, & Oyelere, 2007; Boud & Falchikov, 1989; Lahore, 2008). A study by Ballantine, McCourt Larres and Oyelere (2007) used computer usage as a context to determine the validity of self-assessment. Results of the study found that both experienced and inexperienced users of computers had a tendency to overestimate their computing competency.

A study by Lahore (2008) identified differences between subjective self-assessment of computing and Internet technology skills/knowledge and performance-based assessment of computing and Internet technology skills/knowledge. The results (N = 241) indicate "…51% of the students participating in this study over-assessed and 25% under-assessed their skill levels when comparing the difference between the subjective self-assessment and an objective computer-based assessment" (p.80). Seventy-six percent of the students in this study incorrectly assessed their actual computing and Internet technology skills/knowledge.

Self-assessment/perceptual surveys have an appropriate place in research settings where insight into feelings, thoughts and attitudes is desired. Performance-based assessments are designed to objectively measure skills. The next section on computing and Internet technology skills/knowledge of preservice teachers examined studies where performance-based assessment was used.

Computing and Internet Technology Skills/Knowledge of Preservice Teachers Measured by Performance-Based Assessments

Six studies used performance-based assessment methods to measure computing and Internet technology skills/knowledge of preservice teachers. The performance-based assessment methods in the six studies varied from commercially available computer-based assessment systems, most notably the SAM Assessment system (SAM Central, 2007) by Course Technology Cengage Learning, to customized assessment methods that included faculty proctors, artifact creation, faculty assessment groups and portfolios.

Bowling Green State University in Ohio created a performance assessment system as a part of their overall preservice teacher program (Banister & Vannatta, 2006). Bowling Green used a multi-faceted approach to prepare preservice teachers to integrate computing and Internet technology skills/knowledge into various curricular areas. However, the computing and Internet technology skills/knowledge levels of incoming freshmen preservice teachers was found to be lower than assumed. A performance-based assessment system, the Assessment of Technology Competencies (ATC) was developed. The ATC is a proctored performance-based assessment that required the freshmen preservice teacher to meet in a common campus computer lab to create artifacts in Microsoft (MS) Word, MS Excel, MS Power Point and to use graphic features of MS Word. Results from the initial pilot (*N* = 568) of the ATC found "…only 28.6% of the students passed all four sections of the ATC during the first attempt" (Banister & Vannatta, 2006, p. 219). Almost 8 percent (*N* = 41) failed all four portions of the assessment during their first attempt. Subsequent retake opportunities did demonstrate improved results. Three years after the initial pilot with approximately 1000 students having completed the ATC, "…only 25% to 40% [of the students were] passing all sections/products on the first attempt" (Vannatta & Banister, 2008, p. 93). Vannatta and Banister also provided a survey asking study participants to judge their high school experience with computing and Internet technology skills/knowledge. The results of this survey found that approximately 70% of the students believed their high school experience prepared them to succeed in the ATC assessment "…despite the fact that only 25% to 40% typically pass the ATC in the first attempt" (p. 94).

A study at Mississippi State University assessed computing and Internet technology skills/knowledge for a broad spectrum, freshmen to senior, of preservice teachers (Butler, 2007). The assessment instrument used was the Basic Computer Skills Performance-Based Assessment instrument (BCSPBA) which is a customized performance assessment utilizing Course Technology Cengage Learning's SAM assessment system (Cengage, 2009). Two nationally known assessment instruments were considered in the development of BCSPBA instrument; the ISTE Online Technology Assessment (NETS Online Technology Assessment, 2007) and the Internet and Computing Core Certification (IC^3® Exam) from Certiport (IC^3® Home, 2009). The computing and Internet technology skills/knowledge demonstrated by preservice teachers at Mississippi State University (*N* = 79) were found to be marginal.

A study at the University of North Carolina-Wilmington determined the level of computing and Internet technology skills/knowledge possessed by undergraduate preservice teachers before they took a required computer skills course (Dickerson, 2005). The performance-based assessment was Course Technology Cengage Learning's SAM assessment system (Cengage, 2009). Results of this study (*N* = 186) indicate:

> … with the exception of Excel (18.3%), the vast majority (75.3%-93.2%) of all students in the sample entered…[the required computer skills course]… knowing at least five out of 10 of the computer skills… taught in the areas of Access, Excel, FrontPage, PowerPoint, Windows XP and Word. (Dickerson, 2005, p. 73)

The statistically positive results of this study may have their roots in superior learning experiences of the study population. Up until July of 2009, North Carolina public schools required basic computer literacy for graduation (Accountability Services, 2009). This literacy requirement was assessed during a student's eighth-grade experience. In addition, the majority of the study participants, being upperclassmen at the University of North Carolina-Wilmington, would have likely had experiences that would lend themselves to better performance on the assessment.

A study at the University of Memphis examined technology integration related computing and Internet technology skills/knowledge of preservice teachers (Marvin, 2004). A customized perception survey, two performance assessment instruments and a performance rubric were created and used in this study. Results found that preservice teachers overestimated their actual skills. As far as performance:

> … the preservice teachers were able to accurately complete less than 70% of the performance tasks in each category [of the performance assessments] and [obtained an]

overall [composite score of 64.69%] (spreadsheet = 62.59%, presentation = 66.34 %, Internet = 67.19%). This result indicates that the preservice teachers in this study were not fully prepared with technology-integration-related computer skills. (p. 76-77)

Lindo (2001) examined top teacher preparation programs to determine the degree in which consistent standards, curriculum and assessment existed related to computing and Internet technology skills/knowledge. Although this particular study did not use performance-based assessment, some of the teacher preparation programs examined did identify the use some form of performance-based assessment. When asked to report what percentage of preservice teachers already possessed basic prerequisite technology skills, "[A] majority of the respondents indicated that they "disagreed" or "strongly disagreed" that a majority [25% to 50%] of preservice teachers already possessed prerequisite technology skills" (p. 19).

Researchers at the University of Connecticut developed a performance-based assessment called "Level I" competencies. The Level 1 competencies are a part of a three level educational technology requirement established by the Connecticut State Department of Education (Archambault, Kulikowich, Brown, & Rezendes, 2002). Each teacher assessed was asked to demonstrate basic computing and Internet technology skills/knowledge while at the same time creating a demonstration artifact within a particular context. The results of this pilot assessment showed a varying level of computing and Internet technology skills/knowledge. Because this was a pilot group of practicing educators, skill proficiency demonstrated was likely better than preservice teachers. Further statistical analysis showed the "Level 1" Technology Assessment to be a valid performance-based assessment instrument. An unintended outcome of this pilot was the effect of performance-based assessment on self-efficacy related to computing and Internet technology skills/knowledge. As stated by the investigators, "Although the goal of this process was to assess educational technology competency, we may have found that the assessment process itself positively impacts perceived educational technology competency" (p. 12).

Computing and Internet Technology Skills/Knowledge of Other Post-Secondary Audiences Measured by Performance-Based Assessments

Studies using performance-based assessment measuring computing and Internet technology skills/knowledge have been conducted for other post-secondary audiences. Thirteen studies were examined for this section of the literature review.

The University of Texas at Arlington (UTA) wanted to assure their students demonstrated basic computing and Internet technology skills/knowledge (Cardell & Nickel, 2003). To assure the basic computing and Internet technology skills/knowledge, students had the choice of a performance-based assessment or a proficiency course. Before UTA students take the Computer Proficiency Examination, the UTA Assessment Services unit provided tutorials for each of the five competency areas. General results show:

> The majority of students pass the word processing, Internet, e-mail and library components on the first try. Students who fail word processing tend to fail the entire exam. Approximately 10 percent of examinees failed the spreadsheet component on their first try. A student who fails a component of the test may re-take that component six weeks later. A student may re-take a slightly modified version of a component once. Those students who fail a component twice are advised to register for a full course. (p. 10)

During the fall 2002 and spring 2003 semesters, UTA students who completed the Computer Proficiency Examination were surveyed to determine the impact of the UTA Assessment Services tutorials and whether or not the examination assessed what it was supposed to assess. Results of the survey indicated that 86% of the students found the UTA Assessment Services tutorials to be helpful and 72% of the students believed that the Computer Proficiency Examination measured their computing and Internet technology skills/knowledge.

A study at a Northeastern university determined the requisite computing and Internet technology skills/knowledge of incoming freshmen business students (Clariana & Wallace, 2005). The business department at this university had required a course (Computer Fundamentals) to address foundational computing and Internet technology skills/knowledge. The Computer Fundamentals course was going to be eliminated based on the assumption that incoming freshmen already possessed the requisite computing and Internet technology skills/knowledge. Results of this study indicated:

> The assumption that incoming freshman business students possess adequate knowledge of both computer concepts and computer literacy skills is not accurate. In fact, the average score of 58 percent on the Concepts pre-test and 60 percent on the Excel pre-test suggests that students do not possess the necessary skills to function in an undergraduate School of Business. In addition, in this study, 64 percent of the students failed, or scored below 60 percent in one of the two tests. In addition, the percentage that failed both tests was 39 percent. Thus, the data indicates that only about one third of the freshman business students tested could exempt or "test out" of the course if given that option. (p. 149)

A study at Northwest Missouri State University determined the impact of skill practice on the computing and Internet technology skills/knowledge of students enrolled in a computer literacy course (Clark, 2007). The instrument used for the pre and post testing and the training was the SAM (Skills Assessment Manager), available from Course Technology and Thomson

Learning. The pre and posttests utilized actual performance demonstration of an application skill in a simulated environment. The training system "…provided the students with several learning alternatives each including prepare, observe, practice, and apply options. The students could select the option that best met their learning needs for each particular task" (p. 18-19). The results of this study (N = 183) showed a favorable relationship between training, practice and overall skill proficiency. "The data in this study revealed a significant correlation between the number of practice activities completed by the student and the student's actual exam score" (p. 43).

A study at North Carolina Central University compared perceived computing and Internet technology skills/knowledge to actual skills/knowledge for revising a required undergraduate introductory business computer applications course (Grant, Malloy, & Murphy, 2009). Two instruments were used in this study; the Perceived Computer Skills Survey and the SAM Challenge 2003. Results of this study (N = 173) indicate discrepancies in the student's perceived skills/knowledge versus actual skills/knowledge. Besides revising curriculum to emphasize improvement of spreadsheet skills and de-emphasis in those skills accurately perceived as sufficient, implications of this study would recommend caution when using perception as a measure of skill/knowledge performance.

A study examined faculty perceptions of required basic computing and Internet technology skills/knowledge to determine if a basic computing and Internet technology skills/knowledge course should be required for graduation in all State of Missouri public four year universities. Along with the faculty perceptions, the computing and Internet technology skills/knowledge of new freshmen undergraduate students were sampled at Northwest Missouri State University to identify the typical skills of an incoming freshmen undergraduate student in the State of Missouri (Hardy, 2005). Two instruments were used to identify the computing and Internet technology skills/knowledge of new freshmen undergraduate students at Northwest Missouri State University. QMark (Question Mark) was used to assess computer concept knowledge and SAM (Skills Assessment Manager) assessed actual computing application skills.

Results of the faculty survey (*N* = 357) showed that "… (64%) of the respondents indicated computer literacy/skills were very important and … (31.6%) [of the] respondents indicated computer literacy/skills were important" (p. 57) and that "… (85.1%) agree or strongly agree that a computer literacy/skills course or equivalent test out should be required of all undergraduate students" (p. 125). Results demonstrating the computing concept and skills proficiency of new freshmen undergraduate students at Northwest Missouri State University (*N* = 164) is summarized in the following paragraph:

> In regards to the student assessment, if the goal is for students to show proficiency at 60% or higher, student assessment results indicate that the majority of students demonstrate proficiency in word processing and presentation skills, but do not show proficiency on computer concepts, spreadsheet, or database skills. If the goal is for students to show mastery at 80% or higher, student assessment results provide evidence that the majority of students have not mastered computer concepts, word processing skills, spreadsheet skills, presentation skills, or database skills. (p. 124)

The Robinson College of Business at Georgia State University created and piloted a computing and Internet technology skills/knowledge assessment to aid student development of computing and Internet technology skills/knowledge (McDonald, 2004). The Software Assessment Manager (SAM) 2000 system was utilized to assess Robinson College of Business students. Six exams were created to cover the Robinson College of Business basic and advanced

Computer Skill Prerequisites (CSP) requirements. Each student in the Robinson College of Business was required to pass all six exams with a passing score of 65% per exam. Results of the Robinson College of Business pilot study (*N* = 7083) showed that "… 28.4% of graduate students majoring in Computer Information Systems failed to pass all six exams. [Fifty percent] of CIS undergraduate majors were not able to successfully pass the six computer literacy exams" (p. 26).

A study at the University of Calgary compared "…demonstrated computer literacy of final year baccalaureate nursing students and 200 acute care registered nurses (RNs) employed by the Calgary Health Region (the Region)" (McKee, 2008, p. 17). The assessment instrument used in this study was an expanded version of the Computer Literacy Series (CLS) by Office Jobs.com (Job Seekers, 2010). The expanded assessment was used to match the required basic computing and Internet technology skills/knowledge identified through an extensive review of literature performed by the investigator.

Results of this comparative study showed that "…self-reported computer skills are not a reliable indicator when making decisions about curriculum and on the job training" (p. 66). The computer skills assessment showed:

> Ninety-three percent (*N* = 77) of the students met the [Calgary Health] Region's standards for computer literacy compared to 39% (*N* = 77) of the RNs. RNs consistently scored lower than the students did. Graduating student nurses have the computer skills needed by the [Calgary Health] Region and when compared to RNs are better prepared to use computers. Therefore, employers [in greater Calgary] can be confident that most graduating students are practice ready in the area of computer literacy. (p. 67)

Indiana University of Pennsylvania conducted a pilot study of an assessment instrument to compliment the Micro-based Computer Literacy course they provided to their undergraduate students (Pierce et al., 2001). The pilot of the assessment instrument had three objectives. First was to provide a test-out option for the Micro-based Computer Literacy course. The second objective was to provide data for curriculum revision as it was generally understood computing and Internet technology skills/knowledge change frequently. Third, the question of whether or not a computer literacy course was needed could be informed by the computer literacy assessment. Results from the pilot of the computing literacy assessment showed that only 5% of the students participating in the pilot (N = 170) met the exception criteria. Students performed best in Part I of the assessment, the concepts section, where they correctly answered about 50% of the questions. The results of Part II of the assessment, the skills section, showed "…the median [score] for all four software packages rang[ing] between 40 and 45% of the tasks completed correctly" (p. 84). Results comparing perception of computing and Internet technology skills/knowledge versus actual skills/knowledge showed a slight tendency toward over assessment.

A study at Fort Hays State University in Kansas compared the effectiveness of computer-based instruction versus face-to-face instruction for an introductory computing course (Swindler, 2006). This study also compared undergraduate students from large high schools and small high schools to determine if computing and Internet technology skills/knowledge differences existed. Besides the differences between traditional face-to-face instruction and computer-based instruction, both groups in the study used common assessment tools. The assessment tools consisted of a conceptual knowledge examination hosted on the Fort Hays State course management system, Blackboard. The performance-based skill assessment, as well as the instructional elements used by the computer-based instruction treatment group, was hosted by Train & Assess IT from Prentice Hall. Results of this comparative study found that there was no statistical difference between the control group (N = 79) and the treatment group (N = 75). In addition, the computing and Internet technology skills/knowledge of students from large high schools were not statistically different from students who came from small high schools.

A performance-based basic computing and Internet technology skills/knowledge assessment was piloted at the University of Kansas (Tarnow & Mayo-Rejai, 2005). The goal of the pilot was to create an assessment through which undergraduate nursing students would learn identified prerequisite computing and Internet technology skills/knowledge. The assessment consisted of a live performance setting facilitated by nursing faculty. Results showed the first group of undergraduate nursing students taking this assessment all passed. Basic computing and Internet technology skills/knowledge were learned and or affirmed through the assessment. Individuals needing specific help were identified and nursing faculty were able to focus time and attention to curricular nursing content versus time on remedial computing and Internet technology skills/knowledge.

The College of Business at Xavier University created and piloted a computing and Internet skills assessment designed to determine the placement of incoming freshmen to a remedial one-credit basic computing and Internet technology skills/knowledge course or a core management information systems course (Crable, Murphy, & Tesch, 2006). The problem identified by faculty was basic computing and Internet technology skills/knowledge deficiencies by incoming freshmen. Because of the deficiencies, faculty spent an inordinate amount of instructional time on basic computing and Internet technology skills/knowledge versus using computing technologies to solve business problems. The assessment was designed to reflect the basic computing and Internet technology skills/knowledge covered in remedial one-credit course "[The assessment] …was implemented using SAM 2003 version 1.5. SAM 2003 is a skills assessment manager from Course Technology that offers skills assessment of the Microsoft Office Suite in a simulated environment" (p. 5). Results of the assessment pilot (N = 164) showed "[F]orty (24%) of the students received an assessment of 80[%] or better and were placed in the information systems core course. During advising, an additional 10 who scored 79[%] were offered the opportunity to enroll directly into [the information systems core course]" (p. 6). The remaining students (N = 114) were required to take [the remedial one-credit course] to learn basic computing and Internet technology skills/knowledge.

A study at Indiana State University examined undergraduate student's perception of computing and Internet technology skills/knowledge compared to actual skills/knowledge. The study also compared perception of computing and Internet technology skills/knowledge and actual skills/knowledge demonstrated with ethnicity (Wilkinson, 2006). Two instruments were used in this study. The first instrument was used to "…collect demographic data [ethnic background included] as well as …perceived computer experience" (p. 113). The second instrument used in this study measuring the computing and Internet technology skills/knowledge of the study participants was the Software Assessment Management (SAM) system. Results of this study (N = 91) indicated significant differences between perception of computing and Internet technology skills/knowledge and actual skills/knowledge. Students in this study tended to overestimate their computing and Internet technology skills/knowledge. Ethnic groups, representing 29% of the study participants, showed some computer skill deficiencies when compared to the majority. However, no significant difference was shown between any of the ethnic groups when perception of computing and Internet technology skills/knowledge and actual skills/knowledge was compared.

A study at the University of Central Missouri measured the computing and Internet technology skills/knowledge of incoming freshmen (Williams & Scott, 2005). Prior to assessing the computing and Internet technology skills/knowledge of the incoming freshmen, faculty at the University of Central Missouri was surveyed to determine the extent to which computing and Internet technology skills/knowledge were deemed important. The results of the survey indicated that the university faculty did value competence with computing and Internet technology skills/knowledge and incoming freshmen should possess such skills/knowledge for academic and professional success. With the establishment of the importance computing and Internet technology skills/knowledge by university faculty, the pilot assessment of incoming freshmen was conducted. The instrument used to assess the incoming freshmen was the IC³® Exam by Certiport. Results of the pilot assessment of incoming freshmen (*N* = 570) showed that:

> …only 42 students (7 percent) successfully achieved computer literacy certification [IC³® Certification], giving evidence of the digital divide in Missouri. Consequently, educators at the University are now challenged to find a means to accurately identify those students each semester who are prepared to precede with the information management demands in higher education, and to appropriately provide rewarding training for the remaining 93 percent with possible skill gaps. (p. 11)

Learning Experiences/Strategies to Develop the Computing and Internet Technology Skills/Knowledge for Preservice Teachers

The literature is abundant with studies and best practice articles recommending learning experiences/strategies to develop computing and Internet technology skills/knowledge for preservice teachers. The following review of literature highlighted 20 studies/articles with the emphasis on identifying recommended best practices for teacher preparation programs to prepare preservice teachers to use and integrate computing and Internet technology skills/knowledge.

A study at West Virginia University examined the attitudes of preservice teachers toward computing and Internet technology skills/knowledge after a semester long course that required the use of computing and Internet technology skills/knowledge to complete assignments and to integrate with course activities (Abbott & Faris, 2000). Three different attitude-toward-computing assessment instruments were used in a pretest /posttest process. The results of this study (N = 63) showed a statistically significant attitude improvement based on the use of computing technologies in the semester long course. Best practices identified in this study suggest "…teacher education programs should not only teach preservice teachers how to use hardware and software but also teach them how to incorporate computers into their teaching strategies and activities" (p. 158). Experiences/strategies the investigators considered important included collaborative learning, focused instruction respective of individual learning styles and integrated use of computing and Internet technology skills/knowledge to solve real problems. Also, see Jeffs and Banister (2006).

Bowling Green State University education faculty came to a variety of conclusions about best practices when preparing preservice teachers to use computing and Internet technology skills/knowledge (Banister & Vannatta, 2006). Basic computing and Internet technology skills/knowledge must precede integrated use.

> ...students [must] demonstrate basic technology skills, and [be given] support systems to strengthen their development of these skills, insur[ing] that they are poised to expand their use and understanding of educational technologies as they move into their professional preparation phase. (p. 222)

The expectation that basic computing and Internet technology skills/knowledge will be used in professional education courses also contributes to context-specific skill development. "Faculty [based upon understanding student's computing and Internet technology skills] …have demanded that students be more prepared to use technology as a part of their coursework, without requiring the instructors to teach the technology" (p. 223). Another outcome of the study by Banister and Vannatta was the observation of student awareness of technology standards, such as the National Educational Technology Standards (NETS), and how that awareness contributed to the development of self-directed personal learning strategies.

> Students …developed strategies regarding their approach to learning new technology skills. They were able to determine how they might master these applications, choosing from an array of support structures available. Identifying and practicing strategies for learning various computer applications… are foundational for teacher candidates' continued development in the area of educational technologies. (p. 223-224)

Finally, Banister and Vannatta discovered that computing and Internet technology skills/knowledge created a need to make sure as teaching faculty they were prepared to model appropriate use.

A study examined the effects of online computing and Internet technology skills/knowledge tutorials on preservice special education teachers at the University of Illinois at Urbana-Champaign (Basham, Palla, & Pianfetti, 2005). The National Educational Technology Standards (NETS-T) teacher standards were the foundation for the pre and post data collected to gauge the effectiveness of the online tutorials. The results of this study (N = 34) show that "…the online tutorial project and instructional framework led to greater perceived NETS-T ability in the special education preservice teachers" (p. 271). Part of the instructional framework designed into the study was a collaborative element to utilize computing and Internet technology skills/knowledge for a context specific purpose. All of the study groups were able to successfully complete their projects. Despite the successful results of using online tutorials and collaboration as strategies for improved use of computing and Internet technology skills/knowledge, it was concluded that:

> …skill training does provide preservice teachers with the tools they need to use technology; [however], it is not enough. If classroom technology integration is desired, teacher educators must further participate in the process by modeling and discussing the pedagogical relationships between preservice course instruction and the integration of technology, as well as by helping preservice teachers shape their definitions of a teacher. (p. 274)

A study at Utah Valley State College examined the impacts of computing and Internet technology skills/knowledge training on the skills and attitudes of preservice teachers (Benson, Farnsworth, & Bahr, 2004). Preservice teachers (N = 62. Junior Status) were given a pre assessment, the Educator's Knowledge and Implementation of Technology (E-KIT) survey, designed to identify perceived computing and Internet technology skills/knowledge. After nine weeks of classroom instruction, the preservice teachers participated in a three-week field experience. After the completion of the field experience, the E-KIT was taken again as a post assessment. A random sample of the study group (N = 27) was taken and interviewed to gauge the effects of the skills training and the field experience on the preservice teachers. Finally, the E-KIT was taken a third time during the first semester of the study participant's senior year. Results of this study showed that perceived computing and Internet technology skills/knowledge showed significant improvement because of the instructional media course. Attitude toward the use of computing and Internet technology skills/knowledge in instruction also was positive. Also see (Gulbahar, 2008; Ince, Goodway, & Ward, 2006; Yakin & Sumuer, 2007) for additional research related to computing and Internet technology skills/knowledge and attitude. The incorporation of the field experience in the instructional media course positively contributed to skills learned. A significant phenomenon in this study was observed in that only a small number of the preservice teachers required their students to create lesson artifacts with computing and Internet technology skills/knowledge as a part of the instruction because of lack confidence on the part of the preservice teachers. This outcome speaks to a conclusion the study investigators made:

> A 12-week course in computer-supported instruction plus the three week applied field experience makes a positive difference in the skills and attitudes of preservice teachers. However, without continual reinforcement of the use of technology, skill level will not be maintained. (Benson et al., 2004, p. 659)

An article by teacher education faculty from Indiana University and Auburn University pointed to strategies successfully used to prepare preservice social studies teachers to effectively integrate and use computing and Internet technology skills/knowledge (Brush & Saye, 2009).

The first strategy is the use of field experiences. See also Johnson-Gentile, Lonberger, & Parana, (2000). Utilizing computing and Internet technology skills/knowledge in an authentic setting is the best strategy. However, with the best situation come complexities that can make a field experience problematic.

> A number of factors affect the quality of [a field experience], including lack of resources available in field placements, lack of experience or expertise with regard to technology integration among field placement teachers, and lack of opportunities for preservice teachers to integrate technology in meaningful ways. (p. 48)

The authors suggest the use of case studies as a way to reduce the complexities of field experiences demonstrating various pedagogical scenarios related to the integration of computing and Internet technology skills/knowledge. Another strategy the authors found effective is modeling by the use of computing and Internet technology skills/knowledge.

> Teacher education faculty members serve as the teachers for these [computing and Internet technology skills/knowledge enhanced] activities and are then able to discuss the affordances technology can provide within the activities, the strengths and weaknesses of the activities from a pedagogical standpoint, and potential issues with implementing these activities in more authentic settings. (p. 50)

Butler (2007) concluded that preservice teachers need to have basic computing and Internet technology skills/knowledge before integrating with curricular content and engaging in problem solving. The best strategy to develop basic computing and Internet technology skills/knowledge was the formal class setting. See Wang and Chen (2006) to get further insight into formal training processes through a designated computing and Internet technology skills/knowledge course. Butler also emphasized that teacher preparation programs should also:

> [Require] instructors in… teacher education programs… to model use of computer skills…and require students to use more research, problem-solving and decision-making skills throughout the curriculum. Hands-on experience on application of [computing and Internet technology skills/knowledge] … and sustained use will allow [preservice teachers]…to improve and retain the use of [computing and Internet technology skills/knowledge] …acquired through computer training. (p. 137)

A study examined preservice teacher preparation to use computing and Internet technology skills/knowledge in Texas two-year colleges (Cavenall, 2008). Results indicated that preservice teachers believed they were prepared to use computing and Internet technology skills/knowledge as teaching professionals. Related to learning strategies, a number of conclusions were realized. Teacher preparation faculty must have an understanding of what is new and relevant in computing and Internet technology skills/knowledge to model effective use. The learning experiences/strategies for the preservice teachers are a combination of faculty modeling, skill training, problem solving with computing and Internet technology skills/knowledge and field experiences with authentic use opportunities.

Clark (2007) examined the impact of practice on computing and Internet technology skills/knowledge proficiency. The results of this study showed the more practice; the more proficient the user of computing and Internet technology skills/knowledge. Another conclusion supporting preservice teacher's development of computing and Internet technology skills/knowledge was "As the [preservice teachers] …devote time to practice, they are able to develop cognitive structures that will mediate learning" (p. 43).

A study at the University Of Ontario Institute Of Technology explored the effectiveness of four learning strategies to learn computing and Internet technology skills/knowledge (Kay, 2007a). The four strategies were collaboration, using authentic tasks, formal instruction and exploratory learning. Seventy-four preservice teachers participated in the examination of the four strategies completing pre and post surveys (learning strategies, change in computer knowledge and use of computers in the classroom) after participating in preservice preparation activities over an eight-month period. Results (N = 74) of this study found:

> Collaborative learning, authentic tasks and exploratory learning were the most preferred strategies– formal instruction was the least preferred. A collaborative approach to learning was the best predictor of gains in computer knowledge. Authentic tasks and collaborative strategies were significant predictors of teacher use of computers in the classroom. Preference for authentic tasks was the only predictor of use of computers by students. (p. 378)

Kay concluded saying "…regardless of strategy preference, selecting more than one primary learning tool was significantly correlated with amount learned and use of the computers in the classroom" (p. 378-379).

A study at Georgia State University determined the extent to which a cohort of undergraduate preservice early childhood educators was prepared to use computing and Internet technology skills/knowledge (Collier, Weinburgh, & Rivera, 2004). A survey identifying teaching faculty's opinion of what computing and Internet technology skills/knowledge were important for preservice early childhood educators was used and compared with the perceived computing and Internet technology skills/knowledge of the preservice early childhood educators. Teaching faculty's course syllabi were also analyzed to find evidence supporting the use of computing and Internet technology skills/knowledge. A survey was used to determine the preservice early childhood educator's perception of value and readiness to use computing and

Internet technology skills/knowledge professionally. All instruments were used in a pretest, posttest format with the cohort of preservice early childhood educators for three semesters of professional education courses leading up to student teaching placement. Results of this study (N = 43 preservice early childhood educators and N = 13 teaching education faculty) showed improvement in perceived computing and Internet technology skills/knowledge along with improvements in perceived value and readiness to use computing and Internet technology skills/knowledge in an instructional setting. Analysis of the teaching faculty's syllabi revealed basic computing and Internet technology skills/knowledge prerequisite requirements that were needed for the courses preservice early childhood educators were required to take. Integration of computing and Internet technology skills/knowledge into curricular occurred with this group of teaching faculty. Reflecting on the learning experiences/strategies of this study, the investigators stated:

> This study suggests that teacher educators need to act as a cohesive unit (also see Schaffer and Richardson, 2004). When they take seriously the alignment of daily training experiences with national technology standards (NETS-T), faculty are poised to attend to their collective expectations. …when the focus is on program content as a whole, the result is a learning context in which technology skill development is a natural outcome of seamless integration. Teacher educators are able to make a difference in preservice teacher technology skill acquisition and development if they are willing to infuse technology education into existing curricular subjects. (p. 466)

A recommendation from Collier, Rivera and Weinburgh appeals to personal learning strategies to train teachers in expected changes in computing and Internet technology skills/knowledge. Also, see Hsu and Huang (2006) and Stephens (2006) to observe the impact of computing and Internet technology skills/knowledge self-efficacy on development of personal learning strategies.

A case study conducted at the University of Missouri-St. Louis examined the impact of e-portfolio use on the development of personal learning strategies of preservice teachers (Huang, 2006). The instrument used to measure personal learning strategies was the Self-Directed Learning Readiness Scale (SDLRS) (Guglielmino, 1977). Results of this study (N = 5) reflective of personal learning strategies found that those preservice teachers who score high in the SDLRS also demonstrated a great adaptability to new instructional setting and challenges. However, there was not a statistically significant relationship between the use of an e-portfolio and the development of personal learning strategies. Generally, the author of this study concluded by stating:

> …we can neither generalize to all E-portfolios authored by preservice teachers in all colleges of education, nor to teacher E-portfolios in general. Other E-portfolio authors operate in settings with different cultural artifacts. However, the study contributes a better understanding of the possible impact of learners' E-portfolios' use has on preservice teachers' [computing and Internet technology skills/knowledge] proficiency and [personal learning strategies]. (p. 127)

Dickerson (2005) recommended learning experiences /strategies to prepare preservice teachers to use computing and Internet technology skills/knowledge. These experiences/strategies include the use of performance-based assessments to measure computing and Internet technology skills/knowledge. Performance-based assessment data could "…aid in developing an individualized training plan so that [preservice teachers] could receive specialized training in the areas where they are not proficient, while the students who know the skills are able to move on to other assignments" (p. 79). Another learning experience /strategy recommended related to curricular design by teacher education faculty. Actual skill assessment gave a true insight into computing and Internet technology skills/knowledge preservice teachers possessed versus common assumptions.

> …educators, trainers and researchers who teach courses that are heavy in computer skills should not rely on making assumptions about students, but rather collect data that represents demonstrated skills of the students. This research also suggests the usefulness of having demonstration based computer skills data on students. It also suggests how this data can lead to improved instructional decision making. The researcher believes that pre testing before skills instruction has the potential of being helpful to any technology course that includes skills-based instruction, and allows the instructor to understand the student before teaching begins. (p. 79) Also see Goodfellow and Wade (2006).

