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The Effects of Wireless, Mobile Computing on Course Performance: A Course Comparison and Participant Perception Analysis

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The Effects of Wireless, Mobile Computing on Course Performance: A Course Comparison and Participant Perception Analysis

A graduate thesis submitted to Dakota State University in partial fulfillment of the requirements for the degree of

Master of Science

in

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By

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We certify that we have read this thesis and that, in our opinion, it is satisfactory in scope and quality as a thesis for the degree of Master of Science in Information Systems.

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Claver P. Hategekimana
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ABSTRACT

Educational institutions recognize that technology is an increasingly important factor in today's world as a skill and as a facilitator for learning. In response, Dakota State University introduced the wireless, mobile computing initiative (WMCI) that made tablet personal computers (Tablet PCs) mandatory learning tools for both instructors and students. However, little is known about the effect of this technology on course performance. First, this study focuses on quantitative analysis to verify the relationship between student performance and Tablet PC. To achieve this goal, we statistically compared learning outcomes before and after the integration of tablets. The comparison showed that one out of five evaluated courses indicated a significant positive difference, while four courses did not show any significant impact. Second, we used data from three surveys to compare expectations of students and faculty in pre implementation with their perception in post adoption of the tablets. Fourteen out of sixteen evaluated items did not show any significant impact on satisfaction of faculty. The remaining two items showed that instructors are concerned with the quality of education students receive and expressed a need for training to effectively adopt tablets into their courses. Student evaluation of 18 items indicated that this new technology significantly exceeded their expectations, except students feel that the price of tablet is too high. Some data showed that students and faculty believe the tablets help them to accomplish school work, but at the same time tablets are viewed as distraction. In conclusion, action is needed to minimize student distractions and maximize training outcomes to address complexities associated with adoption of wireless, mobile computing technology in the curriculum.

DECLARATION

I hereby certify that this thesis constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of another.

I declare that the thesis describes original work that has not previously been presented for the award of any other degree of any institution.

Signed,

_____

Claver P. Hategekimana

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CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

In the 1980s, personal computers (PCs) reached affordability for schools and institutions prompting curriculums in computer technology application. Now computers are frequently regarded by institutions as essential tools in supporting student learning. They also recognize that students graduating and entering the job market will need an understanding of and a familiarity with current technologies to perform their jobs (Mt. Adams School District, 2004). Dakota State University (DSU) has embraced computer technology and continues to explore new ways to stretch the expectations of learner productivity. In fact, this school's mission focuses on the widespread integration of technology into all aspects of instruction.

One can say that in 2004 DSU experienced another evolutional change not only in its instructional delivery distribution mechanisms, but also in its computing infrastructure. The wireless, mobile computing initiative (WMCI) was one of the leading elements for the change in DSU's computing structure. Prior to the fall of 2004, the wireless, mobile computing initiative committee envisioned a technology that would improve quality and course delivery mechanism. The idea was to empower students, faculty, and DSU personnel with wireless computing capabilities. After careful consideration, the WMCI task force made a recommendation on the new computing system, Tablet PCs and wireless, mobile computing, that was implemented in fall of

2004. The functionality of the Tablet far exceeds that of a laptop and put in the hands of students and instructors a highly versatile computing tool. The integration of the Tablets implied that faculty had to design learning activities that would accommodate this new technology.

Currently, instructors and students can take advantage of Tablet PC features and wireless capabilities to enhance their learning experience. For example, we have all witnessed that students at DSU are shifting from using a traditional pencil to a digital pen. Studying places, among others, were extended from cubical confinements and computer stations located in public study rooms to locations commensurate with students' needs. The Tablet PC offers greater mobility and immediate access to the full power of regular work station computers. Tablet PC differs from a conventional laptop computer in that it gives users the power to scrawl notes, draw diagrams onto the screen with the touch of a pen-like stylus, and save them electronically (Roach, 2004). Another powerful feature of the Tablet PC is that it allows for the annotated notes to be archived and made available to the students after lecture via internet. This is an alternative to writing on the chalkboard and provides a continuous access (Cox & Rogers, 2005).

However, the impact of Tablet PCs and wireless, mobile computing at DSU can be interpreted differently depending on the goal of the evaluator. For example, technical and financial feasibility analysis is regarded as the most prominent factor from an IT project management prospective. Policy makers often work from a cost-benefit model with increased norm referenced and criterion referenced test scores viewed as the primary benefits. In contrast, instructors tend to believe that educational technology benefits include preparing students for jobs, increased student interest in learning, increased

access to information, and making learning an active experience (Heinecke et al., 1999). Thus, the central issue is to assess the effectiveness of a new information technology in an educational setting and determine what instrument to use.

In the long run, the overall effectiveness of WMCI will be evaluated based on the educational results. The educational results can be understood as data on student retention, graduation rates, number of students going on to graduate and professional schools, placement rate in professional jobs, etc. In the short run, however, the effectiveness of WMCI needs to be evaluated based on learning results and satisfaction of participants, which is the main focus of this study. Learning results can be defined as the actual data presented by the institution on the level of learning and achievement of students. In other words, learning results indicators put great emphasis on quantitative analysis that shows at what level learning was impacted by a factor under consideration. According to DiGiorgio (2004), the effectiveness of Tablet PCs can be evaluated based on a number of points ranging from improvement in student learning, instructors reaction, and students' level of engagement.

1.2 Statement of the problem

While many information technology (IT) professionals and some educators emphasize the potential benefits of Tablets and mobile computing in education, others highlight its drawbacks. In addition, tablets enhanced learning environment creates a challenge for these who need to verify the effects of instructional technology on course performance. Promoters of the WMCI believe that users of tablets will be more effective and independent learners because the technology helps to develop new skills to access, distribute, and analyze information in a timely fashion. But, some stakeholders argue that

there is no convincing evidence that tablets improve quality of education and learning outcomes. Others argue that WMCI was a marketing strategy for computing firms. Some instructors express technical concerns associated with the functionality of Tablet PCs in the classroom. In addition, they express concern that learners are distracted by using these mobile devices for chatting, playing games, and other activities, instead of focusing on instructions.

1.3 Objectives of the study

This evaluation is based on the comparison of the learning outcomes of five undergraduate courses pre and post WMCI integration. Extant survey data collected in April 2004, December 2004, and May 2005 is examined to shed light on the perspectives of the participants in DSU's wireless, mobile computing initiative. The evaluation is expected to reveal information that is essential to quality decision making for stakeholders.

Primary stakeholders include DSU's administrators, faculty, students, and parents who need to insure that the initiative is productive. Students also want to know that the education they are promised provides good returns on their investment. The secondary stakeholders include prospective students and parents who want to know what to expect from this Tablet PC and wireless technology enhanced learning environment. Other secondary stakeholders are educational institutions, policy makers, investors, alumni, etc.

CHAPTER 2

LITERATURE REVIEW

2.1. Learning in the Digital Environment Era

Throughout the history of human kind we have recognized the advantages of education. Creative strategies for teaching and learning continue to be implemented to accomplish individual and group goals to expand the horizon of human knowledge. In early1800s, many schools, including kindergarten, high schools, and colleges were opened to provide formal education (Newman, 1998). Educational materials to supplement the quality of instruction distribution were very limited and library resources were almost non existent. Later, new technology inventions caused paradigmatic changes in the education. Along with science, computers were one of the technologies that fueled dynamic learning environments and enabled scientists from different disciplines to join efforts and solve complex problems that were once thought to be a mystery.

"Computers," the most powerful machines in human history (Shasha & Lazere, 1998) existed in minds of scientists more than 100 years before the first physical computing machine existed. For example, documentations of early scientists show that in 1820s, Charles Babbage had envisioned a mechanical computational machine called Analytical Engine. His dream machine would not only foresee, but it would also act on the foresight. Unfortunately, the Analytical Engine existed only in theory (Shasha & Lazere, 1998).

The first real computers were huge, inefficient, limited in function, complex to

operate, and very expensive to build. For example, ABC (Atanasoff-Berry Computer), the first electronic digital computer that was designed and built in 1937-1947, occupied the entire basement of Atanasoff Hall building at Iowa State University. ENIAC, the first electronic numerical integrator and computer that was designed and built in 1943-1946, weighed 20 tons, contained 18,000 vacuum tubes, occupied a thirty by fifty foot space, and consumed 160 kilowatts of power. (Shelly, Cashman, & Vermaat, 2005).

Today's computers come in different shapes and sizes. They can be as small as wallet size, with vast computing power, and their prices have dropped dramatically. Presently, Tablet PCs are becoming an acceptable, integral part of educational process. DSU embraced Tablet PCs technology through wireless, mobile computing initiative (WMCI). With the implementation of the initiative in fall of 2004, DSU was regarded as the only campus in the state of South Dakota to have such initiative and one of the first schools in the United States to utilize the tablet computing systems (Hawkes, 2004).

