THE EFFECT OF HANDHELD TECHNOLOGY USE IN PRE-SERVICE SOCIAL STUDIES EDUCATION ON THE ATTITUDES OF FUTURE TEACHERS TOWARD TECHNOLOGY INTEGRATION IN SOCIAL STUDIES

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

The Topic and Its Context

In a society that is becoming increasingly dependent on computer technology, it is essential that social studies educators teach with and about the latest technology to give their students the building blocks they need to become active citizens (NCSS, 1994). Given the ever-increasing influence of the Internet and the explosion in data collection, processing, and storage due to the myriad of new developments in computer technology, there is a pressing need for social studies educators to teach students how to use the available technology to find, process, and analyze information, and make meaning of it all (Fitzpatrick, 2000; Rice & Wilson, 1999; Risinger, 1998; Saye, 1998; see also Doolittle & Hicks, 2003 for an overview). In addition, because of the nature of the content that they teach, social studies educators should think and teach about the far-reaching impact of technology on society (including their students), and as technology becomes more sophisticated and complex, we must be increasingly adamant about evaluating its effects on our lives (Ross, 2000).

Consequently, it should be clear that colleges of education across the country have an increasingly important responsibility to prepare future social studies teachers to effectively integrate technology in their teaching, because this integration allows for changes in how and what teachers teach and students learn. Existing research shows that merely increasing the amount of existing training in the use of computer technology is not sufficient (Bradley & Russell, 1997; Ropp, 1999), but that educational technology instruction should be integrated into all education courses (Doering, Hughes, & Huffman, 2003; ISTE, 1999a, 1999b; Mason, Berson, Diem, Hicks, Lee, & Dralle, 2000; Willis &

Mehlinger, 1996). In addition, to bring about instructional reform in K-12 social studies education there is a need for curriculum development and instructional design that is considerate of learners and their social context (Shaver, 1999). Unfortunately, the recent past has revealed that while many colleges and universities have acquired vast amounts of computer hardware and software they have mostly neglected to model for their pre-service teachers how to appropriately integrate technology (Doering, Hughes, & Huffman, 2003; ETS, 1997; ISTE, 1999b; NCATE, 1997; Willis & Mehlinger, 1996), and have avoided the issue of how to effectively deal with the effect of technology use at the college level on student teachers' attitudes toward technology integration in the subject areas they are going to teach.

Besides effective technology integration, the quality of pre-service teachers' experiences with computer technology is important as well, because it affects their attitudes toward personal technology use, and consequently, technology integration in their teaching (Crowe, 2003; 2004; Rosen & McGuire, 1990). According to Keiper, Harwood, and Larson (2000), besides the level of a person's computer use, teacher interest in technology for learning is the most important factor that determines technology integration by educators (see also Gibson & Hart, 1997; Ropp, 1999). Therefore, it is important for pre-service teacher educators to understand pre-service teacher beliefs and perceptions and effectively model appropriate technology integration in their own courses in order to raise interest levels and better prepare future teachers for their profession (Pajares, 1992). The technology used should be representative of current technology usage trends in society, especially as it applies to K-12 students.

One of these technologies consists of mobile computers, including devices such as handheld computers, mobile gaming devices, and cell phones. Handheld computers, the devices used in this study, are roughly the size of a small calculator, easily portable, resemble computers in that they have an operating system and software applications, and often depend on a touch screen for user input. While these portable devices have been commonplace in math and science education, only a relatively small number of social studies teachers have ventured into this area of technology. However, initial evaluation reports and academic research have yielded baseline data that indicate that a large majority of teachers across subject areas (including social studies) considers handhelds to be effective tools in the classroom, and believes that they can have a positive impact on student learning, especially because it is more realistic now than ever to attain a 1:1 computer to student ratio (Soloway et al., 2001; Vahey & Crawford, 2002; van 't Hooft, Diaz, & Swan, 2004). In addition, the National Technology Leadership Initiative (NTLI) was created in 2000 to investigate the potentially substantial effects of ubiquitous computing on education, including social studies education (van Hover, Berson, Mason, & Swan, 2004).

The term "ubiquitous computing" was defined in 1991 by Mark Weiser from Zerox PARC as an environment in which "a new way of thinking about computers in the world … allows the computers themselves to vanish into the background" and become indistinguishable from everyday life (p. 94). Weiser emphasized that ubiquitous computing in this sense does not just mean portability, mobility, and instant connectivity, but the existence of an environment in which people use many computing devices of varying sizes (which he described as tabs, pads, and boards) that interact with each other, combined with the aforementioned change in human psychology to the point where users have learned to use the technology well enough that they are no longer aware of its presence and do not have to be. While the change in our knowledge and use of a wide variety of computing devices is not yet at the level that Weiser envisioned more than a decade ago, we are much closer to reaching its technology requirements: "cheap, low-power computers that include equally convenient displays, a network that ties them all together, and software systems implementing ubiquitous applications" (Weiser, 1991, p. 99).

Weiser's vision of ubiquitous computing fits well with current visions of technology integration in education and its potential impact on teaching and learning. The NTLI concluded that ubiquitous computing is going to have a substantial impact on schools and that educators must be prepared to make the best use of this new technology (van Hover, Berson, Mason, & Swan, 2004). Therefore, it is important to expose pre-service teachers to this type of technology in a positive way. The present study looks at the integration of handheld computers in a social studies methods course in the teacher education program of a university in the Great Lakes region, and how their use affects pre-service teachers' attitudes toward technology integration in secondary social studies education.