A study at Buketov Karaganda State University in Kazakhstan described the implementation of computing and Internet technology skills/knowledge into a foreign language teaching and learning course for preservice English teachers (Egorov, Jantassova, & Churchill, 2007). The objective of this study was to investigate how the computing and Internet technology skills/knowledge would affect skill development, confidence and attitudes. Results of this study (N = 59) were favorable. The study investigators believed that the course, Information and Communication Technologies in Learning Foreign Languages, positivity influenced the teaching and learning practices of the preservice teachers. From post-course surveys, the study investigators found an interesting shortcoming of the course. The course did not allow opportunity for exploring innovations in computing and Internet technology skills/knowledge, which in retrospect was believed to be vital considering the pace at which computing and Internet technology skills/knowledge change.

Another international perspective on the use of computing and Internet technology skills/knowledge in teacher education came from Europe in the form of the European Computer Driving License (ECDL) (Fisher & Solliday-McRoy, 1998). Started in Finland in the early 1990's, the ECDL:

> …is administered by the ECDL Foundation whose primary role is accreditation and testing to empower all of Europe for the information age. To gain the ECDL, applicants must pass one theoretical and six practical tests. Though the length of each test varies according to the skill level of the students, courses take from eight to sixteen hours of teaching time per module, plus the same amount of practice time. The ECDL examination does not test memory; it tests practical applications. The emphasis is on what an applicant can do, rather than what they theoretically understand. Those passing the examination show that they have basic skills in information technology widely required in today's evolving information society. (p. 226)

From a learning experiences/strategies perspective, the authors believe that teacher education in the United States could benefit from the systematic approach in the development and accountability represented by the ECDL.

> By instituting a modified version of the ECDL, specifically targeted at teacher certification, teacher preparation programs in the United States could begin to standardize the degree of computer skills acquisition necessary for teachers. This can begin to ensure that teachers know how to use basic computer software available in most learning environments (e.g., avoiding the problem of teachers not using the overhead [computing

and Internet technologies in the schools] because they do not know how to use it). (p. 230)

A study within the fifteen peer institutions of the University of North Dakota examined university faculty's technology literacy and the impact of university-sponsored technology training on the integration of computing and Internet technology skills/knowledge development across curriculum (Georgina & Hosford, 2009). Results of this study (N = 237) showed that faculty perceived they were technologically literate. The study also showed university-sponsored training was not significantly connected to integration of computing and Internet technology skills/knowledge development across curriculum. The faculty surveyed in this study indicated that 94% of their institutions provided training to use computing and Internet technology skills/knowledge. However, the faculty surveyed indicated that "…only 7.2% …claimed that they attended to a very great extent. The majority of the faculty attended university-sponsored training to some extent at 50.4%" (p. 693). Some insight into the observed under-utilization of university-sponsored training by the faculty became known with the identification of the faculty's preferred learning methods. The faculty indicated that they preferred learning "…in small faculty forums with trainers…56% [of the time]. The next highest response was in asking colleagues at 52%" (p. 693-694).

A study at George Mason University examined strategies to facilitate integration of computing and Internet technology skills/knowledge across curriculum for early childhood, elementary and secondary preservice teachers (Groth, Dunlap, & Kidd, 2007). A case study approach was used and common themes were identified. The results of this study (N = 13 early childhood; N = 35 elementary; N = 15 secondary) identified themes that inform best practice strategies for the integration of computing and Internet technology skills/knowledge development across curriculum. First, proper preparation and support to use computing and Internet technology skills/knowledge was needed by the teaching faculty. Second, support of the preservice teachers in the form of appropriate professional modeling and technical support was identified. Third, authentic application of computing and Internet technology skills/knowledge to solve problems was identified as important. Finally, the use of computing and Internet technology skills/knowledge training courses was deemed moderately value but only if used in a larger context. Several of the study participants did not think such courses alone aided them in successful integration of computing and Internet technology skills/knowledge. The study investigators encourage a multifaceted, proactive approach to prepare preservice teachers to use computing and Internet technology skills/knowledge development across curriculum.

> University faculty must strive toward exemplary technology integration in preservice classes in order to prepare these [preservice] educators. Preservice teacher candidates need increased awareness of the value of the role of the computer, instruction on ways to integrate technology, and additional confidence in their own abilities to use technology in the classroom…[T]his learning will not occur incidentally. University faculty must be proactive when designing curricula for preservice courses. The models presented [in this study] demonstrate that it is possible to successfully integrate technology into preservice literacy classes at the early childhood, elementary, and secondary levels. (p. 382)

A review of literature was conducted to inform the use of computing and Internet technology skills/knowledge in middle school mathematics curriculum (Guerrero, Walker, & Dugdale, 2004). Types of literature reviewed included “teachers’ technology experience and access” (p. 8), “teacher and student attitudes toward technology” (p. 9), “implementation trends”

(p. 12), and “students' mathematical skills and conceptual understanding” (p. 14). Conclusions from this review of literature indicate:

> When technology is used well in middle grade mathematics, it can have positive effects on students' attitudes toward learning, on students' confidence in their abilities to do mathematics, and on their engagement patterns, including motivation and time on task. Further, technology use can have a positive impact on students' learning, with significant gains in mathematical achievement and conceptual understanding. (p. 17)

Preservice teacher preparation learning experiences/strategies recommended to effectively integrate computing and Internet technology skills/knowledge development across curriculum included:

> Technology experience cast in the context of curriculum and pedagogy …is more effective than technology training alone. Beyond the need for teacher training in pedagogically, …there is a need for revised …curricula that fully exploit the potential of technology [and] technological training and support for teachers …calls for long-term commitments from districts, schools, and the …education community overall. (p. 18)

Also see Mayo, Kajs, & Tanguma, (2005).

A study at a south central university explored preservice elementary educators perceived computing and Internet technology skills/knowledge and the perceived ability to integrated computing and Internet technology skills/knowledge across curriculum (Hardy, 2003). The results of this study (N = 43) showed that the preservice elementary education teachers perceived their computing and Internet technology skills/knowledge to be adequate. Two areas in this study that were not as positive related to integration of computing and Internet technology skills/knowledge development across curriculum and overall satisfaction of the teacher preparation program.

> …an inadequacy in the extent to which teacher educators [the faculty] effectively modeled or taught the use of [computing and Internet technology skills/knowledge] as an instructional tool was highlighted by 60% of the [study] participants in a open-response question concerning how the university had failed to prepare the participants to teach with [computing and Internet technology skills/knowledge]. …83.7% of the participants indicated they did not receive enough instruction regarding methods of using [computing and Internet technology skills/knowledge] resources to teach a concept or process… 44.2% of the preservice teachers [in this study] highlighted having only one course dealing with [computing and Internet technology] resources… a [clear] weakness of their [preservice elementary education] degree program. (p. 12)

Learning experience/strategy recommendations to improve preservice teacher's preparation to use computing and Internet technology skills/knowledge development across curriculum included the use of a skills course, use of education methods courses to use computing and Internet technology skills/knowledge for specific tasks and consistent integration of computing and Internet technology skills/knowledge development across teacher education curriculum. "Teacher educators may need to revise teacher preparation programs to better incorporate [computing and Internet technology skills/knowledge] and to provide preservice teachers with more experience with [computing and Internet technology skills/knowledge] resources as both a learning and instructor" (p. 15).

Kay (2007b) examined the impact of preservice teacher's emotions on use of computing and Internet technology skills/knowledge. The four basic emotions, anger, anxiety, happiness, sadness, were measured as preservice education teachers engaged in computing and Internet technology skills/knowledge use while taking preparatory education courses and completing require field experiences. Results of this study (N = 184) indicated:

> Exposing preservice teachers to an integrated laptop program, helped to significantly reduce reported anxiety and anger levels. Ubiquitous access to computing appears to play a significant role in altering computer related behaviors. Emotions toward computers can be changed—they are not necessarily fixed, innate, pre-ordained, or inevitable. With a steady infusion of integrated computer use, more positive emotional responses can lead to increased use of computers. (p. 470-471)

Results connecting emotions and field experience use of computing and Internet technology skills/knowledge showed that:

> …if [preservice teacher's] emotional experiences were positive, use of [computing and Internet technology skills/knowledge] increased in the field. If [preservice teacher's] emotional experiences were negative, preservice teachers were less inclined to employ [computing and Internet technology skills/knowledge] as a teaching tool or strategy. (p. 470)

Kay (2006) examined studies focused on development of computing and Internet technology skills/knowledge for preservice teachers. Ten key strategies for development of computing and Internet technology skills/knowledge for preservice teachers were identified. The value of a given strategy was judged by the observed impact on preservice teacher's attitude, ability and use of computing and Internet technology skills/knowledge. The ten strategies identified were:

> …integrating technology in all courses (44%, N=30); using multimedia (37%, N=25); focusing on education faculty (31%, N=21); delivering a single technology course (29%, N=20); modeling how to use technology (27%, N=18); collaboration among preservice teachers, mentor teachers, and faculty (25%, N=17); practicing technology in the field (19%, N=13); offering mini-workshops (18%, N=12); improving access to software, hardware, and/or support (14%, N=10); and focusing on mentor teachers (13%, N=9). (p. 387)

Several learning experiences/strategies emerged from Kay's review of the literature. First, most of the studies reviewed looked at multiple strategies to develop computing and Internet technology skills/knowledge of preservice teachers. Second, Kay found that while each of the studies expended a great deal of effort and resources on learning strategies to develop preservice teacher's computing and Internet technology skills/knowledge, very little effort was put into measuring the results. Also, see Marvin (2004) in his study comparing perceptual assessments of computing and Internet technology skills/knowledge versus performance-based assessments. Finally, Kay synthesized a best practices model for preservice teacher preparation to use and integrate computing and Internet technology skills/knowledge.

> First, good access (also, see Negishi, Elder, Hamil, & Mzoughi, 2003) to software, hardware and support is [essential]. Second …whether the [preparation strategies include] single-course, workshop, integration, multimedia-based, or a combination, it is important that every effort be made to model and construct authentic teaching activities. Third, collaboration among preservice teachers, faculty, and mentor teachers is ideal. [At the very least], partnerships (also see O'Bannon & Judge, 2004) between preservice and

mentor teachers may work [to encourage positive attitude and use of computing and Internet technology skills/knowledge]. (p. 394)

Chapter III: Methodology

This section describes the study methodology. Description of research method, subject selection, subject description, instrumentation, data collection, data analysis, limitations and concluding summary are addressed.

Description of Research Method

This study was a comparative study of UW-Stout freshmen and senior education majors computing and Internet technology skills/knowledge and associated learning experiences.

Subject Selection

Subject selection process. The subjects in this study were full-time undergraduate students. Twenty-three UW-Stout freshmen education majors and 25 UW-Stout senior education majors participated. The process of subject selection went as follows:

1. The UW-Stout Budget, Planning and Analysis (BPA) office queried the Central Data Repository (CDR) at UW-System in Madison and the UW-Stout data warehouse to create lists of fall 2008 freshmen and senior education majors who had full-time status.
2. The BPA office put the results of the query into an Excel file and emailed them to the investigator. The lists were created no earlier than the 10^{th} day after the start of the fall 2008 semester to assure class status of both student populations.
3. All freshmen and senior education majors identified by the BPA office query were emailed an invitation to participate in the study.
4. Students interested in participating were entered into an Excel workbook. Based on a first-come; first served basis, up to 120 students could have been invited to participate in the study.

Email communications. The first emailing was to find if students from the freshmen and senior education categories would be interested to participate in the study. Content of the email included the purpose of the study, potential benefits to the student and information telling the potential participant where and when the research event would take place. Information in the first email also explained that participation was limited to 60 freshmen and 60 senior participants and that eventual selection was on a first come; first serve basis.

The second emailing confirmed that a potential study participant had been officially invited to participate in the study. The content of this email asked the students to reply within five days if they accepted the invitation to participate in the study. Upon receiving a positive reply, a third email was sent that included an affirmation to the students who agreed to participate, reaffirmed the purpose of the study and the benefits to the participant. The affirmation email, the third email, clearly defined the research event including: where and when the event occurred, the amount of time expected for data collection, a brief description of the data gathering instruments, how the research payment of $20.00 was to be distributed and technology requirements.

Subject Description

It was the hope of the investigator to select study participants to represent the overall demographics and characteristics of all UW-Stout freshmen and senior education majors. The selected study participants represented some of the undergraduate education degree programs at UW-Stout. These undergraduate degree programs included:

- Art Education
- Career and Technical Education and Training
- Early Childhood Education

- Family and Consumer Sciences Education
- Marketing Education
- Business Education
- Applied Science: Science Education
- Special Education
- Technology Education
- Health Occupations Education

Instrumentation

Two instruments were used in this study. The Internet and Computing Core Certification (IC^{3}®) Exam by Certiport (IC^{3}® Home, 2009) and the Computing and Internet Skills Learning Experiences Survey designed and developed by the researcher.

Content of the IC^{3}® Exam. The following information about the content of the IC^{3}® Exam comes from the IC^{3}® Exam Validation Brief provided by Certiport (2002-2003).

> The Internet & Computing Core Certification (IC^{3}® Exam) is a standards-based certification program for basic computing and Internet literacy. IC^{3}® provides specific guidelines for the knowledge and skills required to be a functional user of computer hardware, software, networks and the Internet. By establishing this vendor-independent standard, IC^{3}® provides a reliable, universal measure of basic computing and Internet skills. IC^{3}® consists of three competency [tests]. Passing [the] three IC^{3}® [tests] qualify an individual to receive IC^{3}® Certification. Computing Fundamentals: this [test] measures examinee knowledge of computer hardware, software, and basic operating system skills. Key Applications: this [test] evaluates examinee proficiency in [three] computer applications (word processor, spreadsheet [and presentation]) and the common

> features of different applications. Living Online: this [test] measures basic skills in using networks, electronic mail, the Internet, and Web browsing software as well as an understanding of how computers and the Internet affect society. Each [test] uses various test-question methods. Whenever possible, testing the ability to use specific product functions (such as file and system management functions of Windows) is done with performance based test items where candidates are asked to perform specific software tasks in a realistic simulation of the software environment. Performance-based testing has proven to have a high degree of statistical reliability and user satisfaction. Testing of other knowledge types (such as knowledge of hardware and software) is done with traditional linear type questions, like multiple choice, multiple response and matching test items. The appropriate mix of linear and performance-based testing questions to measure the knowledge, skills and abilities of candidates for IC^{3}® ensures a high degree of validity, reliability and impartiality for all participants in the program. (p. 2)

Validity of the IC^{3}® Exam. Validity of the IC^{3}® Exam has been established through a rigorous collaborative process. Certiport created the IC^{3}® Exam with professional assistance from SkillCheck, Inc., and The Donath Group. SkillCheck, Inc., is "…a leading provider of assessment and testing products to the education and training, human resources, and staffing services Industries" (p. 2). The Donath Group is "…a leading psychometric and evaluative research consulting organization with over fifty years of highly specialized experience in test construction, measurement, and statistical analysis" (p. 2). The following information details the processes Certiport and its partners when through to validate the IC^{3}® Exam.

From the beginning of IC³® Exam development, the goal was to create an exam that would meet or exceed industry validation standards. The following standards organizations provided guidance for the development of the IC³® Exam:

> The Standards for Educational and Psychological Testing (American Educational Research Association, the American Psychological Association and National Council on Measurement and Education), The Uniform Guidelines on Employee Selection Procedures (The Equal Opportunity Commission, Civil Service Commission, Department of Labor and Department of Justice) and Certification: A NOCA Handbook (National Organization for Competency Assurance). (IC³® Validation Brief, 2002-2003, p. 5)

Three validation processes were used in the development of the IC³® Exam. These validation processes were content-orientated, construct-related and criterion-related. Content-orientated validation refers to:

> [T]he extent to which test scores measure the content they are intended to measure. The IC³® examinations were developed from research in the field of computer and Internet literacy, and then empirically established the most important areas to measure skills and knowledge for this behavioral domain. Additionally, subject matter experts (SMEs) carefully reviewed the IC³® test objectives and test items for item-objective congruence. The blueprint survey review of the content defined the appropriate content of the examination and the test item reviewers verified that the test items measure and represent the content of each of the test objectives covered in the examination. (p. 5-6)

Construct-related validation refers to:

> [T]he extent to which the test scores measure the construct it is intended to measure. The construct being measured by the IC³® Exam is basic knowledge and skills in computing,

> as it exists today for most entry-level jobs using computers. This construct is supported by current research literature, qualitative evaluations by SMEs, and a factor analysis that determined there is an underlying statistical construct for the IC³® test data. (p. 6)

The last validation method used was criterion-related validation. Criterion-related validation refers to:

> [H]ow well test scores correlate or predict other measures of importance, such as some level of job performance, experience, knowledge or skills. Criterion-related validity was established by comparing and analyzing survey responses by certification candidates to their IC³® Exam score distributions. IC³® Exam scores were found to highly correlate to a candidate's computing and other appropriate experience levels. Additionally, when analyzing pass and fail decisions compared to candidate experience, the decisions are very consistent with their levels of experience. Each IC³® [test] had strong relationships with these predictor variables. (p. 6)

To further support the claim for validity and give specific evidence of the three aforementioned validation methods used for the IC³® Exam, see the IC³® Validation Brief in Appendix A.

Reliability of the IC³® Exam. The following information on reliability of the IC³® Exam comes from the unpublished IC³® Examination Development Report provided by Certiport, Inc. Please contact Certiport, Inc. to obtain the full report (The Donath Group Inc., 2002).

The following quotes gives background to the processes used to test the reliability of the IC³® Exam.

> The development process [included] a beta period in which tests [were] taken by a large representative sample of candidates to determine the difficulty and reliability of each test item as well as how each test is working as a whole. Research results [were] used to refine each test, establish cut scores and build plans for ongoing development and validation to advance the IC³® Certification standard. (p. 144) An analysis [was] conducted using a class of methods for estimating reliability based on the administration of a single test form. Members of the class include[d] coefficient alpha, Kuder-Richardson formulas and methods involving internal splits of the test. The internal reliability coefficient, Cronbach's alpha, when computed for binary (e.g., correct/wrong) items, is identical to the so-called Kuder-Richardson-20 formula of reliability for sum scales (test scores). In either case, because the reliability is actually estimated from the consistency of all items in the sum scales, the reliability coefficient computed in this manner is also referred to as the internal-consistency reliability. KR-20 and Cronbach's Alpha should be used only for homogeneous tests, since these formulas reflect item homogeneity. If a test measures a variety of traits, coefficient alpha and Kuder-Richardson reliability will be inappropriately low. (p. 149)

For testing the reliability of each test within the IC³® Exam, the Kuder-Richardson Formula 20 was used. The Kuder-Richardson Formula 20 is

> …a measure of internal consistency reliability for measures with dichotomous choices. It is analogous to Cronbach's α, except Cronbach's α is also used for non-dichotomous (continuous) measures. A high KR-20 coefficient (e.g., >0.90) indicates a homogeneous test. Values can range from 0.00 to 1.00 (sometimes expressed as 0 to 100) with high values indicating that the examination is likely to correlate with alternate forms (a

> desirable characteristic). The *KR20* is impacted by difficulty, spread in scores and length of the examination. In the case when scores are not tau-equivalent (for example when there is not homogeneous but rather examination items of increasing difficulty) then the KR-20 is an indication of the lower bound of internal consistency (reliability). (Kuder-Richardson Formula 20, 2010, ¶. 1)

After the initial IC³® Exam pilot analysis, each IC³® Exam test was revised into its final form and analyzed for reliability using the Kuder-Richardson Formula 20 (*KR20*). The following *KR20* results indicate each IC³® Exam test to be homogeneous and reliable (The Donath Group Inc., 2002).

- Computing Fundamentals test (α = .90).
- Key Applications test (α = .90).
- Living Online test (α = .88).

Content of the Computing and Internet Skills Learning Experiences survey. Created by the investigator, the construct of the Computing and Internet Skills Learning Experiences survey was focused on cumulative formal and informal computing and Internet technology skills/knowledge learning experiences. To view the Computing and Internet Skills Learning Experiences survey, please see Appendix B. The Computing and Internet Skills Learning Experiences survey has four sections, excluding demographics. The sections are Formal Learning Experiences, Informal Learning Experiences, Modeling the Use of Computing and Internet Skills and Preparation to Use Computing and Internet Technologies.

Formal Learning Experiences are learning experiences created through formal schooling or employment. The learning experiences would most likely occur in a class or training session with the benefit of formally established learning outcomes. This section of the survey asked the study participant to identify formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge and where the formal exclusively-focused learning experiences took place. The "where" are levels of formal schooling and employment. The second portion of the Formal Learning Experiences section asked the study participant to identify learning experiences where computing and Internet technology skills/knowledge were formally integrated within curriculum (other than computing and Internet technology skills/knowledge curriculum). The final portion of the Formal Learning Experiences section asked the study participant to identify employment-based formal exclusively-focused training to learn computing and Internet technology skills/knowledge specific to employment.

Informal Learning Experiences are experiences created through means that are self-directed and/or outside the confines of a formal class or training section and do not have the benefit of formally established learning outcomes. From a list of possible self-directed methods, study participants were asked to identify how they teach themselves computing and Internet technology skills/knowledge. This section concluded by asking the study participant to identify employment-based informal training to learn computing and Internet technology skills/knowledge.

Modeling the Use of Computing and Internet Skills asked study participants to identify people they observed regularly and consistently using computing and Internet technology skills/knowledge. The list of possible answers included teachers, friends, parents and employers.

Preparation to Use Computing and Internet Technologies asked study participants to rate their level preparation to effectively use computing and Internet technology skills/knowledge for personal and professional purposes. Questions rating the importance of computing and Internet technology skills/knowledge for chosen education majors and the importance of computing and

Internet technology skills/knowledge for the study participant's future students were also included.

Demographics questions asked study participants to identify gender, age, class-status, declared undergraduate education major and whether or not they had ever taken an online course.

Format of the Computing and Internet Skills Learning Experiences survey. The medium used for this survey was paper-based. Overall, there were 24 questions in the survey. The time required to complete the survey was approximately 15 minutes. To view the Computing and Internet Skills Learning Experiences survey, please see Appendix B.

Development of the Computing and Internet Skills Learning Experiences survey. The following steps were taken in the development of the Computing and Internet Skills Learning Experiences survey.

1. The investigator brainstormed possible ways people might learn computing and Internet technology skills/knowledge. From the initial brainstorming, sub-categories were created that separated the possible learning experiences into formal and informal. Additional questions were added that addressed modeling, preparation and perceived value of computing and Internet technology skills/knowledge. Finally, a set of demographic questions was created to complete the initial survey.
2. The initial survey was presented to two of the three members of the investigator's committee. Each committee member was told the purpose of the survey was to identify formal and informal learning experiences used by study participants to develop computing and Internet technology skills/knowledge. After the purpose of the survey was explained, each committee member was asked to review the initial

survey and make comments and suggestions. After meeting with the committee members, both affirmed the four original sections of the survey.

3. Changes suggested by research committee member, Dr. Steve Schlough. Use a simple demographic identifying class status (Freshmen/Senior) versus asking the study participant to identify class status based on credits earned. The demographic question on age might not be appropriate. The items on Preparation to Use Computing and Internet Technologies section might be too broad. Finally, a suggestion for coding the survey in preparation for data analysis was made.
4. Changes suggested by research committee member, Dr. Urs Haltinner. This member did not believe it was appropriate to include the items that identified formal and informal learning experiences in elementary school because it was assumed that elementary school does not address computing and Internet technology skills/knowledge. The demographic question asking study participants to identify their major was changed because one major was missing. It was suggested the Marketing and Business Education be split up into Marketing Education and Business Education. The "major" survey item was changed to allow for more than one major to be selected by a study participant. A suggestion was made for the Informal Learning Experiences section that the question "I teach myself how to use computing and Internet technologies" be turned into a YES/NO question and that following the leading question the study participant identify all the methods they use for self-teaching. This suggestion affirmed the format of the questions in the Formal Learning Experiences section and created a consistency between the first two sections of the survey. The last suggestion made changed the Preparation to Use Computing

and Internet Technologies section of the Computing and Internet Skills Learning Experiences survey. The revision of the original question created two questions. The two new questions distinguished preparation to use computing and Internet technologies for personal and professional use and preparation to use computing and Internet technologies integrated into the curriculum.

5. The investigator met with Dr. David Johnson, professor of Training and Development at UW-Stout to get advice on employment-based training to develop computing and Internet technology skills/knowledge. Based on suggestions made by Dr. Johnson, questions were added to the Formal Learning Experiences and Informal Learning Experiences sections of the survey prompting study participants to identify learning experiences experienced while employed.
6. The investigator revised the Computing and Internet Skills Learning Experiences survey during the development of the final survey and before a pilot test. The order of survey sections was changed to first emphasis formal and informal learning experiences, then modeling, preparation, and demographics. The rating scales in the survey's preparation items were broadened from an initial range of three "Very Prepared, Prepared, Not Prepared" to a range of 10 "1=Poorly Prepared to 10=Well Prepared". The rating scales in the survey's Preparation to Use Computing and Internet Technologies section were broadened from an initial range of three "Very Important, Important, Not Important" to a range of 10 "1=Not Important to 10=Important". Survey items were adjusted to provide the option of OTHER in both Formal Learning Experiences, Informal Learning Experiences sections. Each section

would then have a pattern of items as follows: YES or NO, If YES, identify all… and if OTHER, please explain.

7. No changes were suggested by research committee chair, Dr. Sylvia Tiala. The discussion on the survey related to coding the survey items and creating a codebook for eventual data analysis.
8. Changes suggested by independent study professor, Dr. Amy Gillett. After view of the survey, no changes were recommended.
9. The survey was piloted during the fall 2007 semester. The free online survey service SurveyMonkey (http://www.surveymonkey.com) was used as the medium to administer the survey. Seventy students from the investigator's Information and Communication Technologies course took the survey as a part of a course activity designed to have the students reflect on where they have come from and where they need to be in the development of computing and Internet technology skills/knowledge. The results of the pilot showed that the survey items measure what was expected. The one survey item that was problematic was the question that asked the study participants to identify formal exclusively-focused development of computing and Internet technology skills/knowledge. The pilot students did not understand the meaning of "exclusively-focused". This item was clarified and a survey administration process was put in place to clarify the item.
10. After the survey pilot, the Computing and Internet Skills Learning Experiences survey was put into its final form and readied for use. For the purpose of this study, a paper-based version of the Computing and Internet Skills Learning Experiences survey was used.

Validity and Reliability of the Computing and Internet Skills Learning Experiences survey. No measures of validity or reliability were documented since Computing and Internet Skills Learning Experiences survey was designed specifically for this study.

Data Collection

Data collection for this study occurred during the fall 2008 semester. The Information Technology Management program's computer networking lab in Fryklund Hall was used for data gathering event. The computer-networking lab supported the data collection activities adequately.

The investigator facilitated the data gathering activities to control the data gathering process. The IC^3® Exam requires an IC^3® certified instructor to proctor its use because a study participant who passes the three tests that make up the IC^3® Exam can gain IC^3® Certification. The investigator is an IC^3® certified instructor.

The time needed for the data-collection process was about 165 minutes. The data collection process went as follows:

1. Introduction. Welcome, overview of the study, review and signature of the confidentiality waiver and establishment of a Certiport user account used to document IC^3® Exam results and coding for the data collection. Time: 15 minutes.
2. IC^3® Exam. The three tests (Key Applications, Living Online and Computing Fundamentals) each have a time limit of 45 minutes. In this step, study participants were asked to select one of the lab computers and turn it on. Each lab computer had the IC^3® Exam engine installed before the data gathering event. All study participants were asked to open Internet Explorer and login to their online Certiport

user account. Each study participant was given three test vouchers. Once the voucher information was entered, the exam began. Time: 135 minutes.

3. Computing and Internet Skills Learning Experiences survey. A paper-based survey that identified the participant's past formal and informal learning experiences related to the development of computing and Internet technology skills/knowledge. This survey was given after the study participant completed the IC³® Exam. Time: 15 minutes.
4. After the data collection was completed, participants were required to fill out the "Payment of Human Subjects" form. After the form was completed, the participant received $20.00. Each participant was thanked for their participant in the study and dismissed.
5. All Computing and Internet Skills Learning Experiences surveys were securely stored.
6. All "Payment of Human Subjects" forms were hand-delivered to Ted Wenum in the UW-Stout Business Services office to account for payment to individual transactions as well as any unused payment to individual funds.

Data Analysis

Based on the objectives of this study, the following statistical methods were used to analyze the collected data. Additional analysis was conducted in light of notable results. See Chapter IV: Results for the details.

Study objectives one and two. Measure the computing and Internet technology skills/knowledge of UW-Stout freshmen and senior education majors. Data from the IC³® Exam answered these study objectives. The following analyses were used to describe freshmen and senior education majors computing and Internet technology skills/knowledge:

1. Descriptive statistics on the skill sets within the Key Applications, Living Online and Computing Fundamentals tests. Minimum, maximum, mean, standard deviation and variance.
2. Descriptive statistics on composite scores for the Key Applications, Living Online and Computing Fundamentals tests. Minimum, maximum, mean, standard deviation and variance.
3. Number of study participants who passed the Key Applications, Living Online and Computing Fundamentals tests. Frequency count.
4. Number of study participants who passed the IC³® Exam and earned IC³® Certification. Frequency count.

Study objectives three and four. Identify the learning experiences of UW-Stout freshmen and senior education majors in relationship to development of computing and Internet technology skills/knowledge. Data from the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey answered these study objectives. The following analyses were used to describe freshmen and senior education majors learning experiences to develop computing and Internet technology skills/knowledge:

1. Levels of school where “formal exclusively-focused” learning was experienced to develop computing and Internet technology skills/knowledge. Frequency count.

2. OTHER levels of school where "formal exclusively-focused" learning was experienced to develop computing and Internet technology skills/knowledge. A list of additional levels of school was created and a frequency count calculated.
3. Levels of school where "formally integrated" learning was experienced to develop computing and Internet technology skills/knowledge. Frequency count.
4. OTHER levels of school where "formally integrated" learning was experienced to develop computing and Internet technology skills/knowledge. A list of additional levels of school was created and a frequency count calculated.
5. Experiencing "employment-based formal exclusively-focused training" to develop computing and Internet technology skills/knowledge. Frequency Count.
6. With a YES answer for the survey item "employment-based formal exclusively-focused training" to develop computing and Internet technology skills/knowledge, a list of "employment-based formal exclusively-focused training" methods was created and a frequency count for each method calculated.
7. "Informal self-teaching methods" used to develop computing and Internet technology skills/knowledge. Frequency count.
8. OTHER "informal self-teaching methods" used to develop computing and Internet technology skills/knowledge. A list of additional "informal self-teaching methods" was created and a frequency count calculated.
9. Experiencing "employment-based informal training" to develop computing and Internet technology skills/knowledge. Frequency count.
10. With a YES answer for the survey item "employment-based informal training" to develop computing and Internet technology skills/knowledge, a list of "employment-

based informal training" methods was created and a frequency count for each method calculated.

Study objective five. Compare the measured computing and Internet technology skills/knowledge of UW-Stout freshmen and senior education majors. Data from the IC³® Exam answered this study objective. The following analyses were used to compare the computing and Internet technology skills/knowledge of UW-Stout freshmen and senior education majors:

1. Skill sets within the Key Applications, Living Online and Computing Fundamentals tests. Mann-Whitney U Test.
2. Composite scores for the Key Applications, Living Online and Computing Fundamentals tests. Mann-Whitney U Test.
3. Passed the Key Applications, Living Online and Computing Fundamentals tests. Chi-Square Test of Independence.
4. Passed the IC³® Exam and earned IC³® Certification. Chi-Square Test of Independence.

Study objective six. Compare the identified learning experiences of UW-Stout freshmen education majors and senior education majors associated with the development of computing and Internet technology skills/knowledge. Data from the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey answered this study objective. The following analyses were used to compare the identified learning experiences of UW-Stout freshmen and senior education majors associated with the development of computing and Internet technology skills/knowledge:

1. Levels of school where "formal exclusively-focused" learning was experienced to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
2. OTHER levels of school where "formal exclusively-focused" learning was experienced to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
3. Levels of school where "formally integrated" learning was experienced to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
4. OTHER levels of school where "formally integrated" learning was experienced to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
5. Experiencing "employment-based formal exclusively-focused training" to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
6. With a YES answer for the survey item "employment-based formal exclusively-focused training" to develop computing and Internet technology skills/knowledge, a list of "employment-based formal exclusively-focused training" methods. Chi-Square Test of Independence.
7. "Informal self-teaching methods" used to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
8. OTHER "informal self-teaching methods" used to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.