The computing device that was introduced by the WMCI is the Gateway M275 Tablet PC. This machine looks much like a regular laptop. It is powered by Intel Pentium M 1.6 GHz processor; 30GB hard drive (expendable to 60GB), convertible 14.1 inch monitor, integrated CDRW+DVD-ROM combo drive, and weighs 5.7 lbs. The machine is also equipped with Microsoft Windows XP Tablet PC Edition. In addition to the basic functionality of regular laptops, a Tablet PC has built-in wireless support, digital ink capability, voice recognition, Windows Journal software, screen clipping tool, and others. Tablet PC users at DSU are connected to the Internet via a wireless local area network (LAN) using either 802.11b or 802.11g wireless access points technology that serve the entire campus. All classrooms, including the library and conference rooms are equipped

with wireless projectors that Tablet PC users can connect to. Furthermore, the University's computing services opened a technology support desk to assist the Tablet PC initiative when technical problems arise. Overall, the integration of Tablet PCs into course design requires special skills to accommodate complexity associated with this technology.

2.2 Tablets PCs and Web Enhanced Learning Environment

Much research has been done in the area of technology supported instruction to understand the effectiveness of various teaching and learning models. Learning environments may include the traditional classroom, distance education, and hybrid learning. Traditional classroom or face-to-face based instruction has been the most widely accepted learning model since the beginning of formal education. As the name implies, face-to-face instruction takes place in a conventional classroom where instructor and learners engage in face-to-face interaction to accommodate their learning needs. Currently, computer technologies and internet are becoming integral part of face-to-face instruction to enhance instructional quality and learner productivity. With the distance education model, instructors and learners are located in remote physical locations, which implies that instructional delivery mechanisms heavily relay on computer networks, Internet, satellite, and/or any other form of correspondence. On the other hand, the hybrid learning model (HLM), known as electronic learning (E-learning), is the newer form of learning environment that is gaining popularity. E-learning includes any means of delivering learning materials via World Wide Web that may combine online technology, campus based delivery, and distance learning (Hareton, 2003)

Each of these instructional models has its own unique potential benefits, strengths, and weaknesses. For example, Internet-based courses are inherently dependent on technology, which means that students and faculty must effectively use computers and specialized software to exchange information. This means the learning process has a new added level of complexity; students must not only learn the course material, but also how to use computer hardware and software effectively (Christoph, Christoph & Dennis, 2004).

Tablet PCs and web-enhanced environments in particular, have its own unique issues. Research conducted at Virginia Polytechnic Institute and State University indicates that Tablet PCs are ineffective for programming tasks. Pen-based input is inadequate for typical program editing tasks, and a pen is less effective as a pointing device than a mouse when typing at a keyboard. In addition, handwriting recognition provided within the operating system appears to be optimized for writing English purpose. The system makes heuristic judgments when converting programming codes from digital ink annotation into ASCII text (Eduards & Barnette, 2004). Other research conducted at the DePaul University showed that computer technology along with the internet has caused distractions for students. Students identified emails, instant messaging, internet browsing, etc. as common distractions to their learning experiences (Berque, Bonebright & Whitesell, 2004). Pietraszewski and Smith (2004) have emphasized that the most challenging aspect of the tablets functionality was its method of data input. Based on literature review, technical implications, and concerns of these people who view tablets as a source of distraction, we can predict that this technology will have negative effect on student performance. Therefore, a research hypothesis is

developed and stated in null form to compare learning outcome in pre and post implementation of WMCI.

Hypothesis-1:

No difference exists in the learning outcomes of students from pre to post adoption of wireless, mobile computing initiative.

2.3 The Need to Evaluate Perceptions of Participants

Dakota State University is an institution that attempts to pervasively infuse instructional technology in their major areas of concentration including Arts and Sciences, Business and Information Technology, and Education. The dean, faculty members, and alumni believe that their integration of technology tools in degree programs helps to improve learning success. The institution has a high placement rate for its graduates and those moving into graduate programs arrive at some of the best institutions in the country. The institution emphasizes technology interaction issues regarding the improvement of the student's technological literacy and the implementation of effective special programs to deliver technology enhanced courses. However, a continuing evaluation process is necessary to insure that desired learning outcome is maintained.

The indicators of program success are diversified and range from the manageability of institutional activities to internal and external collaborations to student learning outcomes. Primary emphasis is given to student satisfaction and learning results. It is worth noting that DSU has been engaged in multiple forms of institutional assessment. Those efforts include student and alumni surveys of satisfaction and short

surveys at course registration. The institution assesses the entry-level status of students' writing and math competency upon admission. Departments have periodic program reviews and they occasionally meet with employers or advisory groups to inform the currency and real-world "fit" of their programs. In addition, students' performances on tests stand in testimony of learning experience.

There are many activities of assessment underway; however, wireless, mobile computing initiative exhibits unique characteristics that deserve a careful consideration to validate its effectiveness. For example, technology presents new opportunities for students and teachers that can be organizational, instructional, individual, procedural and cultural, but because learning and technology interact in such a complex way, evaluation may fail to yield the most useful information about how technology affects learning (Hawkes & Cambre, 2001). On the other hand, a well conducted study will provide essential information needed for quality decision making. For example, feedback provided to instructors and designers can improve the instructional process as adjustments are made, as needed, from the information provided (Gwendolyn, 2003). Researchers have also proved that student performance based on pre and post course measures is an acceptable evidence of system impact (Hawkes & Cambre, 2000).

Chambers and Fernandez (2004) state that faculty believe learning outcomes can be used to improve teaching. Smith, Zsidisin, & Harrison (2005) emphasize that grades are the way that the instructor present student to interested parties within and beyond the institution. The pre/post design strategy is the primary quasi-experimental methodology applied in this study. The system is also effective if it meets users' expectations and lower satisfaction level will indicate its weaknesses. Satisfaction has been a widely used

parameter to evaluate the effectiveness both in academic and business setting (Picolli et al., 2001). While Hypothesis-1 attempts to compare learning outcomes, a second research hypothesis stated in null form is also developed to measure satisfaction of participants that is expected to equal or exceed their expectation. In the worse case scenario, the study would show lower satisfactions.

Hypothesis-2:

> *No difference exists in the expectation/satisfaction of participants from pre to post adoption of wireless, mobile computing initiative.*

CHAPTER 3

RESEARCH METHODOLOGY

Understanding the claims about the effects of wireless, mobile computing on course performance, and to make effective educational decisions, we need to tap into both quantitative and qualitative forms of data. This study focuses on quantitative analysis of learning outcomes based on course administered test scores as well as perceptions of instructors and students gathered by institutional self-report survey administered by the evaluator of the WMCI initiative. The evaluation is expected to either validate or challenge established hypotheses-1 and hypothesis-2.

3.1 Data Collection Process

The study focused on two groups of undergraduate students taking courses at DSU's main campus in Madison, South Dakota. One group (279 students) did not use the tablets and the other group (276 students) did use the tablets. Students not using the Tablet computers were part of a pre-wireless, mobile computing initiative and students with the tablets were part of the post-initiative group. The fundamental instructional difference between these two groups was the new technology that was integrated into the course design. The instructors and course contents were held constant for both groups. Courses examined were 100 and 200 level offerings designed for freshman and sophomore students. All selected courses for this study had similarities in the design. At the beginning of each semester, instructors explained and handed out the syllabus to the

students. Each syllabus description included at least five highlights: the main goal of the course, instructional methods, course requirements, evaluation procedure, and the course outline. A comparison analysis of course design between pre and post adoption of WMCI enabled us to isolate factors, other than integration of the new technology that may have affected learning outcomes. The evaluated courses included students from different majors offered at DSU, which implies that the recommendations of the study accurately explain the impact Tablet PCs and wireless technology have on the academic success of all students who use this educational technology.

Another important, and possibly confounding instructional component acknowledged in evaluating Tablet PCs and wireless technology, was the application of course management system, WebCT, a product of WebCT Inc.. WebCT is an online management software that aids instructors and learners by creating, managing, organizing, and housing a web-based learning environment. Instructors accommodated Tablet PCs and wireless technology by incorporating web components into their course. Therefore, WebCT was extensively used throughout the instruction distribution, feedback and learning team collaboration. Some of the pros of WebCT along with Tablet PCs technology include increased student access to information, increased interaction, manageability of student data, and accommodation of self learning style. Some of its limitations, however, are that learning depends on technology and it requires learners to be computer literate. According to the study conducted at Oakland University by Kraemer (2003), the benefits returned from the investment in the application of WebCT outweighs the drawbacks.

a. Prediction:

- Tablet PCs and wireless technology enhanced courses are expected to affect learning outcomes because they are supposed to empower instructors and learners with technological tools that improve learning experience and productivity. However, complications associated with its integration in course design and functionality toward learning goals may yield decreased learning outcomes. This assumption is tested through the attempt to challenge Hypothesis-1.
- When participants are confronted with new technology intensive learning environment, they tend to have negative or positive attitudes based on their level of satisfaction as compared to their expectations with the new system. This assumption is tested through the attempt to challenge Hypothesis-2

b. Population:

- The evaluated population is students who use Tablet PCs at Dakota State University: this population is our main focus because students are the most impacted by the adoption of WMCI and quality education is the main mission of the school.

c. Sample:

- Five classes were chosen from 100 and 200-level courses. Each selected class was taught by the same instructor before and after adoption of Tablet PCs. Care was taken to make sure that as little instructional change as possible in course delivery took place between the two administrations of the courses. Surveys administered in April 2004 (253 students, 52 instructors), December 2004 (283 students, 54 instructors), and April 2005 (54 students) are used to examine perspectives of the

participants.

d. Data source:

- Instructors of the selected courses provided course syllabi; course test scores, and assisted the evaluator with feedback about the course design. Also, data from an existing data source, including participant surveys administered institution wide in spring 2004 and fall 2004, were used. These surveys measured the level of agreement and concern of students and faculty in regards to the impact of Tablet PCs and mobile computing technology. In addition, the CIS-251 (Business Application Programming) instructor provided data gathered from a survey designed to assess satisfaction of students toward the usage of Tablet PCs.

e. Quality of data:

- To insure the quality of data, we only considered grades earned on quizzes and tests that were administered in the classroom with supervision of the instructor. The issue with take home assignments or tests taken without supervision of the instructor is how you verify whether the student who is being assessed is actually doing his or her work. The alternative approach would have been to complete all assessment activities either on campus or in a proctored environment to verify that the work was actually completed by a particular student (Distance Education Report, 2004).
- Records of students who completed all quizzes and tests under consideration were included in the sample of study, whereas those who did not complete all the quizzes and tests under study were disregarded from the sample.
- Courses that had major adjustments (e.g., author and text book change) other than

application of WebCT and Tablet PCs were also excluded from the study. All the evaluated courses used WebCT prior to the implementation of the tablets initiative.

f. Software and testing:

- The SYSTAT Version 9, a software product of SPSS Inc., for Windows platform was used to perform statistical analysis.
- A two sample t-test dealing with independent means was used to compare learning outcomes of two classes in pre/post integration of WMCI.
- Within-treatment comparison was performed (using a two sample t-test) to compare learning outcomes of a course taught in two sections. In the case a course was taught in more than two sections, an analysis of variance (ANOVA) test was performed.
- In the case within-treatment test showed that there was no difference in learning outcomes, then the sections were pooled together to form one sample. Otherwise, the class was excluded from the study.

g. Perception measurement:

- From the ex post facto institutional survey data, an analysis was conducted to understand participant perceptions and concern about tablet computing.

3.2 About the Courses

3.2.1 About Math-102: College Algebra

Math-102 is a three credit class that is offered every year in the fall and spring. The instructor of this course emphasized that there is almost always a difference when

comparing students learning outcomes in fall and spring semesters. On numerous occasions the instructor noticed that students perform better on tests in the fall than they score in the spring semester. This claim was well supported not only by data from classes the instructor administered, but also the same claim holds true based on the study conducted at the University of Alabama, Enhancing Learning Through Computer Based Instruction College of Arts and Sciences, Department of Mathematics. The instructor at DSU suggested that the difference in scores was not due to the random make up of the classes, but it was mainly justified by the time a student takes Math-102 class relative to the graduation time from high school. Consequently, the study compared learning outcomes realized in the Math-102 classes of fall 2003 and fall 2004. In fall 2003, the course was offered in two sections while in fall 2004 it was offered in one section.

The main goal of the course was to understand and apply fundamental mathematical processes and reasoning. The instructional methods helped students learn mathematics by doing mathematics. This learning style involved active learning that encourages a learning environment where lessons and assignments were developed to engage students and facilitate learning. WebCT and PowerPoint presentations were used extensively throughout the course distribution. A detailed list of activities to be accomplished during each class session was also developed and handed out to students on the first day of the class. Prerequisite to Math-102 was Math-101 (Intermediate Algebra). Each participant in Math-102 class was expected to have basic computer skills that included word processor, spreadsheet, graphic application, and internet experience.

In addition to the course requirement described above, in fall 2004 students were required to have Tablet PCs and use associated technology. WebCT was used to deliver

course supplement, daily quizzes, weekly assignments, and served as the primary communication tool between students and instructor. In regards to the evaluation procedure, the course grades were assigned based on a 400 points scale that included four exams. Each exam was an hour long except the final exam which was two hours long. There were 10 quizzes, but these quizzes were not incorporated in the evaluation process of this study.

3.2.2 About ENG-101: English Composition I

ENG-101 is a three credit class offered in the fall and spring. The course was offered by the same instructor in fall 2003 and fall 2004. In the present study, we did not consider spring 2004 test scores because the instructor was different from the previous semester. During the two semesters of interest, we realized that the course was offered in 3 sections that met on different days of the week and different times of the day. The main goal of the course was to understand and apply academic writing skills. The instructional methodology included research on a variety of academic and non-academic texts, rhetorical structures, and critical thinking. Tablets PCs, WebCT, and PowerPoint presentations were used through out the course distribution. Voice recording, a built-in feature of Tablet PC, was used on numerous occasions to provide feedback on assignments to students. It is worth noting that voice recording based feedback was never used before the integration of Tablet PCs. In fall 2003, the evaluation process included four quizzes and one grammar test totaling 500 points. In fall 2004, four quizzes, one grammar test, and a final exam totaling 504 points were administered. All of these quizzes and tests were supervised by the instructor. In addition, several take-home

assignments in a format of essay questions were completed. However, these essays were not included in the data of this evaluation.

3.2.3 CIS-251: Business Application Programming

CIS-251 is a three credit computer class offered every year in the fall and spring, but our study compared spring 2004 and spring 2005 because the same instructor offered the course during these two semesters respectively. Each class was made up of only one section. CIS-251 course is the second course of programming in the Visual Basic environment offered at DSU. The main goal of the course was to understand and apply fundamental principles used in logical design, programming techniques, and test business programs. The prerequisite to CIS-251 was CIS-130 (Visual Basic Programming). The instructional methodology included a combination of lecture, discussion, demonstrations, computer lab, and lab assignments. The learning environment encouraged active learning where lessons and assignments were developed to encourage student participation and facilitate learning. Tablets, WebCT, and PowerPoint presentations were used on a daily basis through out the course distribution. The WebCT was used to deliver course materials, weekly assignments, and daily quizzes on a 5 points scale. Several online and take home assignments were also performed. During these two semesters under consideration, evaluation process included four exams administered in the classroom or computer lab. These tests were assigned a total grade of 400 points. In May 2005, the instructor conducted a survey that measured student perception about Tablet PCs.

3.2.4 HIST-121: Western Civilization I

The instructor provided data from HIST-121 classes of fall 2003 and fall 2004. The HIST-121 is a three credit history class that was offered three times a week. The first objective of HIST-121 was to provide students with basic understanding of the development of the western civilization from its beginnings through the reformation and religious wars. The second objective was to improve writing skills of students and use technology as a tool for communication. This course satisfied general education graduation requirements for several on campus majors. The course had no prerequisite requirements, but students were expected to have basic computer and internet skills to access the course web site as well as WebCT. The instructional methodology included a combination of lectures and in-class discussions. In fall 2004, Tablets PCs were used to accessing the course web site, note taking, and completing online quizzes. The evaluation process also included a mid-term exam and a final exam totaling 200 points. Several quizzes and essay questions were also administered, but they were discarded from the study.

3.2.5 HIST-152: History of the United States Since 1877

The instructor provided data from HIST-152 classes of spring 2004 and spring 2005. The main objective of HIST-152 course was to provide students with a basic understanding of the historical development of the United States from the end of reconstruction to the end of the Cold War. The other objectives were to improve the writing skills of students and use technology tools for communication, and examine the contribution of different cultures from a historical prospective. The course did not have

any prerequisite requirements. However, the students were expected to possess basic computer and internet skills needed to access the course and text book web site, as well as WebCT. In both semesters, the course was taught in two sections that met three times a week. Tablet PCs were used to access the course web site, note taking, and completing online quizzes. The instructional methodology included a combination of lecture, assigned readings, online discussion boards, chat rooms, and email to obtain peer and instructor's feedback. The testing process included several take-home assignments, two major tests and one final exam. Each major test and final exam included an essay portion that tested students' abilities to analyze and write coherently about historical events.

3.3 Perception of Participants

In April and December 2004, DSU's wireless computing initiative committee conducted surveys developed by Dr. Mark Hawkes (2004) with intent to determine student and faculty attitudes toward the initiative and how those attitudes evolve over time. The evaluation approach involved understanding the level of acceptance of the initiative among faculty, staff, and students. Perspectives the survey explored include satisfaction of participants in terms of technology support, training, integration, functionality, interoperability and utility. While this study used data from these two surveys, we narrowed down the scope of our study to analyze questions related to participants concern for the initiative and participants perspectives of value the initiative brings to the institution. Survey questions were formulated using four-point Likert-type format. The Likert-type method was chosen because it is designed to allow targeted audiences respond in varying degrees to each item that describes the service or product

we needed to measure (Hayes, 1992). The survey also included a short introduction explaining its purpose. In spring 2004, the survey instrument for students' perception measurement was paper based, while the survey in the fall 2004 was web based. Survey instruments used in spring and fall 2004 for faculty were web based. Both surveys used in spring of 2004 are presented in Appendix A and B. A list of selected questions to measure agreement and concern level, 18 items for students, and 16 items for faculty, is presented in Table 1 and Table 2. In addition, demographic information such as gender and college major was collected (see Table 3 and Table 4).