Because it is so important for teacher educators to effectively address pre-service teacher attitudes toward technology integration, especially given the continuous changes in the field of educational technology, the increasing complexity of technology integration in secondary classrooms, and the aforementioned lack of teacher preparation to use technology (OTA, 1995; Wiske, 1988), there is a real need for instruments that adequately measure pre-service teachers' attitudes toward technology and its integration in teaching and learning. The Computer Attitude Survey (CAS), developed by Loyd and Gressard in 1984, has long been one of the instruments of choice for such assessment, and the existence of a substantial amount of research literature related to its psychometric characteristics in a variety of applications has shown that the instrument is valid and reliable (Gardner, Discenza, & Richard, 1993). However, because the field of instructional technology has changed so much in recent years, it is imperative to re-evaluate the instruments that measure constructs related to this field, including the CAS. A preliminary research study was done with one-week-long technology staff development sessions for in-service, inner-city teachers in preparation for this project The CAS was administered immediately before and after the staff development sessions and a third administration took place two months later (van 't Hooft, 2001). Survey data showed no significant difference in attitudes between pre and post-session administrations of the CAS. In this case, the pre-treatment scores were almost as high as scores after treatment, both immediately following the treatment as well as on a follow-up survey done two months later. Demographic data indicated that the vast majority of teachers in the session had a computer at home (97%), and about 60% considered themselves to be intermediate technology users (defined as "I use computers on a regular basis and am pretty good at using them. I use a variety of applications as well as the Internet for browsing and email. I know how to solve some problems"). On average, study participants indicated they had been using computers for personal use for about 11 years, and for teaching for about 6 years. In addition, they reported an average length of Internet usage of about 6 years. These demographic data could provide an explanation for the ceiling effect in the CAS data that emerged in this study. A majority of teachers today own and use computers on a regular basis for tasks such as word processing, multimedia, and Internet browsing, and as a result their attitudes may not change much over time. The same can be said for college students, including those in colleges of education across the country (Jones, 2002).

As a result, general attitudes toward computers may be more positive now than they were at the time the CAS was developed, because computer technology and the Internet are virtually everywhere today. This raises the question whether the CAS can still be adequately used to measure whether in-service or pre-service education in instructional technology brings about significant changes in attitudes toward computer technology. Therefore, it would make sense to adjust the CAS to current trends in instructional technology.

The first part of this study does just that. The 40-item version of the CAS was adapted to measure attitudes toward handheld technology by replacing the word "computer" with the phrase "handheld computer", and changing its name to Handheld Computer Attitude Scale (HCAS). Nothing else was changed in the phrasing of the questions or the scale of measurement used (a five-point Likert scale). The instrument was field tested, and confirmatory factor analysis was used to determine whether the HCAS measures underlying constructs similar to the CAS (handheld computer confidence/anxiety, handheld computer liking, handheld computer usefulness, and learning activities related to handheld computer training). Following the pilot phase the instrument was then used to gather the data needed to answer the main question of this research study.

Importance of Study

Until fairly recently, research in the area of technology use in social studies education (both K-12 and pre-service education) has been a low priority (Berson, 1996; Martorella, 1997; Whitworth & Berson, 2003), often due to limited access to technology, a lack of knowledge and training related to hardware and software, the extensive time commitment required to integrate technology, and a lack of expectations for use in social studies (Ehman & Glenn, 1990; Whitworth & Berson, 2003). In addition, publications that do exist in the area of technology use in social studies education have been primarily focused on Internet resources for teachers. Examples of systematic research in the area of the effectiveness of technology integration in social studies education are few and far between or suffer from methodological weaknesses (Shaver, 2001; Whitworth & Berson, 2003).

While the current project builds on existing research in the area of student attitudes toward computers (Liu & Johnson, 1998), it is designed to fill a void in the aforementioned area of social studies by gathering and analyzing information about the integration of handheld technology in pre-service social studies education, and how this affects the attitudes of pre-service social studies teachers towards technology integration, social studies, and social studies education.

The reason why this study focuses on pre-service training instead of in-service staff development is that beliefs and attitudes towards teaching are formed during pre-service training, especially during field observations and student teaching, but also to some extent in the college classroom (Hardy, 1998; Wallinger, 1997). Positive attitudes towards technology formed during pre-service training are easier to create and maintain, and will be more difficult to alter once developed (Pajares, 1992). In addition, training pre-service teachers to be agents of change in technology integration has an even more powerful overall effect. Once these pre-service teachers become in-service teachers and are using technology in their classrooms, they will provide for more access to computers and create more computer-literate students in their classrooms, some of whom will eventually enter post-secondary education. Those students choosing to enter the teaching profession will then tend to be more positive towards integrating technology upon entry into a teaching training program (Sheffield, 1998). Teachers with more positive attitudes toward technology will make adoption and successful technology use easier and more effective (Hunt & Bohlin, 1993; Lawton & Gerschner, 1982; Stevens, 1980), thereby creating and maintaining an upward spiral of usage.

Research Questions and Hypotheses: Pilot Study

The following questions and hypotheses were developed to test the HCAS for validity and reliability.

Content Validity

Research question

To what extent does the HCAS measure pre-service teacher attitudes toward handheld computers?

Null hypothesis

H_0: $I_{ik} = 0$ for any item, where I_{ik} equals the item-construct congruence score for any item i on any construct k.

Explanation

One of the first concerns when examining an instrument is its content validity, which can be determined through the use of a subjective content review (face validity) or a more systematic examination of the contents (logical validity; Allen & Yen, 1979; Crocker & Algina, 1986). Even though logical validity is deemed more appropriate for tests that measure carefully defined content domains than vaguer constructs like attitudes, the HCAS was examined for logical validity using the four hypothesized constructs as the domains to be measured. A panel of experts determined whether or not the HCAS measures what it proposes to measure, i.e. pre-service teacher attitudes toward handheld computers, by asking questions about the constructs handheld computer confidence/anxiety, handheld computer liking, handheld computer usefulness, and learning activities related to handheld computer training. The expert panel consisted of three researchers with expertise in the areas of educational technology and measurement. Panel members were given a list of the HCAS items and asked to match each of them with one of the four constructs. The judges' scores were then used to calculate item-construct congruence (Crocker & Algina, 1989).

Construct validity

Five questions were developed to test the instrument's construct validity, or the extent to which it measures an underlying construct or trait (Allen & Yen, 1979). The first four were used to determine if certain items could be grouped together, while the fifth question examined the extent to which the four hypothesized factors were different from each other:

Research question 1

Is there a relationship between items 1, 4, 6, 9, 12, 14, 15, 16, 18, 22, 24, 28, 30, 33, and 40 on the HCAS (handheld computer anxiety factor)?

Null hypothesis

H_0: $?_{i_j i_k} = 0$, where $i_j i_k$ equals any pair of items in the handheld computer anxiety factor.

Research question 2

Is there a relationship between items 2, 7, 11, 19, 25, 27, 31, 35, 36 and 37 on the HCAS (handheld computer liking construct)?

Null hypothesis

H_0: $?_{i_l i_m} = 0$, where $i_l i_m$ equals any pair of items in the handheld computer liking factor.