9. Experiencing "employment-based informal training" to develop computing and Internet technology skills/knowledge. Chi-Square Test of Independence.
10. With a YES answer for the survey item "employment-based informal training" to develop computing and Internet technology skills/knowledge, a list of "employment-based informal training" methods. Chi-Square Test of Independence.

Notable undergraduate education degree program comparisons. Statistical analyses were performed upon notable undergraduate degree program groupings. Data used to describe and compare the notable undergraduate degree program groupings included IC³® Exam results, identified Formal Learning Experiences and identified Informal Learning Experiences.

1. Earned IC³® Certification. Comparison of two groups. Chi-Square Test of Independence.
2. Formal Learning Experiences: Formal exclusively-focused in school. Chi-Square Test of Independence.
3. Formal Learning Experiences: Formally integrated in school. Chi-Square Test of Independence.
4. Informal Learning Experiences: Informal self-teaching methods. Chi-Square Test of Independence.
5. Formal Learning Experiences: Employment-based formal exclusively-focused training. Chi-Square Test of Independence.
6. Informal Learning Experiences: Employment-based informal training. Chi-Square Test of Independence.
7. Earned IC³® Certification. Comparison of three groups. Kruskal-Wallis H Test.

Limitations

Limitations of this study included:

- Results of this study were focused only on UW-Stout education majors.
- The instrument used to measure computing and Internet technology skills/knowledge, the IC^{3}® Exam, is a performance-based instrument. No data identifying perceived computing and Internet technology skills/knowledge of study participants was collected.
- This study utilized a survey developed by the investigator. The instrument may have contained errors, misinterpretations, misstatements, or omissions not intended by the investigator. Every effort was made to develop a reliable and valid instrument.
- Because of the ever-changing nature of software applications, Microsoft's new version of the Office Suite 2007 may have interfered with the results of the Key Applications test (CNET.com, 2006).
- The process used to select study participants was not a random sample. A convenient sampling method was used to select study participants.
- Because of the limited number of IC^{3}® Exams purchased, a representation of all UW-Stout School of Education undergraduate degree programs was not possible.
- A substantial time commitment was expected of the study participants. Because of this commitment, paying the participants for their time was paramount to assure enough participants in the study to run the statistical tests of significance.
- The IC^{3}® Exam is computer-based. There was the possibility to experience technical issues that would interfere with the data collection process.

Summary

This chapter described the study methodology. Description of research method, subject selection, subject description, instrumentation, data collection, data analysis and limitations were addressed. The next chapter will review the results of this study.

Chapter IV: Results

Descriptive statistics, frequency count, range, minimum, maximum, mean, standard deviation and variance, and comparative statistics, Mann-Whitney U Test, Chi-Square Test of Independence and Kruskal-Wallis H Test, were used to analyze the collected data. Study participants were identified by class and major in the data analysis and tables that follow. The following are results based upon the original six study objectives. Additional analysis was conducted after preliminary analysis identified notable comparisons between undergraduate education degree programs.

Study Objective One

Study objective one measured the computing and Internet technology skills/knowledge of UW-Stout freshmen education majors using the IC³® Exam. The IC³® Exam consists of three separate tests that include Key Applications, Living Online and Computing Fundamentals. The Key Applications test measured proficiency in three computer applications, including word processor, spreadsheet and presentation software, and the common features of all applications. The Living Online test measured aspects of working in an Internet or networked environment including basic knowledge of networks and the Internet, skills in specific applications such as electronic mail software and web browsers, skills required to find and evaluate information and an understanding of issues related to computing and the Internet being used at work, home and school. The Computing Fundamentals test measured knowledge of subjects needed for a foundational understanding of computing including knowledge and use of computer hardware, software and operating systems (IC³® 2005 Skill Set Summary, 2004).

Each of the IC³® Exam tests consisted of 45 items made up of linear and performance-based test items. Linear test items consist of multiple choice, multiple response and matching test items. Performance-based test items consist of interactive simulations of the software product that requires the performance of functions exactly as would be experienced with the application. There were approximately 25 linear test items and 20 performance-based test items for each of the IC³® Exam tests (S. Washington, personal communication, March 13, 2009).

Key Applications test results for UW-Stout freshmen education majors. The Key Applications test skills sets include:

- Common Program Functions. Opening and closing a file/application, cut-copy-paste information, preview a document before printing and using the help function.
- Spreadsheet Functions. Sorting data in a worksheet, manipulating data formulas, and creating charts depicting data.
- Word Processing Functions. Formatting text, utilizing automatic text formatting features, utilizing document elements such as tables, charts and various graphics.
- Presentation Functions. Creating and formatting simple presentations (IC³® 2005 Skill Set Summary, 2004).

The scoring scale for the Key Applications test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Key Applications test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-three UW-Stout freshmen education majors took the Key Applications test. The results are shown in Table 1.

Table 1

Key Applications Test Results for UW-Stout Freshmen Education Majors

Key Applications Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Common Program Functions	64	27	91	60.61	21.668	469.522
Spreadsheet Functions	100	0	100	42.87	29.197	852.482
Word Processing Functions	100	0	100	51.61	22.791	519.431
Presentation Functions	80	0	80	43.48	27.404	750.988
(*N* = 23)						

Summary of Key Applications test results for UW-Stout freshmen education majors. Table 1 (above) shows that UW-Stout freshmen education majors obtained a higher mean, a lower standard deviation and a lower variance on the Common Program Functions skill set (*M* = 60.61, *SD* = 21.668, *VAR* = 469.522) than they did for the Word Processing Functions skill set (*M* = 51.61, *SD* = 22.791, *VAR* = 519.431), the Presentation Functions skill set (*M* = 43.48, *SD* = 27.404, *VAR* = 750.988) and the Spreadsheet Functions skill set (*M* = 42.87, *SD* = 29.197, *VAR* = 852.482). The range of scores was lowest for the Common Program Functions skill set (*RANGE* = 64, *MIN* = 27, *MAX* = 91) versus the range of scores for Presentation Functions (*RANGE* = 80, *MIN* = 0, *MAX* = 80), Word Processing Functions (*RANGE* = 100, *MIN* = 0, *MAX* = 100) and Spreadsheet Functions skill sets (*RANGE* = 100, *MIN* = 0, *MAX* = 100).

Living Online test results for UW-Stout freshmen education majors. The Living Online test skills sets include:

- Networks. Identifying benefits and risks of networked computing and identifying fundamental principles of security on a network.
- Electronic Mail. Identifying how electronic mail works on a network or the Internet, managing attachments, identifying the appropriate use of electronic mail and electronic mail related netiquette.
- Computers and Society. Identifying how computers and the Internet are used to collect, organize and evaluate information and promote learning. Identifying software threats, including viruses and worms, identifying concepts related to intellectual property laws including copyrights, trademarks and plagiarism. Internet basics like identifying different types of websites by their extensions, the purposes of different types of websites, navigating the World Wide Web using a web browser and using a search engine to search for information based on specified keywords (IC^3® 2005 Skill Set Summary, 2004).

The scoring scale for the Living Online test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Living Online test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-three UW-Stout freshmen education majors took the Living Online test. The results from the Living Online test are shown in Table 2.

Table 2

Living Online Test Results for UW-Stout Freshmen Education Majors

Living Online Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Computers and Society	67	25	92	67.48	15.147	229.443
Electronic Mail	61	31	92	71.43	17.275	298.439
Internet	77	23	100	67.83	19.745	389.877
Networks	100	0	100	55.91	27.894	778.083
(*N* = 23)						

Summary of Living Online test results for UW-Stout freshmen education majors. Table 2 (above) shows that UW-Stout freshmen education majors had the lowest range of scores and highest mean score for the Electronic Mail skill set (*RANGE* = 61, *MIN* = 31, *MAX* = 92, *M* = 71.43) as compared to the range scores and mean scores for the Computers and Society (*RANGE* = 67, *MIN* = 25, *MAX* = 92, *M* = 67.48), Internet (*RANGE* = 77, *MIN* = 23, *MAX* = 100, *M* = 67.83) and Networks (*RANGE* = 100, *MIN* = 0, *MAX* = 100, *M* = 55.91) skill sets. The Networks skill set had the highest standard deviation and variance (*SD* = 27.894, *VAR* = 778.083). The standard deviation and variance of the Computers and Society (*SD* = 15.147, *VAR* = 229.443), Electronic Mail (*SD* = 17.275, *VAR* = 298.439) and Internet (*SD* = 19.745, *VAR* = 389.877) skills sets were similar.

Computing Fundamentals test results for UW-Stout freshmen education majors. The Computing Fundamentals test skills sets include:

- Computer Hardware. Identifying the types and purposes of external computer components, including standard input and output devices, identifying factors that affect computer performance and identifying criteria for selecting a personal computer.
- Computer Software. Identifying how hardware and software interact, identifying fundamental concepts and uses for word processing, spreadsheet, presentation, database and multimedia applications.
- Operating Systems. Identifying the difference between interacting with command based and graphical operating systems, managing files, display and managing control settings (IC³® 2005 Skill Set Summary, 2004).

The scoring scale for the Computing Fundamentals test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Computing Fundamentals test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-three UW-Stout freshmen education majors took the Computing Fundamentals test. The results from the Computing Fundamentals test are shown in Table 3.

Table 3

Computing Fundamentals Test Results for UW-Stout Freshmen Education Majors

Computing Fundamentals Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Computer Hardware	70	30	100	57.61	18.822	354.249
Computer Software	67	33	100	69.74	17.869	319.292
Operating Systems	75	19	94	65.74	19.668	386.838
(N = 23)						

Summary of Computing Fundamentals test results for UW-Stout freshmen education majors. Table 3 (above) shows that UW-Stout freshmen education majors had the lowest range of scores and the highest mean score for the Computer Software skill set (*RANGE* = 67, *MIN* = 33, *MAX* = 100, *M* = 69.64) when compared to the Computer Hardware (*RANGE* = 70, *MIN* = 30, *MAX* = 100, *M* = 57.61) and Operating Systems (*RANGE* = 75, *MIN* = 19, *MAX* = 94, *M* = 64.74) skill sets. The Computer Hardware skill set had a low mean score (*M* = 57.61) while at the same time having similar range, standard deviation and variance scores (*RANGE* = 70, *SD* = 18.822, *VAR* = 354.249) when compared to the Computer Software (*RANGE* = 67, *SD* = 17.869, *VAR* = 319.292) and Operating Systems (*RANGE* = 75, *SD* = 19.668, *VAR* = 386.838) skill sets. Further examination of the distribution of the Computer Hardware skill set scores showed that three of 23 freshmen education majors scored in the 90 to 100 range of scores, increasing the range of scores. Twenty freshmen education majors scored in the 30 to 70 range of scores. The resulting positively skewed distribution shows that freshmen education majors scored lower in the Computer Hardware skill set as compared to their scores in the Computer Software and Operating Systems skill sets.

IC³® Exam tests composite results for UW Stout freshmen education majors. A composite score was determined for each of the three tests that make up the IC³® Exam by calculating them as a percentage of exam questions answered correctly ((questions correct/45)*1000). The scores are standardized by converting percentage correct to a scale of zero to 1000. The composite exam score is used to describe overall performance and to determine potential IC³® Certification (J. Haber, personal communication, April 29, 2009). Statistical analysis methods used to describe the composite test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-three UW-Stout freshmen education majors took the Key Applications, Living Online and Computing Fundamentals tests. The composite results from the IC³® Exam tests are shown in Table 4.

Table 4

IC³® Exam Tests Composite Results for UW-Stout Freshmen Education Majors

IC³® Exam Tests	Passing Score	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Key Applications	750	711	156	867	534.43	212.175	45018.348
Living Online	800	712	244	956	668.52	160.357	25714.352
Computing Fundamentals	800	578	378	956	628.96	156.888	24613.953
(*N* = 23)							

Summary of IC³® Exam tests composite results for UW Stout freshmen education majors. Table 4 (above) shows that UW-Stout freshmen education majors had a higher mean composite score for the Living Online test (*M* = 668.52) as compared to the mean composite scores of the Computing Fundamentals test (*M* = 628.96) and Key Applications test (*M* = 534.43). Of the three tests, the range of scores for the Computing Fundamentals test was lower (*RANGE* = 578, *MIN* = 378, *MAX* = 956) than the Key Applications test (*RANGE* = 711, *MIN* = 156, *MAX* = 867) and Living Online test (*RANGE* = 712, *MIN* = 244, *MAX* = 956). The Key Applications test had distinctly higher standard deviation and variance scores (*SD* = 212.175, *VAR* = 45018.348) while the Living Online test (*SD* = 160.357, *VAR* = 25714.352) and Computing Fundamentals test (*SD* = 156.888, *VAR* = 24613.953) had similar standard deviation and variance scores.

The Key Applications test composite results show UW-Stout freshmen education majors with an overall mean exam score (M = 543.43) lower than the predetermined test passing score ($PASS$ = 750). Six (26.1%) UW-Stout freshmen education majors scored above the predetermined test passing score.

The Living Online test composite results show UW-Stout freshmen education majors with an overall mean test score (M = 668.52) lower than the predetermined test passing score ($PASS$ = 800). Six (26.1%) UW-Stout freshmen education majors scored above the predetermined test passing score.

The Computing Fundamentals test composite results show UW-Stout freshmen education majors with an overall mean test score (M = 628.96) lower than the predetermined test passing score ($PASS$ = 800). Four (17.4%) UW-Stout freshmen education majors scored above the predetermined test passing score.

UW-Stout freshmen education majors earning IC³® Certification. UW-Stout freshmen education majors who passed the Key Applications, Living Online and Computing Fundamentals tests earned IC³® Certification. A frequency count showed that four (17.4%) freshmen education majors earned IC³® Certification. Nineteen (82.6%) freshmen education majors failed to earn IC³® Certification.

Study Objective Two

Study objective two measured the computing and Internet technology skills/knowledge of UW-Stout senior education majors using the IC³® Exam. The IC³® Exam consists of three separate tests that include Key Applications, Living Online and Computing Fundamentals. The Key Applications test measured proficiency in three computer applications, including word processor, spreadsheet and presentation software, and the common features of all applications.

The Living Online test measured aspects of working in an Internet or networked environment including basic knowledge of networks and the Internet, skills in specific applications such as electronic mail software and web browsers, skills required to find and evaluate information and an understanding of issues related to computing and the Internet being used at work, home and school. The Computing Fundamentals test measured knowledge of subjects needed for a foundational understanding of computing including knowledge and use of computer hardware, software and operating systems (IC³® 2005 Skill Set Summary, 2004).

Each of the IC³® Exam tests consisted of 45 items made up of linear and performance-based test items. Linear test items consist of multiple choice, multiple response and matching test items. Performance-based test items consist of interactive simulations of the software product that requires the performance of functions exactly as would be experienced with the application. There were approximately 25 linear test items and 20 performance-based test items for each of the IC³® Exam tests (S. Washington, personal communication, March 13, 2009).

Key Applications test results for UW-Stout senior education majors. The Key Applications test skills sets include:

- Common Program Functions. Opening and closing a file/application, cut-copy-paste information, preview a document before printing and using the help function.
- Spreadsheet Functions. Sorting data in a worksheet, manipulating data formulas, and creating charts depicting data.
- Word Processing Functions. Formatting text, utilizing automatic text formatting features, utilizing document elements such as tables, charts and various graphics.
- Presentation Functions. Creating and formatting simple presentations (IC³® 2005 Skill Set Summary, 2004).

The scoring scale for the Key Applications test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Key Applications test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-five UW-Stout senior education majors took the Key Applications test. The results are shown in Table 5.

Table 5

Key Applications Test Results for UW-Stout Senior Education Majors

Key Applications Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Common Program Functions	64	36	100	77.16	15.293	233.890
Spreadsheet Functions	78	22	100	74.28	22.484	505.543
Word Processing Functions	67	33	100	67.20	20.795	432.417
Presentation Functions	60	40	100	78.40	19.933	397.333
(*N* = 25)						

Summary of Key Applications test results for UW-Stout senior education majors. Table 5 (above) shows that UW-Stout senior education majors obtained a similar low range of scores and high means in both the Common Program Functions skill set (*RANGE* = 64, *M* = 77.16) and Presentation Functions skill set (*RANGE* = 60, *M* = 78.40) as compared to the Word Processing Functions skill set (*RANGE* = 67, *M* = 67.20) and the Spreadsheet Functions skill set (*RANGE* = 78, *M* = 74.28). The standard deviation and variance of the Common Program Functions skill set (*SD* = 15.293, *VAR* = 233.890) and the Presentation Functions skill set (*SD* = 19.933, *VAR* = 397.333) were lower when compared to the Word Processing Functions skill set

(*SD* =20.795, *VAR* = 432.417) and the Spreadsheet Functions skill set (*SD* = 22.484, *VAR* = 505.543). Further examination of the score distribution for the Spreadsheet Functions skill set found five of 23 senior education majors scoring 100 causing the distribution of scores to be negatively skewed and platykurtic kurtosis; a flat distribution. Without the five 100 scores, the mean score would decrease (*M* = 67.85) as well as a standard deviation and variance (*SD* = 20.518, *VAR* = 420.976). One UW-Stout senior education major obtained a maximum score of 100 in each skill set within the Key Applications test.

Living Online test results for UW-Stout senior education majors. The Living Online test skills sets include:

- Networks. Identifying benefits and risks of networked computing and identifying fundamental principles of security on a network.
- Electronic Mail. Identifying how electronic mail works on a network or the Internet, managing attachments, identifying the appropriate use of electronic mail and electronic mail related netiquette.
- Computers and Society. Identifying how computers and the Internet are used to collect, organize and evaluate information and promote learning. Identifying software threats, including viruses and worms, identifying concepts related to intellectual property laws including copyrights, trademarks and plagiarism. Internet basics like identifying different types of websites by their extensions, the purposes of different types of websites, navigating the World Wide Web using a web browser and using a search engine to search for information based on specified keywords (IC^3® 2005 Skill Set Summary, 2004).

The scoring scale for the Living Online test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Living Online test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-five UW-Stout senior education majors took the Living Online test. The results from the Living Online test are shown in Table 6.

Table 6

Living Online Test Results for UW-Stout Senior Education Majors

Living Online Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Computers and Society	50	50	100	79.32	15.574	242.560
Electronic Mail	43	57	100	86.92	11.015	121.327
Internet	31	69	100	87.96	10.652	113.457
Networks	71	29	100	77.72	17.119	293.043
(*N* = 25)						

Summary of Living Online test results for UW-Stout senior education majors. Table 6 (above) shows that UW-Stout senior education majors obtained the highest scores in the Internet skill set (*RANGE* = 31, *M* = 87.96, *SD* = 10.652, *VAR* = 113.457) followed closely by the Electronic Mail skill set (*RANGE* = 43, *M* = 86.92, *SD* = 11.015, *VAR* = 121.327). UW-Stout senior education majors obtained the lowest score on the Networks skill set (*RANGE* = 71, *M* = 77.72, *SD* = 17.119, *VAR* = 293.043) followed closely by the Computers and Society skill set (*RANGE* = 50, *M* = 79.32, *SD* = 15.574, *VAR* = 242.560). One UW-Stout senior education major obtained a maximum score of 100 in each skill set within the Living Online test.

Computing Fundamentals test results for UW-Stout senior education majors. The Computing Fundamentals test skills sets include:

- Computer Hardware. Identifying the types and purposes of external computer components, including standard input and output devices, identifying factors that affect computer performance and identifying criteria for selecting a personal computer.
- Computer Software. Identifying how hardware and software interact, identifying fundamental concepts and uses for word processing, spreadsheet, presentation, database and multimedia applications.
- Operating Systems. Identifying the difference between interacting with command based and graphical operating systems, managing files, display and managing control settings (IC³® 2005 Skill Set Summary, 2004).

The scoring scale for the Computing Fundamentals test is based on a percentage of questions in each skill set category answered correctly. Statistical analysis methods used to describe the Computing Fundamentals test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-five UW-Stout senior education majors took the Computing Fundamentals test. The results from the Computing Fundamentals test are shown in Table 7.

Table 7

Computing Fundamentals Test Results for UW-Stout Senior Education Majors

Computing Fundamentals Test Skill Sets	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Computer Hardware	65	35	100	78.20	19.251	370.583
Computer Software	56	44	100	79.28	14.761	217.877
Operating Systems	62	38	100	78.88	16.746	280.443
(*N* = 25)						

Summary of Computing Fundamentals test results for UW-Stout senior education majors. Table 7 (above) shows that UW-Stout senior education majors obtained the highest scores on the Computer Software skill set (*RANGE* = 56, *M* = 79.28) though all skill sets had comparable scores; Computer Hardware (*RANGE* = 65, *M* = 78.20) and Operating Systems (*RANGE* = 62, *M* = 78.88). The widest scoring distribution was evidenced on the Computer Hardware skill set (*SD* = 19.251, *VAR* = 370.583). The scoring distribution for the Computer Software skill set (*SD* = 14.761, *VAR* = 217.877) and the Operating Systems skill set (*SD* = 16.746, *VAR* = 280.443) were more narrow and similar. One UW-Stout senior education major obtained a maximum score of 100 in each skill set within the Computing Fundamentals test.

IC³® Exam tests composite results for UW-Stout senior education majors. A composite score was determined for each of the three tests that make up the IC³® Exam by calculating them as a percentage of exam questions answered correctly ((questions correct/45)*1000). The scores are standardized by converting percentage correct to a scale of zero to 1000. The composite exam score is used to describe overall performance and to determine potential IC³® Certification (J. Haber, personal communication, April 29, 2009). Statistical analysis methods used to describe the composite test results include range, minimum, maximum, mean, standard deviation and variance. Twenty-five UW-Stout senior education majors took the Key Applications, Living Online and Computing Fundamentals tests. The composite results from the IC³® Exam tests are shown in Table 8.

Table 8

IC³® Exam Tests Composite Results for UW-Stout Senior Education Majors

IC³® Exam Tests	Passing Score	Range	Minimum	Maximum	Mean	Standard Deviation	Variance
Key Applications	750	534	422	956	748.00	159.423	25415.667
Living Online	800	356	622	978	840.04	99.304	9861.373
Computing Fundamentals	800	511	467	978	785.72	149.576	22372.877
(N = 25)							

Summary of IC³® Exam tests composite results for UW-Stout senior education majors. Table 8 (above) shows that UW-Stout senior education majors obtained a lower range of scores and a higher mean score on the Living Online test (*RANGE* = 356, M = 840.04) as compared to a range of scores and mean score for the Computing Fundamentals test (*RANGE* = 511, M = 785.72) and the Key Applications test (*RANGE* = 534, M = 748.00). UW-Stout senior education majors also obtained a lower standard deviation and variance on the Living Online test (*SD* = 99.304, *VAR* = 9861.373) as compared to the standard deviation and variance of the

Computing Fundamentals test (*SD* = 149.576, *VAR* = 22372.877) and the Key Applications test (*SD* = 159.423, *VAR* = 25415.667).

Key Applications test composite results show UW-Stout senior education majors with an overall mean exam score (*M* = 748.00) almost equal to the predetermined exam passing score (*PASS* = 750). Fifteen (60.0%) UW-Stout senior education majors scored above the predetermined test passing score.

Living Online test composite results show UW-Stout senior education majors with an overall mean exam score higher (*M* = 840.04) than the predetermined exam passing score (*PASS* = 800). Sixteen (64.0%) UW-Stout senior education majors scored above the predetermined test passing score.

Computing Fundamentals test composite results show UW-Stout senior education majors with an overall mean exam score (*M* = 785.72) slightly lower than the predetermined test passing score (*PASS* = 800). Fifteen (60.0%) UW-Stout senior education majors scored above the predetermined test passing score.

UW-Stout senior education majors earning IC^3® Certification. UW-Stout senior education majors who passed the Key Applications, Living Online and Computing Fundamentals tests earned IC^3® Certification. A frequency count showed that 12 (48%) senior education majors earned IC^3® Certification. Thirteen (52.0%) senior education majors failed to earn IC^3® Certification.

Study Objective Three

Study objective three identified the learning experiences of UW-Stout freshmen education majors in relationship to development of computing and Internet technology skills/knowledge using the Computing and Internet Skills Learning Experiences survey. The

Computing and Internet Skills Learning Experiences survey consists of four separate sections that include Formal Learning Experiences, Informal Learning Experiences, Modeling the Use of Computing and Internet Skills and Preparation to Use Computing and Internet Technologies.

Formal Learning Experiences section. Identified learning experiences that take place in a setting where someone or some organization other than the individual learner establishes learning outcomes related to the development of computing and Internet technology skills/knowledge.

- Formal exclusively-focused. Identified levels of school where courses/classes exclusively focused to develop computing and Internet technology skills/knowledge.
- Formally integrated. Identified levels of school where courses/classes integrated computing and Internet technology skills/knowledge with curricular content.
- Employment-based formal exclusively-focused training. Identified exclusively focused employment training to develop computing and Internet technology skills/knowledge for employment purposes.

Informal Learning Experiences section. Identified learning experiences that took place in a setting where the individual learner decides the learning outcomes related to the development of computing and Internet technology skills/knowledge.

- Informal self-teaching methods. Identified the ways individuals teach themselves how to use computing and Internet technology skills/knowledge.
- Employment-based informal training. Identified informal employment training to develop computing and Internet technology skills/knowledge for employment purposes.

Modeling the Use of Computing and Internet Skills section. Identified the individuals study participants observed regularly, consistently using computing, and Internet technology skills/knowledge. Models potentially identified included teachers, family, friends, employers and other individuals.

Preparation to Use Computing and Internet Technologies section. Study participants rated their preparation to use computing and Internet technology skills/knowledge. Rating questions focused on:

- Preparation for personal and professional use.
- Preparation to integrate computing and Internet technology skills/knowledge into the content focus of a specific education major.
- Perceived importance of computing and Internet technology skills/knowledge associated with a specific education major.
- Perceived importance of computing and Internet technology skills/knowledge for the study participant's future students.

The Computing and Internet Skills Learning Experiences survey consisted of 24 items made up of linear, scale and short answer survey items. Linear survey items consisted of multiple choice and multiple response items. Scale survey items consisted of self-rating questions. Short answer survey items consisted of open-ended questions to allow study participants the ability to identify OTHER learning experiences not included on the survey. There were 15 linear test items, two scale items and seven short answer survey items in the Computing and Internet Skills Learning Experiences survey. Data from the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey were used to answer this study objective.

Formal Learning Experiences results for UW-Stout freshmen education majors: Formal exclusively-focused in school. UW-Stout freshmen education majors were asked to identify the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER schooling. A frequency count of YES/NO was used to identify levels of schooling reflective of the survey question. Twenty-three UW-Stout freshmen education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 9.

Table 9

Formal Learning Experiences Results for UW-Stout Freshmen Education Majors: Formal Exclusively-Focused in School

Frequency	Elementary School	Middle School	High School	Post-secondary School	OTHER
Yes/%	8 (34.8%)	12 (52.2%)	13 (56.5%)	6 (26.1%)	0 (0.0%)
No/%	15 (65.2%)	11 (47.8%)	10 (43.5%)	17 (73.9%)	23 (100.0%)
(N = 23)					

Summary of Formal Learning Experiences results for UW-Stout freshmen education majors: Formal exclusively-focused in school. Table 9 (above) shows that UW-Stout freshmen education majors were more likely to have formal exclusively-focused learning experiences in high school (56.5%) and middle school (52.2%). The levels of school where UW-Stout freshmen education majors were least likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge were post-secondary school (26.1%) and elementary school (34.8%). UW-Stout freshmen education majors identified no OTHER levels of schooling.

Formal Learning Experiences results for UW-Stout freshmen education majors: Formally integrated in school. UW-Stout freshmen education majors were asked to identify the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER schooling. A frequency count of YES/NO was used to identify levels of schooling reflective of the survey question. Twenty-three UW-Stout freshmen education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 10.

Table 10

Formal Learning Experiences Results for UW-Stout Freshmen Education Majors: Formally Integrated in School

Frequency	Elementary School	Middle School	High School	Post-secondary School	OTHER
Yes/%	6 (26.1%)	10 (43.5%)	16 (69.6%)	7 (30.4%)	2 (8.7%)
No/%	17 (73.9%)	13 (56.5%)	7 (30.4%)	16 (69.6%)	21 (91.3%)
(*N* = 23)					

Summary of Formal Learning Experiences results for UW-Stout freshmen education majors: Formally integrated in school. Table 10 (above) shows that UW-Stout freshmen education majors were more likely to have formally integrated learning experiences in high school (69.6%) and middle school (43.5%). Levels of school where UW-Stout freshmen education majors were least likely to have formally integrated learning experiences were elementary school (26.1%) and post-secondary school (30.4%). Two UW-Stout freshmen education majors (12.5%) indicated OTHER levels of school where they had formally integrated learning experiences:

- "In most of my business classes such as DECA in high school".
- "Pretty much all my advanced marketing and DECA stuff".

Formal Learning Experiences results for UW-Stout freshmen education majors:

Employment-based formal exclusively-focused training. UW-Stout freshmen education majors were asked to indicate if they experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. A frequency count of YES/NO was used reflective of the survey question. If a YES response was given, the respondent was asked to provide specific details. Twenty-three UW-Stout freshmen education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. One UW-Stout freshmen education major (4.3%) indicated that they experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge:

- "As a manager in a retail company, I was trained on all the computers & there functions in order to train my associates".

Informal Learning Experiences results for UW-Stout freshmen education majors:

Informal self-teaching methods. UW-Stout freshmen education majors were asked to identify the informal self-teaching methods they use to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a knowledgeable person and asking them questions.
- Using the help menu.
- Experimentation.
- Observation of others using computing and Internet technologies.
- OTHER methods.

A frequency count of YES/NO was used to identify self-teaching methods. Twenty-three UW-Stout freshmen education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 11.

Table 11

Informal Learning Experiences Results for UW-Stout Freshmen Education Majors: Informal Self-Teaching Methods

Informal Self Teaching Methods	Frequency Yes	Frequency No
Training Manuals/How-to-Books	2 (8.7%)	21 (93.1%)
Online Tutorials	12 (52.2%)	11 (47.8%)
Video/CD-ROM/DVD Tutorials	6 (26.1%)	17 (73.9%)
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	21 (91.3%)	2 (8.7%)
Using the Help Menu	16 (69.6%)	7 (30.4%)
Experimenting (Trial and Error)	22 (95.7%)	1 (4.3%)
Observing Other People using Computing and Internet Technologies.	19 (82.6%)	4 (17.4%)
OTHER Methods	0 (0.0%)	23 (100.0%)
(N = 23)		

Summary of Informal Learning Experiences results for UW-Stout freshmen education majors: Informal self-teaching methods. Table 11 (above) shows that UW-Stout freshmen education majors were most likely to use the informal self-teaching methods of "experimenting" (95.7%), "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (91.3%) and "observing other people using computing and Internet technologies" (82.6%). UW-Stout freshmen education majors were least likely to use the informal self-teaching methods of "training manuals/how-to books" (8.7%), "video/CD-ROM/DVD tutorials" (26.1%) "online tutorials" (52.2%) and "using the help menu" (69.6%). No OTHER informal self-teaching methods were identified.

Informal Learning Experiences results for UW-Stout freshmen education majors: Employment-based informal training. UW-Stout freshmen education majors were asked to indicate if they experienced employment-based informal training to develop computing and Internet technology skills/knowledge. A frequency count of YES/NO was used reflective of the survey question. If a YES response was given, the respondent was ask to provide specific details. Twenty-three UW-Stout freshmen education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. Five UW-Stout freshmen education majors (21.7%) indicated that they experienced employment-based informal training to develop computing and Internet technology skills/knowledge:

- "Asked for help and they explained."
- "I designed a web page 2 summers ago for a small business."
- "I worked at a bank. It taught me a lot about computers."
- "Online books."
- "Trial and error. Experiment with new programs such as Access and Photoshop."

Study Objective Four

Study objective three identified the learning experiences of UW-Stout senior education majors in relationship to development of computing and Internet technology skills/knowledge using the Computing and Internet Skills Learning Experiences survey. The Computing and Internet Skills Learning Experiences survey consists of four separate sections that included Formal Learning Experiences, Informal Learning Experiences, Modeling the Use of Computing and Internet Skills and Preparation to Use Computing and Internet Technologies.

Formal Learning Experiences section. Identified learning experiences that take place in a setting where someone or some organization other than the individual learner establishes learning outcomes related to the development of computing and Internet technology skills/knowledge.