Table 1. Items form survey questions to measure students' level of agreement and concern.

Abbreviation	Items: Student's Level of Agreement and Concern
	a. Agreement:
	Please read each of the following items below and indicate how strongly you agree or disagree with them.
	(Strongly Disagree=1, Disagree=2, Agree=3, Strongly Agree =4)
Q01-Effect	1. The integration of wireless technology will have a positive effect on the quality of my education.
Q02-Profession	2. The integration of wireless technology will help me prepare for the world of work in my profession.
Q03-Homework	3. The integration of wireless technology will have a positive effect on my ability to complete homework and assignments.
Q04-Mission	4. Wireless, mobile computing is particularly appropriate at DSU because of our institutional mission.
Q05-Leading Edge	5. Wireless, mobile computing at DSU will help us continue to show that we are a university on the leading edge of using technology for teaching and learning.
Q06-Input	6. DSU students have an opportunity to provide input about incorporating Tablet computers and wireless networks.
Q07-Fee $275	7. The $275 per semester charge is reasonable because it provides access to a state of the art, mobile computer.
Q08-Attraction	8. The DSU Wireless, Mobile Computing Initiative is important for attracting other high quality students to campus.
Q09-Desktop	9. I prefer using a desktop computer to a laptop or Tablet computer.
	b. Concern:
	When you think about DSU's wireless—mobile computing, how much of a concern is:(Not a concern=1, Minor Concern=2, Concerned, but not worried=3, Major Concern, 4)
Q10-Cost	10. Cost
Q11-Power	11. Keeping it powered and running
Q12-Operate	12. Being able to operate it
Q13-Getting	13. Getting the Tablet when I arrive back on campus
Q14-Teach	14. My professors and instructors being able to teach with the Tablets
Q15-Summer	15. Being able to keep it over the summer
Q16-Support	16. Support and service
Q17-Breaking	17. Breaking it
Q18-Application	18. Running the applications that I like and use

Table 2. Items form survey questions to measure faculty's level of agreement and concern.

Abbreviation	Items: Faculty's Level of Agreement and Concern
	a. Agreement: *Please read each of the following items below and indicate how strongly you agree or disagree with them.* *(Strongly Disagree=1, Disagree=2, Agree=3, Strongly Agree=4)*
Q01-Effect	1. The integration of wireless technology is having a positive effect on the quality of students' education.
Q02-Profession	2. The integration of wireless technology is helping prepare students for the world of work in their chosen professions.
Q03-Homework	3. The integration of wireless technology is having a positive effect on students' ability to complete homework and assignments
Q04-Mission	4. Wireless, mobile computing is particularly appropriate at DSU because of our institutional mission.
Q05-Leading Edge	5. Wireless, mobile computing at DSU is helping us continue to show that we are a university on the leading edge of using technology for teaching and learning.
Q06-Attraction	6. The DSU Wireless, Mobile Computing Initiative is important for attracting high quality students to campus.
Q07-Productivity	7. Integrating wireless, mobile computing is improving my professional productivity.
Q08-Adapt	8. The training I have received has helped me learn to effectively adapt the Tablet PC into my course(s).
Q09-Desktop	9. I prefer using a desktop computer to a laptop or Tablet computer.
	b. Concern: *When you think about DSU's wireless—mobile computing, how much of a concern is: (Not a concern=1, Minor Concern=2, Concerned, but not worried=3, Major Concern, 4)*
Q10-Transition	10. Transitioning from a desktop to a Tablet personal computer
Q11-Power	11. Keeping it powered and running
Q12-Operate	12. Being able to operate
Q13-Use	13. Being able to effectively use the wireless technology in my course(s)
Q14-Training	14. Receiving the training I need to operate the Tablet computers
Q15-Support	15. Support and service
Q16-Application	16. Running the applications that I like and use

Table 3. Students demographic information summary.

Students	Spring 2004	Spring 2004 Percent	Fall 2004	Fall 2004 Percent
Gender				
Male	133	52.6%	120	42.4%
Female	117	46.2%	162	57.2%
Blank	3	1.2%	1	0.4%
Total	**253**		**283**	100%
College of Chosen Major				
1. Arts & Sciences	70	27.7%	58	20.4%
2. Business and Information Systems	86	34.0%	132	46.8%
3. Education	88	34.8%	78	27.5%
4. Undecided	2	0.8%	13	4.6%
5. Blank	7	2.8%	2	0.7%
Total	**253**	100%	**283**	100%

Table 4. Faculty demographic information summary.

Faculty	Spring 2004	2004 SP Percent	Fall 2004	2004 FA Percent
Gender				
Female	20	38.5%	15	27.8%
Male	32	61.5%	39	72.2%
Total	**52**	100%	**54**	100%
College				
1.Arts & Sciences	15	28.8%	19	35.1%
2.Business and Information Systems	24	46.1%	21	38.9%
3.Education	11	21.2%	11	20.4%
4.Library	2	3.9%	3	5.6%
Total	**52**	100%	**54**	100%

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Courses' outcome data analysis

In this section, a quick review of the characteristics of the groups is first presented. Then, the findings on the performance of each group of learners, the perception of participants, and highlight any specific differences that were identified are presented. The data were analyzed based on the mean, standard deviation, and percentages.

4.1.1 Math 102 - Data Analysis

The Math-102 class of the fall 2003 had two sections (sample sizes: 42 and 28) and the fall 2004 had one section (sample size: 36). Within-treatment comparison of two fall 2003 class sections showed there is no difference between learning outcomes in the two sections of fall 2003 class (df= 53.4, t= 0.964, *P*= 0.339, see Table 5 and Figure 1). Since these two sections were similar, we pooled them together to form a new sample (70 students) to represent the entire class of fall 2003. The comparison between the fall 2003 and fall 2004 classes indicated that the difference was statistically significant (df= 89.7, t= 2.842, *P*= 0.006). Therefore, we rejected null Hypothesis-1 and concluded that there was a significant difference in learning outcomes between fall 2003 and fall 2004 classes. By looking at the means and standard deviations, we realized that the class of the fall of 2004 had a larger exam score mean of 61.792 as compared to the class of fall 2003 with a

mean of 52.405. In conclusion, tablets and wireless technology had a positive effect on the learning outcomes of the students in the Math-102 class (see Table 6 and Figure 2).

Table 5. Within-treatment comparison of learning outcomes between 2 sections of fall 2003 class, Math-102.

Course: Math-102, without Tablet PCs	***Fall 2003, Section A***	***Fall 2003, Section B***
Number of observations (n)	42.000	28.000
Minimum	21.333	16.667
Maximum	92.333	83.000
Mean	**54.238**	**49.655**
Standard Deviation (SD)	18.160	20.316
Probability (p)	**0.339**	
Significance level	0.05	
Null hypothesis	**Accept**	

Table 6. Comparison of learning outcomes between fall 2003 and fall 2004 classes, Math-102.

Course: Math-102	***Fall 2003, without Tablet PCs***	***Fall 2004, with Tablet PCs***
Number of observations (n)	70.000	36.000
Minimum	16.667	31.000
Maximum	92.333	84.750
Mean	**52.405**	**61.792**
Standard Deviation (SD)	19.041	14.365
Probability (p)	**0.006**	
Significance level	0.05	
Null hypothesis	**Reject**	

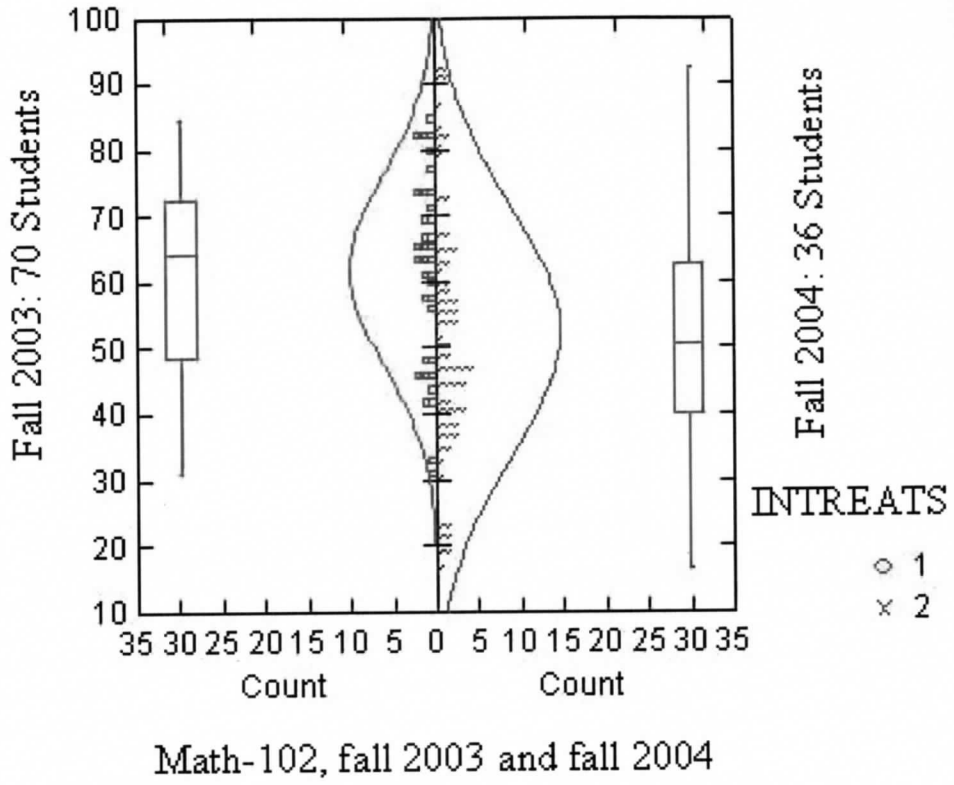

Figure 1. Comparison of learning outcomes between fall 2003 and fall 2004 classes, Math-102.