Research question 3

Is there a relationship between items 3, 8, 13, 17, 21, 23, 32, 34 and 38 on the HCAS (handheld computer usefulness construct)?

Null hypothesis

H_0: $?_{i_p i_q} = 0$, where $i_p i_q$ equals any pair of items in the handheld computer usefulness factor.

Research question 4

Is there a relationship between items 5, 10, 20, 26, 29 and 39 on the HCAS (learning activities related to handheld computer training construct)?

Null hypothesis

H_0: $?_{i_r i_s} = 0$, where $i_r i_s$ equals any pair of items in the learning activities related to handheld computer training factor.

Research question 5

Are any of the four constructs (handheld computer anxiety/comfort, handheld computer liking, handheld computer usefulness, learning activities related to handheld computer training) on the HCAS related to each other?

Null hypothesis

H_0: $?_{c_j c_k} = 1$, where $c_j c_k$ equals any pair of the four hypothesized constructs.

Explanation

Existing research on the CAS shows that items can be grouped using four constructs (computer anxiety/comfort, computer liking, computer usefulness, learning activities related to computer training). In order to test if these groupings are maintained for handheld computers on the HCAS, the instrument was tested for construct validity (Crocker & Algina, 1986; Gorsuch, 1983). Confirmatory factor analysis using a maximum likelihood approach was used. This type of analysis tests the nature and fit of hypothesized factors. More specifically, it extracts predefined factors and then determines if the residual matrix still contains significant variance. It also yields chi-square statistics that can be tested for statistical significance and are additive in nature. Therefore, multiple models can be compared to determine which one provides the best model-data fit (Gorsuch, 1983). In this case, two models were tested, one without any common factors at all, and the other consisting of the four hypothesized factors.

To prepare the second model with the hypothesized structure consisting of four factors, $f^2 + 1$ or $4^2 + 1 = 17$ parameters needed to be defined in the second model to yield a restricted solution. Based on prior research, the factors are assumed to be correlated at least to some extent (i.e. the off-diagonals in the R_{ff} matrix cannot be set to 0). However, factor loadings of variables that are supposed to load on certain factors can be set to a value of 1. In addition, because confirmatory maximum likelihood factor analysis is driven by prior theory related to the factor structure of the HCAS, rotation of the factors is not necessary because the results can be interpreted as is (Gorsuch, 1983, pp. 175-176).

Internal-Consistency Reliability

Research question

Are the handheld computer confidence/anxiety, handheld liking, handheld usefulness, and attitudes toward learning activities related to handheld computer training subscales on the HCAS internally consistent?

Null hypothesis

$a_i = .80$, where i equals any of the four HCAS subscales.

Explanation

To determine internal consistency of an instrument, an examination of the average correlations among its items is appropriate. If the items on the instrument have a wide range of scoring weights, Cronbach's Alpha is an appropriate procedure (Crocker & Algina, 1986). When the instrument consists of scales measuring different traits as is the case with the HCAS, internal consistency should be established for each subscale separately (Dimitrov, Rumrill, Fitzgerald, & Hennesey, 2001, Gliem & Gliem, 2003). Because prior calculations of Cronbach's Alpha have been high, and research in educational technology generally expects reliability levels of instruments to be at .80 or higher, a directional hypothesis was used here.

Test-Retest Reliability

Research question

Are scores on the HCAS consistent over time?

Null hypothesis

H_0: ?$_{a_j a_k}$ = 0, where $a_j a_k$ equals any pair of survey administrations.

Explanation

Correlation analysis was performed on the overall instrument as well as the individual subscales, comparing data from all three survey administrations. Spearman correlations were used to analyze the ordinal data in order to detect statistically significant correlations between administrations.

Research Questions and Hypotheses: Main Study

The following research question and associated null hypothesis were developed for the main focus of this research study: What is the effect of handheld technology integration in a social studies methods course on pre-service social studies teachers' attitudes toward technology use in social studies education? Null hypothesis:

$$H_0: \mu_{1_{adj}} = \mu_{2_{adj}}$$

where $\mu_{1_{adj}}$ and $\mu_{2_{adj}}$ equal the adjusted population mean vectors for each group.

Due to the nature of the data collected (survey data using Likert-scale items on four constructs measuring student attitudes toward handheld computers), the analysis consisted of a repeated measures, non-parametric MANOVA (Stevens, 2002). The data set was checked to ensure that the assumptions were met (observations are independent;

dependent variables have a multivariate normal distribution, and the population covariance matrices for the dependent variables are equal (Stevens, 2002, p. 257). Next, the raw subscale scores were changed into rank scores in order to calculate the non-parametric MANOVA. Next, Pillai-Bartlett's trace statistic was calculated and adjusted, using a simple transformation described by Zwick (1985). This entailed recalculating Pillai-Bartlett's V as $(N\text{-}1)V$ and comparing the resulting statistic to the chi-square distribution using $P(K\text{-}1)$ degrees of freedom (where P equals the number of dependent variables and K equals the number of groups; in this case 4 and 2 respectively).

Initial power analysis indicated that a two-group research design with one independent and four dependent variables should yield acceptable results. With alpha levels set at .05 and group sizes at about 21 each, the statistic should have a power level of about .70 for large effect sizes and .90 for very large effect sizes (Stevens, 2002). These are conservative estimates, given the fact that using a repeated measures design tends to increase power levels.

Operational Definitions

Pilot Study

Attitude: An individual's reaction to or evaluation of something or someone in a positive or negative fashion (Aiken, 1980; Fishbein & Ajzen, 1975; Greenwald, 1989).

Attitude toward (handheld) computers: Refers to how much pre-service teachers enjoy, like, or are interested in learning about or working with (handheld) computers.

Handheld computer anxiety/comfort: The extent to which someone is comfortable using handheld computers.

Handheld computer liking: The extent to which someone likes handheld computers.

Handheld computer usefulness: The extent to which someone perceives handheld computers to be useful.

Learning activities associated with handheld computer training: Someone's perception of his/her abilities in learning about handheld computers.

Handheld computer: A computer device that is small in size and portable, and performs most functions a desktop or laptop is capable of performing. It has a touch-screen and text input takes place through handwriting recognition or small keyboards.

Main Study

Besides the definitions provided in the pilot study section, the following terms were operationalized for the main study.