- Formal exclusively-focused. Identified levels of school where courses/classes exclusively focused to develop computing and Internet technology skills/knowledge.
- Formally integrated. Identified levels of school where courses/classes integrated computing and Internet technology skills/knowledge with curricular content.
- Employment-based formal exclusively-focused training. Identified exclusively focused employment training to develop computing and Internet technology skills/knowledge for employment purposes.

Informal Learning Experiences section. Identified learning experiences that took place in a setting where the individual learner decides the learning outcomes related to the development of computing and Internet technology skills/knowledge.

- Informal self-teaching methods. Identified the ways individuals teach themselves how to use computing and Internet technology skills/knowledge.

- Employment-based informal training. Identified informal employment training to develop computing and Internet technology skills/knowledge for employment purposes.

Modeling the Use of Computing and Internet Skills section. Identified the individuals study participants observed regularly, consistently using computing, and Internet technology skills/knowledge. Models potentially identified included teachers, family, friends, employers and other individuals.

Preparation to Use Computing and Internet Technologies section. Study participants rated their preparation to use computing and Internet technology skills/knowledge. Rating questions focused on:

- Preparation for personal and professional use.
- Preparation to integrate computing and Internet technology skills/knowledge into the content focus of a specific education major.
- Perceived importance of computing and Internet technology skills/knowledge associated with a specific education major.
- Perception of the importance of computing and Internet technology skills/knowledge for the study participant's future students.

The Computing and Internet Skills Learning Experiences survey consisted of 24 items made up of linear, scale and short answer survey items. Linear survey items consisted of multiple choice and multiple response items. Scale survey items consisted of self-rating questions. Short answer survey items consisted of open-ended questions to allow study participants the ability to identify other learning experiences not included on the survey. There were 15 linear test items, two scale items and seven short answer survey items in the Computing and Internet Skills Learning Experiences survey. Data from the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey were used to answer this study objective.

Formal Learning Experiences results for UW-Stout senior education majors: Formal exclusively-focused in school. UW-Stout senior education majors were asked to identify the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER schooling. A frequency count of YES/NO was used to identify levels of schooling reflective of the survey question. Twenty-five UW-Stout senior education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 12.

Table 12

Formal Learning Experiences Results for UW-Stout Senior Education Majors: Formal Exclusively-Focused in School

Frequency	Elementary School	Middle School	High School	Post-secondary School	OTHER
Yes/%	7 (28.0%)	11 (44.0%)	13 (52.0%)	13 (52.0%)	0 (0.0%)
No/%	18 (72.0%)	14 (56.0%)	12 (48.0%)	12 (48.0%)	25 (100.0%)
(*N* = 25)					

Summary of Formal Learning Experiences results for UW-Stout senior education majors: Formal exclusively-focused in school. Table 12 (above) shows that UW-Stout senior education majors were more likely to have formal exclusively-focused learning experiences in high school (52.0%) and post-secondary school (52.0%) to develop computing and Internet technology skills/knowledge. Levels of school where UW-Stout senior education majors were least likely to have to have formal exclusively-focused learning experiences were elementary school (28.0%) and middle school (44.0%). UW-Stout senior education majors identified no OTHER levels of schooling.

Formal Learning Experiences results for UW-Stout senior education majors: Formally integrated in school. UW-Stout senior education majors were asked to identify the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER schooling. A frequency count of YES/NO was used to identify levels of schooling reflective of the survey question. Twenty-five UW-Stout senior education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 13.

Table 13

Formal Learning Experiences Results for UW-Stout Senior Education Majors: Formally Integrated in School

Frequency	Elementary School	Middle School	High School	Post-secondary School	OTHER
Yes/%	9 (36.0%)	15 (60.0%)	20 (80.0%)	23 (92.0%)	3 (12.0%)
No/%	16 (64.0%)	10 (40.0%)	5 (20.0%)	2 (8.0%)	22 (88.0%)
(*N* = 25)					

Summary of Formal Learning Experiences results for UW-Stout senior education majors: Formally integrated in school. Table 13 (above) shows that UW-Stout senior education majors were more likely to have formally integrated learning experiences in post-secondary school (92.0%) and high school (80.0%) to develop computing and Internet technology skills/knowledge. Levels of school where UW-Stout senior education majors were least likely to have formally integrated learning experiences were elementary school (36.0%) and middle school (60.0%). Three UW-Stout senior education majors (12.0%) indicated OTHER levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge.

- "Basic Internet skills have been taught in high school & college but were not specific to that".
- "I've used a lot of this stuff for everything".
- "Military (USAF: 95' to 99')".

Formal Learning Experiences results for UW-Stout senior education majors: Employment-based formal exclusively-focused training. UW-Stout senior education majors were asked to indicate if they experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. A frequency count of YES/NO was used reflective of the survey question. If a YES response was given, the respondent was asked to provide specific details. Twenty-five UW-Stout senior education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. Five UW-Stout senior education majors (20.0%) indicated that they had experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge:

- “Help Desk Training. STAR Student Trainings taught but restricted to only staff at UW-Stout”.
- “I am a peer trainer for Ask5000 on campus”.
- “I have learned several different types of software from internal company software (banking software) to Microsoft Office software such as Outlook”.
- “I sell computers and software at Best Buy. It’s a part of our training”.
- “I work at a computer helpdesk on campus (Ask5000). I’ve had training in nearly all software offered (MS Office, Adobe Products, etc.)”.

Informal Learning Experiences results for UW-Stout senior education majors:

Informal self-teaching methods. UW-Stout senior education majors were asked to identify the informal self-teaching methods they use to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a knowledgeable person and asking them questions.
- Using the help menu.
- Experimentation.
- Observation of others using computing and Internet technologies.
- OTHER methods.

A frequency count of YES/NO was used to identify self-teaching methods. Twenty-five UW-Stout senior education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. The results are shown in Table 14.

Table 14

Informal Learning Experiences Results for UW-Stout Senior Education Majors: Informal Self-Teaching Methods

Informal Self Teaching Methods	Frequency Yes	Frequency No
Training Manuals/How-to-Books	5 (20.0%)	20 (80.0%)
Online Tutorials	19 (76.0%)	6 (24.0%)
Video/CD-ROM/DVD Tutorials	10 (40.0%)	15 (60.0%)
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	23 (92.0%)	2 (8.0%)
Using the Help Menu	20 (80.0%)	5 (20.0%)
Experimenting (Trial and Error)	25 (100.0)	0 (0.0%)
Observing Other People using Computing and Internet Technologies.	20 (80.0%)	5 (20.0%)
OTHER Methods	2 (8.0%)	23 (92.0%)
(*N* = 25)		

Summary of Informal Learning Experiences results for UW-Stout senior education majors: Informal self-teaching methods. Table 14 (above) shows that UW-Stout senior education majors were most likely to use the informal self-teaching methods of "experimenting" (100.0%), "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (92.0%), "observing other people using computing and Internet technologies" (80.0%), "using the help menu" (80.0%) and "online tutorials" (76.0%) to develop computing and Internet technology skills/knowledge. UW-Stout senior education majors were least likely to use the informal self-teaching methods of "training manuals/how-to books" (20.0%) and "video/CD-ROM/DVD tutorials" (40.0%). Two UW-Stout senior education majors (8.0%) indicated using OTHER informal self-teaching methods to develop computing and Internet technology skills/knowledge.

- "Explanation not given".
- "Web forums can be used to learn how to fix most things".

Informal Learning Experiences results for UW-Stout senior education majors: Employment-based informal training. UW-Stout senior education majors were asked to indicate if they experienced employment-based informal training to develop computing and Internet technology skills/knowledge. A frequency count of YES/NO was used reflective of the survey question. If a YES response was given, the respondent was ask to provide specific details. Twenty-five UW-Stout senior education majors completed this portion of the Computing and Internet Skills Learning Experiences survey. Sixteen UW-Stout senior education majors (64.0%) indicated that they had experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The responses provided by the UW-Stout senior education majors were categorized and further analyzed. A frequency count was created based on the categories. The results are shown in Table 15.

Table 15

Informal Learning Experiences Results for UW-Stout Senior Education Majors: Employment-Based Informal Training

Employment-Based Informal Training Category	Frequency	Informal Training Experience
Trial and Error	7 (28.0%)	• "All experimentation (trial and error)". • "By informal instruction and trial & error". • "I do a lot of data entry so I experiment a lot"! • "I'm always messing around with something". • "There is much trial and error at Ask5000. We seek others as well as look online for solutions to computer issues". • "Trial and Error". • "We had to punch in orders using a computer--Trial & Error when the system froze".
Social Interactions	5 (20.0%)	• "At the computer helpdesk (Ask 5000). I learn a lot by users coming in with problems, co-workers, and Google or technology forums online". • "I had to learn how to use a website to order food for work. My boss gave me a quick overview, but I taught myself". • "I've learned to use the Stout Blue Drive with help from someone at work". • "We get to play with the latest technology to see what we like or dislike". • "Working with others to solve common hardware/software issues".
OTHER	4 (16.0%)	• "Charter Communications". • "Clerical work on different forms & templates in Word. As well as a mail merge". • "I used web design software I was unfamiliar with". • "No explanation given".
NO Answer	9 (36.0%)	
(N = 25)		

Summary of Informal Learning Experiences results for UW-Stout senior education majors: Employment-based informal training. Table 15 (above) shows that UW-Stout senior education majors were most likely to experience employment-based informal training reflective of trial and error (28.0%) followed by social interactions (20.0%) and OTHER methods (16.0%).

Study Objective Five

Study objective five compared the measured computing and Internet technology skills/knowledge of UW-Stout freshmen and UW-Stout senior education majors. Data from the IC³® Exam was used to answer this study objective. Twenty-three freshmen education majors and 25 senior education majors completed the IC³® Exam (N = 48). The Mann-Whitney U test and the Chi-Square test of independence were used to compare the measured computing and Internet technology skills/knowledge. The significance level used for both the Mann-Whitney U test and the Chi-Square test of independence was five percent (.05%).

Comparison of Key Applications test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was used to compare Key Applications test results for UW-Stout freshmen and senior education majors. The Key Applications test skill sets compared were Common Program Functions, Spreadsheet Functions, Word Processing Functions and Presentation Functions. The results of the comparison are found in Table 16.

Table 16

Comparison of Key Applications Test Results for UW-Stout Freshmen and Senior Education Majors (Mann-Whitney U Test)

Key Applications Test Skill Sets	Group	*N*	Mean Rank	Sum of Ranks	*U*	*Z*	Asymp. Sig. (2-tailed)
Common Program Functions	Freshmen	23	18.96	436.00	160.000	-2.640	.008
	Senior	25	29.60	740.00			
Spreadsheet Functions	Freshmen	23	16.96	390.00	114.000	-3.610	.000
	Senior	25	31.44	786.00			
Word Processing Functions	Freshmen	23	19.72	453.50	177.500	-2.299	.022
	Senior	25	28.90	722.50			
Presentation Functions	Freshmen	23	15.93	366.50	90.500	-4.164	.000
	Senior	25	32.38	809.50			

Summary of comparison of Key Applications test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was calculated examining the Common Program Functions skill set scores for UW-Stout freshmen and senior education majors. Table 16 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 18.96) at a statistically significant level on the Common Program Functions skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 29.60; U = 160.000, Z = -2.640, p = .008).

A Mann-Whitney U test was calculated examining the Spreadsheet Functions skill set scores for UW-Stout freshmen and senior education majors. Table 16 (above) shows that UW-

Stout freshmen education majors performed poorer (*MEAN RANK* = 16.96) at a statistically significant level on the Spreadsheet Functions skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 31.44; *U* = 114.000, *Z* = - 3.610, *p* = .000).

A Mann-Whitney U test was calculated examining the Word Processing Functions skill set scores for UW-Stout freshmen and senior education majors. Table 16 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 19.72) at a statistically significant level on the Word Processing Functions skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 28.90; *U* = 177.500, *Z* = - 2.299, *p* = .022).

A Mann-Whitney U test was calculated examining the Presentation Functions skill set scores for UW-Stout freshmen and senior education majors. Table 16 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 15.93) at a statistically significant level on the Presentation Functions skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 32.38; *U* = 90.500, *Z* = - 4.164, *p* = .000).

Comparison of Living Online test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was used to compare Living Online test results for UW-Stout freshmen and senior education majors. The Living Online test skill sets compared were Computers and Society, Electronic Mail, Internet and Networks. The results of the comparison are found in Table 17.

Table 17

Comparison of Living Online Test Results for UW-Stout Freshmen and Senior Education Majors (Mann-Whitney U Test)

Living Online Test Skill Sets	Group	*N*	Mean Rank	Sum of Ranks	*U*	*Z*	Asymp. Sig. (2-tailed)
Computers and Society	Freshmen	23	19.46	447.50	171.500	-2.428	.015
	Senior	25	29.14	728.50			
Electronic Mail	Freshmen	23	17.74	408.00	132.000	-3.270	.001
	Senior	25	30.72	768.00			
Internet	Freshmen	23	16.54	380.50	104.500	-3.831	.000
	Senior	25	31.82	795.50			
Networks	Freshmen	23	18.54	426.50	150.500	-2.894	.004
	Senior	25	29.98	749.50			

Summary of comparison of Living Online test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was calculated examining the Computers and Society skill set scores for UW-Stout freshmen and senior education majors. Table 17 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 19.46) at a statistically significant level on the Computers and Society skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 29.14; $U = 171.500$, $Z = -2.428$, $p = .015$).

A Mann-Whitney U test was calculated examining the Electronic Mail skill set scores for UW-Stout freshmen and senior education majors. Table 17 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 17.74) at a statistically significant level on the Electronic Mail skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 30.72; *U* = 132.000, *Z* = -3.270, *p* = .001).

A Mann-Whitney U test was calculated examining the Internet skill set scores for UW-Stout freshmen and senior education majors. Table 17 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 16.54) at a statistically significant level on the Internet skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 31.82; *U* = 104.500, *Z* = - 3.831, *p* = .000).

A Mann-Whitney U test was calculated examining the Networks skill set scores for UW-Stout freshmen and senior education majors. Table 17 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 18.54) at a statistically significant level on the Networks skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 29.98; *U* = 150.500, *Z* = - 2.894, *p* = .004).

Comparison of Computing Fundamentals test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was used to compare Computing Fundamentals test results for UW-Stout freshmen and senior education majors. The Computing Fundamentals test skill sets compared were Computer Hardware, Computer Software and Operating Systems. The results of the comparison are found in Table 18.

Table 18

Comparison of Computing Fundamentals Test Results for UW-Stout Freshmen and Senior Education Majors (Mann-Whitney U Test)

Computing Fundamentals Test Skill Sets	Group	*N*	Mean Rank	Sum of Ranks	*U*	*Z*	Asymp. Sig. (2-tailed)
Computer Hardware	Freshmen	23	17.80	409.50	133.500	-3.193	.001
	Senior	25	30.66	766.50			
Computer Software	Freshmen	23	20.91	481.00	205.000	-1.744	.081
	Senior	25	27.80	695.00			
Operating Systems	Freshmen	23	19.52	449.00	173.000	-2.377	.017
	Senior	25	29.08	727.00			

Summary of comparison of Computing Fundamentals test results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was calculated examining the Computer Hardware skill set scores for UW-Stout freshmen and senior education majors. Table 18 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 17.80) at a statistically significant level on the Computer Hardware skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 30.66; $U = 133.500$, $Z = -3.193$, $p = .001$).

A Mann-Whitney U test was calculated examining the Computer Software skill set scores for UW-Stout freshmen and senior education majors. Table 18 (above) shows that no significant difference in the results were found ($U = 205.000$, $Z = -1.744$, $p = .081$). UW-Stout freshmen education majors averaged a mean rank of 20.91 on the Computer Software skill set, while the UW-Stout senior education majors averaged a mean rank 27.80.

A Mann-Whitney U test was calculated examining the Operating Systems skill set scores for UW-Stout freshmen and senior education majors. Table 18 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 19.52) at a statistically significant level on the Operating Systems skill set as compared to UW-Stout senior education majors (*MEAN RANK* = 29.08; *U* = 173.000, *Z* = - 2.377, *p* = .017).

Comparison of IC³® Exam tests composite results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was used to compare the composite scores for each of the tests that make up the IC³® Exam for UW-Stout freshmen and senior education majors. The three tests are Key Applications, Living Online and Computing Fundamentals. The results of the comparison are found in Table 19.

Table 19

Comparison of IC³® Exam Tests Composite Results for UW-Stout Freshmen and Senior Education Majors (Mann-Whitney U Test)

IC³® Exam Tests	Group	*N*	Mean Rank	Sum of Ranks	*U*	*Z*	Asymp. Sig. (2-tailed)
Key Applications	Freshmen	23	17.33	398.50	122.500	-3.409	.001
	Senior	25	31.10	777.50			
Living Online	Freshmen	23	16.09	370.00	94.000	-4.003	.000
	Senior	25	32.24	806.00			
Computing Fundamentals	Freshmen	23	17.91	412.00	136.000	- 3.131	.002
	Senior	25	30.56	764.00			

Summary of comparison of IC³® Exam tests composite results for UW-Stout freshmen and senior education majors. A Mann-Whitney U test was calculated examining the Key Applications test composite scores for UW-Stout freshmen and senior education majors. Table 19 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN* RANK = 17.33) at a statistically significant level on the Key Applications test as compared to UW-Stout senior education majors (*MEAN RANK* = 31.10; U = 122.500, Z = - 3.409, p = .001).

A Mann-Whitney U test was calculated examining the Living Online test composite scores for UW-Stout freshmen and senior education majors. Table 19 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 16.09) at a statistically significant level on the Living Online test as compared to UW-Stout senior education majors (*MEAN RANK* = 32.24; U = 94.000, Z = - 4.003, p = .000).

A Mann-Whitney U test was calculated examining the Computing Fundamentals test composite scores for UW-Stout freshmen and senior education majors. Table 19 (above) shows that UW-Stout freshmen education majors performed poorer (*MEAN RANK* = 17.91) at a statistically significant level on the Computing Fundamentals test as compared to UW-Stout senior education majors (*MEAN RANK* = 30.56; U = 136.000, Z = - 3.131, p = .002).

Comparison of UW-Stout freshmen and senior education majors earning IC³® Certification. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who earned IC³® Certification by passing all three tests that make up the IC³® Exam. The results of the comparison are found in Table 20.

Table 20

Comparison of UW-Stout Freshmen and Senior Education Majors Earning IC³® Certification (Chi-Square Test of Independence)

IC³® Exam Tests	Group	*N*	Passed Test/Passed IC³® Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Key Applications	Freshmen	23	6 (26.1%)	5.598	1	.018
	Seniors	25	15 (60.0%)			
Living Online	Freshmen	23	6 (26.1%)	6.936	1	.008
	Seniors	25	16 (64.0%)			
Computing Fundamentals	Freshmen	23	4 (17.4%)	9.094	1	.003
	Seniors	25	15 (60.0%)			
Earned IC³® Certification	Freshmen	23	4 (17.4%)	5.050	1	.025
	Seniors	25	12 (48.0%)			

Summary of comparison of UW-Stout freshmen and senior education majors earning IC³® Certification. A Chi-Square test of independence was calculated comparing the frequency of UW-Stout freshmen and senior education majors who passed the Key Applications test. Table 20 (above) shows a significant interaction was found (χ^2 (1) =5.598, p =.018). UW-Stout senior education majors were more likely to pass the Key Applications test (60.0%) than were freshmen education majors (26.1%).

A Chi-Square test of independence was calculated comparing the frequency of UW-Stout freshmen and senior education majors who passed the Living Online test. Table 4.20 (above) shows a significant interaction was found (χ^2 (1) =6.936, p =.008). UW-Stout senior education majors were more likely to pass the Living Online test (64.0%) than were freshmen education majors (26.1%).

A Chi-Square test of independence was calculated comparing the frequency of UW-Stout freshmen and senior education majors who passed the Computing Fundamentals test. Table 20 (above) shows a significant interaction was found (χ^2 (1) =9.094, p =.003). UW-Stout senior education majors were more likely to pass the Computing Fundamentals test (60.0%) than were freshmen education majors (17.4%).

A Chi-Square test of independence was calculated comparing the frequency of UW-Stout freshmen and senior education majors who earned IC^3® Certification. Table 20 (above) shows a significant interaction was found (χ^2 (1) =5.050, p =.025). UW-Stout senior education majors were more likely to earn IC^3® Certification (48.0%) than were freshmen education majors (17.4%).

Study Objective Six

Study objective six compared the identified learning experiences of UW-Stout freshmen education majors and UW-Stout senior education majors associated with the development of computing and Internet technology skills/knowledge. Data from the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey were used to answer this study objective. Twenty-three freshmen education majors and 25 senior education majors completed the Formal Learning Experiences and Informal Learning Experiences sections of the Computing and Internet Skills Learning Experiences survey (N = 48). The Chi-Square test of independence was used to compare the identified learning experiences of UW-Stout freshmen and senior education majors related to the computing and Internet technology skills/knowledge. The significance level used for the Chi-Square test of independence was five percent (.05%).

Comparison of Formal Learning Experiences results for UW-Stout freshmen and senior education majors: Formal exclusively-focused in school. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 21.

Table 21

Comparison of Formal Learning Experiences Results for UW-Stout Freshmen and Senior Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	Freshmen	23	8 (34.8%)	.257	1	.613
	Seniors	25	7 (28.0%)			
Middle School	Freshmen	23	12 (52.2%)	.321	1	.571
	Seniors	25	11 (44.0%)			
High School	Freshmen	23	13 (56.5%)	.099	1	.753
	Seniors	25	13 (52.0%)			
Post-secondary School	Freshmen	23	6 (26.1%)	3.364	1	.067
	Seniors	25	13 (52.0%)			
OTHER	Freshmen	23	0 (100.0%)	--	--	*Constant*
	Seniors	25	0 (100.0%)			

Summary of comparison of Formal Learning Experiences results for UW-Stout freshmen and senior education majors: Formal exclusively-focused in school. Table 21 (above) shows that no significant relationship was found for elementary school (χ^2 (1) =.257, p =.613). UW-Stout freshmen education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (34.8%) than were UW-Stout senior education majors (28.0%).

Table 21 (above) shows that no significant relationship was found for middle school (χ^2 (1) =.321, p =.571). UW-Stout freshmen education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (52.2%) than were UW-Stout senior education majors (44.0%).

Table 21 (above) shows that no significant relationship was found for high school (χ^2 (1) =.099, p =.753). UW-Stout freshmen education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (56.5%) than were UW-Stout senior education majors (52.0%).

Table 21 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) =3.364, p =.067). UW-Stout freshmen education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (26.1%) than were UW-Stout senior education majors (52.0%).

Table 21 (above) shows that UW-Stout freshmen and senior education majors did not identify OTHER levels of school where they experienced formal exclusively-focused learning to develop computing and Internet technology skills/knowledge.

Comparison of Formal Learning Experiences results for UW-Stout freshmen and senior education majors: Formally integrated in school. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 22.

Table 22

Comparison of Formal Learning Experiences Results for UW-Stout Freshmen and Senior Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	Freshmen	23	6 (26.1%)	.548	1	.459
	Seniors	25	9 (36.0%)			
Middle School	Freshmen	23	10 (43.5%)	1.310	1	.252
	Seniors	25	15 (60.0%)			
High School	Freshmen	23	16 (69.6%)	.696	1	.404
	Seniors	25	20 (80.0%)			
Post-secondary School	Freshmen	23	7 (30.4%)	19.373	1	.000
	Seniors	25	23 (92.0%)			
OTHER	Freshmen	23	2 (8.7%)	.140	1	.708
	Seniors	25	3 (12.0%)			

Summary of comparison of Formal Learning Experiences results for UW-Stout freshmen and senior education majors: Formally integrated in school. Table 22 (above) shows that no significant relationship was found for elementary school (χ^2 (1) =.548, p = .459). UW-Stout freshmen education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (26.1%) than were UW-Stout senior education majors (36.0%).

Table 22 (above) shows that no significant relationship was found for middle school (χ^2 (1) =1.310, p = .252). UW-Stout freshmen education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (43.5%) than were UW-Stout senior education majors (60.0%).

Table 22 (above) shows that no significant relationship was found for high school (χ^2 (1) =.696, p = .404). UW-Stout freshmen education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (69.6%) than were UW-Stout senior education majors (80.0%).

Table 22 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) =19.373, p =.000). UW-Stout freshmen education majors were less likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (30.4%) than were UW-Stout senior education majors (92.0%).

Table 22 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) =.140, p =.708). UW-Stout freshmen education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (8.7%) than were UW-Stout senior education majors (12.0%). View the OTHER levels of school items identified by UW-Stout freshmen education majors in study objective three results and by UW-Stout senior education majors in study objective four results.

Comparison of Formal Learning Experiences results for UW-Stout freshmen and senior education majors: Employment-based formal exclusively-focused training. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. One UW-Stout freshman education major and five UW-Stout senior education majors provided a response for this survey question. No significant relationship was found (χ^2 (1) =2.683, p =.101). UW-Stout freshmen education majors (4.3%) were no more likely to experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge than were UW-Stout senior education majors (20.0%). No further comparative analysis was conducted on this survey item. UW-Stout freshmen and senior education majors did not identify a sufficient number of explanations to categorize and analyze with the Chi-Square test of independence. Please view explanations provided by UW-Stout freshmen education majors in study objective three results and UW-Stout senior education majors in study objective four results identifying employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge.

Comparison of Informal Learning Experiences results for UW-Stout freshmen and senior education majors: Informal self-teaching methods. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who identified using informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 23.

Table 23

Comparison of Informal Learning Experiences Results for UW-Stout Freshmen and Senior Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	Freshmen	23	2 (8.7%)	1.229	1	.268
	Seniors	25	5 (20.0%)			
Online Tutorials	Freshmen	23	12 (52.2%)	2.973	1	.085
	Seniors	25	19 (76.0%)			
Video/CD-ROM/DVD Tutorials	Freshmen	23	6 (26.1%)	1.043	1	.307
	Seniors	25	10 (40.0%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	Freshmen	23	21 (91.3%)	.008	1	.931
	Seniors	25	23 (92.0%)			
Using the Help Menu	Freshmen	23	16 (69.6%)	.696	1	.404
	Seniors	25	20 (80.0%)			
Experimenting (Trial and Error)	Freshmen	23	22 (95.7%)	1.110	1	.292
	Seniors	25	25 (100.0%)			
Observing Other People using Computing and Internet Technologies.	Freshmen	23	19 (82.6%)	.054	1	.817
	Seniors	25	20 (80.0%)			
OTHER Methods	Freshmen	23	0 (0.0%)	1.920	1	.166
	Seniors	25	2 (8.0%)			

Summary of comparison of Informal Learning Experiences results for UW-Stout freshmen and senior education majors: Informal self-teaching methods. Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "training manuals/how-to books" (χ^2 (1) =1.229, p = .268). UW-Stout freshmen education majors were no more likely to use "training manuals/how-to books" to teach themselves computing and Internet technology skills/knowledge (8.7%) than were UW-Stout senior education majors (20.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "online tutorials" (χ^2 (1) =2.973, p = .085). UW-Stout freshmen education majors were no more likely to use "online tutorials" to teach themselves computing and Internet technology skills/knowledge (52.2%) than were UW-Stout senior education majors (76.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "video/CD-ROM/DVD tutorials" (χ^2 (1) =1.043, p = .307). UW-Stout freshmen education majors were no more likely to use "video/CD-ROM/DVD tutorials" to teach themselves computing and Internet technology skills/knowledge (26.1%) than were UW-Stout senior education majors (40.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (χ^2 (1) =.008, p = .931). UW-Stout freshmen education majors were no more likely to use "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" to teach themselves computing and Internet technology skills/knowledge (91.3%) than were UW-Stout senior education majors (92.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "using the help menu" (χ^2 (1) =.696, p = .404). UW-Stout freshmen education majors were no more likely to use "using the help menu" to teach themselves computing and

Internet technology skills/knowledge (69.6%) than were UW-Stout senior education majors (80.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "experimenting" (χ^2 (1) =1.110, p = .292). UW-Stout freshmen education majors were no more likely to use "experimenting" to teach themselves computing and Internet technology skills/knowledge (95.7%) than were UW-Stout senior education majors (100.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "observing other people using computing and Internet technologies" (χ^2 (1) =.054, p = .817). UW-Stout freshmen education majors were no more likely to use "observing other people using computing and Internet technologies" to teach themselves computing and Internet technology skills/knowledge (82.6%) than were UW-Stout senior education majors (80.0%).

Table 23 (above) shows that no significant relationship was found for the informal self-teaching method "OTHER methods" (χ^2 (1) =1.920, p = .166). UW-Stout freshmen education majors were no more likely to use "OTHER methods" to teach themselves computing and Internet technology skills/knowledge (0.0%) than were UW-Stout senior education majors (8.0%). No further comparative analysis was conducted on this survey item. UW-Stout freshmen and senior education majors did not identify a sufficient number of OTHER informal self-teaching methods to categorize and analyze with the Chi-Square test of independence. Please view OTHER informal self-teaching methods to develop computing and Internet technology skills/knowledge identified by UW-Stout freshmen in study objective three results and UW-Stout senior education majors in study objective four results.

Comparison of Informal Learning Experiences results for UW-Stout freshmen and senior education majors: Employment-based informal training. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout freshmen and senior education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. With a YES answer for the lead survey item, UW-Stout freshmen and senior education majors identified the employment-based informal training they experienced. From the identified employment-based informal training methods, categories were formed and the identified employment-based informal training methods were analyzed. The categories of employment-based informal training methods to develop computing and Internet technology skills/knowledge were:

- Trial and error.
- Social interactions.
- Employment activities.
- OTHER informal training experiences.

See the specific informal employment training methods explanations given by UW-Stout freshmen education majors in study objective three results and UW-Stout senior education majors study objective four results. The results of the comparison are found in Table 24.

Table 24

Comparison of Informal Learning Experiences Results for UW-Stout Freshmen and Senior Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)

Employment-based Training Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Overall Response to the Lead YES/NO Survey Item.	Freshmen	23	5 (21.7%)	8.694	1	.003
	Seniors	25	16 (64.0%)			
Trial and Error	Freshmen	23	1 (4.3%)	4.825	1	.028
	Seniors	25	7 (28.0%)			
Social Interactions	Freshmen	23	1 (4.3%)	2.683	1	.101
	Seniors	25	5 (20.0%)			
Employment Activities	Freshmen	23	2 (8.7%)	.451	1	.502
	Seniors	25	1 (4.0%)			
OTHER Informal Learning Experiences	Freshmen	23	1 (4.3%)	.918	1	.338
	Seniors	25	3 (12.0%)			

Summary of comparison of Informal Learning Experiences results for UW-Stout freshmen and senior education majors: Employment-based informal training. Table 24 (above) shows that a significant relationship was found (χ^2 (1) =8.964, p =.003) for the overall response to the lead YES/NO survey item, "In my place of employment (past or present), I developed computing and Internet skills through informal learning experiences". UW-Stout senior education majors were more likely to develop computing and Internet technology skills/knowledge through employment-based informal training methods (64.0%) than were UW-Stout freshmen education majors (21.7%).

Table 24 (above) shows that a significant relationship was found (χ^2 (1) =4.825, p = .028) for the employment-based informal training method category of "trial and error". UW-Stout senior education majors were more likely to develop computing and Internet technology skills/knowledge through "trial and error" (28.0%) than were UW-Stout freshmen education majors (4.3%).

Table 24 (above) shows that no significant relationship was found (χ^2 (1) =2.683, p = .101) for the employment-based informal training method category of "social interactions". UW-Stout freshmen education majors were no more likely to develop computing and Internet technology skills/knowledge through "social interactions" (4.3%) than were UW-Stout senior education majors (20.0%).

Table 24 (above) shows that no significant relationship was found (χ^2 (1) =.451, p = .502) for the employment-based informal training method category of "employment activities". UW-Stout freshmen education majors were no more likely to develop computing and Internet technology skills/knowledge through "employment activities" (8.7%) than were UW-Stout senior education majors (4.0%).

Table 24 (above) shows that no significant relationship was found (χ^2 (1) =.918, p = .338) for the employment-based informal training method category of "OTHER informal learning experiences". UW-Stout freshmen education majors were no more likely to develop computing and Internet technology skills/knowledge through "OTHER informal learning experiences" (4.3%) than were UW-Stout senior education majors (12.0%).