4.1.2 ENG-101 - Data Analysis

The class of fall 2003 had three sections (sample sizes: 24, 24, and 29). The class of fall 2004 had three sections as well (sample sizes: 28, 18, and 22). The ANOVA test indicated that the difference between learning outcomes of sections of the fall 2003 ENG-101 class was not significant (F= 0.788, P= 0.459, see Table 7 and Figure 3). Evaluation also indicated that the difference between the learning outcomes of sections of the fall 2004 class was not significant (F= 1.298, P= 0.280, see Table 8 and Figure 4). Hence, sections of each class were pooled together and formed two samples of 77 and 65 students. Then, a t-test to compare the two groups was performed. The test showed that

the difference between these two samples was not significant (df= 139.0, t= 1.174, *P*= 0.242). Therefore, the null hypothesis was not rejected and it was concluded that there was no difference between learning outcomes in the ENG-101 class of fall 2003 and fall 2004 (Table 9 and Figure 5). Comparing the means of the two classes (83.642 and 81.873), there is an indication that the class that used Tablet PCs exhibited a lower exam score mean; however, there is no statistical evidence to prove that Tablet PCs had a negative impact on the learning outcomes of students in the ENG-101 class.

Table 7. Within-treatment comparison of learning outcomes between 3 sections of the fall 2003 class, ENG-101.

Course: ENGL-101, without Tablet PCs	***Fall 2003, Section A***	***Fall 2003, Section B***	***Fall 2003, Section C***
Number of observations (n)	24.000	24.000	29.000
Minimum	47.800	55.200	62.808
Maximum	98.200	98.800	95.000
Mean	**85.733**	**83.825**	**81.759**
Standard Deviation (SD)	12.174	12.225	9.573
Probability (p)		**0.459**	
Significance level		0.05	
Null hypothesis		**Accept**	

Table 8. Within-treatment comparison of learning outcomes between 3 sections of the fall 2004 classes, ENG-101.

Course: ENG-101, with Tablet PCs	***Fall 2004, Section A***	***Fall 2004, Section B***	***Fall 2004, Section C***
Number of observations (n)	25.000	18.000	22.000
Minimum	60.135	59.940	60.948
Maximum	98.581	98.212	99.603
Mean	**84.113**	**80.038**	**79.646**
Standard Deviation (SD)	9.256	11.166	10.481
Probability (p)		**0.280**	
Significance level		0.05	
Null hypothesis		**Accept**	

Table 9. Comparison of learning outcomes between fall 2003 and fall 2004 classes, ENG-101.

Course: ENGL-101	*Fall 2003, without Tablet PCs*	*Fall 2004, with Tablet PCs*
Number of observations (n)	77.000	65.000
Minimum	47.800	59.940
Maximum	98.800	99.603
Mean	**83.642**	**81.873**
Standard Deviation (SD)	11.476	10.523
Probability (p)	**0.242**	
Significance level	0.05	
Null hypothesis	**Accept**	

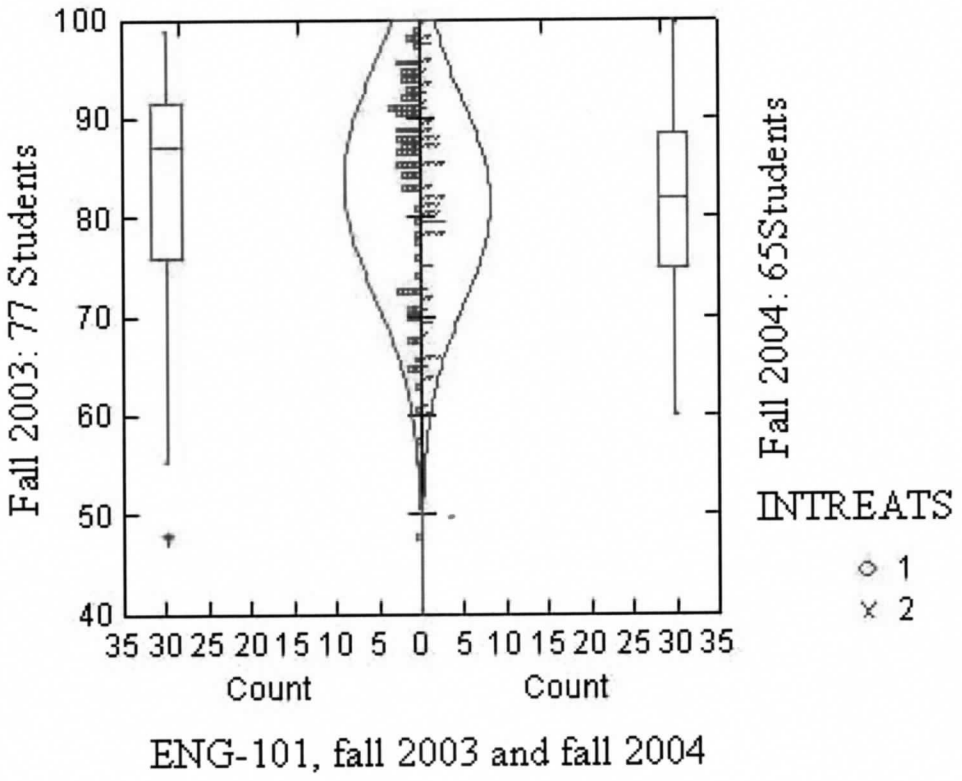

Figure 2. Comparison of learning outcomes between fall 2003 and fall 2004 classes, ENG-101.

4.1.3 CIS-251 - Data Analysis

Each of the two CIS-251 classes evaluated consisted of one section (sample sizes: 50 and 54). Statistical analysis indicated that there is no significant difference between learning outcomes of spring 2004 and spring 2005 CIS-251 classes (df= 100.5, t= 0.102, *P*= 0.919), see Table 10 and Figure 6. The standard deviations (9.961 and 9.518) and the means (77.328 and 77.132) were also too close to reveal any significant tendency of the impact of WMCI on the CIS-251 class.

Table 10. Comparison of learning outcomes between spring 2004 and spring 2005 classes, CIS-251.

Course: CIS-251	***Spring 2004, without Tablet PCs***	***Spring 2005, with Tablet PCs***
Number of observations (n)	50.000	54.000
Minimum	52.750	56.750
Maximum	93.500	94.500
Mean	**77.328**	**77.132**
Standard Deviation (SD)	9.961	9.518
Probability (p)	**0.919**	
Significance level	0.05	
Null hypothesis	**Accept**	

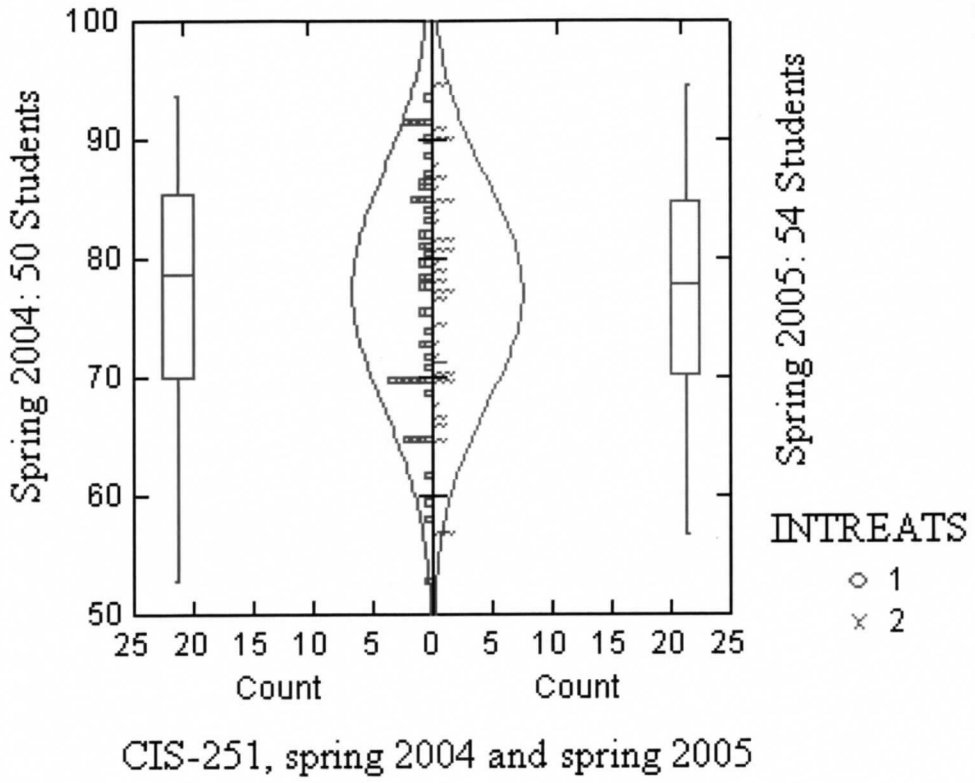

Figure 3. Comparison of learning outcomes between spring 2004 and spring 2005 classes, CIS-251.