Pre-service teacher: A person who is enrolled in a teacher education program in order to receive initial licensure to become an in-service teacher in a public or private school at the secondary level, grades 7-12.

Teacher education program: A multi-year college program that prepares qualified teachers by providing comprehensive preparation for the art of teaching (Author, 1998).

Social studies: "the integrated study of the social sciences and humanities to promote civic competence. Within the school program, social studies provides coordinated, systematic study drawing upon such disciplines as anthropology, archaeology, economics, geography, history, law, philosophy, political science, psychology, religion, and sociology, as well as appropriate content from the humanities, mathematics, and natural sciences" (NCSS, 1994, p. 3).

Secondary social studies: Social studies in grade levels 7-12.

Social studies education: The teaching of social studies "to help young people develop the ability to make informed and reasoned decisions for the public good as citizens of a culturally diverse, democratic society in an interdependent world" (NCSS, 1994, p. 3).

Educational technology: Computer hardware, software, and networks that are used as tools for teaching and learning. Usage may include, but is not limited to, drill and practice, multimedia, research, and communications.

Technology integration: The degree to which technology is used by teachers to support student-centered approaches to instruction while the teacher assumes the role of facilitator or coach (OTA, 1995).

Rationale

The influence of computer technology is an ever-growing force in our society. It is important for social studies teachers to teach with and about it, in order to prepare their students to become active and informed citizens. Preparing teachers to teach with technology begins at the pre-service level. It is essential for pre-service teacher educators to effectively model technology integration in college classrooms in order to be a positive influence on pre-service teachers' attitudes toward technology use in teaching and learning.

Purpose

The purpose of this study is to investigate the effect of handheld computer integration in a secondary social studies methods course on the attitudes of pre-service teachers toward technology integration in social studies classrooms.

CHAPTER II: REVIEW OF LITERATURE

An investigation into pre-service teacher attitudes toward handheld technology for teaching and learning in social studies requires an understanding of technology integration from a variety of angles. Therefore, this chapter starts with an overview of existing research in the area of technology integration in K-12 education, followed by a more focused summary of work related to handheld computer use for teaching and learning. This overview provides a framework for a description of technology and handheld devices in K-12 social studies classrooms. To supplement the technology integration research done at the K-12 level, a similar description of research related to technology integration in pre-service teacher education is added, which sets the stage for a discussion of pre-service teacher attitudes toward technology integration, especially as it applies to social studies.

Technology Integration in Education

Computer technology has been a part of American education since 1959, with the implementation of Bitier's PLATO project at the University of Illinois, the first large-scale use of computers in education which served undergraduates, local elementary schools, a community college in Urbana, and several campuses in Chicago. The next breakthrough followed four years later with the development of BASIC at Dartmouth and individualized computer-aided instruction at Stanford's research labs, and it soon became possible to create computer-based teaching and learning materials (Molnar, 1997). From then on events snowballed and educational technology slowly began to move away from managerial-driven education focused on *memorization* and learning *about* computers to more open-ended teaching and learning methods based on *thinking* and learning *with* technology. Examples of this shift include the development of tools such as Logo (Papert, 1980), different types of electronic data visualization tools such as spreadsheets, databases, and concept mapping, and the advent of the Internet for immediate access to literally a world full of information. However, it was not until the development of relatively inexpensive microcomputers in the 1980s such as the Apple IIe and IBM's PC Junior that schools could afford to put computing tools in the hands of teachers and students. From that point on, new tools followed each other in rapid succession with the introduction of equipment such as laptops, digital imaging devices, wireless networks, science probes, and handheld computers. The hardware is complemented by a virtually endless list of software ranging from simple word processors and Internet browsers to high end multimedia programs and data analysis tools (Molnar, 1997; Williams, 2004).

Trends in educational technology generally follow those in society, because educational institutions are responsible for preparing their students to become productive citizens in that same society (Davis, 1997). Within this context, integrating technology in teaching and learning has become an increasingly difficult yet essential task for educators. As life becomes more complex and data-driven on a regular basis, it is no longer a matter of learning what you need to know, but learning how to access, evaluate, and use huge amounts of fluid information, and what tools to use to accomplish this task (Fitzpatrick, 2000; Molnar, 1997).

School districts have spent enormous amounts of time and money to approach the daunting task of teaching students the skills they need to be successful. In the 2002-2003 academic year, K-12 schools invested an estimated $5.74 billion in educational technology. This is a considerable amount compared to other expenditures even though it was down from an $8.36 billion high in 1998-1999 (QED, 2004). To put things in perspective, in the 2000-2001 academic year, the most recent year for which comparison data are available, schools across the United States spend $6.45 billion on technology while spending $10.4 billion on other supplies (QED, 2004; St. John, 2004). In the same time period, Internet access in schools rose to 92% (note this says schools, not classrooms), and the ratio of students to computers with Internet access decreased from 12:1 in 1998 to 4.8:1 in 2003 (US Department of Education, 2003). In addition, a series of studies done by the Center for Research on Information Technology and Organizations found that by 1998, 93% of all teachers in grades 4-12 were using computers as a part of their professional lives for tasks such as preparing instructional materials, managing student information, and finding content-related materials. While 71% of all teachers stated they assign computer work to their students, only about one-third said they do so on a regular basis (Becker, Ravitz, & Wong, 1999). These findings are also reflected in the Snapshot Surveys, which are a collaboration between researchers at the University of North Texas and the University of Michigan. In this case, 82.4% of approximately 3,600 teacher respondents indicated that their students use computers less than 45 minutes per week for non-Internet activities, and 93.7% stated that their students spend less than 45 minutes per week on the Internet (Norris, Sullivan, Poirot, & Soloway, 2003). In both cases, lack of access and time needed to integrate technology into the curriculum were given as reasons for limited use of technology by students for learning activities at school. Other barriers to use include a lack of appropriate software, a lack of support (technical and administrative), a lack of training, or limited notions of what should be done with computers in the classroom (Becker, Ravitz, & Wong, 1999). The logical conclusion is that while spending and teacher usage of educational technology are increasing, technology integration in the curriculum and student use of technology in school have lagged behind. This has resulted in harsh criticism that over the past 25 years or so, the impact of instructional technology on student learning in K-12 has been virtually non-existent (Cuban, 2001; Norris, Sullivan, Poirot, & Soloway, 2003; Oppenheimer, 1997).