Notable Undergraduate Education Degree Program Comparisons

Statistical analyses were performed upon notable undergraduate degree program groupings. Data used to described and compare the notable undergraduate degree program groupings included IC³® Exam results, identified Formal Learning Experiences and identified Informal Learning Experiences.

Notable undergraduate degree program groupings for UW-Stout freshmen education majors included Marketing and Business Education (MBE) compared to OTHER freshmen education majors, Early Childhood Education (ECE) compared to OTHER freshmen education majors, Marketing and Business Education compared to Early Childhood Education and Marketing and Business Education, Early Childhood Education and OTHER freshmen education majors compared.

Notable undergraduate degree program groupings for UW-Stout senior education majors included Marketing and Business Education compared to OTHER senior education majors, Technology Education (TE) compared to OTHER senior education majors, Marketing and Business Education compared to Technology Education and Marketing and Business Education, Technology Education and OTHER senior education majors compared.

Notable UW-Stout freshmen education major groupings: Marketing and Business Education compared to OTHER freshmen education majors. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who earned IC³® Certification. The results of the comparison are found in Table 25.

Table 25

Comparison of UW-Stout Freshmen Marketing and Business Education Majors and OTHER UW-Stout Freshmen Education Majors Who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exam	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	MBE	9	3 (33.3%)	2.616	1	.106
	OTHER	14	1 (7.1%)			

Table 25 (above) shows a non-significant interaction was found (χ^2 (1) = 2.616, p = .106). UW-Stout Freshmen Marketing and Business Education majors were no more likely to earn IC³® Certification (33.3%) than were OTHER UW-Stout freshmen education majors (7.1%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 26.

Table 26

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education and OTHER UW-Stout Freshmen Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	4 (44.4%)	.608	1	.435
	OTHER	14	4 (28.6%)			
Middle School	MBE	9	5 (55.6%)	.068	1	.795
	OTHER	14	7 (50.0%)			
High School	MBE	9	6 (66.7%)	.619	1	.431
	OTHER	14	7 (50.0%)			
Post-secondary School	MBE	9	6 (66.7%)	12.627	1	.000
	OTHER	14	0 (0.0%)			
OTHER	MBE	9	0 (100.0%)	--	--	*Constant*
	OTHER	14	0 (100.0%)			

Table 26 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .608, p = .435). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (44.4%) than were OTHER UW-Stout freshmen education majors (28.6%).

Table 26 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .068, p = .795). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were OTHER UW-Stout freshmen education majors (50.0%).

Table 26 (above) shows that no significant relationship was found for high school (χ^2 (1) = .619, p = .431). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (66.7%) than were OTHER UW-Stout freshmen education majors (50.0%).

Table 26 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) = 12.627, p = .000). UW-Stout Freshmen Marketing and Business Education majors were more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge (66.7%) than were OTHER UW-Stout freshmen education majors (0.0%).

Table 26 (above) shows that UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors did not identify OTHER levels of school where they had formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of

school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 27.

Table 27

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education and OTHER UW-Stout Freshmen Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	1 (11.1%)	1.720	1	.190
	OTHER	14	5 (35.7%)			
Middle School	MBE	9	2 (22.2%)	2.718	1	.099
	OTHER	14	8 (57.1%)			
High School	MBE	9	6 (66.7%)	.059	1	.809
	OTHER	14	10 (71.4%)			
Post-secondary School	MBE	9	3 (33.3%)	.059	1	.809
	OTHER	14	4 (28.6%)			
OTHER	MBE	9	1 (11.1%)	.109	1	.742
	OTHER	14	1 (7.1%)			

Table 27 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = 1.720, p = .190). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (11.1%) than were OTHER UW-Stout freshmen education majors (35.7%).

Table 27 (above) shows that no significant relationship was found for middle school (χ^2 (1) = 2.718, p = .099). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (22.2%) than were OTHER UW-Stout freshmen education majors (57.1%).

Table 27 (above) shows that no significant relationship was found for high school (χ^2 (1) = .059, p = .809). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (66.7%) than were OTHER UW-Stout freshmen education majors (71.4%).

Table 27 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) = .059, p = .809). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (33.3%) than were OTHER UW-Stout freshmen education majors (28.6%).

Table 27 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) = .109, p = .742). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (11.1%) than were OTHER UW-Stout freshmen education majors (7.1%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who used informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 28.

Table 28

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education and OTHER UW-Stout Freshmen Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	MBE	9	0 (0.0%)	1.408	1	.235
	OTHER	14	2 (14.3%)			
Online Tutorials	MBE	9	3 (33.3%)	2.103	1	.147
	OTHER	14	9 (64.3%)			
Video/CD-ROM/DVD Tutorials	MBE	9	3 (33.3%)	.403	1	.526
	OTHER	14	3 (21.4%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	MBE	9	8 (88.9%)	.109	1	.742
	OTHER	14	13 (92.9%)			
Using the Help Menu	MBE	9	6 (66.7%)	.059	1	.809
	OTHER	14	10 (71.4%)			
Experimenting (Trial and Error)	MBE	9	8 (88.9%)	1.626	1	.202
	OTHER	14	14 (100.0%)			
Observing Other People using Computing and Internet Technologies.	MBE	9	7 (77.8%)	.240	1	.624
	OTHER	14	12 (85.7%)			
OTHER Methods	MBE	9	0 (0.0%)	--	--	*Constant*
	OTHER	14	0 (0.0%)			

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “training manuals/how-to books” (χ^2 (1) = 1.408, p = .235). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “training manuals/how-to books” to teach themselves computing and Internet technology skills/knowledge (0.0%) than were OTHER UW-Stout freshmen education majors (14.3%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “online tutorials” (χ^2 (1) = 2.103, p = .147). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “online tutorials” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were OTHER UW-Stout freshmen education majors (64.3%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “video/CD-ROM/DVD tutorials” (χ^2 (1) = .403, p = .526). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “video/CD-ROM/DVD tutorials” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were OTHER UW-Stout freshmen education majors (21.4%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (χ^2 (1) = .109, p = .742). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were OTHER UW-Stout freshmen education majors (92.9%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “using the help menu” (χ^2 (1) = .059, *p* = .809). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “using the help menu” to teach themselves computing and Internet technology skills/knowledge (66.7%) than were OTHER UW-Stout freshmen education majors (71.4%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “experimenting” (χ^2 (1) = 1.626, *p* = .202). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “experimenting” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were OTHER UW-Stout freshmen education majors (100.0%).

Table 28 (above) shows that no significant relationship was found for the informal self-teaching method “observing other people using computing and Internet technologies” (χ^2 (1) = .240, *p* = .624). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “observing other people using computing and Internet technologies” to teach themselves computing and Internet technology skills/knowledge (77.8%) than were OTHER UW-Stout freshmen education majors (85.7%).

Table 28 (above) shows that UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors did not identify OTHER informal self-teaching methods to teach themselves computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 29.

Table 29

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education and OTHER *UW-Stout Freshmen Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)*

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	0 (0.0%)	.672	1	.412
OTHER	14	1 (7.1%)			

Table 29 (above) shows that no significant relationship was found was found ($\chi^2(1) = .672$, $p = .412$). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge (0.0%) than were OTHER UW-Stout freshmen education majors (7.1%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and OTHER UW-Stout freshmen education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 30.

Table 30

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education and OTHER UW-Stout Freshmen Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	4 (44.4%)	4.480	1	.034
OTHER	14	1 (7.1%)			

Table 30 (above) shows that a significant relationship was found was found (χ^2 (1) = 4.480, p = .034). UW-Stout Freshmen Marketing and Business Education majors were more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (44.4%) than were OTHER UW-Stout freshmen education majors (7.1%).

Notable UW-Stout freshmen education major groupings: Early Childhood Education compared to OTHER freshmen education majors. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who earned IC³® Certification. The results of the comparison are found in Table 31.

Table 31

Comparison of UW-Stout Freshmen Early Childhood Education Majors and OTHER UW-Stout Freshmen Education Majors who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exam	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	ECE	8	0 (0.0%)	2.582	1	.108
	OTHER	15	4 (26.7%)			

Table 31 (above) shows a non-significant interaction was found (χ^2 (1) = 2.582, p = .108). UW-Stout Freshmen Early Childhood Education majors were no more likely to earn IC³® Certification (0.0%) than were OTHER UW-Stout freshmen education majors (26.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 32.

Table 32

Comparison of Formal Learning Experiences Survey Results for UW-Stout Early Childhood Education and OTHER UW-Stout Freshmen Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	N	Frequency of Experience (YES Response)	χ^2	df	Asymp.Sig. (2-sided) (p)
Elementary School	ECE	8	2 (25.0%)	.518	1	.472
	OTHER	15	6 (40.0%)			
Middle School	ECE	8	4 (50.0%)	.023	1	.879
	OTHER	15	8 (53.3%)			
High School	ECE	8	4 (50.0%)	.212	1	.645
	OTHER	15	9 (60.0%)			
Post-secondary School	ECE	8	0 (0.0%)	4.329	1	.037
	OTHER	15	6 (40.0%)			
OTHER	ECE	8	0 (100.0%)	--	--	*Constant*
	OTHER	15	0 (100.0%)			

Table 32 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .518, p = .472). UW-Stout Freshmen Early Childhood Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (25.0%) than were OTHER UW-Stout freshmen education majors (40.0%).

Table 32 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .023, p = .879). UW-Stout Freshmen Early Childhood Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (50.0%) than were OTHER UW-Stout freshmen education majors (53.3%).

Table 32 (above) shows that no significant relationship was found for high school (χ^2 (1) = .212, p = .645). UW-Stout Freshmen Early Childhood Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (50.0%) than were OTHER UW-Stout freshmen education majors (60.0%).

Table 32 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) = 4.329, p = .037). UW-Stout Freshmen Early Childhood Education majors were less likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (0.0%) than were OTHER UW-Stout freshmen education majors (40.0%).

Table 32 (above) shows that UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors did not identify OTHER levels of school where they experienced formal exclusively-focused learning to develop computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of

school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 33.

Table 33

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Early Childhood Education and OTHER UW-Stout Freshmen Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	ECE	8	2 (25.0%)	.008	1	.931
	OTHER	15	4 (26.7%)			
Middle School	ECE	8	3 (37.5%)	.178	1	.673
	OTHER	15	7 (46.7%)			
High School	ECE	8	5 (62.5%)	.289	1	.591
	OTHER	15	11 (73.3%)			
Post-secondary School	ECE	8	1 (12.5%)	1.864	1	.172
	OTHER	15	6 (40.0%)			
OTHER	ECE	8	0 (0.0%)	1.168	1	.280
	OTHER	15	2 (13.3%)			

Table 33 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .008, p = .931). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (25.0%) than were OTHER UW-Stout freshmen education majors (26.7%).

Table 33 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .178, p = .673). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (37.5%) than were OTHER UW-Stout freshmen education majors (46.7%).

Table 33 (above) shows that no significant relationship was found for high school (χ^2 (1) = .289, p = .591). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (62.5%) than were OTHER UW-Stout freshmen education majors (73.3%).

Table 33 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) = 1.864, p = .172). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (12.5%) than were OTHER UW-Stout freshmen education majors (40.0%).

Table 33 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) = 1.168, p = .280). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (0.0%) than were OTHER UW-Stout freshmen education majors (13.3%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who use informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 34.

Table 34

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Early Childhood Education and OTHER UW-Stout Freshmen Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	ECE	8	1 (12.5%)	.224	1	.636
	OTHER	15	1 (6.7%)			
Online Tutorials	ECE	8	7 (87.5%)	6.135	1	.013
	OTHER	15	5 (33.3%)			
Video/CD-ROM/DVD Tutorials	ECE	8	1 (12.5%)	1.174	1	.278
	OTHER	15	5 (33.3%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	ECE	8	8 (100.0%)	1.168	1	.280
	OTHER	15	13 (86.7%)			
Using the Help Menu	ECE	8	7 (87.5%)	1.864	1	.172
	OTHER	15	9 (60.0%)			
Experimenting (Trial and Error)	ECE	8	8 (100.0%)	.558	1	.455
	OTHER	15	14 (93.3%)			
Observing Other People using Computing and Internet Technologies.	ECE	8	7 (87.5%)	.204	1	.651
	OTHER	15	12 (80.0%)			
OTHER Methods	ECE	8	0 (0.0%)	--	--	*Constant*
	OTHER	15	0 (0.0%)			

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “training manuals/how-to books” (χ^2 (1) = .224, p = .636). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “training manuals/how-to books” to teach themselves computing and Internet technology skills/knowledge (12.5%) than were OTHER UW-Stout freshmen education majors (6.7%).

Table 34 (above) shows that a significant relationship was found for the informal self-teaching method “online tutorials” (χ^2 (1) = 6.135, p = .013). UW-Stout Freshmen Early Childhood Education majors were more likely to use “online tutorials” to teach themselves computing and Internet technology skills/knowledge (87.5%) than were OTHER UW-Stout freshmen education majors (33.3%).

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “video/CD-ROM/DVD tutorials” (χ^2 (1) = 1.174, p = .278). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “video/CD-ROM/DVD tutorials” to teach themselves computing and Internet technology skills/knowledge (12.5%) than were OTHER UW-Stout freshmen education majors (33.3%).

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (χ^2 (1) = 1.168, p = .280). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” to teach themselves computing and Internet technology skills/knowledge (100.0%) than were OTHER UW-Stout freshmen education majors (86.7%).

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “using the help menu” (χ^2 (1) = 1.864, *p* = .172). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “using the help menu” to teach themselves computing and Internet technology skills/knowledge (87.5%) than were OTHER UW-Stout freshmen education majors (60.0%).

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “experimenting” (χ^2 (1) = .558, *p* = .455). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “experimenting” to teach themselves computing and Internet technology skills/knowledge (100.0%) than were OTHER UW-Stout freshmen education majors (93.3%).

Table 34 (above) shows that no significant relationship was found for the informal self-teaching method “observing other people using computing and Internet technologies” (χ^2 (1) = .204, *p* = .651). UW-Stout Freshmen Early Childhood Education majors were no more likely to use “observing other people using computing and Internet technologies” to teach themselves computing and Internet technology skills/knowledge (87.5%) than were OTHER UW-Stout freshmen education majors (80.0%).

Table 34 (above) shows that UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors did not identify OTHER informal self-teaching methods to teach themselves computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 35.

Table 35

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Early Childhood Education and OTHER UW-Stout Freshmen Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
ECE	8	0 (0.0%)	.558	1	.455
OTHER	15	1 (6.7%)			

Table 35 (above) shows that no significant relationship was found was found ($\chi^2(1) = .558$, $p = .455$). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge (0.0%) than were OTHER UW-Stout freshmen education majors (6.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 36.

Table 36

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Early Childhood Education and OTHER *UW-Stout Freshmen Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)*

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
ECE	8	1 (12.5%)	.615	1	.433
OTHER	15	4 (26.7%)			

Table 36 (above) shows that no significant relationship was found was found (χ^2 (1) = .615, $p = .433$). UW-Stout Freshmen Early Childhood Education majors were no more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (12.5%) than were OTHER UW-Stout freshmen education majors (26.7%).

Notable UW-Stout freshmen education major groupings: Marketing and Business Education compared to Early Childhood Education. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who earned IC³® Certification. The results of the comparison are found in Table 37.

Table 37

Comparison of UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors Who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exams	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	MBE	9	3 (33.3%)	3.238	1	.072
	ECE	8	0 (0.0%)			

Table 37 (above) shows a non-significant interaction was found ($\chi^2(1) = 3.238$, $p = .072$). UW-Stout Freshmen Marketing and Business Education majors were no more likely to earn IC³® Certification (33.3%) than were UW-Stout Freshmen Early Childhood Education majors (0.0%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 38.

Table 38

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	4 (44.4%)	.701	1	.402
	ECE	8	2 (25.0%)			
Middle School	MBE	9	5 (55.6%)	.052	1	.819
	ECE	8	4 (50.0%)			
High School	MBE	9	6 (66.7%)	.486	1	.486
	ECE	8	4 (50.0%)			
Post-secondary School	MBE	9	6 (66.7%)	8.242	1	.004
	ECE	8	0 (0.0%)			
OTHER	MBE	9	0 (100.0%)	--	--	*Constant*
	ECE	8	0 (100.0%)			

Table 38 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .701, p = .402). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (44.4%) than were UW-Stout Freshmen Early Childhood Education majors (25.0%).

Table 38 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .052, p = .819). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were UW-Stout Freshmen Early Childhood Education majors (50.0%).

Table 38 (above) shows that no significant relationship was found for high school (χ^2 (1) = .486, p = .486). UW-Stout Freshmen Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (66.7%) than were UW-Stout Freshmen Early Childhood Education majors (50.0%).

Table 38 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) = 8.242, p = .004). UW-Stout Freshmen Marketing and Business Education majors were more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (66.7%) than were UW-Stout Freshmen Early Childhood Education majors (0.0%).

Table 38 (above) shows that UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors did not identify formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 39.

Table 39

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	1 (11.1%)	.562	1	.453
	ECE	8	2 (25.0%)			
Middle School	MBE	9	2 (22.2%)	.476	1	.490
	ECE	8	3 (37.5%)			
High School	MBE	9	6 (66.7%)	.032	1	.858
	ECE	8	5 (62.5%)			
Post-secondary School	MBE	9	3 (33.3%)	1.022	1	.312
	ECE	8	1 (12.5%)			
OTHER	MBE	9	1 (11.1%)	.944	1	.331
	ECE	8	0 (0.0%)			

Table 39 (above) shows that no significant relationship was found for elementary school ($\chi^2(1) = .562$, $p = .453$). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (11.1%) than were UW-Stout Freshmen Early Childhood Education majors (25.0%).

Table 39 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .476, p = .490). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (22.2%) than were UW-Stout Freshmen Early Childhood Education majors (37.5%).

Table 39 (above) shows that no significant relationship was found for high school (χ^2 (1) = .032, p = .858). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (66.7%) than were UW-Stout Freshmen Early Childhood Education majors (62.5%).

Table 39 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) = 1.022, p = .312). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (33.3%) than were UW-Stout Freshmen Early Childhood Education majors (12.5%).

Table 39 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) = .944, p = .331). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (11.1%) than were UW-Stout Freshmen Early Childhood Education majors (0.0%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who use informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 40.

Table 40

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	MBE	9	0 (0.0%)	1.195	1	.274
	ECE	8	1 (12.5%)			
Online Tutorials	MBE	9	3 (33.3%)	5.130	1	.024
	ECE	8	7 (87.5%)			
Video/CD-ROM/DVD Tutorials	MBE	9	3 (33.3%)	1.022	1	.312
	ECE	8	1 (12.5%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	MBE	9	8 (88.9%)	.944	1	.331
	ECE	8	8 (100.0%)			
Using the Help Menu	MBE	9	6 (66.7%)	1.022	1	.312
	ECE	8	7 (87.5%)			
Experimenting	MBE	9	8 (88.9%)	.944	1	.331
	ECE	8	8 (100.0%)			
Observing Other People using Computing and Internet Technologies.	MBE	9	7 (77.8%)	.275	1	.600
	ECE	8	7 (87.5%)			
OTHER Methods	MBE	9	0 (0.0%)	--	--	*Constant*
	ECE	8	0 (0.0%)			

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “training manuals/how-to books” (χ^2 (1) = 1.195, *p* = .274). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “training manuals/how-to books” to teach themselves computing and Internet technology skills/knowledge (0.0%) than were UW-Stout Freshmen Early Childhood Education majors (12.5%).

Table 40 (above) shows that a significant relationship was found for the informal self-teaching method “online tutorials” (χ^2 (1) = 5.130, *p* = .024). UW-Stout Freshmen Marketing and Business Education majors were less likely to use “online tutorials” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were UW-Stout Freshmen Early Childhood Education majors (87.5%).

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “video/CD-ROM/DVD tutorials” (χ^2 (1) = 1.022, *p* = .312). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “video/CD-ROM/DVD tutorials” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were UW-Stout Freshmen Early Childhood Education majors (12.5%).

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (χ^2 (1) = .944, *p* = .331). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Freshmen Early Childhood Education majors (100.0%).

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “using the help menu” (χ^2 (1) = 1.022, p = .312). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “using the help menu” to teach themselves computing and Internet technology skills/knowledge (66.7%) than were UW-Stout Freshmen Early Childhood Education majors (87.5%).

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “experimenting” (χ^2 (1) = .944, p = .331). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “experimenting” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Freshmen Early Childhood Education majors (100.0%).

Table 40 (above) shows that no significant relationship was found for the informal self-teaching method “observing other people using computing and Internet technologies” (χ^2 (1) = .275, p = .600). UW-Stout Freshmen Marketing and Business Education majors were no more likely to use “observing other people using computing and Internet technologies” to teach themselves computing and Internet technology skills/knowledge (77.8%) than were UW-Stout Freshmen Early Childhood Education majors (87.5%).

Table 40 (above) shows that UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors did not identify OTHER informal self-teaching methods to teach themselves computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 41.

Table 41

Comparison of Formal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	0 (0.0%)	--	--	*Constant*
ECE	8	0 (0.0%)			

Table 41 (above) shows that no comparative analysis was conducted because neither UW-Stout Freshmen Marketing and Business Education majors nor UW-Stout Freshmen Early Childhood Education majors identified employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors and UW-Stout Freshmen Early Childhood Education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 42.

Table 42

Comparison of Informal Learning Experiences Survey Results for UW-Stout Freshmen Marketing and Business Education Majors and UW-Stout Freshmen Early Childhood Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	4 (44.4%)	2.082	1	.149
ECE	8	1 (12.5%)			

Table 42 (above) shows that no significant relationship was found was found (χ^2 (1) = 2.082, p = .149). UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (44.4%) than were UW-Stout Freshmen Early Childhood Education majors (12.5%).

Notable UW-Stout freshmen education major groupings: Marketing and Business Education, Early Childhood Education and OTHER freshmen education majors compared. A Kruskal-Wallis *H* test was conducted comparing the frequency of UW-Stout Freshmen Marketing and Business Education majors, UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors who earned IC³® Certification. The results of the comparison are found in Table 43.

Table 43

Comparison of the Frequency UW-Stout Freshmen Marketing and Business Education Majors, UW-Stout Freshmen Early Childhood Education Majors and OTHER UW-Stout Freshmen Education Majors Who Earned IC³® Certification (Kruskal-Wallis H Test)

IC³® Exam	Group	*N*	Mean Rank	*H*	*df*	Asymp.Sig. (*p*)
Earned IC³® Certification	MBE	9	13.83	3.136	2	.208
	ECE	8	10.00			
	OTHER	6	11.92			

Table 43 (above) shows that no significant difference was found (H (2) = 3.136, p = .208) indicating that UW-Stout Freshmen Marketing and Business Education majors, UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors did not significantly differ from each other relative to earning IC³® Certification. UW-Stout Freshmen Marketing and Business Education majors had the highest mean rank (13.83) followed by OTHER UW-Stout freshmen education majors (11.92) and UW-Stout Freshmen Early Childhood Education majors (10.00).

Notable UW-Stout senior education major groupings: Marketing and Business Education compared to OTHER senior education majors. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who earned IC³® Certification. The results of the comparison are found in Table 44.

Table 44

Comparison of UW-Stout Senior Marketing and Business Education Majors and OTHER UW-Stout Senior Education Majors Who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exam	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	MBE	9	6 (66.7%)	1.963	1	.161
	OTHER	16	6 (37.5%)			

Table 44 (above) shows a non-significant interaction was found ($\chi^2(1) = 1.963$, $p = .161$). UW-Stout Senior Marketing and Business Education majors were no more likely to earn IC³® Certification (66.7%) than were OTHER UW-Stout senior education majors (37.5%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 45.

Table 45

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education and OTHER UW-Stout Senior Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	3 (33.3%)	.198	1	.656
	OTHER	16	4 (25.0%)			
Middle School	MBE	9	5 (55.6%)	.762	1	.383
	OTHER	16	6 (37.5%)			
High School	MBE	9	5 (55.6%)	.071	1	.790
	OTHER	16	8 (50.0%)			
Post-secondary School	MBE	9	8 (88.9%)	7.667	1	.006
	OTHER	16	5 (31.3%)			
OTHER	MBE	9	0 (100.0%)	--	--	*Constant*
	OTHER	16	0 (100.0%)			

Table 45 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .198, p = .656). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (33.3%) than were OTHER UW-Stout senior education majors (25.0%).

Table 45 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .762, p = .383). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were OTHER UW-Stout senior education majors (37.5%).

Table 45 (above) shows that no significant relationship was found for high school (χ^2 (1) = .071, p = .790). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (55.6%) than were OTHER UW-Stout senior education majors (50.0%).

Table 45 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) = 7.667, p = .006). UW-Stout Senior Marketing and Business Education majors were more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (88.9%) than were OTHER UW-Stout senior education majors (31.3%).

Table 45 (above) shows that UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors did not identify OTHER levels of school where they experienced formal exclusively-focused learning to develop computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of

school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 46.

Table 46

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education and OTHER UW-Stout Senior Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	2 (22.2%)	1.159	1	.282
	OTHER	16	7 (43.8%)			
Middle School	MBE	9	5 (55.6%)	.116	1	.734
	OTHER	16	10 (62.5%)			
High School	MBE	9	8 (88.9%)	.694	1	.405
	OTHER	16	12 (75.0%)			
Post-secondary School	MBE	9	9 (100.0%)	1.223	1	.269
	OTHER	16	14 (87.5%)			
OTHER	MBE	9	1 (11.1%)	.011	1	.918
	OTHER	16	2 (12.5%)			

Table 46 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = 1.159, p = .282). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (22.2%) than were OTHER UW-Stout senior education majors (43.8%).

Table 46 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .116, p = .734). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were OTHER UW-Stout senior education majors (62.5%).

Table 46 (above) shows that no significant relationship was found for high school (χ^2 (1) = .694, p = .405). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (88.9%) than were OTHER UW-Stout senior education majors (75.0%).

Table 46 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) = 1.223, p =.269). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (100.0%) than were OTHER UW-Stout senior education majors (87.5%).

Table 46 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) = .011, p = .918). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (11.1%) than were OTHER UW-Stout senior education majors (12.5%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who use informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 47.

Table 47

Comparison of Informal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education and OTHER UW-Stout Senior Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	MBE	9	3 (33.3%)	1.563	1	.211
	OTHER	16	2 (12.5%)			
Online Tutorials	MBE	9	6 (66.7%)	.672	1	.412
	OTHER	16	13 (81.3%)			
Video/CD-ROM/DVD Tutorials	MBE	9	3 (33.3%)	.260	1	.610
	OTHER	16	7 (43.8%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	MBE	9	8 (88.9%)	.185	1	.667
	OTHER	16	15 (93.8%)			
Using the Help Menu	MBE	9	8 (88.9%)	.694	1	.405
	OTHER	16	12 (75.0%)			
Experimenting (Trial and Error)	MBE	9	9 (100.0%)	--	--	*Constant*
	OTHER	16	16 (100.0%)			
Observing Other People using Computing and Internet Technologies.	MBE	9	8 (88.9%)	.694	1	.405
	OTHER	16	12 (75.0%)			
OTHER Methods	MBE	9	1 (11.1%)	.185	1	.667
	OTHER	16	1 (6.3%)			

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method “training manuals/how-to books” (χ^2 (1) = 1.563, p = .211). UW-Stout Senior Marketing and Business Education majors were no more likely to use “training manuals/how-to books” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were OTHER UW-Stout senior education majors (12.5%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method “online tutorials” (χ^2 (1) = .672, p = .412). UW-Stout Senior Marketing and Business Education majors were no more likely to use “online tutorials” to teach themselves computing and Internet technology skills/knowledge (66.7%) than were OTHER UW-Stout senior education majors (81.3%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method “video/CD-ROM/DVD tutorials” (χ^2 (1) = .260, p = .610). UW-Stout Senior Marketing and Business Education majors were no more likely to use “video/CD-ROM/DVD tutorials” to teach themselves computing and Internet technology skills/knowledge (33.3%) than were OTHER UW-Stout senior education majors (43.8%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (χ^2 (1) = .185, p = .667). UW-Stout Senior Marketing and Business Education majors were no more likely to use “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were OTHER UW-Stout senior education majors (93.8%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method "using the help menu" (χ^2 (1) = .694, p = .405). UW-Stout Senior Marketing and Business Education majors were no more likely to use "using the help menu" to teach themselves computing and Internet technology skills/knowledge (88.9%) than were OTHER UW-Stout senior education majors (75.0%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method "experimenting". UW-Stout Senior Marketing and Business Education majors were no more likely to use "experimenting" to teach themselves computing and Internet technology skills/knowledge (100.0%) than were OTHER UW-Stout senior education majors (100.0%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method "observing other people using computing and Internet technologies" (χ^2 (1) = .694, p = .405). UW-Stout Senior Marketing and Business Education majors were no more likely to use "observing other people using computing and Internet technologies" to teach themselves computing and Internet technology skills/knowledge (88.9%) than were OTHER UW-Stout senior education majors (75.0%).

Table 47 (above) shows that no significant relationship was found for the informal self-teaching method "OTHER methods" (χ^2 (1) = .185, p = .667). UW-Stout Senior Marketing and Business Education majors were no more likely to use "OTHER methods" to teach themselves computing and Internet technology skills/knowledge (11.1%) than were OTHER UW-Stout senior education majors (6.3%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 48.

Table 48

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education and OTHER UW-Stout Senior Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	3 (33.3%)	1.563	1	.211
OTHER	16	2 (12.5%)			

Table 48 (above) shows that no significant relationship was found was found (χ^2 (1) = 1.563, p = .211). UW-Stout Senior Marketing and Business Education majors were no more likely to experience employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge (33.3%) than were OTHER UW-Stout senior education majors (12.5%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and OTHER UW-Stout senior education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 49.

Table 49

Comparison of Informal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education and OTHER UW-Stout Senior Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	7 (77.8%)	1.159	1	.282
OTHER	16	9 (56.3%)			

Table 49 (above) shows that no significant relationship was found was found (χ^2 (1) = 1.159, p = .282). UW-Stout Senior Marketing and Business Education majors were no more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (77.7%) than were OTHER UW-Stout senior education majors (56.3%).

Notable UW-Stout senior education major groupings: Technology Education compared to OTHER senior education majors. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who earned IC³® Certification. The results of the comparison are found in Table 50.

Table 50

Comparison of UW-Stout Senior Technology Education Majors and OTHER UW-Stout Senior Education Majors Who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exam	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	TE	12	6 (50.0%)	.037	1	.848
	OTHER	13	6 (46.2%)			

Table 50 (above) shows a non-significant interaction was found (χ^2 (1) = .037, p = .848). UW-Stout Senior Technology Education majors were no more likely to earn IC³® Certification (50.0%) than were OTHER UW-Stout senior education majors (46.2%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 51.

Table 51

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Technology Education and OTHER UW-Stout Senior Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	TE	12	4 (33.3%)	.326	1	.568
	OTHER	13	3 (23.1%)			
Middle School	TE	12	5 (41.7%)	.051	1	.821
	OTHER	13	6 (46.2%)			
High School	TE	12	7 (58.3%)	.371	1	.543
	OTHER	13	6 (46.2%)			
Post-secondary School	TE	12	5 (41.7%)	.987	1	.320
	OTHER	13	8 (61.5%)			
OTHER	TE	12	0 (100.0%)	--	--	*Constant*
	OTHER	13	0 (100.0%)			

Table 51 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .326, p = .568). UW-Stout Senior Technology Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (33.3%) than were OTHER UW-Stout senior education majors (23.1%).

Table 51 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .051, p = .821). UW-Stout Senior Technology Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (41.7%) than were OTHER UW-Stout senior education majors (46.2%).

Table 51 (above) shows that no significant relationship was found for high school (χ^2 (1) = .371, p = .543). UW-Stout Senior Technology Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (58.3%) than were OTHER UW-Stout senior education majors (46.2%).

Table 51 (above) shows that no significant relationship was found for post-secondary school (χ^2 (1) = .987, p = .320). UW-Stout Senior Technology Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (41.7%) than were OTHER UW-Stout senior education majors (61.5%).

Table 51 (above) shows that UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors did not identify OTHER levels of school where they experienced formal exclusively-focused learning to develop computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 52.