4.1.4 HIST-121 Data Analysis

Each of the two HIST-121 classes evaluated consisted of one section (sample sizes: 19 and 37). A t-test revealed that there is no difference between learning outcomes in HIST-121 classes of fall 2003 and fall 2004 (df= 30, t= 0.348, *P*= 0.730, see Table 11 and Figure 7). Thus, the analysis failed to reject the null hypothesis and it was concluded that, when considering WMCI as a factor for change, there is no difference in the learning outcomes of students in pre and post adoption of WMCI. The means (77.763 and 76.527) showed that the class using Tablet PCs had a lower exam score mean. But again,

there is no statistical evidence that the usage of Tablet PCs affected learning outcomes of students in this history class.

Table 11. Comparison of learning outcomes between fall 2003 and fall 2004 classes, HIST-121.

Course: HIST-121	***Fall 2003, without Tablet PCs***	***Fall 2004, with Tablet PCs***
Number of observations (n)	19.000	37.000
Minimum	53.000	44.000
Maximum	98.500	95.500
Mean	**77.763**	**76.527**
Standard Deviation (SD)	13.435	10.702
Probability (p)	**0.730**	
Significance level	0.05	
Null hypothesis	**Accept**	

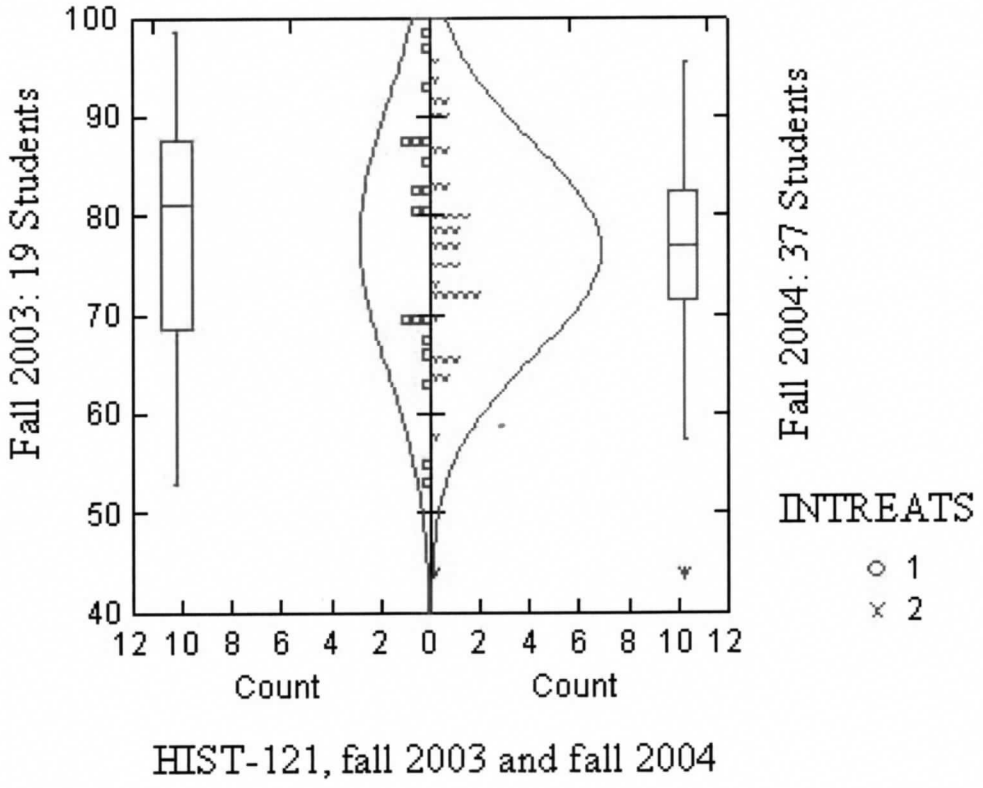

Figure 4. Comparison of learning outcomes between fall 2003 and fall 2004 classes, HIST-121.

4.1.5 HIST-152 Data Analysis

As shown in Table 12 and Figure 8, a t-test indicated that the difference between learning outcomes in spring 2004 and spring 2005 HIST-152 classes was not significant (df= 137.5, t= 0.245, *P*= 0.807). Therefore, we failed to reject the null hypothesis and it was concluded that there was no difference between learning outcomes in spring 2004 and spring 2005 HIST-152 classes

Table 12. Comparison of learning outcomes between Spring-04 and Spring-05 classes, HIST-152.

Course: HIST-152	***Spring 2004, without Tablet PCs***	***Spring 2005, with Tablet PCs***
Number of observations (n)	63	84
Minimum	48.333	78.718
Maximum	100.667	52.333
Mean	**48.333**	**101.333**
Standard Deviation (SD)	11.330	12.001
Probability (p)	**0.807**	
Significance level = 0.05	0.05	
Null hypothesis	**Accept**	

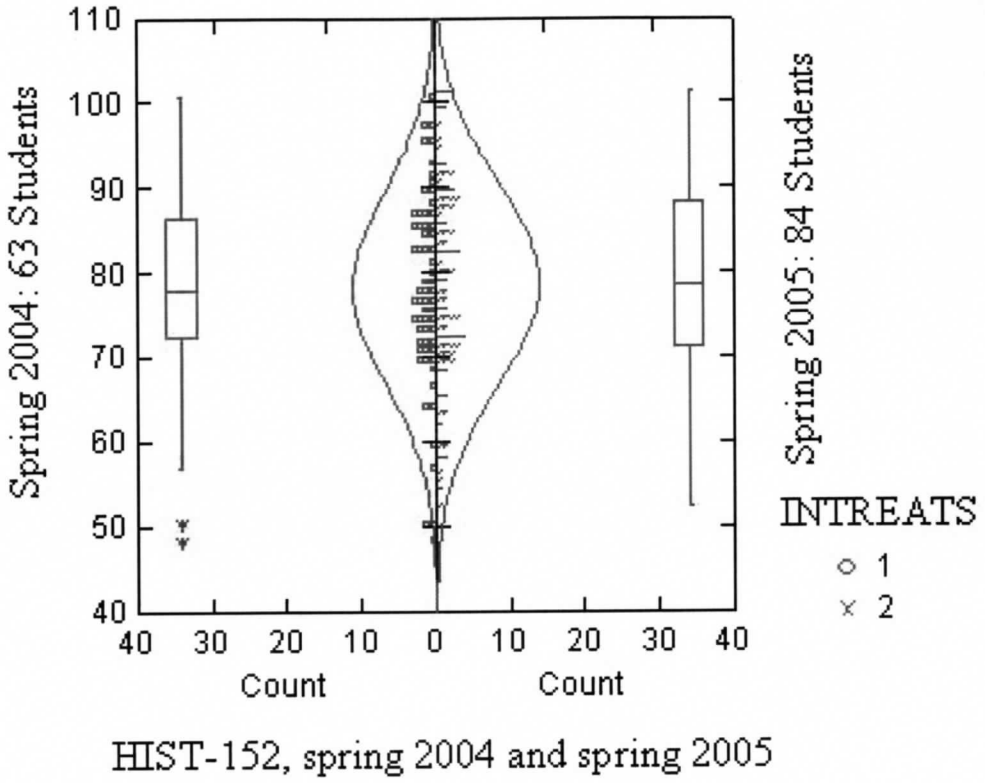

Figure 5. Comparison of learning outcomes between Spring-04 and Spring-05 classes, HIST-152.

4.2 Perception of Participants, 54 students survey.

As it was mentioned in the "About the Courses" section, the instructor of the CIS-251 - Business Application Programming course conducted a survey of the 54 students in the last session of the course. The instructor used checklist-formatted questions on addressing student satisfaction and usefulness of Tablet PCs. Students were asked to respond "yes" if they were satisfied with the tablets. They also responded "no" if they were not satisfied with using the tablets. The checklist method was chosen because participants could easily indicate whether or not the item described the satisfaction they

gained (Hayes, 1992). However, this survey reveals that students have mixed feelings toward wireless, mobile computing.