Despite this, there are plenty of examples of successful technology use in schools, as long as it is introduced and used within the contexts of the learning environment and content. According to Ely (1994), technology should be a means to an end if it is to transform teaching and learning, and should be integrated, not added on, to a school's curriculum. In addition, when integrated into the curriculum it is important to monitor how the technology is used. Even with its potential to enhance teaching and learning, there is always a danger in some of the ways in which technology is employed. These dangers include shifting the locus of control from the teacher to the software developer, removing teachers from the instructional loop, reinforcing old models of important knowledge, and even validating bad teaching (Callister & Dunne, 1992).

What does the research say about the effectiveness of technology usage in K-12 education? Ample research is available that documents the impact of traditional uses of technology in classrooms (i.e., to learn discrete skills and facts of curriculum). Kulik (1994), for example, did a meta-analysis of over 500 such studies and found that student motivation, on-task behavior, and levels of learning tended to be higher when technology is used for classroom instruction (see also Bayraktar, 2002; Kulik & Kulik, 1991; Schachter, 1999). However, more recent studies argue that previous conclusions have been drawn based on an aging body of literature (and therefore obsolete technology); that technology should be used as a supplement by, not as a replacement for, the teacher; and that methodological flaws in the research can only lead to the conclusion that the use of instructional technology for more traditional tasks is at least as effective as conventional instruction (Jenks & Springer, 2002; Lowe, 2001).

In contrast, large scale research is limited when it comes to the role of technology in student-centered learning models and its impact on cognitive, behavioral, and affective student outcomes. One of the more recent meta-analyses that focuses on this area calculated effect sizes from 42 studies and concluded that teaching and learning with technology had a small positive effect on student outcomes (Waxman, Lin, Michko, 2003). However, the authors point out that the results are based on a limited number of research articles, most of which lacked a randomized, experimental design and enough details to perform a thorough analysis, or were based on technology nearly a decade old. All in all though, the authors are cautiously optimistic in their findings in that they yielded effect sizes roughly twice the size of similar recent meta-analyses (d = .41 and .21 respectively). Examples of these studies include analyses of computer-based instructional simulations (Blok, Oostdam, Otter, & Overmaat, 2002; Lee, 1999), interactive distance education technologies (Cavanaugh, 2001), and small group versus individualized learning with technology (Lou, Abrami, & d'Appolonia, 2001).

Interestingly enough, there is a complete absence of meta-analyses in the field of student-centered learning in a ubiquitous computing environment. This can potentially be explained by the general lack of systematic research in the area of instructional technology as reiterated by Waxman, Lin, and Michko (2003), as well as the as of yet relatively unexplored field of ubiquitous computing in which handheld, mobile devices play a pivotal role. As handheld computers become more important in K-12 classrooms and colleges of education around the country, this is an area which should have high priority for educational researchers.

Handheld Computers in Education

One of the more recent developments in the field of educational computing is that of handheld devices. Even though graphing calculators have been around for a long time and over 80% of high school mathematics teachers report using them for classroom instruction (Burrill, Allison, Breaux, Kastberg, Leatham, & Sanchez, 2002), the real push to introduce portable computers in all subject areas and at most grade levels has emerged in the last five years with the arrival of devices that have a wide variety of computing capabilities yet are small enough to fit in your pocket. Leaders in the handheld industry, using initiatives such as the Palm Education Pioneer (PEP) program and the Texas Instruments (TI)/National Council for Social Studies (NCSS) Strategic Alliance, have promoted the influx of palm-size devices in schools. As stated earlier, student access to computers is essential when it comes to computer use and its potential impact. Current research shows that computer use and student learning gains are strongly related to the immediate availability of technology in classrooms as opposed to putting it in a separate computer lab (Becker, Ravitz, and Wong 1999; Marx, et al., 2000; Norris & Soloway, 2001; Norris, Sullivan, Poirot, & Soloway, 2003; Soloway, Norris, Blumenfeld, Fishman, Krajcik, & Marx, 2001), and a 1:1 student to computer ratio is needed to make computing in schools truly personal and effective. For many school districts, especially the larger or poorer ones, attaining this ratio is a financial impossibility (Norris & Soloway, 2001).

Handheld computers, which are small in size and cost a fraction of the price of desktop and laptop computers, can provide schools with a more realistic alternative for integrating technology into the classroom and meeting the challenges of improving student achievement (Hennessy, 1997; Robertson, S. I., Calder, J., Fung, P., Jones, A., O'Shea, T., & Lambrechts, G., 1996; Sharples, 2000a).

Besides potentially increasing the student to computer ratio to 1:1, handheld devices are a disruptive technology that will change the nature of technology integration and its use in teaching and learning (Norman, 1999). Fung, Hennessy, and O'Shea (1998) describe this changing role of technology as a paradigm shift, comparing it to the historic shift from reading as done only in centers of learning to reading as an integral part of everyday life. More specifically, handheld computing differs fundamentally from the more traditional desktop computing environment in that users who interact in a mobile environment not only work with other users but also with a variety of computing devices simultaneously (Cole & Stanton, 2003; Danesh, Inkpen, Lau, Shu, & Booth, 2001; Mandryk, Inkpen, Bilezkjian, Klemmer, & Landay, 2001; Roth, 2002). Therefore, handheld computers help facilitate more collaborative learning if used appropriately. Roschelle and Pea (2002), for example, highlight three ways handheld devices have been used to increase learning collaboratively –1) classroom response systems; 2) participatory simulations; and 3) collaborative data gathering – and suggest, like others, that there are many more such uses (Danesh, Inkpen, Lau, Shu, & Booth, 2001; Mandryk, Inkpen, Bilezkjian, Klemmer, & Landay, 2001; Roschelle, 2003). Finally, because of their small size, handheld computing devices no longer constrain the user like laptops do, and have the potential of becoming lifelong-learning tools anywhere, anytime (Inkpen, 2001; Sharples, 2000b).