Table 52

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Technology Education and OTHER UW-Stout Senior Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	TE	12	5 (41.7%)	.322	1	.571
	OTHER	13	4 (30.8%)			
Middle School	TE	12	9 (75.0%)	2.163	1	.141
	OTHER	13	6 (46.2%)			
High School	TE	12	11 (91.7%)	1.963	1	.161
	OTHER	13	9 (69.2%)			
Post-secondary School	TE	12	12 (100.0%)	2.007	1	.157
	OTHER	13	11 (84.6%)			
OTHER	TE	12	2 (16.7%)	.467	1	.490
	OTHER	13	1 (7.7%)			

Table 52 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .322, p = .571). UW-Stout Senior Technology Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (41.7%) than were OTHER UW-Stout senior education majors (30.8%).

Table 52 (above) shows that no significant relationship was found for middle school (χ^2 (1) = 2.163, p = .141). UW-Stout Senior Technology Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (75.0%) than were OTHER UW-Stout senior education majors (46.2%).

Table 52 (above) shows that no significant relationship was found for high school ($\chi^2(1) = 1.963$, $p = .161$). UW-Stout Senior Technology Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (91.7%) than were OTHER UW-Stout senior education majors (69.2%).

Table 52 (above) shows that no significant relationship was found for post-secondary school ($\chi^2(1) = 2.007$, $p = .157$). UW-Stout Senior Technology Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (100.0%) than were OTHER UW-Stout senior education majors (84.6%).

Table 52 (above) shows that no significant relationship was found for OTHER levels of school ($\chi^2(1) = .467$, $p = .490$). UW-Stout Senior Technology Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (16.7%) than were OTHER UW-Stout Senior Education majors (7.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who use informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.

- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 53.

Table 53

Comparison of Informal Learning Experiences Survey Results for UW-Stout Senior Technology Education and OTHER UW-Stout Senior Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	TE	12	2 (16.7%)	.160	1	.689
	OTHER	13	3 (23.1%)			
Online Tutorials	TE	12	10 (83.3%)	.680	1	.409
	OTHER	13	9 (69.2%)			
Video/CD-ROM/DVD Tutorials	TE	12	6 (50.0%)	.962	1	.327
	OTHER	13	4 (30.8%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	TE	12	11 (91.7%)	.003	1	.953
	OTHER	13	12 (92.3%)			
Using the Help Menu	TE	12	9 (75.0%)	.361	1	.548
	OTHER	13	11 (84.6%)			
Experimenting	TE	12	12 (100.0%)	--	--	*Constant*
	OTHER	13	13 (100.0%)			
Observing Other People using Computing and Internet Technologies.	TE	12	9 (75.0%)	.361	1	.548
	OTHER	13	11 (84.6%)			
OTHER Methods	TE	12	1 (8.3%)	.003	1	.953
	OTHER	13	1 (7.7%)			

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “training manuals/how-to books” (χ^2 (1) = .160, p = .689). UW-Stout Senior Technology Education majors were no more likely to use “training manuals/how-to books” to teach themselves computing and Internet technology skills/knowledge (16.7%) than were OTHER UW-Stout senior education majors (23.1%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “online tutorials” (χ^2 (1) = .680, p = .409). UW-Stout Senior Technology Education majors were no more likely to use “online tutorials” to teach themselves computing and Internet technology skills/knowledge (83.3%) than were OTHER UW-Stout senior education majors (69.2%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “video/CD-ROM/DVD tutorials” (χ^2 (1) = .962, p = .327). UW-Stout Senior Technology Education majors were no more likely to use “video/CD-ROM/DVD tutorials” to teach themselves computing and Internet technology skills/knowledge (50.0%) than were OTHER UW-Stout senior education majors (30.8%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (χ^2 (1) = .003, p = .953). UW-Stout Senior Technology Education majors were no more likely to use “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” to teach themselves computing and Internet technology skills/knowledge (91.7%) than were OTHER UW-Stout senior education majors (92.3%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “using the help menu” (χ^2 (1) = .361, p = .548). UW-Stout Senior Technology Education majors were no more likely to use “using the help menu” to teach themselves computing and Internet technology skills/knowledge (75.0%) than were OTHER UW-Stout senior education majors (84.6%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “experimenting”. UW-Stout Senior Technology Education majors were no more likely to use “experimenting” to teach themselves computing and Internet technology skills/knowledge (100.0%) than were OTHER UW-Stout senior education majors (100.0%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “observing other people using computing and Internet technologies” (χ^2 (1) = .361, p = .548). UW-Stout Senior Technology Education majors were no more likely to use “observing other people using computing and Internet technologies” to teach themselves computing and Internet technology skills/knowledge (75.0%) than were OTHER UW-Stout senior education majors (84.6%).

Table 53 (above) shows that no significant relationship was found for the informal self-teaching method “OTHER methods” (χ^2 (1) = .003, p = .953). UW-Stout Senior Technology Education majors were no more likely to use “OTHER methods” to teach themselves computing and Internet technology skills/knowledge (8.3%) than were OTHER UW-Stout senior education majors (7.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 54.

Table 54

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Technology Education and OTHER UW-Stout Senior Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
TE	12	2 (16.7%)	.160	1	.689
OTHER	13	3 (23.1%)			

Table 54 (above) shows that no significant relationship was found was found (χ^2 (1) = .160, p = .689). UW-Stout Senior Technology Education majors were no more likely to experience employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge (16.7%) than were OTHER UW-Stout senior education majors (23.1%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 55.

Table 55

Comparison of Informal Learning Experiences Survey results for UW-Stout Senior Technology Education and OTHER UW-Stout senior education majors: Employment-based informal training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
TE	12	6 (50.0%)	1.963	1	.161
OTHER	13	10 (76.9%)			

Table 55 (above) shows that no significant relationship was found was found (χ^2 (1) = 1.963, p = .161). UW-Stout Senior Technology Education majors were no more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (50.0%) than were OTHER UW-Stout senior education majors (76.9%).

Notable UW-Stout senior education major groupings: Marketing and Business Education compared to Technology Education. A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who earned IC^3® Certification. The results of the comparison are found in Table 56.

Table 56

Comparison of UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors Who Earned IC³® Certification (Chi-Square Test of Independence)

IC³® Exam	Group	*N*	Passed Exam Frequency	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Earned IC³® Certification	MBE	9	6 (66.7%)	.583	1	.445
	TE	12	6 (50.0%)			

Table 56 (above) shows a non-significant interaction was found (χ^2 (1) = .583, p = .445). UW-Stout Senior Marketing and Business Education majors were no more likely to earn IC³® Certification (66.7%) than were UW-Stout Senior Technology Education majors (50.0%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who identified the levels of school where they experienced formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. The levels of school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 57.

Table 57

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors: Formal Exclusively-Focused in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	3 (33.3%)	.000	1	1.000
	TE	12	4 (33.3%)			
Middle School	MBE	9	5 (55.6%)	.398	1	.528
	TE	12	5 (41.7%)			
High School	MBE	9	5 (55.6%)	.016	1	.899
	TE	12	7 (58.3%)			
Post-secondary School	MBE	9	8 (88.9%)	4.863	1	.027
	TE	12	5 (41.7%)			
OTHER	MBE	9	0 (100.0%)	--	--	*Constant*
	TE	12	0 (100.0%)			

Table 57 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .000, p = 1.000). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in elementary school (33.3%) than were UW-Stout Senior Technology Education majors (33.3%).

Table 57 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .398, p = .528). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were UW-Stout Senior Technology Education majors (41.7%).

Table 57 (above) shows that no significant relationship was found for high school (χ^2 (1) = .016, p = .899). UW-Stout Senior Marketing and Business Education majors were no more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in high school (55.6%) than were UW-Stout Senior Technology Education majors (58.3%).

Table 57 (above) shows that a significant relationship was found for post-secondary school (χ^2 (1) = 4.863, p = .027). UW-Stout Senior Marketing and Business Education majors were more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Senior Technology Education majors (41.7%).

Table 57 (above) shows that UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors did not identify OTHER levels of school where they experienced formal exclusively-focused learning to develop computing and Internet technology skills/knowledge.

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who identified the levels of school where they experienced formally integrated learning experiences to develop computing and Internet technology skills/knowledge. The levels of

school included elementary school, middle school, high school, post-secondary school and OTHER study participant identified schooling. The results of the comparison are found in Table 58.

Table 58

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors: Formally Integrated in School (Chi-Square Test of Independence)

Levels of School	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Elementary School	MBE	9	2 (22.2%)	.875	1	.350
	TE	12	5 (41.7%)			
Middle School	MBE	9	5 (55.6%)	.875	1	.350
	TE	12	9 (75.0%)			
High School	MBE	9	8 (88.9%)	.046	1	.830
	TE	12	11 (91.7%)			
Post-secondary School	MBE	9	9 (100.0%)	--	--	*Constant*
	TE	12	12 (100.0%)			
OTHER	MBE	9	1 (11.1%)	.130	1	.719
	TE	12	2 (16.7%)			

Table 58 (above) shows that no significant relationship was found for elementary school (χ^2 (1) = .875, *p* = .350). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (22.2%) than were UW-Stout Senior Technology Education majors (41.7%).

Table 58 (above) shows that no significant relationship was found for middle school (χ^2 (1) = .875, p = .350). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in middle school (55.6%) than were UW-Stout Senior Technology Education majors (75.0%).

Table 58 (above) shows that no significant relationship was found for high school (χ^2 (1) = .046, p = .830). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (88.9%) than were UW-Stout Senior Technology Education majors (91.7%).

Table 58 (above) shows that no significant relationship was found for post-secondary school. UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (100.0%) than were UW-Stout Senior Technology Education majors (100.0%).

Table 58 (above) shows that no significant relationship was found for OTHER levels of school (χ^2 (1) = .130, p = .719). UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in OTHER levels of school (11.1%) than were UW-Stout Senior Technology Education majors (16.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who use informal self-teaching methods to develop computing and Internet technology skills/knowledge. The informal self-teaching methods included:

- Training manuals/how-to-books.
- Online tutorials.
- Video/CD-ROM/DVD tutorials.
- Seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions.
- Using the help menu.
- Experimenting.
- Observing other people using computing and Internet technologies.
- OTHER methods identified by study participants.

The results of the comparison are found in Table 59.

Table 59

Comparison of Informal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors: Informal Self-Teaching Methods (Chi-Square Test of Independence)

Informal Self Teaching Methods	Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
Training Manuals/How-to-Books	MBE	9	3 (33.3%)	.788	1	.375
	TE	12	2 (16.7%)			
Online Tutorials	MBE	9	6 (66.7%)	.788	1	.375
	TE	12	10 (83.3%)			
Video/CD-ROM/DVD Tutorials	MBE	9	3 (33.3%)	.583	1	.445
	TE	12	6 (50.0%)			
Seeking Out a Person Who is Knowledgeable in the Use of Computing and Internet Technologies and Asking Them Questions	MBE	9	8 (88.9%)	.046	1	.830
	TE	12	11 (91.7%)			
Using the Help Menu	MBE	9	8 (88.9%)	.643	1	.422
	TE	12	9 (75.0%)			
Experimenting	MBE	9	9 (100.0%)	--	--	*Constant*
	TE	12	12 (100.0%)			
Observing Other People using Computing and Internet Technologies.	MBE	9	8 (88.9%)	.643	1	.422
	TE	12	9 (75.0%)			
OTHER Methods	MBE	9	1 (11.1%)	.046	1	.830
	TE	12	1 (8.3%)			

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method "training manuals/how-to books" (χ^2 (1) = .788, p = .375). UW-Stout Senior Marketing and Business Education majors were no more likely to use "training manuals/how-to books" to teach themselves computing and Internet technology skills/knowledge (33.3%) than were UW-Stout Senior Technology Education majors (16.7%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method "online tutorials" (χ^2 (1) = .788, p = .375). UW-Stout Senior Marketing and Business Education majors were no more likely to use "online tutorials" to teach themselves computing and Internet technology skills/knowledge (66.7%) than were UW-Stout Senior Technology Education majors (83.3%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method "video/CD-ROM/DVD tutorials" (χ^2 (1) = .583, p = .445). UW-Stout Senior Marketing and Business Education majors were no more likely to use "video/CD-ROM/DVD tutorials" to teach themselves computing and Internet technology skills/knowledge (33.3%) than were UW-Stout Senior Technology Education majors (50.0%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (χ^2 (1) = .046, p = .830). UW-Stout Senior Marketing and Business Education majors were no more likely to use "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" to teach themselves computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Senior Technology Education majors (91.7%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method “using the help menu” (χ^2 (1) = .643, p = .422). UW-Stout Senior Marketing and Business Education majors were no more likely to use “using the help menu” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Senior Technology Education majors (75.0%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method “experimenting”. UW-Stout Senior Marketing and Business Education majors were no more likely to use “experimenting” to teach themselves computing and Internet technology skills/knowledge (100.0%) than were UW-Stout Senior Technology Education majors (100.0%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method “observing other people using computing and Internet technologies” (χ^2 (1) = .643, p = .422). UW-Stout Senior Marketing and Business Education majors were no more likely to use “observing other people using computing and Internet technologies” to teach themselves computing and Internet technology skills/knowledge (88.9%) than were UW-Stout Senior Technology Education majors (75.0%).

Table 59 (above) shows that no significant relationship was found for the informal self-teaching method “OTHER methods” (χ^2 (1) = .046, p = .830). UW-Stout Senior Marketing and Business Education majors were no more likely to use “OTHER methods” to teach themselves computing and Internet technology skills/knowledge (11.1%) than were UW-Stout Senior Technology Education majors (8.3%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who experienced employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 60.

Table 60

Comparison of Formal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors: Employment-Based Formal Exclusively-Focused Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	3 (33.3%)	.788	1	.375
TE	12	2 (16.7%)			

Table 60 (above) shows that no significant relationship was found was found (χ^2 (1) = .788, p = .375). UW-Stout Senior Marketing and Business Education majors were no more likely to experience employment-based formal exclusively-focused training to develop computing and Internet technology skills/knowledge (33.3%) than were UW-Stout Senior Technology Education majors (16.7%).

A Chi-Square test of independence was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors and UW-Stout Senior Technology Education majors who experienced employment-based informal training to develop computing and Internet technology skills/knowledge. The results of the comparison are found in Table 61.

Table 61

Comparison of Informal Learning Experiences Survey Results for UW-Stout Senior Marketing and Business Education Majors and UW-Stout Senior Technology Education Majors: Employment-Based Informal Training (Chi-Square Test of Independence)

Group	*N*	Frequency of Experience (YES Response)	χ^2	*df*	Asymp.Sig. (2-sided) (*p*)
MBE	9	7 (77.8%)	1.683	1	.195
TE	12	6 (50.0%)			

Table 61 (above) shows that no significant relationship was found was found (χ^2 (1) = 1.683, p = .195). UW-Stout Senior Marketing and Business Education majors were no more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge (77.8%) than were UW-Stout Senior Technology Education majors (50.0%).

Notable UW-Stout senior education major groupings: Marketing and Business Education, Technology Education and OTHER senior education majors compared. A Kruskal-Wallis *H* Test was conducted comparing the frequency of UW-Stout Senior Marketing and Business Education majors, UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors who earned IC³® Certification. The results of the comparison are found in Table 62.

Table 62

Comparison of the Frequency UW-Stout Senior Marketing and Business Education Majors, UW-Stout Senior Technology Education Majors and OTHER UW-Stout Senior Education Majors Who Earned IC³® Certification (Kruskal-Wallis H Test)

IC³® Exam	Group	*N*	Mean Rank	*H*	*df*	Asymp.Sig. (*p*)
	MBE	9	15.33			
Earned IC³® Certification	TE	12	13.25	4.769	2	.092
	OTHER	4	7.00			

Table 62 (above) shows that no significant difference was found (H (2) = 4.769, p = .092) indicating that UW-Stout Senior Marketing and Business Education majors, UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors did not significantly differ from each other relative to earning IC³® Certification. UW-Stout Senior Marketing and Business Education majors had the highest mean rank (15.33) followed by UW-Stout Senior Technology Education majors (13.25) and OTHER UW-Stout senior education majors (7.00).

Chapter V: Discussion

Chapter five concludes the comparative study of University of Wisconsin-Stout freshmen and senior education majors computing and Internet technology skills/knowledge and associated learning experiences. Limitations, conclusions, recommendations to improve the computing and Internet technology skills/knowledge of UW-Stout education majors and recommendations for further study are discussed.

Limitations

Limitations of this study included:

- Results of this study were focused only on UW-Stout education majors.
- The instrument used to measure computing and Internet technology skills/knowledge, the IC³® Exam, is a performance-based instrument. No data identifying perceived computing and Internet technology skills/knowledge of study participants was collected.
- This study utilized a survey developed by the investigator. The instrument may have contained errors, misinterpretations, misstatements, or omissions not intended by the investigator. Every effort was made to develop a reliable and valid instrument.
- Because of the ever-changing nature of software applications, Microsoft's new version of the Office Suite 2007 may have interfered with the results of the Key Applications test (CNET.com, 2006).
- The process used to select study participants was not a random sample. A convenient sampling method was used to select study participants.
- Because of the limited number of IC³® Exams purchased, a representation of all UW-Stout School of Education undergraduate degree programs was not possible.

- A substantial time commitment was expected of the study participants. Because of this commitment, paying the participants for their time was paramount to assure enough participants in the study to run the statistical tests of significance.
- The IC³® Exam is computer-based. There was the possibility to experience technical issues that would interfere with the data collection process.

Conclusions

The conclusions of this study were ordered using the original six study objectives and by the notable undergraduate education degree program comparisons identified in Chapter IV. As in Chapter IV, class and major in the conclusions that follow identified study participants.

Study objective one conclusions. Study objective one measured the computing and Internet technology skills/knowledge of UW-Stout freshmen education majors using Certiport's Internet and Computing Core Certification (IC³®) Exam. UW-Stout freshmen education majors scored well below passing on each of the three tests that make up the IC³® Exam. Living Online test (M = 668.52), Computing Fundamentals test (M = 628.96) and Key Applications test (M = 534.43). Only four (17.4%) UW-Stout freshmen education majors earned IC³® Certification. Nineteen (82.6%) UW-Stout freshmen education majors failed to earn IC³® Certification.

UW-Stout freshmen education majors performed marginally on Electronic Mail (M = 71.43) within the Living Online test. This result is somewhat surprising since Electronic Mail is a nearly universal communication application in school, work and home. Common Program Functions (M = 60.61) within the Key Applications test was another area where UW-Stout freshmen education majors performed marginally. This result is also surprising because Common Program Functions within the Key Applications test is meant to focus on functions, features and menus that are used in all software applications.

UW-Stout freshmen education majors performed poorly on the Word Processing Functions (M = 51.61), Presentation Functions (M = 43.48) and Spreadsheet Functions (M = 42.87) within the Key Applications test. UW-Stout freshmen education majors also performed poorly on the Computer Software (M = 69.64), Computer Hardware (M = 57.61) and Operating Systems (M = 65.74) within the Computing Fundamentals test. UW-Stout freshmen education majors have very little demonstrated skill or knowledge of common computer software or basic computer hardware. The overall poor performance on the Key Applications and Computing Fundamentals tests by UW-Stout freshmen education majors validates the investigators past observations of poor software applications skills/knowledge of UW-Stout freshmen education majors and UW-Stout freshmen in general. Studies demonstrating similar outcomes include (Banister & Vannatta, 2006; Butler, 2007; Clariana & Wallace, 2005; Crable et al., 2006; Dickerson, 2005; C. A. Hardy, 2005; McDonald, 2004; Williams & Scott, 2005).

The results of this study show UW-Stout freshmen education majors significantly lacking in basic computing and Internet technology skills/knowledge. This conclusion challenges the assumptions of computing and Internet technology skills/knowledge proficiencies attributed to the "digital generation", "digital natives" and other monikers given to traditional-age college freshmen entering institutions of higher learning. Also see Clariana and Wallace (2005) reflecting assumptions of innate computing and Internet technology skills/knowledge of incoming college freshmen.

Study objective two conclusions. Study objective two measured the computing and Internet technology skills/knowledge of UW-Stout senior education majors using Certiport's Internet and Computing Core Certification (IC³®) Exam. UW-Stout senior education majors performed above standard on the Living Online test (M = 840.04) and slightly below standard on the Key Applications test (*M* =748.00) and the Computing Fundamentals test (*M* = 785.72). Twelve (48%) UW-Stout senior education majors earned IC³® Certification. Thirteen (52.0%) UW-Stout senior education majors failed to earn IC³® Certification.

UW-Stout senior education majors performed well on Internet (*M* = 87.96) and Electronic Mail (*M* = 86.92) within the Living Online test. These particular results within the Living Online test are not surprising. Use of the Internet and Electronic Mail are common in nearly all levels of formal schooling. It is likely that UW-Stout senior education majors have been given numerous opportunities to sharpen their use of Internet technologies and resources through various research opportunities and class assignments. Electronic Mail use at UW-Stout is a near universal form of communication for all campus functions.

UW-Stout senior education majors also performed well on the Presentation Functions (*M* = 78.40), Common Program Functions (*M* = 77.16) and Spreadsheet Functions (*M* = 74.28) within the Key Applications test. These results are directly influenced by the UW-Stout senior education majors who participated in this study. Of the 25 UW-Stout senior education majors who participated, 21 of them were a combination of Marketing and Business Education (*N* = 9) and Technology Education (*N* = 12) majors. The Marketing and Business Education program has an overt focus on computing and Internet technology skills/knowledge; to a less formal extent, the Technology Education program does as well.

The performance by UW-Stout senior education majors on Spreadsheet Functions was a particularly deceiving result. Most studies (see Dickerson, 2005) do not show proficiency in the use of spreadsheet applications by undergraduates. Through further analysis, it was found that five of 25 UW-Stout senior education majors scored 100% on Spreadsheet Functions causing the overall distribution of scores to be negatively skewed and flat. Without the five perfect scores, the composite mean score reflecting the skills of UW-Stout senior education majors using Spreadsheet Functions would have been much lower (*M* = 67.85 vs. *M* = 74.28). It is likely that the Spreadsheet Functions results observed in this study were influenced by the nine UW-Stout Senior Marketing and Business Education study participants. UW-Stout Senior Marketing and Business Education majors are expected to use and teach Spreadsheet Functions in K-12 schools.

UW-Stout senior education majors performed below standard on Word Processing Functions (*M* = 67.20) within the Key Applications test. The Word Processing Functions result was somewhat surprising because of the assumption that UW-Stout senior education majors would likely have used Word Processing Functions more frequently that most software applications and therefore would demonstrate better skill proficiency.

UW-Stout senior education majors also obtained scores slightly below standard on Computers and Society (*M* = 79.32) and Networks (*M* = 77.72) within the Living Online test. This result may show UW-Stout senior education majors more likely to be consumers of computing and Internet technologies versus understanding the basic interworking of such technologies.

The score distributions for the Living Online test (*SD* = 99.304) were closer together than the Computing Fundamentals test (*SD* = 149.576) and the Key Applications test (*SD* = 159.423). The more narrow distribution of scores on the Living Online test indicate more consistent learning experiences for all UW-Stout senior education majors. The wider distribution of scores as seen with the Computing Fundamentals test and the Key Applications test would seem to indicate less consistency in learning experiences for UW-Stout senior education majors. As previously mentioned, Senior Marketing and Business Education and Technology Education majors made up the majority of participants (21 of the 25 senior study participants) and likely affected wider distribution of scores on each of the tests.

Reflecting upon the literature (Butler, 2007; Dickerson, 2005; Marvin, 2004; McDonald, 2004; McKee, 2008; Pierce et al., 2001), UW-Stout senior education majors would appear to have performed better than most other senior undergraduates have nationally; all majors included. However, it should be noted that performance assessment literature for seniors and upperclassmen is sparse. Most computing and Internet technology skills/knowledge performance studies focus on college freshmen. In addition, the influence of Senior Marketing and Business Education and Technology Education majors in this study skew the results and gives an impression of competency for all UW-Stout senior education majors. While many UW-Stout senior education majors participating in this study demonstrated foundational computing and Internet technology skills/knowledge measured by the IC³® Exam, the majority of the participating UW-Stout senior education majors did not.

Study objective three conclusions. Study objective three identified the learning experiences of UW-Stout freshmen education majors in relationship to development of computing and Internet technology skills/knowledge. Only slightly more than half of UW-Stout freshmen education majors identified having had formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in middle school (52.2%) and high school (56.5%). These identified formal exclusively-focused learning experiences likely contributed to the poor computing and Internet technology skills/knowledge demonstrated by UW-Stout freshmen education majors on the IC³® Exam. Apparently, for the majority of the freshmen study participants, the K-12 schools they attended did not provide sufficient formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge.

UW-Stout freshmen education majors were also less likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge in post-secondary school (26.1%). The UW-Stout freshmen education majors who participated in this study were only eight weeks into the fall semester of their first year. To identify formal exclusively-focused learning experiences this soon may not give an accurate indication of potential formal exclusively-focused learning experiences. A better indication of formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge would be the program plans for undergraduate majors in the School of Education at UW-Stout. At the time of this study, the Marketing and Business Education program was the only undergraduate education program to prescribe formal exclusively-focused learning experiences for their students. The literature supports the use of formal exclusively-focused learning experiences as a contribution to computing and Internet technology skill/knowledge development (Abbott & Faris, 2000; Banister & Vannatta, 2006; Basham et al., 2005; Benson et al., 2004; Butler, 2007; Cavenall, 2008; Collier et al., 2004; Egorov et al., 2007; Georgina & Hosford, 2009; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007a).

UW-Stout freshmen education majors were more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in high school (69.6%) and middle school (43.5%). These results further contribute to the poor computing and Internet technology skills/knowledge demonstrated by UW-Stout freshmen education majors on the IC³® Exam suggesting that integration of computing and Internet technology skills/knowledge is inconsistent in K-12 schools. Integration and use of computing and Internet technology skills/knowledge across the curriculum has been identified in the literature as a positive contributor to computing and Internet technology skill/knowledge development (Butler, 2007; Cavenall, 2008; Collier et al., 2004; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007b).

Only 30% of UW-Stout freshmen education majors experienced formally integrated learning experiences during their first semester at UW-Stout. This identified lack of formally integrated learning experiences speaks to possible teaching faculty issues that prevent integration of computing and Internet technology skills/knowledge development across curriculum. The literature has identified the need to properly train faculty in computing and Internet technology skills/knowledge and develop instructional strategies to use computing and Internet technologies to aid learning beyond learning only computing and Internet technology skills/knowledge (Collier et al., 2004; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007a). The literature has also stressed the importance of access to appropriate technology and technical support to facilitate formal integrated curriculum development (Groth et al., 2007; Kay, 2006; Kay, 2007b). It is a reasonable expectation that all teaching faculty at UW-Stout should be given what they need to effectively integrate computing and Internet technology skills/knowledge development across curriculum. The teaching and learning community within the UW-Stout School of Education must also make definite commitments on all levels to support teaching faculty be successful in the use and integration of computing and Internet technology skills/knowledge. The literature stresses the importance of a collaborative, all encompassing commitment by administration, teaching faculty and stakeholders to use and integrate computing and Internet technology skills/knowledge (Basham et al., 2005; Guerrero et al., 2004; Kay, 2006;

Kay, 2007a). Finally, the literature supports the importance of modeling by teaching faculty as a contributor to computing and Internet technology skill/knowledge development (Banister & Vannatta, 2006; Basham et al., 2005; Brush & Saye, 2009; Butler, 2007; Cavenall, 2008; Hardy, 2003; Kay, 2006).

Two of the four UW-Stout freshmen education majors who earned IC³® Certification indicated OTHER levels of school where they experienced formally integrated learning to develop computing and Internet technology skills/knowledge. The success of these freshmen, identified as Marketing and Business Education majors, reflects learning experiences through co-curricular activities such as DECA. Experiences in DECA which is the "…co–curricular education of students with interest in marketing, management and entrepreneurship" (Welcome to DECA, 2008, ¶.4) positively contributed to the computing and Internet technology skills/knowledge demonstrated by these UW-Stout freshmen. The literature supports the use of co-curricular field experiences and authentic problem solving situations to positively contribute to computing and Internet technology skills/knowledge development (Benson et al., 2004; Brush & Saye, 2009; Cavenall, 2008; Groth et al., 2007; Kay, 2006; Kay, 2007a).

UW-Stout freshmen education majors were most likely to use the informal self-teaching method of "experimenting" (95.7%), "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (91.3%) and "observing other people using computing and Internet technologies" (82.6%). These results confirm the investigator's past observations of informal self-teaching methods used by most undergraduate students. The literature supports "experimenting" as a preferred informal self-teaching method (Egorov et al., 2007; Kay, 2007a).

The social aspects of “seeking out a person and asking them questions and observing other people using computing and Internet technologies” reflect a collaborative element of learning that the literature identifies as a positive contributor to computing and Internet technology skills/knowledge development (Basham et al., 2005; Georgina & Hosford, 2009; Kay, 2007a).

UW-Stout freshmen education majors were least likely to use the informal self-teaching methods of “training manuals/how-to-books” (8.7%). The result showing UW-Stout freshmen education majors disfavoring “training manuals/how-to-books” as an informal self-teaching method has been the previous observation of the study investigator.

A surprising result identified nearly 70% of UW-Stout freshmen education majors “using the help menu” as an informal self-teaching method. It was assumed by the investigator that “using the help menu” and “training manuals/how-to-books” would be valued equally low. This result may indicate help menus are improving and/or students are being encouraged to use help menus to learn computing and Internet technology skills/knowledge.

Use of “online tutorials” would seem to be an informal self-teaching method that is growing in popularity. Like many post-secondary institutions, UW-Stout has invested in online tutorials to help students learn computing and Internet technology skills/knowledge. A study by Basham, Palla and Pianfetti (2005) demonstrated the effectiveness of online tutorials as an informal self-teaching method. As UW-Stout freshmen education majors continue their education at UW-Stout, they will likely get more opportunities to use online tutorials to develop computing and Internet technology skills/knowledge.

UW-Stout freshmen education majors have poor computing and Internet technology skills/knowledge because they have had poor formal and informal learning experiences. The quality and number of formal and informal learning experiences is directly related to demonstrated computing and Internet technology skills/knowledge (Kay, 2006). The UW-Stout freshmen education majors who participated in this study did not have quality formal and informal learning experiences to develop computing and Internet technology skills/knowledge in their K-12 school experience. Learning experiences during their first year at UW-Stout are an improvement, but are still somewhat suspect based on inconsistent formal integrated use of computing and Internet technology skills/knowledge development across curriculum by some UW-Stout teaching faculty and lack of formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge.

Study objective four conclusions. Study objective four identified the learning experiences of UW-Stout senior education majors in relationship to development of computing and Internet technology skills/knowledge. UW-Stout senior education majors were more likely to have a formal exclusively-focused learning experience in high school (52.0%) and post-secondary school (52.0%) to develop computing and Internet technology skills/knowledge.

The formal exclusively-focused development of computing and Internet technology skills/knowledge in post-secondary school is significant. The number of UW-Stout senior education majors who identified having experienced formal exclusively-focused learning in their time at UW-Stout is significantly low. The cause, as stated in the study objective three conclusions, is that no formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge are required for the majority of UW-Stout education majors. Only the Marketing and Business Education undergraduate program has prescribed formal exclusively-focused learning experiences focused on development of computing and Internet technology skills/knowledge. The literature supports the use of formal exclusively-focused learning experiences as a positive contributor to the development of computing and Internet technology skill/knowledge (Abbott & Faris, 2000; Banister & Vannatta, 2006; Basham et al., 2005; Benson et al., 2004; Butler, 2007; Cavenall, 2008; Collier et al., 2004; Egorov et al., 2007; Georgina & Hosford, 2009; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007a).

UW-Stout senior education majors were more likely to experience formally integrated learning experiences to develop of computing and Internet technology skills/knowledge in post-secondary school (92.0%) and high school (80.0%). The formally integrated development of computing and Internet technology skills/knowledge experienced in high school combined with post-secondary school experiences positively contributes to the IC³® Exam results demonstrated by UW-Stout senior education majors. The integrated development experiences of UW-Stout senior education majors in both high school and post-secondary school may also reflect specialized educational interests since 21 of the 25 senior study participants were Marketing and Business Education and Technology Education majors. Since the UW-Stout senior education majors participating in this study were predominately Marketing and Business Education and Technology Education majors, the formally integrated learning experiences of all UW-Stout senior education majors is not known. Computing and Internet technology skills/knowledge development across curriculum has been identified in the literature as a positive contributor to computing and Internet technology skill/knowledge development (Butler, 2007; Cavenall, 2008; Collier et al., 2004; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007b).