As shown in Table 13, percentages (88.46%, 86.54%, and 82.69%) on three items indicate that students believe in the usefulness of the tablets to accomplish their school projects, such as completing homework, studying for tests, accessing online materials, and taking notes. On the other hand, percentages (40.38%, 17.31%, and 32.69%) on three other items show that students regard tablets as a distraction. It is interesting to see that 17.31% of the students who find what others are doing on the tablet during class distracts them. These students also think that tablets do not help them to learn better in the class. It would be interesting to conduct independent study to find trends such as the level of impact of what others are doing on their tablets has on the overall satisfaction of class participants. These findings on student perception hint that instructors will have to develop new techniques and designs of their courses to increase students' engagement in class participation. These findings agree with recent researchers who believe that Tablet PCs are a positive add to technology enhanced courses, but at the same time, it is a major distraction that justifies the need for further research.

Table 13. CIS-251 student survey, usefulness and concern with tablets, spring 2005.

Students agreement (Yes or No, 54 students)	Yes	No
Usefulness of tablets:		
1. Did you find the Tablet helpful to complete homework and assignments?	88.46%	11.54%
2. Did you use Tablet to study for tests?	86.54%	13.46%
3. Did you think the Tablet helped you to learn better in the class because of access to online materials, access to WebCT, interactive activities, taking notes, organizing materials etc.?	82.69%	17.31%
Concern / issues with tablets		
4. Is the tablet a distraction for you in class in that you are easily distracted because of chat, email, Internet, games, etc.?	40.38%	59.62%
5. Did you find that what others were doing on the Tablet during class distracted you?	17.31%	82.69%
Other		
6. Do you think teachers should be stricter on how students use the Tablet in class to try to stop some of the distractions?	32.69%	67.31%

4.2.1 Perception of Students and Data Analysis.

When evaluating overall student perceptions between pre and post adoption of WMCI, it was clear that the level of agreement and acceptance of tablets improved significantly. Data presented in Table 14 show that 10 out of 18 items evaluated in the present study were positively perceived, while seven items out of 18 items did not statistically show significant differences. Only one item related to the $275/month charges to lease a tablet showed a negative feeling (means: 2.582 versus 2.551). However, this is not surprising as we may all agree that a consumer is always looking for the best bargain.

Table 14. Comparison of students' level of agreement and concern based on 18 selected items from survey administered in spring 2004 and fall 2004. The t-test with independent mean at the 0.05 level of significance was performed to test Hypothesis-2.

Items	N	Mean	SD	df	T	p-value	Null Hyp.
Q01-Effect	252 , 283	2.976, 3.132	0.708 , 0.698	522.6	2.553	0.011	Reject
Q02-Profession	253 , 280	2.949 , 3.139	0.019 , 0.717	525.3	3.06	0.002	Reject
Q03-Homework	253 , 283	2.921 , 3.201	0.778 , 0.752	522.9	4.233	0.000	Reject
Q04-Mission	253 , 282	3.099 , 3.351	0.914 , 0.654	451.3	3.634	0.000	Reject
Q05-Leading Edge	253 , 282	3.138 , 3.355	0.896 , 0.649	455.0	3.166	0.002	Reject
Q06-Input	253 , 280	2.719 , 3.025	0.784 , 0.669	497.8	4.814	0.000	Reject
Q07-Fee $275	253 , 281	2.581, 2.551	1.061 , 0.821	473.1	2.053	0.041	Reject
Q08-Attraction	253 , 279	2.787 , 2.932	0.874 , 0.744	497.2	2.055	0.040	Reject
Q09-Desktop	253 , 279	2.680, 2.208	0.902 , 0.865	519.8	6.146	0.000	Reject
Q10-Cost	253 , 283	2.937, 2.809	0.936 , 0.837	508.7	1.655	0.099	Accept
Q11-Power	253 , 283	2.458 , 2.597	1.033 , 0.923	508.5	1.632	0.103	Accept
Q12-Operate	253 , 282	1.972 , 1.887	1.277 , 1.002	477.0	0.858	0.391	Accept
Q13-Getting	252 , 280	2.226 , 2.421	1.026 , 1.124	529.9	2.095	0.037	Reject
Q14-Teach	253 , 282	2.206 , 2.323	0.997 , 1.033	528.8	1.324	0.187	Accept
Q15-Summer	252 , 282	2.413 , 2.723	1.148 , 1.179	528.0	3.082	0.002	Reject
Q16-Support	250 , 282	2.468 , 2.567	1.080 , 1.062	520.3	1.068	0.286	Accept
Q17-Breaking	252 , 283	2.421 , 2.406	1.128 , 1.025	510.2	0.152	0.879	Accept
Q18-Application	252 , 282	2.385 , 2.394	1.093 , 1.099	526.0	0.092	0.921	Accept

4.2.2 Perception of Faculty and Data Analysis.

Overall, perceptions of faculty in post adoption did not improve as compared to their expectations in pre implementation. As shown in Table 15, the 14 items out of 16 items did not statistically show any significant difference. However, two major differences related to items Q01-Effect and Q08-Adapt deserve a careful consideration. Prior to the implementation of WMCI, instructors' expectations were too high concerning the level of positive effect tablets would bring to the quality of education (means: 3.231 versus 2.944). We may speculate that their personnel experience in classroom made them

realize that tablets are a major distraction that affects the quality of learning that takes place. It is also worth noting that in post implementation instructors felt a lower level of satisfaction with the training they had received to help them integrated wireless, mobile technology into their courses (means: 3.500 versus 2.780). This suggests that instructors need additional training to enhance their skills to effectively adopt the tablet as a tool.

Table 15. Comparison of faculty's level of agreement and concern based on 18 selected items from survey administered in spring 2004 and fall 2004. The t-test with independent mean at the 0.05 level of significance was performed to test Hypothesis-2.

Questions	n	Mean	SD	df	T	p-value	Null Hyp
Q01-Effect	52 , 54	3.231 , 2.944	0.614 , 0.614	104.0	2.375	0.019	Reject
Q02-Profession	52 , 53	3.231 , 2.981	0.614 , 0.720	101.0	1.912	0.059	Accept
Q03-Homework	52 , 52	3.396 , 2.942	0.603 , 0.777	96.0	1.128	0.262	Accept
Q04-Mission	52 , 52	3.654 , 3.519	0.480 , 0.505	101.8	1.393	0.167	Accept
Q05-Leading Edge	52 , 54	3.481 , 3.352	0.671 , 0.756	103.3	0.929	0.355	Accept
Q06-Attraction	52 , 53	3.115 , 3.019	0.832 , 0.693	99.1	0.645	0.520	Accept
Q07-Productivity	52 , 53	2.865 , 2.623	0.864 , 1.023	100.8	1.314	0.192	Accept
Q08-Adapt	52 , 50	3.500 , 2.780	0.672 , 0.708	99.1	0.264	0.000	Reject
Q09-Desktop	52 , 53	2.232 , 2.151	0.899 , 0.864	102.6	0.646	0.644	Accept
Q10-Transition	52 , 53	1.981 , 1.736	1.038 , 0.812	96.5	1.345	0.182	Accept
Q11-Power	52 , 53	2.058 , 1.755	0.938 , 0.731	96.4	1.844	0.068	Accept
Q12-Operate	52 , 52	1.519 , 1.423	0.804 , 0.696	99.9	0.652	0.516	Accept
Q13-Use	52 , 53	2.019 , 2.245	0.980 , 0.998	103.0	1.171	0.244	Accept
Q14-Training	52 , 53	1.596 , 1.717	1.015 , 0.841	98.9	0.664	0.508	Accept
Q15-Support	52 , 53	2.269 , 2.321	1.223 , 1.327	102.6	0.207	0.836	Accept
Q16-Application	52 , 53	1.962 , 2.094	1.028 , 1.131	102.4	0.630	0.530	Accept

4.3. Future of the Traditional Classroom

The findings agreed that wireless, mobile computing technology did not negatively affect learning experience in terms of learning outcomes. The attempt to evaluate Hypothesis-1 based on learning outcome comparison stands testimony. In general, participants have a positive attitude toward this technology as it was demonstrated by the attempt to evaluate Hypothesis-2.

It is clear that in the near future, all traditional classrooms, at least in the developed countries, will be equipped with computer technologies that encourage active learning. As computer and web enhanced courses continue to gain popularity, tablets will be regarded as a tool of choice for schools (Foster, 2004) at all levels of formal education. There will be a need to radically change the method of delivering instructions to empower students with tools their need to be independent and self-sufficient learners.

In classrooms, presentations will be extended beyond the PowerPoint slide show to bridge the gap between learning team collaborations such as in-classroom or take-home group activities. However, more research is needed to address potential benefits, weaknesses, and strengths associated with each new educational technology.

4.4 Limitations and Possible Future Research

While this study attempted to evaluate the impact of wireless, mobile computing on course performance, we realize that there some resources limitations that are worth noting. Some of these limitations were data availability and time constraints.

- This evaluation study started in January and ran through July 2005. By January 2005, the tablets have been operational in classrooms for only one semester. It

would have been better if we had had many semesters to compare. This implies continuing research is needed to assess the impact of this technology as it matures.