However, the introduction of handheld devices in a learning environment that already incorporates technology does not automatically lead to the replacement of existing equipment such as desktop and laptop computers. In fact, the presence of handheld devices complements existing technology and amplifies its importance, in a way becoming the glue that holds different technologies together. Norris and Soloway (2004), describe this type of environment as the "handheld-centric classroom", a place where teachers and learners have access to a variety of personal and shared digital tools making up a total technology infrastructure that promotes project-based learning. This type of ubiquitous computing, they contend, supports artifact creation and revision, collaboration, learning in context, and managing and coordinating the use of multiple resources. In addition, ongoing assessment and communication between teachers and students, parents, administrators and the larger community will flourish as well. Examples of these environments include complex systems such as a wireless, mobile, and ad hoc learning network for scaffolding learning about bird watching (Chen, Kao, & Sheu, 2003), and a Wireless Technology Enhanced Classroom that supports project-based learning facilitated by a combination of a wireless LAN, wireless handheld learning devices, an electronic whiteboard, an interactive classroom server, and a resource and class management server (Liu, Wang, Liang, Chan, & Yang, 2003); as well as much simpler environments such as one in which 1:1 handheld computing was combined with five desktop computers and digital imaging devices to learn about the Great Depression using a classroom simulation (van 't Hooft & Kelly, 2004).

Technology and Social Studies Education

Levels of computer technology use in social studies education have historically been lower than in other subject areas such as science and math (Becker, 2001). Early myths related to the complexity of computer technology; a lack of knowledge about and training related to hardware and software; limited access; a lack of expectations of technology use in social studies; and a lack of time, technical support, or adequate software persisted as barriers to use in the 1980s and 1990s and often created a resistance among social studies teachers toward the integration of technology into their curriculum (Becker, 1998; Clark, 1992; Cuban, 1999; Ehman & Glenn, 1990; Pahl, 1996; Ross, 1988). Research in the area of technology in social studies education was sporadic and inconsistent. As early as the late 1970s and early 1980s, social studies educators were having limited discussions about the potential impact of technology on student learning through drill and practice, tutorials, and simulations, which could increase motivation, a sense of control, and perseverance (Bolton & Moscow, 1981; Clegg, 1990; Ehman & Glenn, 1990; Roberts, 1976; Vincent, 1986). This was followed by infrequent research that indicated that computers could be used as tools by students to foster critical thinking, decision making, and problem solving, at first through the use of databases (Rawitsch, 1987; White, 1986; 1987), and more recently by way of the Internet and multimedia tools (Berson, Lee, & Stuckart, 2001; Eaton, 1999; Risinger, 2000; Wilson, Rice, Bagley, & Rice, 2000). However, claims that technology integration is effective were often not supported by systematic research (Barth, 1990, Chan, 1989), or the research itself was flawed in its design and methodologies (Becker, 1990; Berson, 1996; Ehman & Glenn, 1990; Shaver, 2001). All in all, by the late 1990s changes in technology seemed to have bypassed social studies classrooms and research institutions, as White (1997) stated that technology in social studies classrooms looked very similar to what it was in the 1980s, and Martorella called it "a sleeping giant in the social studies curriculum" (1997, p. 511). In addition, there has been a continued call for more systematic research on the effectiveness of technology in social studies education, especially when it comes to the acquisition of citizenship skills and student achievement (Becker, 1990; Berson, 1996; Martorella, 1997; Mason et al., 2000; Whitworth & Berson, 2003).

On one hand, the lack of research in technology integration in social studies is not surprising, as the absence of rigorous research in social studies education in general has been frequently criticized and documented over the past forty years, spanning from Metcalf's 1963 chapter in the *Handbook of Research on Teaching*, to Shaver's (2001) more recent review of social studies research, citing shortcomings such as weak designs, issues with reliability and validity, the lack of replication studies, and the inappropriate use of statistical tests. On the other hand, the absence of a body of systematic, academic knowledge in the area of technology and social studies should come as a surprise given the important dual role technology plays in this subject area. For one, students should learn actively *with* technology to develop a variety of critical thinking skills needed to access and analyze information that is growing at an exponential rate, a process that can be enhanced by technology if used appropriately (Fitzpatrick, 2000; Jonassen, 2000; Rice & Wilson, 1999; Risinger, 1998; Saye, 1998). In addition, students should learn *about* technology's impact on the society in which they live (including the educational system), especially when considering its pervasiveness and speed of change (Mehlinger, 1996; Ross, 2000; Whitworth & Berson, 2003). Ross also argues that up to now the general public has been relatively lax when it comes to scrutinizing new technology and that instead, as instructional technology becomes more sophisticated and complex, so must be our assessment of this technology's impact on our lives and society as a whole (Ross, 2000). In sum, the combination of learning with and about technology in the social studies classroom should give students the knowledge, skills, and attitudes they will need to actively participate as citizens in a democratic society (NCSS, 1994).

Social studies educators are slowly coming to the realization that even though technology is not a panacea, it is a phenomenon that continues to have an enormous impact on people's lives and is not going away any time soon. This is evidenced by the inclusion of a science, technology, and society strand in the NCSS's *Expectations for Excellence* (1994). In addition, recent discussions have focused on ways to effectively prepare social studies educators to use technology in their classrooms, including guidelines for using technology in pre-service education (Mason, et al., 2000), what theoretical underpinnings these guidelines should have (Crocco, 2001; Doolittle, 2001), and how to address the negative aspects of technology in social studies classrooms as well as society as a whole (Crocco, 2001; Ross, 2000). One of the newer, mobile technologies that has the potential to revolutionize the way in which technology is used in K-12 social studies classrooms and which is already having a substantial impact on people's lives is described below.

Handheld Computers in Social Studies Education

Handhelds are slowly making their presence felt in social studies classrooms, and can be used for a wide variety of activities, including brainstorming, writing, research, data collection, and multimedia projects. The development of handheld hardware and software currently enables users to take pictures, shoot video, create and carry sound files, and do multimedia presentations as well, as newer handhelds have ever-faster processors and virtually unlimited memory through the inclusion of expansion slots that can currently hold memory cards up to 2 gigabytes. As has been the case with previous developments in instructional technology for social studies education, little research is available as of yet. The literature that is available tends to focus on integration of handheld technology into the curriculum; examples include a general overview of handheld technology for social studies (Whitworth, Swan, & Berson, 2002), the use of graphing calculators to explore social studies topics such as monetary policy in the Populist era (Lee & Robinson, 2003), and the use of handheld devices in a stock market simulation during the Great Depression (van ‘t Hooft & Kelly, 2004). The only systematic research findings that are currently available were gathered by SRI International’s Palm Education Pioneer project (Vahey & Crawford, 2002; van ‘t Hooft, Diaz, & Andrews, 2003; van ‘t Hooft, Diaz, & Swan, 2004). Generally speaking, this research indicates that when a 1:1 student to technology ratio is created, students spend more time using technology for learning, are more motivated, and spend more time collaborating and communicating, because they have a portable device that is personal and can be used anywhere, anytime, validating Norris et al’s (2003) findings that access leads to use, and use leads to impact.