UW-Stout senior education majors were most likely to use the informal self-teaching methods of “experimenting” (100.0%), “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (92.0%), "observing other people using computing and Internet technologies" (80.0%), "using the help menu" (80.0%) and "online tutorials" (76.0%). The literature affirms, "experimenting" as a desired method of learning for many undergraduate students (Egorov et al., 2007; Kay, 2007a).

The social aspects of "seeking out a person and asking them questions" and "observing other people using computing and Internet technologies" reflect a collaborative element of learning computing and Internet technology skills/knowledge. The literature also identifies collaboration as a positive contributor to computing and Internet technology skills/knowledge development (Basham et al., 2005; Georgina & Hosford, 2009; Kay, 2007a).

The informal self-teaching method of "online tutorials" appears to be more developed with UW-Stout senior education majors. This result indicates more exposure to online tutorials, such as Lynda@UW-Stout, and more instances where UW-Stout senior education majors have either been encouraged to use "online tutorials" by their instructors or they have personally found "online tutorials" helpful and have included them in their own personal learning strategies.

UW-Stout senior education majors were least likely to use the informal self-teaching method of "training manuals/how-to-books" (20.0%). The result showing UW-Stout senior education majors generally disliking "training manuals/how-to-books" as an informal self-teaching method has been the observation of the study investigator.

Sixteen UW-Stout senior education majors (64.0%) indicated that they had developed computing and Internet technology skills/knowledge through employment-based informal training. The informal employment training methods categories identified were "trial and error" (28.0%), "social interactions" (20.0%) and "OTHER" methods (16.0%). The demonstrated computing and Internet technology skills/knowledge by UW-Stout senior education majors were significantly impacted because of the employment-based informal training. The use of computing and Internet technology skills/knowledge in real employment/problem-solving settings develops overall computing and Internet technology skills/knowledge competence. The literature supports the use of authentic experiences to positively contribute to computing and Internet technology skill/knowledge development (Benson et al., 2004; Brush & Saye, 2009; Cavenall, 2008; Groth et al., 2007; Kay, 2006; Kay, 2007a).

The success on the IC³® Exam by some UW-Stout senior education majors demonstrates evidence of sufficient formal and informal learning experiences to develop computing and Internet technology skills/knowledge. However, the array of formal and informal learning experiences for all UW-Stout senior education majors is very inconsistent. The Marketing and Business Education undergraduate program prescribes formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. Development of computing and Internet technology skills/knowledge by Technology Education undergraduate program comes from a combination of formally integrated, informal self-teaching and employment learning experiences. The formal and informal learning experiences of the rest of UW-Stout senior education majors cannot be clearly identified in this study because of non-representative participation. However, because of the identified lack of formal exclusively-focused learning experiences and inconsistent formally integrated experiences, it is reasonable to suspect that UW-Stout senior education majors are not getting the formal and informal learning experiences needed to develop basic computing and Internet technology skills/knowledge.

Study objective five conclusions. Study objective five compared the measured computing and Internet technology skills/knowledge of UW-Stout freshmen and UW-Stout senior education majors. UW-Stout freshmen education majors performed poorer at a statistically significant level on the three tests that make up the IC³® Exam when compared to UW-Stout senior education majors; Key Applications test (p = .001), Living Online test (p = .000) and Computing Fundamentals test (p = .002).

UW-Stout senior education majors were more likely to earn IC³® Certification at a statistically significant level when compared to UW-Stout freshmen education majors (p = .025). Superior performance on the IC³® Exam and IC³® Certification confirms that UW-Stout senior education majors have better computing and Internet technology skills/knowledge than UW-Stout freshmen education majors do.

While it is clear that the UW-Stout senior education majors as a group outperformed the UW-Stout freshmen education majors, the specialized nature of both the Marketing and Business Education and Technology Education seniors who participated in this study created the substantial difference in demonstrated computing and Internet technology skills/knowledge with the UW-Stout freshmen education majors. It should also be noted that 52.0% of the UW-Stout senior education majors did not earn IC³® Certification and 17.4% of the UW-Stout freshmen education majors did earn IC³® Certification. The four UW-Stout freshmen study participants who earned IC³® Certification were statistical outliers related to freshmen group as a whole. The same cannot be said for the 13 UW-Stout senior education majors who did not earn IC³® Certification. Considering that the IC³® Exam is a measure of basic computing and Internet technology skills/knowledge, all UW-Stout senior education majors should reasonably be able earn IC³® Certification (IC³® Home, 2009).

With exception of the Marketing and Business Education and Technology Education undergraduate programs, questions about UW-Stout senior education undergraduate's computing and Internet technology skills/knowledge remain. Evidence based on known undergraduate education degree program plans and performance of OTHER senior education majors in this study points to levels of computing and Internet technology skills/knowledge that are low.

Study objective six conclusions. Study objective six compared the identified learning experiences of UW-Stout freshmen education majors and UW-Stout senior education majors associated with the development of computing and Internet technology skills/knowledge. No statistically significant relationships were found comparing UW-Stout freshmen and senior education majors on formal exclusively-focused development of computing and Internet technology skills/knowledge in elementary school (p = .613), middle school (p = .571), high school (p = .753) or OTHER school (constant). UW-Stout freshmen and senior education majors have had very similar formal exclusively-focused learning experiences. Formal exclusively-focused learning experiences would seem to be marginal in the K-12 schools where all UW-Stout students originate.

The comparison of formal exclusively-focused learning experiences in post-secondary school (p = .067) to develop computing and Internet technology skills/knowledge for UW-Stout freshmen and senior education majors was practically significant. UW Stout senior education majors were more likely to have formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. This result was likely caused by the Marketing and Business Education seniors (N = 9) who have taken a series of prescribed courses to develop computing and Internet technology skills/knowledge.

No statistically significant relationships were found comparing UW-Stout freshmen and senior education majors on formally integrated development of computing and Internet technology skills in elementary school (p = .459), middle school (p = .252), high school (p = .404) or OTHER school (p = .708). UW-Stout freshmen and senior education majors have both had marginal formally integrated learning experiences to development computing and Internet technology skills/knowledge in K-12 school systems.

The comparison of formally integrated learning experiences in post-secondary school was identified as statistically significant (p = .000). UW Stout senior education majors (92.0%) identified more instances of formally integrated learning experiences to develop computing and Internet technology skills/knowledge than did UW-Stout freshmen education majors (30.0%). This result indicates that UW-Stout senior education majors have had more opportunities for learning experiences in their time at UW-Stout where teaching faculty have purposely integrated computing and Internet technology skills/knowledge into curriculum. Again, this positive result should be tempered considering the make-up of the UW-Stout senior education majors who participated in this study; Marketing and Business Education and Technology Education seniors (N = 21).

The informal self-teaching method of "online tutorials" (p = .085) had practical significance. UW-Stout senior education majors were more likely to use "online tutorials" to develop computing and Internet technology skills/knowledge than were UW-Stout freshmen education majors because UW-Stout senior education majors have had more exposure to online tutorials. Lynda@UW-Stout is an online tutorial system that UW-Stout has subscripted to for several years. A study by Basham, Palla and Pianfetti (2005) demonstrated the effectiveness of "online tutorials" as an informal self-teaching method.

UW-Stout senior education majors were more likely to developed computing and Internet technology skills/knowledge through formal (p = .101) and informal (p = .003) employment training than were UW-Stout freshmen education majors. UW-Stout senior education majors are more likely than UW-Stout freshmen education majors to be duly employed and, therefore, learning computing and Internet technology skills/knowledge through formal and informal employment training. The literature identifies authentic employment experiences as a contributor to computing and Internet technology skill/knowledge development (Benson et al., 2004; Brush & Saye, 2009; Cavenall, 2008; Groth et al., 2007; Kay, 2006; Kay, 2007a).

Conclusions for Notable Undergraduate Education Degree Program Comparisons

Notable undergraduate degree program groupings for UW-Stout freshmen education majors included Marketing and Business Education compared to OTHER freshmen education majors, Early Childhood Education compared to OTHER freshmen education majors, Marketing and Business Education compared to Early Childhood Education and Marketing and Business Education, Early Childhood Education and OTHER freshmen education majors compared.

Notable undergraduate degree program groupings for UW-Stout senior education majors included Marketing and Business Education compared to OTHER senior education majors, Technology Education compared to OTHER senior education majors, Marketing and Business Education compared to Technology Education and Marketing and Business Education, Technology Education and OTHER senior education majors compared.

Notable UW-Stout freshmen education major groupings: Marketing and Business Education compared to OTHER freshmen education majors. UW-Stout Freshmen Marketing and Business Education majors were no more likely to earn IC³® Certification than were OTHER UW-Stout freshmen education majors (p =.106). Previous conclusions have shown that the Marketing and Business Education majors successfully demonstrate computing and Internet technology skills/knowledge because of their specialized focus on computing and Internet technology skills/knowledge. However, this result supports the view that all UW-Stout freshmen education majors have the poor computing and Internet technology skills/knowledge.

UW-Stout Freshmen Marketing and Business Education majors were more likely to experience formal exclusively-focused learning in post-secondary school (p = .000) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout freshmen education majors. This result likely reflects the specialized nature of the Marketing and Business Education major with regard to computing and Internet technology skills/knowledge. In the first semester of their first year, Freshmen Marketing and Business Education majors, through formal exclusively-focused experiences, start to develop computing and Internet technology skills/knowledge. The Marketing and Business Education program is the only undergraduate degree program within the UW-Stout School of Education with a prescribed set of courses to develop computing and Internet technology skills/knowledge.

UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning in elementary school (p = .190), middle school (p = .099), high school (p = .809), post-secondary school (p = .809) or OTHER school (p = .742), to development computing and Internet technology skills/knowledge than were OTHER UW-Stout freshmen education majors. This result supports a consistency of poor formally integrated learning experiences for all freshmen education majors participating in this study.

UW-Stout Freshmen Marketing and Business Education majors were no more likely to use the informal self-teaching methods of “training manuals/how-to books” (p = .235), “online tutorials” (p = .147), “video/CD-ROM/DVD tutorials” (p = .526), “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (p = .742), “using the help menu” (p = .809), “experimenting” (p = .202) or “observing other people using computing and Internet technologies” (p = .624) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout freshmen education majors. This result would confirm previous findings showing consistency in use of informal self-teaching methods used by all UW-Stout freshmen education majors.

While UW-Stout Freshmen Marketing and Business Education majors were no more likely to develop computing and Internet technology skills/knowledge through employment-based formal exclusively-focused training, they were more likely to experience employment-based informal training than were OTHER UW-Stout freshmen education majors (p =.034). This result reflects the value of employment experiences in Marketing and Business Education programming in K-12 schools. The UW-Stout Freshmen Marketing and Business Education majors participating in this study have likely been actively employed more so than OTHER UW-Stout freshmen education majors.

Notable UW-Stout freshmen education major groupings: Early Childhood Education compared to OTHER freshmen education majors. UW-Stout Freshmen Early Childhood Education majors were no more likely to earn IC³® Certification than were OTHER UW-Stout freshmen education majors (p = .108). This result further supports the fact that UW-Stout freshmen education majors, as a group, have poor computing and Internet technology skills/knowledge.

UW-Stout Freshmen Early Childhood Education majors were less likely to experience formal exclusively-focused learning experiences in post-secondary school (p = .037) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout freshmen education majors. This result is confirmed by the fact that the Early Childhood Education undergraduate program does not prescribe any formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge for their students.

Though not statistically significant, UW-Stout Freshmen Early Childhood Education majors were less likely in post-secondary school (p = .172) to experience formally integrated learning experiences to development computing and Internet technology skills/knowledge. This result may suggest that the Early Childhood Education program does not deem important computing and Internet technology skills/knowledge development across curriculum.

UW-Stout Freshmen Early Childhood Education majors were more likely to use the informal self-teaching methods of "online tutorials" (p = .013) and "using the help menu" (p = .172) when compared to OTHER UW-Stout freshmen education majors. These results are interesting, as it would appear that the Early Childhood Education freshmen who participated in this study were encouraged by teaching faculty in their first semester at UW-Stout to develop their own personal learning strategies to learn computing and Internet technology skills/knowledge. The literature encourages the development of personal learning strategies as a positive contribution to computing and Internet technology skill/knowledge development (Banister & Vannatta, 2006; Basham et al., 2005; Clark, 2007; Collier et al., 2004; Egorov et al., 2007; Georgina & Hosford, 2009; Huang, 2006; Kay, 2007a).

UW-Stout Freshmen Early Childhood Education majors were no more likely to attend employment-based formal exclusively-focused training (p = .455) or employment-based informal training (p = .433) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout freshmen education majors. This result again shows that most UW-Stout freshmen education majors are not employed in positions where they get opportunities for formal exclusively-focused or informal training to develop computing and Internet technology skills/knowledge.

Notable UW-Stout freshmen education major groupings: Marketing and Business Education compared to Early Childhood Education. UW-Stout Freshmen Marketing and Business Education majors were no more likely to earn IC³® Certification than were UW-Stout Freshmen Early Childhood Education majors (p = .072). This result further supports the fact that UW-Stout freshmen education majors, as a group, have poor computing and Internet technology skills/knowledge.

UW-Stout Freshmen Marketing and Business Education majors were more likely to experience formal exclusively-focused learning in post-secondary school (p = .004) to develop computing and Internet technology skills/knowledge than were UW-Stout Freshmen Early Childhood Education majors. This result reflects the emphasis the UW-Stout Marketing and Business Education undergraduate program puts on the development of computing and Internet technology skills/knowledge using formal exclusively-focused learning experiences.

UW-Stout Freshmen Marketing and Business Education majors were no more likely to experience formally integrated learning to develop computing and Internet technology skills/knowledge in elementary school (p = .453), middle school (p = .490), high school (p = .858), post-secondary school (p = .312) or OTHER school (p = .331) than were UW-Stout Freshmen Early Childhood Education majors. This result seems to further support the overall inconsistency of formally integrated learning experiences to develop computing and Internet technology skills / knowledge development across curriculum for all freshmen participating in this study.

At a statistically significant level (p = .024), UW-Stout Freshmen Marketing and Business Education majors were less likely to use the informal self-teaching method “online tutorials” than were UW-Stout Freshmen Early Childhood Education majors. Conclusions related to this result are similar to the comparison of UW-Stout Freshmen Early Childhood Education majors and OTHER UW-Stout freshmen education majors discussed in the previous section. UW-Stout Freshmen Early Childhood Education majors seem to be encouraged to use "online tutorials" more often than UW-Stout Freshmen Marketing and Business Education majors.

A practically significant relationship (p = .149) was found in that UW-Stout Freshmen Marketing and Business Education majors were more likely to experience employment-based informal training to develop computing and Internet technology skills/knowledge than were UW-Stout Freshmen Early Childhood Education majors. Again, this result likely reflects the specialized nature of Marketing and Business Education majors. Employment experiences are highly encouraged in K-12 Marketing and Business Education curriculum. The UW-Stout Freshmen Marketing and Business Education majors participating in this study likely have been actively employed more so than UW-Stout Freshmen Early Childhood Education majors.

Notable UW-Stout freshmen education major groupings: Marketing and Business Education, Early Childhood Education and OTHER freshmen education majors compared. Comparing the frequency of UW-Stout Freshmen Marketing and Business Education, Early Childhood Education and OTHER UW-Stout freshmen education majors who earned IC^3® Certification found no significant difference (p = .208). This result indicates that UW-Stout freshmen education majors do not significantly differ from each other regarding computing and Internet technology skills/knowledge. UW-Stout freshmen education majors who participated in this study (N = 23) demonstrated similar (poor) computing and Internet technology skills/knowledge.

Notable UW-Stout senior education major groupings: Marketing and Business Education compared to OTHER senior education majors. UW-Stout Senior Marketing and Business Education majors were no more likely to earn IC³® Certification than were OTHER UW-Stout senior education majors (p = .161). From a practical perspective, UW-Stout Senior Marketing and Business Education majors earned IC³® Certification nearly twice as often as OTHER UW-Stout senior education majors did. This result reflects the Marketing and Business Education emphasis on computing and Internet technology skills/knowledge. Marketing and Business Educators have traditionally been consider the “computer-people” in K-12 schools and are prepared for this role reflective of the design of their degree program course work. Still, the fact that only approximately 70% of the Senior Marketing and Business Education majors earned IC³® Certification shows that improvements in the overall formal and informal learning experiences of Marketing and Business education majors would be appropriate.

UW-Stout Senior Marketing and Business Education majors were more likely to take a formal exclusively-focused course in post-secondary school (p = .006) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. This result reflects the specialized nature of the Marketing and Business Education major regarding computing and Internet technology skills/knowledge. As previously noted, the Marketing and Business Education program is the only undergraduate degree program within the UW-Stout School of Education with a prescribed set of courses to develop computing and Internet technology skills/knowledge. Without these formal exclusively-focused learning experiences, the UW-Stout Senior Marketing and Business Education majors would likely demonstrate less ability with computing and Internet technology skills/knowledge.

UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning to development computing and Internet technology skills/knowledge in elementary school (p = .282), middle school (p = .734), high school (p = .405), post-secondary school (p = .269) or OTHER school (p = .918) than were OTHER UW-Stout senior education majors. This result seems to show that UW-Stout Senior Marketing and Business Education majors have the same formally integrated learning experiences as OTHER UW-Stout senior education majors. Computing and Internet technology skills / knowledge development across curriculum in all levels of formal schooling would seem to be lacking a consistent quality.

UW-Stout Senior Marketing and Business Education majors were no more likely to use the informal self-teaching methods of "training manuals/how-to books" (p = .211), "online tutorials" (p = .412), "video/CD-ROM/DVD tutorials" (p = .610), "seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions" (p = .667), "using the help menu" (p = .405), "experimenting" (constant), "observing other people using computing and Internet technologies" (p = .405) or "OTHER methods" (p = .667) to teach themselves computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. This result confirms previous findings showing consistency in use of informal self-teaching methods used by all UW-Stout senior education majors.

UW-Stout Senior Marketing and Business Education majors were no more likely to attend employment-based formal exclusively-focused training (p = .211) or experience employment-based informal training (p = .282) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. The literature identifies authentic employment experiences as a positive contributor to computing and Internet technology skills/knowledge development (Benson et al., 2004; Brush & Saye, 2009; Cavenall, 2008; Groth et al., 2007; Kay, 2006; Kay, 2007a).

Notable UW-Stout senior education major groupings: Technology Education compared to OTHER senior education majors. UW-Stout Senior Technology Education majors were no more likely to earn IC³® Certification than were OTHER UW-Stout senior education majors (p = .848). This result was initially surprising because the UW-Stout Technology Education program does not prescribe any formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. See the "formally integrated learning experiences" portion of this section for more insight into the unexpected performance on the IC³® Exam by UW-Stout Technology Education seniors.

UW-Stout Senior Technology Education majors were no more likely to have formal exclusively-focused learning experiences in elementary school (p = .568), middle school (p = .821), high school (p = .543) or post-secondary school (p = .320) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. This result demonstrates a lack of formal exclusively-focused learning experiences for Senior Technology Education majors. With exception of Marketing and Business Education, Technology Education and all OTHER UW-Stout senior education majors lack formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge.

UW-Stout Senior Technology Education majors were more likely to experience formally integrated learning experiences units in middle school (p = .141), high school (p = .161) and post-secondary school (p = .157) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. UW-Stout Senior Technology Education majors identified consistent, consecutive formally integrated learning experiences that contributed to their surprisingly strong performance on the IC³® Exam. The literature supports formally integrated learning experiences across the curriculum as a positive contributor to computing and Internet technology skill/knowledge development (Butler, 2007; Cavenall, 2008; Collier et al., 2004; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007b).

UW-Stout Senior Technology Education majors were no more likely to use the informal self-teaching methods of “training manuals/how-to books” (p = .689), “online tutorials” (p = .409), “video/CD-ROM/DVD tutorials” (p = .327), “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (p = .953), “using the help menu” (p = .548), “experimenting”(constant), “observing other people using computing and Internet technologies” (p = .548) or “OTHER methods” (p = .953) to teach themselves computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. This result further confirms previous findings showing consistency in the use of informal self-teaching methods by UW-Stout Senior Technology Education majors as well as all UW-Stout senior education majors.

UW-Stout Senior Technology Education majors were no more likely to attend employment-based formal exclusively-focused training (p = .689) or employment-based informal training (p = .161) to develop computing and Internet technology skills/knowledge than were OTHER UW-Stout senior education majors. This result again supports the idea that all UW-Stout senior education majors have consistent learning experiences in their places of employment. The literature identifies authentic employment experiences as a positive contributor to computing and Internet technology skills/knowledge development (Benson et al., 2004; Brush & Saye, 2009; Cavenall, 2008; Groth et al., 2007; R. H. Kay, 2006; R. Kay, 2007a).

Notable UW-Stout senior education major groupings: Marketing and Business Education compared to Technology Education. UW-Stout Senior Marketing and Business Education majors were no more likely to earn IC³® Certification than were UW-Stout Senior Technology Education majors (p = .445). As previously mentioned, this was a surprise result based upon the assumption of the Marketing and Business Education seniors being the only UW-Stout undergraduate education program experiencing formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. It is likely that a combination of formally integrated learning experiences, informal self-teaching methods, employment-based formal exclusively-focused training and employment-based informal training contributed to the IC³® Exam results demonstrated by the UW-Stout Senior Technology Education study participants.

UW-Stout Senior Marketing and Business Education majors were more likely to take a formal exclusively-focused course in post-secondary school (p = .027) to develop computing and Internet technology skills/knowledge than were UW-Stout Senior Technology Education majors. Again, this result reflects the specialized nature of the Marketing and Business Education majors regarding development of computing and Internet technology skills/knowledge along with the fact that the UW-Stout Marketing and Business Education program is the only education program at UW-Stout to prescribe formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge.

UW-Stout Senior Marketing and Business Education majors were no more likely to experience formally integrated learning experiences to develop computing and Internet technology skills/knowledge in elementary school (*p* = .350), middle school (*p* = .350), high school (*p* = .830), post-secondary school (*constant*) or OTHER school (*p* = .819) than were UW-Stout Senior Technology Education majors. Even with no statistically significant differences, formally integrated learning experiences appear to have contributed to the success of UW-Stout Senior Technology Education majors on the IC³® Exam. This fact may speak to the quality of computing and Internet technology skills/knowledge development across curriculum experienced by UW-Stout Technology Education majors. The literature supports integration of computing and Internet technology skills/knowledge across the curriculum as a positive contributor to overall computing and Internet technology skills/knowledge development (Butler, 2007; Cavenall, 2008; Collier et al., 2004; Groth et al., 2007; Guerrero et al., 2004; Hardy, 2003; Kay, 2006; Kay, 2007b).

UW-Stout Senior Marketing and Business Education majors were no more likely to use the informal self-teaching methods of “training manuals/how-to books” (*p* = .375), “online tutorials” (*p* = .375), “video/CD-ROM/DVD tutorials” (*p* = .445), “seeking out a person who is knowledgeable in the use of computing and Internet technologies and asking them questions” (*p* = .830), “using the help menu” (*p* = .422), “experimenting” (constant), “observing other people using computing and Internet technologies” (*p* = .422) or “OTHER methods” (*p* = .830) to teach themselves computing and Internet technology skills/knowledge than were UW-Stout Senior Technology Education majors. This result would confirm previous findings showing consistency in use of informal self-teaching methods used by all UW-Stout senior education majors.

UW-Stout Senior Marketing and Business Education majors were no more likely to attend employment-based formal exclusively-focused training (*p* = .375) or employment-based informal training (*p* = .195) to develop computing and Internet technology skills/knowledge than were UW-Stout Senior Technology Education majors. Both Senior Marketing and Business Education and Senior Technology Education majors have had employment-based formal and informal learning experiences that have positively contributed to their demonstrated computing and Internet technology skills/knowledge.

Notable UW-Stout senior education major groupings: Marketing and Business Education, Technology Education and OTHER senior education majors compared. Comparing the frequency of UW-Stout Senior Marketing and Business Education, UW-Stout Senior Technology Education and OTHER UW-Stout senior education majors who earned IC³® Certification found a practical difference (p = .092). UW-Stout Senior Marketing and Business Education majors, UW-Stout Senior Technology Education majors and OTHER UW-Stout senior education majors did differ from each other relative to earning IC³® Certification. This result seems to speak to the number and quality of formal and informal learning experiences. It is clear that Marketing and Business Education and Technology Education majors performed reasonably well on the IC³® Exam because of the learning experiences they both identified. The OTHER UW-Stout senior education majors performed poorly on the IC³® Exam and identified less formal and informal learning experiences to develop computing and Internet technology skills/knowledge.

In summary, the major conclusions of this study are:

- As a group, UW-Stout freshmen education majors demonstrated poor computing and Internet technology skills/knowledge. The assumption that freshmen entering post-secondary education possess basic computing and Internet technology skills/knowledge is false.

- As a group, UW-Stout senior education majors demonstrated better computing and Internet technology skills/knowledge than UW-Stout freshmen education majors. However, the majority of UW-Stout senior education majors participating in this study did not demonstrate the basic computing and Internet technology skills/knowledge needed to function as digitally literate 21st Century educators.
- Both UW-Stout freshmen and senior education majors have good or poor computing and Internet technology skills/knowledge because of the number and quality of formal and informal learning experiences. The formal and informal learning experiences to develop computing and Internet technology skills/knowledge for all UW-Stout education majors are fragmented, inconsistent or missing. Evidence exists showing UW-Stout undergraduate education programs not providing any formal or informal learning experiences to develop computing and Internet technology skills/knowledge.
- UW-Stout senior education majors computing and Internet technology skills/knowledge are better because they have had more formal and informal learning experiences in post-secondary schooling and employment.
- UW-Stout senior education majors, through more time spent in post-secondary schooling and employment, have better developed informal self-teaching methods, or personal learning strategies, to develop computing and Internet technology skills/knowledge.
- The UW-Stout Marketing and Business Education program is the only undergraduate education program at UW-Stout to prescribe formal exclusively-focused learning experiences to develop computing and Internet technology skills/knowledge. UW-

Stout Marketing and Business Education majors, as a group, earned IC³® Certification more often any other UW-Stout education major participating in this study. This also included three Freshmen Marketing and Business Education majors who earned IC³® Certification.

- UW-Stout Senior Technology Education majors performed surprisingly well on the IC³® Exam. This phenomenon was likely caused by identified formally integrated learning experiences over a time span covering middle school, high school and post-secondary school.

Recommendations to Improve the Computing and Internet Technology Skills/Knowledge of UW-Stout Education Majors

The literature has an abundance of suggestions to best prepare future teachers to use and integrate computing and Internet technology skills/knowledge. Kay (2006) conducted an exhaustive examination of studies focused on development of computing and Internet technology skills/knowledge for preservice teachers. Based upon Kay's strategies and best practices, the following are recommendations to improve the computing and Internet technology skills/knowledge of UW-Stout Education majors.

- Implement a performance-based assessment system to objectively measure the computing and Internet technology skills/knowledge of UW-Stout education majors. Kay found that while each of the studies she reviewed expended a great deal of effort and resources on strategies to develop computing and Internet technology skills in preservice teachers, very little effort was put into objective assessment (Dickerson, 2005; Fisher & Solliday-McRoy, 1998; Kay, 2006; Marvin, 2004). Erroneous assumptions and perceptual assessments of computing and Internet technology skills/knowledge are not reliable methods to determine if a person has basic computing and Internet technology skills/knowledge. Systems such as SAM 2007 by Course Technology Cengage Learning and the IC³® Exam by Certiport, Inc. provide assessment, computer-based training and administrative functions to manage results. Accurate assessment not only identifies the computing and Internet technology skills/knowledge of students but also aids teaching faculty in curriculum development. Knowing what our students need is vital when developing curriculum to address computing and Internet technology skills/knowledge.

- Require all UW-Stout education majors to take a basic computing and Internet technology skills/knowledge course. The results of this study show that K-12 school systems are not providing their students instruction to learn computing and Internet technology skills/knowledge. While it is the view of the investigator that instruction on basic computing and Internet technology skills/knowledge should occur outside of post-secondary education, it is still the responsibility of the post-secondary institution to prepare future educators with skills needed to be relevant 21st Century education professionals.
- Approach the learning of computing and Internet technology skills/knowledge as a personal responsibility. Beyond formal instruction to learn basic computing and Internet technology skills/knowledge, students, teaching faculty and every person who uses computing and Internet technology skills/knowledge needs to take responsibility for their own continued learning. It is clearly understood that the "turn-over" of computing and Internet hardware and software is perpetual. Traditional training models have unsuccessfully tried to keep pace. Even as training does keep

pace, it is not often cost or time efficient to continually go to training to learn the newest computing and Internet technology skills/knowledge. The UW-Stout School of Education should address this situation with a purposeful development of "personal learning strategies". Personal learning strategies are self-directed methods to learn computing and Internet technology skills/knowledge. Personal learning strategies to learn computing and Internet technology skills/knowledge should be a part of every course.

- Integrate computing and Internet technology skills/knowledge in all courses required by UW-Stout education majors. While the formal exclusively-focused computing and Internet technology skills/knowledge course is for learning the technology, integration of computing and Internet technology skills/knowledge development across curriculum is about using computing and Internet technology skills/knowledge to learn. Education majors need to be given the opportunity to use contemporary computing and Internet technology skills/knowledge to solve problems in diverse settings and with diverse subject matter.
- Modeling the use of computing and Internet technology skills/knowledge. This may be the most vital recommendation. Preservice teachers need to see teaching faculty using computing and Internet technology skills/knowledge. Value is placed on the "models" demonstrating computing and Internet technology skills/knowledge to accomplish goals, communicate, create efficiencies and express creativity.
- Along with modeling, providing UW-Stout teaching faculty with the tools and learning experiences they need to successfully use computing and Internet technology skills/knowledge. This often is an overlooked or a "hands-off" area. However, if

teaching faculty do not have basic computing and Internet technology skills/knowledge, how can we expect the preservice teachers they instruct will?

- Provide authentic use opportunities. Instruction on, integration with, and modeling of computing and Internet technology skills/knowledge will only be effective when used in a real teaching and learning setting. Preservice teachers should be given multiple opportunities to use the computing and Internet technology skills/knowledge they have learned in the classroom in their own practicum experiences. These experiences may be pre-clinical experiences, student teaching, community workshops, etc.
- Nurture the collaboration and communication among preservice teachers, mentor teachers, and teacher faculty. This is a recommendation related to the recommendation for authentic use opportunities. The teaching faculty and UW-Stout should continue to build relationships with K-12 partners to provide the best opportunities of authentic use experiences. Placing preservice teachers into school systems that reflect progressive use of computing and Internet technology skills/knowledge is ideal.
- Improving access to software, hardware, and/or support was suggested by Kay. UW-Stout has done a good job providing a computing and Internet technology infrastructure to support the campus learning community. Improvement will occur with an emphasis on computing and Internet technology skills/knowledge development.
- Use multiple strategies to develop the computing and Internet technology skills of preservice teachers at UW-Stout. Kay found that the teacher preparations programs

that had the best results often used multiple strategies from the stand-alone skills course to practicum experiences.

Finally, the concluding recommendation is in the form of a question. The previous ten recommendations depend largely upon the answer to this question:

> Are computing and Internet technology skills/knowledge a part of foundational basic learning that all UW-Stout preservice teachers should have (like writing skills, presentation skills, use of language, etc.) or not?

The literature clearly shows that public schools in the United States have received billions of dollars in public and private funding to provide access to computing and Internet technology skills/knowledge. According to the Education and Library Networks Coalition (EdLiNC), from 1998 to 2005, $14,656,354,950 has been paid out to States and territories of the United States. Of this total funding amount, Wisconsin has received $192,988,880 (Education and Library Networks Coalition, 2007). It is also clear that numerous standards exist that inform the education community in the development of computing and Internet technology skills/knowledge. The Partnership for 21st Century Skills, ISTE's National Educational Technology Standards (NETS) Project and the State of Wisconsin's Model Academics Standards for Information and Technology Literacy just to name a few. With all of these resources, it is reasonable to expect results. Yet, this study and others studies demonstrate that results are poor. So, again,

> Are computing and Internet technology skills/knowledge a part of foundational basic learning that all UW-Stout preservice teachers should have (like writing skills, presentation skills, use of language, etc.) or not?