- The study evaluated outcomes of only five courses whereas the inclusion of many courses as possible is desirable. In the future, a progressive evaluation of all courses utilizing tablets is desirable to help segregate courses that are more suitable to this technology than others.
- The evaluated surveys questions were designed to assess certain items independently, the list of items was not exhaustive. Indeed, future studies may design survey instruments that group certain attributes together to assess specific indicators of program success such as confidence level of participant with technology (self-efficacy), system usability, effectiveness of technical support, overall technology effectiveness in classroom, etc.
- Potential research can also include impact of tablets and wireless technology on sub-population such as gender, age, and gifted and student with special needs. .
- Another study that needs ultimate attention is the tablet customization based on learners needs. For example, a student taking a graphic design class needs graphical software, students participating in accounting class needs accounting software, whereas a student taking a computer programming course need programming applications.

CHAPTER 5

CONCLUSIONS

The purpose of this study was to perform quantitative analysis to verify the relationship between student performance, perception of participants, and wireless, mobile computing initiative. To achieve this goal we isolated and analyzed each factor that may have affected learning outcomes. A careful analysis of course change and design enabled us to segregate courses that have been changed and we retained data from courses that maintained a continuity of stability in pre and post integration of WMCI. Survey data helped us to understand how this new technology is perceived by both learners and instructors. Evaluation findings revealed mixed signals in regards of participants' attitude toward the initiative, while other findings did not show any significant impact to support the claim that tablets have impact on learning outcomes.

Data from one course out of evaluated five courses exhibited significant positive evidence in favor of tablets impact as it was originally predicted by WMCI committee. The remaining four courses did not show any significant impact. Speculations suggest that mixed feelings of participant may have had impact on the learning outcomes.

Findings suggest that students believe tablets help them to accomplish their educational chores, but they also confirmed that tablets are a source of major distraction, and they are concerned with the price they pay to lease the tablets. On the other hand, instructors indicated that they are concerned with the effect of tablets on the quality of

education students receive. They are also concerned with their level of training to integrate tablets and wireless technology into course design. If the system was effectively designed to overcome distraction, and if instructors had achieved desired level of training, then positive impact on course performance could be greater.

While the evaluation was worthwhile, limited evidence of impact of Tablet PCs and wireless technology warrants a continuing study to further clarify its effect on learning outcomes. The issues of minimizing student distraction, usability of Tablet features, techniques to incorporate technology in course design, tablet customization, among others, are also worthy of future investigation. In the meantime, it appears that Tablet PCs are not harmful to the learning outcomes. In the future, the scope of this study may be extended to investigate the relationship between learning outcomes and satisfaction of participants based on demographic data.

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APPENDIX A:

DSU's Wireless Mobile Computing Initiative

Student Survey, Spring 2004

As a university, we are about to launch into a new phase of computing that puts a convertible laptop/tablet into your hands (Gateway M275). Next school year you will be approaching your course work and assignments in new ways. Your instructors will also be making some adaptations to their courses to integrate this technology. The computing and learning environment will be a little bit different around campus.

So that the integration of the laptop/tablet computers at DSU is a smooth one, we have designed an evaluation that helps us determine how we can best implement this project. This evaluation helps us understand how we're doing in terms of distributing and servicing the tablets, and using them for learning. The evaluation will also help us take a look at the long term effects of wireless, mobile computing on your learning and career preparation.

One of the first phases of our ongoing evaluation begins with a short questionnaire. This survey helps us get a sense for your ideas and concerns about the project in this early stage of its planning. It should only take you about 5 minutes to complete the questionnaire. Your responses will remain confidential.

Your feedback is extremely important! It will help us make sure that we are thinking through all of the key issues of making sure your interests are represented in this initiative.

Thanks for you help!

Cecelia Wittmayer, Ph.D.
Academic Vice President
Dakota State University

Appendix A: (Continue)

1. Gender: ❑ Male ❑ Female

2. College of your chosen major:
❑ Arts and Sciences
❑ Business and Information Systems
❑ Education

3. Do you currently own your own computer? (check all that apply)

❑ Tablet ❑ Laptop
❑ Desktop ❑ Handheld

4. Please read each of the following items below and indicate how strongly you agree or disagree with them. Use the scale to the right to record your answers.

		Strongly Disagree	Disagree	Agree	strongly Agree
a.	The integration of wireless technology will have a positive effect on the quality of my education.	❑	❑	❑	❑
b.	The integration of wireless technology will help me prepare for the world of work in my profession.	❑	❑	❑	❑
c.	The integration of wireless technology will have a positive effect on my ability to complete homework and assignments.	❑	❑	❑	❑
d.	Wireless, mobile computing is particularly appropriate at DSU because of our institutional mission.	❑	❑	❑	❑
e.	Wireless, mobile computing at DSU will help us continue to show that we are a university on the leading edge of using technology for teaching and learning.	❑	❑	❑	❑
f.	DSU students have an opportunity to provide input about incorporating Tablet computers and wireless networks.	❑	❑	❑	❑
g.	The $275 per semester charge is reasonable because it provides access to a state of the art, mobile computer.	❑	❑	❑	❑
h.	The DSU Wireless, Mobile Computing Initiative is important for attracting other high quality students to campus.	❑	❑	❑	❑
i.	I prefer using a desktop computer to a laptop or Tablet computer.	❑	❑	❑	❑

Appendix A: (Continue)

5. When you think about DSU's move to wireless mobile computing, how much of a concern is:

		Not a concern	Minor Concern	Concerned, but not worried	Major Concern
a.	Cost	❑	❑	❑	❑
b.	Keeping it powered and running	❑	❑	❑	❑
c.	Being able to operate it	❑	❑	❑	❑
d.	Getting the Tablet when I arrive back on campus	❑	❑	❑	❑
e.	My professors and instructors being able to teach with the Tablets	❑	❑	❑	❑
f.	Being able to keep it over the summer	❑	❑	❑	❑
g.	Support and service	❑	❑	❑	❑
h.	Breaking it	❑	❑	❑	❑
i.	Running the applications that I like and use	❑	❑	❑	❑
j.	Other:_____	❑	❑	❑	❑
k.	Other:_____	❑	❑	❑	❑

Dakota State University (2004)
Mark Hawkes, Evaluator

Thank you.

APPENDIX B:

The Wireless Mobile Computing Initiative

Faculty Survey, Spring 2004

As you know, DSU plans to implement new computing initiative for students and faculty alike. We are very interested in hearing what you have to say about the process. Please take a few minutes to complete this survey in order to help us determine how we can address your interests and concerns (if any).

1. Gender: ❑ Male ❑ Female

2. College:
- ❑ Arts and Sciences
- ❑ Business and Information Systems
- ❑ Education

3. Faculty Rank:
- ❑ Instructor/Lecturer
- ❑ Assistant Professor
- ❑ Associate Professor
- ❑ Full Professor

4. After reading each of the statements below, please indicate how strongly you agree or disagree with them. Use the scale to the right to record your answers.

	Strongly Disagree	Disagree	Agree	Strongly Agree
a. The integration of wireless technology will have a positive effect on the quality of students' education.	❑	❑	❑	❑
b. The integration of wireless technology will help prepare students for the world of work in their chosen professions.	❑	❑	❑	❑
c. The integration of wireless technology will have a positive effect on students' ability to complete homework and assignments.	❑	❑	❑	❑
d. Wireless, mobile computing is particularly appropriate at DSU because of our institutional mission.	❑	❑	❑	❑
e. Wireless, mobile computing at DSU will help us continue to show that we are a university on the leading edge of using technology for teaching and learning.	❑	❑	❑	❑

Appendix B: (Continue)

f. The DSU Wireless, Mobile Computing Initiative is important for attracting high quality students to campus.	❑	❑	❑	❑
g. Integrating wireless, mobile computing will improve my professional productivity.	❑	❑	❑	❑
h. Faculty and staff have an opportunity to provide input about incorporating Tablet computers and wireless networks.	❑	❑	❑	❑
i. I am confident—with the proper training—I can learn to effectively adapt the Tablet computer into my work/ course(s).	❑	❑	❑	❑
j. I prefer using a desktop computer to a laptop or Tablet computer	❑	❑	❑	❑

5. When you think about DSU's move into wireless, mobile computing, how much of a concern is:

	Not a concern	Minor Concern	Concerned, but not worried	Major Concern
a. Transitioning from a desktop to a Tablet personal computer	❑	❑	❑	❑
b. Keeping it powered and running	❑	❑	❑	❑
c. Being able to operate it	❑	❑	❑	❑
d. Being able to effectively use the wireless technology in my course(s)	❑	❑	❑	❑
e. Receiving the training I need to operate the Tablet computers	❑	❑	❑	❑
f. Support and service	❑	❑	❑	❑
g. Running the applications that I like and use	❑	❑	❑	❑
h. Other:_____	❑	❑	❑	❑
i. Other:_____	❑	❑	❑	❑

Dakota State University (2004)
Mark Hawkes, Evaluator

Thank you.