Technology Integration in Pre-Service (Social Studies) Education

By now it should be clear that colleges of education have an increasingly important responsibility to prepare future teachers to integrate technology in their teaching because of its potential to enhance teaching and learning when used appropriately, coupled with the fact that the teacher is the most important factor determining the success of technology integration in the classroom (Beaudin & Grigg, 2001; Bell, 2001; UNESCO, 2003; Wellburn, 1996; Willis, 1997). Unfortunately, the recent past has revealed that while many colleges and universities have acquired vast amounts of computer hardware and software they have mostly neglected training pre-service teachers how to use technology appropriately in their curricula (ETS, 1997; ISTE, 1999; Milken Family Foundation, 2001; Molebash, 2002; NCATE, 1997; US Department of Education, 2000). The reasons for this lack of technology integration in teacher education programs are manifold. For one (and this is especially true in the area of social studies pre-service education), there has been a continuing lack of research that points to models of effective technology integration (Martorella, 1997; van Fossen & Shively, 2003; Whitworth & Berson, 2003). Second, there are a variety of social cognitive factors that affect a pre-service faculty member's choice to integrate technology into his or her courses (Dusick, 1998; Snider, 2002). These include environmental factors such as support, sharing of resources, and training, as well as personal social cognitive factors like attitude, anxiety, self-efficacy, willingness to take risks with technology, and views of technology relevance (Dusick, 1998). Third, the resistance of in-service teachers (who act as cooperating teachers in the pre-service teacher training programs) to the institutionalization of educational technology can become a major obstacle in the process as well (Medcalf-Davenport, 1999; Strudel & Wetzel, 1999). Fourth, because technology changes so quickly, recommended best practices are difficult to pin down because they are so closely related to the technology being used (Cooper & Bull, 1997). As a result, it is crucial for pre-service educators to be flexible and approach technology integration as a constantly changing process (Snider, 2002).

The result is that pre-service teachers are not exposed enough to technology integration in either their own classrooms or the classrooms in which they observe and teach during their pre-service training. They often report feeling inadequately prepared to use technology to teach their subject matter (Laffey & Musser, 1998; OTA, 1995; Topp, 1996), or question the usefulness of technology integration in teaching and learning (Smithey & Hough, 1999; Snider, 2002). The consequences of this scenario are obvious. When new teachers are not convinced about the usefulness of an educational tool that they feel uneasy about using to begin with, usage of that tool in their classrooms will be low. In turn, this fuels the vicious circle in which pre-service teachers are ill-prepared to integrate technology in their classrooms because of a lack of effective modeling in K-12 classrooms.

Recent studies have shown that even in pre-service teaching programs where most of the conditions for technology integration have been met, merely adding technology to one's curriculum is not enough to bring about instructional reform in K-12 education, but rather that there is a need for curriculum development that is considerate of the context in which it is being used, including students and the society they live in (Jonassen, 2000; Shaver, 1999; Willis, 1997; Willis, 2001). This is reflected in NCATE's technology requirements for institutions seeking accreditation (since 1995), and the *International Society for Technology in Education National Education Technology Standards* for teachers (NETS*T; ISTE, 1999a), which lay out the technology competencies that prospective teachers should have. These include basic computer/technology operations and concepts, personal and professional use of technology, and application of technology instruction, in order to integrate technology in effective and meaningful ways (ISTE, 1999a). Therefore, effective technology integration in teaching should create a significant bond between technology and instructional content and process skills in order to take students in directions that would not be possible without technology (Diem, 2000). Training pre-service teachers to do so requires hands-on training in how to use technology in appropriate ways as well as continuous technical and curricular support (Cooper & Bull, 1997; Diem, 2000; Thurston & Secaras, 1997; Willis, 2001). In addition, research has shown that even though technology should always be in the background of teaching and learning strategies, it should be an integral part of *all* pre-service curriculum, with clear instructions and time to practice *with* the technology in hand (Beaudin & Grigg, 2001; Bennett, 2001; Doering, Hughes, & Huffman, 2003; Fox, Thompson, & Chan, 1996; Gibson, 2002; Jonassen, 2000; Mason & Berson, 2000; Willis, 1997; Willis, 2001); with effective modeling of technology integration (Bennett, 2001; Keiper, Harwood, & Larson, 2000; Milman & Heinecke, 2000); and with practice teaching, including how to teach students to use technology if they lack the knowledge or skills (Keiper, Harwood, & Larson, 2000). Finally, it is important that experiences with technology are generative, especially in the subject area methods courses, i.e. they should enable students to fit the technology into the curriculum to provide opportunities for pre-service teachers to experiment with different ways to integrate technology and curriculum (Crowe, 2003; Doering, Hughes, & Huffman, 2003; Halpin, 1999, Molebash, 2002).

In the area of pre-service social studies education, leading educators recently developed a set of guidelines for effective technology integration at the pre-service level of social studies education (Mason et al., 2000). These include extending learning beyond what can be done without technology; introducing technology in context; including opportunities for students to study relationships among science, technology, and society; fostering development of skills, knowledge, and participation as a good citizen in a democratic society; and contributing to the research and evaluation of social studies and technology. The authors conclude that this set of principles is the minimum that is needed for the use of technology in social studies (Mason et al., 2000), and that professional development for technology integration should take place throughout a teacher's career, and be supported by more longitudinal research on the effectiveness of technology in education.

While the proposed set of guidelines can be considered a first step in the right direction, Crocco (2001) has pointed out some serious questions that need to be addressed if the guidelines are to have a positive impact on teaching and learning. These questions include what technology knowledge and skills social studies educators should have, whether the focus should be on skills or usage, how technology can be used to enhance teaching and learning, and how technology could impair education in the long run. Moreover, she argues for more research and pedagogy that is clearly based on learning theory, using constructivism and cognitive psychology as examples.