Senator James Huff Stout had the vision of an education that prepared young people of the late 19th and early 20th Centuries with the general subjects of History, English, Science and Mathematics, and with "…that which best equips a young person for practical life work; that best fits… to earn a living and contribute to the demands of society; that gives… the greatest usefulness and encourages the highest and best citizenship" (Agnew, 1990, p.18). In the 21st Century, computing and Internet technology skills/knowledge are a vital part of what equips preservice teachers for "…that which best equips …for practical life work; that best fits… to earn a living and contribute to the demands of society; that gives… the greatest usefulness and encourages the highest and best citizenship". It is time for the UW-Stout School of Education to take Senator Stout's charge seriously. It is time for UW-Stout education programs to provide the appropriate learning experiences so that the next generation of educators possesses computing and Internet technology skills/knowledge.

Recommendations for Further Study

Based upon the findings of this study, the following are suggested recommendations for further study.

- Identify what K-12 public schools in the State of Wisconsin require their students to learn related to computing and Internet technology skills/knowledge. This recommendation is based upon the identified inconsistent formal and informal learning experiences to develop computing and Internet technology skills/knowledge identified by all of the participants in this study.
- Repeat this research to examine the computing and Internet technology skills/knowledge and formal and informal learning experiences of UW-Stout senior education majors that were not represented in this study. This recommendation is

based upon the fact that the majority of the participants in this study, Marketing and Business Education and Technology Education, are largely specialized education programs that only represent a minority of educators.

- Repeat this research to examine the computing and Internet technology skills/knowledge and learning experiences of freshmen and senior education majors from other teacher preparation programs in the UW-System.
- Repeat this research to examine the computing and Internet technology skills/knowledge of all students at UW-Stout. While it was the focus of this study to examine the computing and Internet technology skills/knowledge and learning experiences of UW-Stout education majors, personal observation and evidence from the literature do suggest that computing and Internet technology skills/knowledge of all college students are questionable. In particular, the computing and Internet technology skills/knowledge of incoming college freshmen.
- Explore issues that may be preventing UW-Stout-Stout teaching faculty from effectively integrating computing and Internet technology skills/knowledge into curriculum. Special focus on those teaching faculty who teach freshmen level courses. This suggestion comes from the evidence in this study showing an inconsistency of computing and Internet technology skills/knowledge development across curriculum identified by the freshmen who participated in this study.
- Examine the computing and Internet technology skills/knowledge development across curriculum phenomena identified by UW-Stout Senior Technology Education majors. To use computing and Internet technology skills/knowledge as tools for learning while learning about the tools is ideal. It would be interesting to examine the

curriculum integration approaches used by the educators to integrate computing and Internet technology skills/knowledge development across their curriculum.

Recommendation to Improve the Computing and Internet Technology Skills/Knowledge of all UW-Stout Students

Based upon the generalization that computing and Internet technology skills/knowledge deficiencies are not just an issue for preservice teachers, the University of Wisconsin-Stout needs to establish a general education requirement assuring foundational computing and Internet technology skills/knowledge for all its students. This requirement would be supported by a hybrid learning system that would utilize performance assessment, classroom learning, computer-based training and an enterprise resource system to manage administrative functions.

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Appendix A: IC³® Validation Brief

The following brief is for the IC³® Exam by Certiport, Inc. Please contact Certiport, Inc for further information.

Certiport, Inc.

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IC³ Validation Brief

2002-2003

CERTIPORT™

DOCUMENT PURPOSE

This Validation Summary document has been created to inform those reviewing or evaluating the Internet & Computing Core Certification (IC³) program of the processes and procedures used to develop and validate the IC³ examinations.

True certification-level exams undergo an in-depth and strenuous development process. In summary form, this document outlines the steps taken by the exam developers to ensure the IC³ program meets the highest industry standards of quality and validity for test and certification program development. This document is not intended to be an exhaustive report of the research, analysis, and developmental steps taken to create the IC³ certification program. The full validation report, prepared by The Donath Group, is available to qualified parties under a non-disclosure agreement.

INTRODUCTION

Internet & Computing Core Certification Overview

The Internet & Computing Core Certification (IC³) is a standards-based certification program for basic computing and Internet literacy. IC³ provides specific guidelines for the knowledge and skills required to be a functional user of computer hardware, software, networks and the Internet. By establishing this vendor-independent standard, IC³ provides a reliable, universal measure of basic computing and Internet skills.

IC³ consists of three different competency exams. Passing all three IC³ exams qualify an individual to receive IC³ certification.

- *Computing Fundamentals*: this exam measures examinee knowledge of computer hardware, software, and basic operating system skills.

- *Key Applications*: this exam evaluates examinee proficiency in two computer applications (a word processor and spreadsheet) and the common features of different applications.

- *Living Online*: this exam measures basic skills in using networks, electronic mail, the Internet, and Web browsing software as well as an understanding of how computers and the Internet affect society.

Each exam uses various test-question methods. Whenever possible, testing the ability to use specific product functions (such as file and system management functions of Windows) is done with performance-based test items where candidates are asked to perform specific software tasks in a realistic simulation of the software environment. Performance-based testing has proven to have a high degree of statistical reliability and user satisfaction. Testing of other knowledge types (such as knowledge of hardware and software) is done with traditional linear type questions, like multiple choice, multiple response and matching test items.

The appropriate mix of linear and performance-based testing questions to measure the knowledge, skills and abilities of candidates for IC³ ensures a high degree of validity, reliability and impartiality for all participants in the program.

IC³ Program Partners

The IC³ program was developed through the partnership of Certiport, Inc., the leading provider of global, performance-based certification programs and services, and SkillCheck, Inc., a leading provider of assessment and testing products to the education and training, human resources, and staffing services industries.

The exam development process was guided by The Donath Group, a leading psychometric and evaluative research consulting organization with over fifty years of highly specialized experience in test construction, measurement, and statistical analysis.

IMPORTANCE OF VALIDATION

Certification Validation Overview

Exams developed as industry recognized certifications must meet high demands of rigor in the test development, validation and analysis processes. By publishing certification exams that have followed the most credible development standards and methodologies, test developers can ensure that certificate holders possess the clearly defined knowledge and/or skill sets corresponding to that specific certification. In short, certifications purporting to be industry standards must also be standards driven—they must adhere to the testing industry's highest set of guidelines of acceptable professional test development processes represented by such guidelines as *The Standards for Educational and Psychological Testing* and the *Uniform Guidelines on Employee Selection Procedures*.

Exam Validity

Exam test validity is the most important consideration in evaluating tests for a particular purpose—especially when exams are used for industry certifications. The concept of validity refers to the meaningfulness, usefulness and appropriateness of inferences made from test scores. Test validation, therefore, is the process of gathering evidence to support the inferences made by test scores.

Validity cannot be adequately summarized by a single set of evidence, such as a reliability coefficient. This is particularly important today as the term "certification" is usually used to make an inference about probable job behavior performance based on the resulting test score. Because of this, it is critically important that validity for a particular test score be supported through an accumulation of empirical, theoretical, statistical, and conceptual evidence.

Types of Validity

The following discusses the main types of validation evidence for interpreting test scores.

Content-oriented validation

Content validity refers to the extent to which test scores measure the content they are intended to measure. Content-related validity evidence can be gathered by examining the degree of congruence between test items and the content domains purportedly measured by the test items. This typically requires convening a panel of subject matter experts and asking them to rate the item-objective congruence according to some established criteria.

Construct-related validation

Construct validity refers to the extent to which the test scores measure the construct it is intended to measure. It focuses on the relationship between the specific research operations used and the abstract labeling of them either in cause or effect constructs. Construct validity can be investigated using factor analysis or a multitrait-multimethod matrix procedure. A construct is usually a theoretical, unobservable dimension of a measurement procedure. Test question responses are used to assess whether there is a statistical underlying factor represented by the responses.

Criterion-related validation

Criterion-related validity evidence refers to how well test scores correlate or predict other measures of importance, such as some level of job performance, experience, knowledge or skills. Criterion-related validity can be determined by contrasting groups of known masters and nonmasters in the content area and perform a comparison of the test score distributions and reliabilities. This has the benefit of being entirely empirical when the two groups are identified.

Standard Validation Methodology

The following are brief descriptions of well-established exam development methodologies used to fulfill the main types of validity and publish high quality certification exams. These activities formed the basis for the validation of the IC³ program.

- Job Task Analysis - Identify the knowledge, skills and abilities required of a certified employee or individual.
- Blueprint Development - Define the scope and content of the skills to be measured by the exam.
- Survey Analysis - Gather supporting evidence from a blueprint survey of subject matter experts.
- Pilot Tryout & Analysis – Pilot all test items through a complete tryout with a representative sample of certification candidates. The tryout demonstrates empirically how each item behaves under standardized testing conditions.
- Pilot Test Analysis - Evaluate key indices such as the item difficulty value, the discrimination, and the correlation with external criteria and background groups.
- Final Exam Construction - Construct the final exam using the best performing items fitting the exam blueprint.
- Standard Setting – Establish cut scores based on an analysis of candidate data and exam score by using a regression analysis.

The following section describes the many steps IC³ went through to ensure the highest levels of validation.

IC³ VALIDATION

IC³ Validation Overview

From its conception, the mission of the IC³ program was to develop state-of-the-art exams that meet or exceed industry validation standards. To this end, The Donath Group guided the IC³ program development and ensured the IC³ program's compliance with the highest test development methods and procedures, including those outlined by the following standards organizations:

- *The Standards for Educational and Psychological Testing* (American Educational Research Association, the American Psychological Association and National Council on Measurement and Education)
- *The Uniform Guidelines on Employee Selection Procedures* (The Equal Opportunity Commission, Civil Service Commission, Department of Labor and Department of Justice)
- *Certification: A NOCA Handbook* (National Organization for Competency Assurance)

IC³ Exam Validity

In commitment to its mission, the IC³ program took steps to accumulate ample empirical, theoretical, statistical, and conceptual evidence to support its claims of achieving the highest levels of exam validity.

The IC³ exams were developed, created, and validated over a two year period—utilizing the expertise of three leading testing, validation, and evaluation corporations—and drawing on the knowledge of over 270 subject matter experts in 19 countries—and, pilot tested in over 40 different locations worldwide, with over 1,500 exams delivered. The IC³ exams are completely vendor-independent, and have garnered endorsements and recognition from recognized industry and government organizations like CompTIA (Computing Technology Industry Association) and NSSB (National Skills Standard Board).

The result of the IC³ program's validation efforts is a true certification program that accurately and reliably can be used to make solid inferences about an individual's knowledge, skills, and applicable job performance based on the resulting exams' scores. The IC³ program is perfect for academic institutions, workforce development programs, and organizations needing a reliable means of ensuring individual computing literacy in an increasingly digital world.

Types of Validity—Fulfilled by IC³

The IC³ exams fulfilled all necessary processes to ensure coverage of the main types of validation evidence for interpreting test scores.

Content-oriented validation

Content validity refers to the extent to which test scores measure the content they are intended to measure. The IC³ examinations were developed from research in the field of computer and Internet literacy, and then empirically established the most important areas to measure skills and knowledge for this behavioral domain.

Additionally, subject matter experts (SMEs) carefully reviewed the IC³ test objectives and test items for item-objective congruence. The blueprint survey review of the content defined the appropriate content of the examination and the test item reviewers verified that the test items measure and represent the content of each of the test objectives covered in the examination.

Content-oriented validation evidence is provided in points 1, 2, 3, 4 and 5 under sub-section "IC³ Validation Methodology."

Construct-related validation

Construct-related validity refers to the extent to which the test scores measure the construct it is intended to measure. The construct being measured by the IC³ exams is basic knowledge and skills in computing as it exists today for most entry-level jobs using computers. This construct is supported by current research literature, qualitative evaluations by SMEs, and a factor analysis that determined there is an underlying statistical construct for the IC³ test data.

Construct-related validation evidence is provided in points 1, 2, 3, 4, 5 and 6 under sub-section "IC³ Validation Methodology."

Criterion-related validation

Criterion-related validity evidence refers to how well test scores correlate or predict other measures of importance, such as some level of job performance, experience, knowledge or skills. Criterion-related validity was established by comparing and analyzing survey responses by certification candidates to their IC³ exam score distributions. IC³ exam scores were found to highly correlate to a candidate's computing and other appropriate experience levels.

Additionally, when analyzing pass and fail decisions compared to candidate experience, the decisions are very consistent with their levels of experience. Each IC³ exam had strong relationships with these predictor variables.

Criterion-related validation evidence is provided in points 6, 7 and 8 under sub-section "IC³ Validation Methodology."

IC³ Validation Methodology

The sections below summarize the steps taken in the development of the IC³ exams. This process follows, and in some cases exceeds, standards for test validation developed in such documents as *APA Standards* and the *Uniform Guidelines on Employee Selection Procedures*.

1. Industry and Academic Research
    - Research was completed identifying the knowledge, skills and abilities required for IC³ certified individuals
    - A thorough literature review was performed of industry training and educational programs that relate to computer literacy and the latest training and educational methodologies (including Digital Literacy, Information Literacy, Fluency in Information Technology, Media Literacy and Digital Divide)
    - A study was completed of existing national and international programs and curriculumns that clearly define needed competencies in hardware, software and operating systems, applications, networking, electronic mail, and use of the Internet
    - An analysis was conducted of training programs from courseware, CBT, training vendors and book publishers which cover material related to this subject matter

- Focus group discussions with SMEs input were conducted

    - ➢ Sample Result: A review of over twenty classroom training programs, CBT and eLearning products, educational texts, commercial books, and testing products revealed a set of 120 features of a word processor and a spreadsheet that 80-100% of all programs consider to be core functionality required by all users of these applications.

    - ➢ Sample Result: A study of the latest methodologies for computer education (including Digital Literacy, Internet Literacy and Fluency in Information Technology) revealed that most current thinking in these areas stress not just technical skill, but the ability to understand and interpret information gathered from online sources.

2. Job Task Analysis
    - A job task analysis (JTA) was carefully documented and analyzed through surveys and discussion groups of SMEs
    - The JTA study defined the important job behaviors for an IC³ certified individual
    - The JTA identified the knowledge, skills, and abilities required to be computer and Internet literate by the IC³ standard
    - The JTA analysis served as the primary source of evidence supporting the content validity of the exams making up the IC³ certification

        - ➢ Sample Result: The JTA determined that "Literacy" in computer applications requires an understanding of at least two applications at a basic level and also an understanding of the common functions (such as common file-management, editing, formatting and printing functions) of all applications.

3. Blueprint Development
    - From an analysis of the Industry and Academic Research and the JTA, a draft specification of the domains and objectives for the three IC³ exams was developed
    - The resulting document from the Industry and Academic Reseach and the JTA is known as the exam blueprint
    - Blueprint development was guided by The Donath Group
    - Initial blueprint content was selected by SMEs participating in focus groups
    - Separate blueprints were developed for each of the three IC³ exams

        - ➢ Sample Result: The original draft of the IC³ exam blueprints consisted of 14 Domains and 42 Objectives. The final version of the IC³ exams resulted in 10 Domains and 30 Objectives.

4. Survey Analysis
    - The IC³ certification blueprints were refined and validated by surveying over 270 SMEs, in 19 countries, who reviewed, rated, and commented on each objective in the three IC³ blueprints
    - The participating SMEs were selected from a pool of more than 1,800 industry professionals
    - An analysis of the survey results provided guidelines for the weighting of different domains for each IC³ exam that was used to create tests that met content validation requirements based on SME input

➢ Sample Result: Based on survey results of the exam blueprint for the IC³ Computing Fundamentals exam, the following weighting of domains was used to develop a pilot exam that would meet content validation requirements:

Table 1: Computing Fundamentals—Domain and Objective Weighting

Domain 1: Computer Hardware	**43%**
1.1 Identify different types of computers, how computers work (process information) and how individual computers fit into larger systems	12%
1.2 Identify the function of computer hardware components and common problems associated with individual components	12%
1.3 Identify issues relating to computer performance and how it is affected by different components of the computer	10%
1.4 Identify the factors that go into a decision on how to purchase a computer or select a computer for work or school	10%
Domain 2: Computer Software	**22%**
2.1 Identify how software works and how software and hardware work together to perform computing tasks	10%
2.2 Identify different types of software, the tasks for which each type of software is most suited, and the popular programs in each software category	12%
Domain 3: Using an Operating System	**35%**
3.1 Be able to identify what an operating system is and how it works	10%
3.2 Be able to manipulate and control the Windows desktop, files and disks	13%
3.3 Be able to change system settings and install software	12%
Total	**100%**

5. Item and Pilot Test Development
    - SMEs wrote high-quality test items that fulfilled the overall IC³ blueprint goals and were representative of the test objectives outlined in each exam blueprint
    - The Donath Group conducted psychometric reviews (verifying that items conformed to proven guidelines and standards) and editorial reviews (verifying the grammar, usage, readability, clarity and consistency of usage) of each proposed test item
    - SMEs participated in a technical review of the proposed test items for technical accuracy, relevance, and importance
    - Based on the results of The Donath Group and the SMEs' analysis of each proposed test item, pilot IC³ exams were automated and created
    - Each IC³ pilot exam included 60 test items, with selection determined by content validation requirements based on final blueprint survey analysis

- Sample Result: The Donath Group's psychometric and editorial analysis of over 250 test items created to meet objectives in the IC³ blueprint determined 180 items (60 for each pilot exam) best met industry test item standards. These items (a mix of performance-based and linear test items) were further reviewed for clarity and adherence to industry item-writing and formatting standards. Final items were automated and used to construct the three exams used for the IC³ pilot.

6. Pilot Tryout & Analysis
    - All IC³ accepted test items were pilot tested in a standardized computer format with over 500 potential certification candidates
    - Pilot tests were conducted at over 40 different testing sites under the exact same conditions in which actual certification testing would take place
    - After taking each pilot exam, each candidate completed a survey of their self-assessed technical skill proficiency and demographic background information
    - Candidate survey results formed the basis for test and item analysis performed by The Donath Group
    - All items were analyzed for item difficulty, item discrimination, and analysis of distracters
    - Items demonstrating statistically aberrant behavior were flagged for possible removal in the final exam, or for further detailed review
    - SMEs conducted additional reviews of questionable items, and assisted in the selection of the final set of items
    - Scores from each pilot exam were reviewed for potential bias in gender, race, age, or any other variable that defines a protected group
    - A mastery composite score for the pilot tryout was calculated and correlated with the pilot test scores
    - A regression analysis of the predictor variables and composite score was used to assess the relationship between the pilot exam and the survey

        - Sample Result: No pattern of statistical differences was determined to exist that would indicate that the IC³ exams are functioning differently for any protected groups.

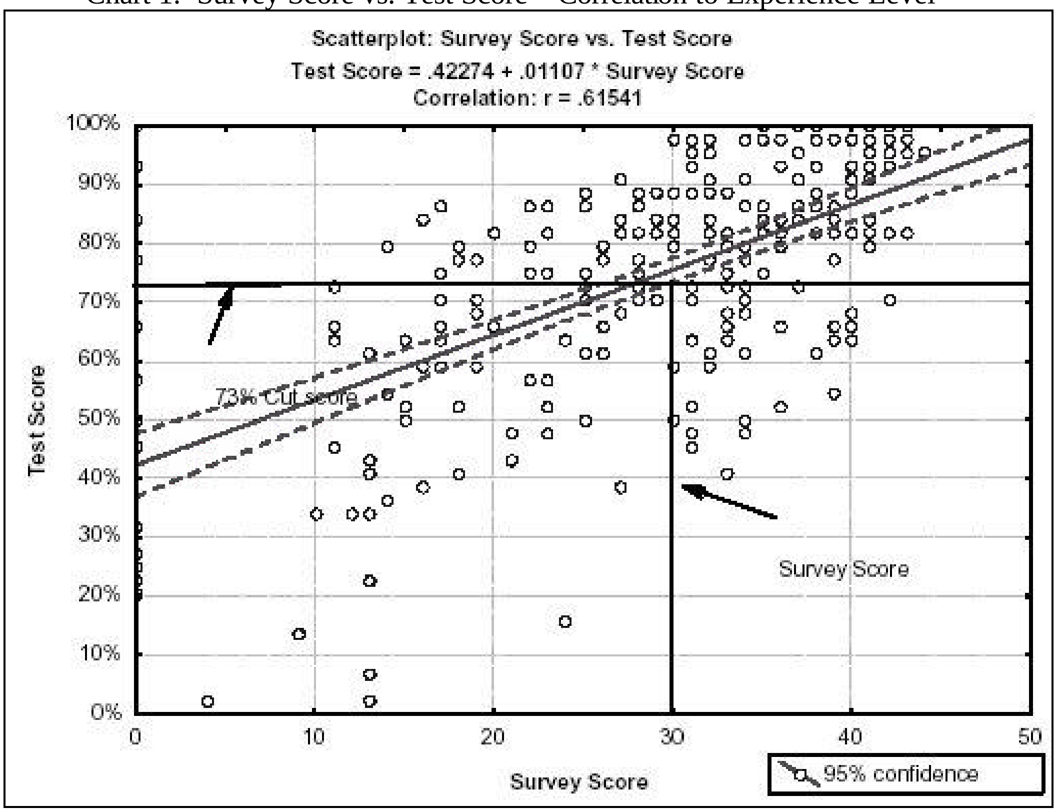
7. Final Exam Construction
    - Based on the results and analysis of the IC³ exams pilot tryout, test items were selected for the final IC³ exams' item pools
    - After detailed analysis test items demonstrating statistically deviant behavior, or potential biases toward gender, race, age, or any other protected group, were discarded
    - A comparison of the remaining test items to the determined IC³ exam content (final blueprint) was conducted to ensure percentage representation remained consistent with content validation requirements
    - The remaining accepted items were included in a set of 44-45 question tests to be used as the final IC³ exams
    - A mastery composite score for the final exam was calculated and correlated with the pilot test scores
    - A regression analysis of the predictor variables and composite score was used to assess the relationship between the pilot exam and the survey
    - Each test candidate taking part in the original beta test had their test results rescored based on the final selection of items in the three IC³ exams

- Sample Result: From the original set of 60 questions for each pilot exam, final IC³ exams were created that included 44-45 high-performing, high-quality items that met content validity requirements based on the original content study.

8. Standard Setting
   - IC³ final exam cut score determination completed by considering level of mastery, standard deviation, test score means, and decision error
   - All test performance results, as well as candidates' self-reported assessment of their skill level, were analyzed together—this analysis provided the mechanism to guide the standard setting, or cut score
   - IC³ certification exams were published for delivery on November 8, 2001

- Sample Result: An analysis of test scores vs. survey results on experience level determined cut score for each exam, as illustrated in the following chart:

Chart 1: Survey Score vs. Test Score—Correlation to Experience Level



CONCLUSION

The Internet & Computing Core Certification (IC³) program was created to offer a unique, validated, global certification program that provides specific standards for the knowledge, skills, and abilities required to be a broad-based, productive user of computer hardware, software, networks, and the Internet. Through in-depth research and analysis into the world of digital literacy, it was determined that three exams were needed to cover the range of subjects necessary for an individual to be IC³ certified.

- *Computing Fundamentals*: a measure of an examinee's knowledge of computer hardware, software, and basic operating system skills.
- *Key Applications*: a measure of an examinee's proficiency in two computer applications (a word processor and spreadsheet) and the common features of different applications.
- *Living Online*: a measure of the basic skills in using networks, electronic mail, the Internet, and Web browsing software as well as how computers and the Internet affect society.

IC³ certification exams were created to meet the highest, standards-based development processes accepted industry-wide. This process was guided by The Donath Group, an industry-recognized leader in exam construction, measurement, and statistical analysis. The IC³ program took steps to accumulate ample empirical, theoretical, statistical, and conceptual evidence to support its claims of achieving the highest levels of exam validity. The quality and validity of the IC³ exams is recognized by other industry organizations like the NSSB and CompTIA.

The final result of the IC³ program's validation efforts is a true certification program that accurately and reliably measures an individual's knowledge, skills, and abilities to effectively live and work in our increasingly digital world.

Appendix B: Computing and Internet Skills Learning Experiences survey

COMPUTING AND INTERNET SKILLS—LEARNING EXPERIENCES SURVEY

FORMAL LEARNING EXPERIENCES

Please answer the following questions on **Formal Learning Experiences.** Formal learning experiences can be defined as experiences that take place in a setting where someone (other than you) establishes official learning outcomes (i.e., course objectives, goals) related to the development of computing and Internet skills.

<table>
<tr><th>The Questions</th><th colspan="2">Your Answers</th></tr>
<tr><td>1. In school, I had a course/class that exclusively focused on the development of computing and Internet skills.

FYI: A course/class that EXCLUSIVELY FOCUSED on the development of computing and Internet skills means that the course/class addressed ONLY computing and Internet skills. Courses/Classes that MIXED computing and Internet skills with OTHER LEARNING are addressed in questions 4 – 6 below.

Examples of EXCLUSIVELY FOCUSED COURSES/CLASSES may include but are not limited to the following: Keyboarding, Word Processing, An Introduction to Computers, Web Page Design and Development, How to Use Search Engines, Accounting Software Applications or any course/class that is focused on a particular software (MS Word, Adobe Photoshop, Apple iMovie, etc…)</td><td colspan="2">(Circle one) YES NO</td></tr>
<tr><td>2. If you answered YES to the previous</td><td>Elementary School</td><td>(Circle one) YES/NO</td></tr>
</table>

<table>
<tr><td rowspan="6">question, please <u>identify</u> the <u>levels of school</u> where you had <u>a course/class that exclusively focused</u> on the development of computing and Internet skills.

FYI: Please select NO for any level of school that does not apply.</td><td>Middle School</td><td>(Circle one) YES/NO</td></tr>
<tr><td>High School</td><td>(Circle one) YES/NO</td></tr>
<tr><td>Technical College</td><td>(Circle one) YES/NO</td></tr>
<tr><td>Community College</td><td>(Circle one) YES/NO</td></tr>
<tr><td>College/University</td><td>(Circle one) YES/NO</td></tr>
<tr><td>Other (Please explain in the next question).</td><td>(Circle one) YES/NO</td></tr>
<tr><td>3. If you answered YES to <u>OTHER</u> in the previous question, please explain in the space provided…</td><td colspan="2"><u>Your Explanation</u></td></tr>
<tr><td>4. In school, I had a <u>course/class</u> where the development of computing and Internet skills <u>was mixed in with the primary content</u> of the <u>course/class.</u>

FYI: A <u>course/class</u> where the development of computing and Internet skills <u>WAS MIXED WITH THE PRIMARY CONTENT</u> of the course/class means that the course/class had a primary focus on other content (examples might include Math, Biology or English). Development of computing and Internet skills in such a course/class would be <u>a secondary goal</u>.

Examples: A <u>Math class</u> where students learn how to create charts and graphs in a</td><td colspan="2">(Circle one) YES NO</td></tr>
</table>

spreadsheet program. A *<u>Biology class</u>* where students learn how to create a digital video to present the step-by-step dissection of a Deer heart. An *<u>English class</u>* where students learn how to create a website portfolio of writing assignments.		
5. If you answered YES to the previous question, please **<u>identify</u>** the **<u>levels of school</u>** where the development of computing and Internet skills **<u>was mixed in with the primary content</u>** of the **<u>course/class.</u>** FYI: Please select NO for any level of school that does not apply.	Elementary School	(Circle one) YES/NO
	Middle School	(Circle one) YES/NO
	High School	(Circle one) YES/NO
	Technical College	(Circle one) YES/NO
	Community College	(Circle one) YES/NO
	College/University	(Circle one) YES/NO
	Other (Please explain in the next question).	(Circle one) YES/NO
6. If you answered YES to **<u>OTHER</u>** in the previous question, please explain in the space provided…	<u>Your Explanation</u>	
7. *In my place of employment* (past or present), I attended training sessions that **<u>that exclusively focused</u>** on the development of computing and Internet	(Circle one) YES NO	

skills. FYI: Training sessions that EXCLUSIVELY FOCUSED on the development of computing and Internet skills means that the training sessions addressed ONLY computing and Internet skills (See question #1 for examples).	
8. If you answered YES in the previous question, please explain in the space provided… ⇨	Your Explanation

INFORMAL LEARNING EXPERIENCES

Please answer the following questions on **Informal Learning Experiences.** Informal learning experiences can be defined as experiences that take place in a setting where you decide the learning outcomes (i.e., what you would need /want/like to learn) related to the development of computing and Internet skills.

The Questions	Your Answers	
9. *I teach myself* how to use computing and Internet technologies.	(Circle one) YES NO	
10. If you answered YES to the previous question, please identify the ways you teach yourself (past or present) how to use computing and Internet technologies.	I use training manuals/how-to books.	(Circle one) YES/NO
	I use online tutorials.	(Circle one) YES/NO
	I use video/CD-ROM/DVD tutorials.	(Circle one) YES/NO

	I seek out a person who is knowledgeable in the use of computing and Internet technologies and ask them questions.	(Circle one) YES/NO
	I use the help menu.	(Circle one) YES/NO
	I experiment (Trial and Error).	(Circle one) YES/NO
	I observe other people using computing and Internet technologies.	(Circle one) YES/NO
	Other (Please explain in the next question).	(Circle one) YES/NO
11. If you answered YES to **<u>OTHER</u>** in the previous question, please explain in the space provided… ⇨	<u>Your Explanation</u>	
12. *In my place of employment* (past or present), I developed computing and Internet skills through informal learning experiences.	(Circle one) YES NO	
13. If you answered YES in the previous question, please explain in the space ⇨	<u>Your Explanation</u>	

provided…	

MODELING THE USE OF COMPUTING AND INTERNET SKILLS

Please answer the following questions on **Modeling the Use of Computing and Internet Skills.** Modeling the Use of Computing and Internet Skills simply asks you to identify those individuals you observe regularly and consistently using computing and Internet skills.

The Questions	Your Answers	
14. From the following list, please **select all the people** who you have observed **regularly and consistently** using computing and Internet technologies. FYI: Please select NO for any people that do not apply.	My elementary school teachers.	(Circle one) YES/NO
	My middle school teachers.	(Circle one) YES/NO
	My high school teachers.	(Circle one) YES/NO
	My technical school teachers.	(Circle one) YES/NO
	My community college teachers.	(Circle one) YES/NO
	My college/university teachers.	(Circle one) YES/NO
	My parents/guardians.	(Circle one) YES/NO
	My friends.	(Circle one) YES/NO
	My employer(s).	(Circle one) YES/NO
	Other (Please explain in the next question).	(Circle one) YES/NO

15. If you answered YES to **OTHER** in the previous question, please explain in the space provided…	Your Explanation

PREPARATION TO USE COMPUTING AND INTERNET TECHNOLOGIES

Please rate your preparation to use Computer and Internet Technologies.

The Questions	**Your Answers**	
16. On a scale of ***1 (Poorly Prepared)*** to ***10 (Well Prepared)***, rate yourself on the following items:	Preparation to use computing and Internet technologies for **professional** and **personal** use?	My rating is:
	Preparation to **integrate** computing and Internet technologies **into the curriculum** of your chosen education major?	My rating is:
17. On a scale of ***1 (Not Important)*** to ***10 (Very Important)***, rate the importance of computing and Internet skills for:	The **area (major)** you would like to eventually teach in?	My rating is:
	Your future students being proficient in the use of computing and Internet skills?	My rating is:

DEMOGRAPHICS

18. (Circle One) Male Female

19. What is your age? (Circle the appropriate age range)

- 17 to 19
- 20 to 22
- 23 to 25
- 26 to 28
- 29 to 31
- Over 31

20. Which of these following indicates your year in school? (Circle One)

- Freshman
- Senior

21. Which undergraduate education program are you a part of? (Circle ALL that apply)

- Art Education
- Career and Technical Education and Training
- Early Childhood Education
- Family and Consumer Sciences Education
- Marketing Education
- Business Education
- Applied Science: Science Education
- Special Education

- Technology Education
- Health Occupations Education

22. Have you ever taken an online course? (Circle: Yes or No)

23. If you answered YES to the **PREVIOUS** question, where did you take the online course?

- Elementary School (Circle one: Yes or No)
- Middle School (Circle one: Yes or No)
- High School (Circle one: Yes or No)
- Technical School (Circle one: Yes or No)
- Community College (Circle one: Yes or No)
- College/University (Circle one: Yes or No)
- Other (Circle one: Yes or No)—Please explain in the next question…

24. If you answered YES to **OTHER** in the previous question, please explain in the space provided below…