Doolittle (2001) takes this argument one step further, proposing that it does not really matter which theoretical approach is taken, but that the crucial step is to take a stand and clarify it. This is necessary to provide justification for the creation of specific guidelines for teaching and learning such as the ones put forth by Mason et al. (2000). He illustrates his point by using Crocco's (2001) examples of cognitive psychology and constructivism, showing how a solid theoretical foundation can answer research questions by using theoretical principles as building blocks for theory formation, which in turn informs the application of theory to practice. Doolittle and Hicks (2003) further develop the use of constructivism as a theoretical foundation for studying technology use in social studies education, lamenting the enduring lack of a theoretical basis for the integration of technology in social studies education, citing Hooper and Hokansen (2000), Lorsbach and Basolo (1999), and White (1999), as examples of noble yet incomplete attempts. They further argue that combining philosophical, theoretical, and pedagogical foundations into a carefully crafted constructivist framework necessitates moving towards a model of social studies education in which technology is used as a means to develop citizenship, including inquiry, meaning making, and exploration of the different sides of an issue. Two case studies that are highlighted as exemplary are Milman and Heinecke's (2000) study of an undergraduate history course in which students worked with primary sources to create a web site, and Molebash's (2002) investigation of how an elementary social studies methods instructor's constructivist philosophical beliefs influenced her integration of technology as encouraged by the CUFA Technology Guidelines.

Pre-Service (Social Studies) Teacher Attitudes toward Technology

Besides the level of a person's computer use, teacher interest in technology for learning is the most important factor that determines technology integration by educators (Gibson & Hart, 1997; Keiper, Harwood, and Larson, 2000; Ropp, 1999). Therefore, pre-service teacher educators should make a conscious attempt to understand pre-service teacher beliefs and perceptions and effectively model appropriate technology integration in their courses to raise interest levels and better prepare future teachers for their profession (Becker, 1990; Pajares, 1992). This idea is based on the arguments that beliefs and attitudes towards teaching are formed during pre-service training (Hardy, 1998; Wallinger, 1997); positive attitudes towards technology are easier to create and maintain at this time; and they are much more difficult to alter once teachers enter the profession (Pajares, 1992). In addition, training pre-service teachers to be agents of change in technology integration can have an even more powerful effect on the teaching profession as a whole. Teachers who use technology in their teaching are more likely to provide students with more access to computers and related peripherals, thereby raising the level of computer literacy for students who eventually enter college. Those students choosing to enter the teaching profession will then tend to be more knowledgeable about and positive towards integrating technology (Sheffield, 1998). More positive teachers will make technology adoption and successful technology use easier and more effective (Lawton & Gerschner, 1982; Stevens, 1980), thus creating and maintaining an upward spiral of usage.

The question to be answered then is what influences pre-service teacher attitudes toward technology use? Generally speaking, the quality of pre-service teachers' experiences with computer technology is important, because it affects their attitudes toward personal technology use, and consequently, technology integration in their teaching (Crowe, 2003; Crowe & van 't Hooft, 2004; Rosen & McGuire, 1990). All too often pre-service teacher attitudes toward all aspects of teaching, including technology, have already been shaped by the way in which they were taught. In social studies, the prevalent teaching model still focuses to a large extent on traditional teaching paradigms of knowledge transmission, both with and without technology (Sprague, 1995). In addition, pre-service teachers tend to follow their cooperating teachers' beliefs and opinions more than those of the university faculty (Sprague, 1995; Wang, 2002).

Learning environments based on new technology impose new challenges on teachers and teacher training systems (Haugen et al., 2000). Teachers are often uncertain about what to do when their teaching and learning environments change to include technology, based on a lack of knowledge but also because computer use will require changes in teaching (Preskill, 1988). Therefore, good experiences at the pre-service level should include effective modeling and technology integration activities that are meaningful, challenging, and active; that will help future teachers make a transition from teacher-centered to student-driven learning; and that will help them make adjustments as the available technology changes (e.g. Wang, 2002).

Effective modeling is important for obvious reasons, and the old adage, a picture is worth a thousand words, comes to mind. Pre-service teachers need to see and experience what is possible with technology above and beyond what they can do in the classroom without it (Keiper, Harwood, & Larson, 2000; Milman & Heinecke, 2000). Therefore, it is important that this modeling includes activities that are meaningful in that they demonstrate appropriate models of technology integration in a social studies environment that promotes critical thinking and informed decision-making and uses technology tools to amplify these processes (Diem, 2000; Jonassen, 2000; Shaver, 1999). The activities that are modeled should also follow the NCSS guidelines for powerful teaching, and college instructors should design curricula that are meaningful, integrative, value-based, challenging, and active (NCSS, 1994). Pre-service teachers should have the opportunity to learn and think with and about technology (Ross, 2000).

Pre-service teachers also need time to practice. This is often difficult to arrange in an already overloaded curriculum, but essential for successful technology integration at the pre-service level (Mason & Berson, 2000). While time is an overriding concern for many future teachers because they are often overwhelmed by the complex tasks involved in getting ready to teach, learning how to integrate technology and do it well takes time; time to learn how to use the technology; time to learn how to plan for technology integration; and time to practice teach with technology, especially learning how to teach students who are not technology-savvy the content and the technology (Keiper, Harwood, & Larson, 2000).

All this needs to take place in a safe environment, where it is alright to stumble, fall down, and get back up again, without the fear of being made fun of, or worse, keeping students from learning. For this to happen students need instructor support in a variety of areas, including curriculum development, technology integration, and technical support. In addition, the learning environment should encourage peer learning and support, thereby setting up a network for pre-service educators to fall back upon in times of need (Crowe, 2003; 2004).

Conclusion

The integration of technology in K-12 classrooms is still an area of teaching where teacher training programs have a lot of work to do. For one, it is difficult to keep up with the technology itself. For example, one of the more recent developments in educational technology that has created a stir in secondary social studies education is that of handheld computers. While these portable devices, such as graphing calculators, have been commonplace in math and science education, only a small number of social studies teachers have ventured into this area of technology.

Second, instructing future teachers how to integrate technology in effective and appropriate ways in their curriculum is not enough. They need to be persuaded that it is important to do so, and that the right tools used in appropriate ways can amplify teaching that encourages active learning including research, data analysis, critical thinking, and informed decision-making. Therefore, colleges of education across the country have an obligation to provide constructive and meaningful experiences in this regard.

The goal of this research study is twofold. First, it examines whether the HCAS developed for this project is a valid and reliable instrument to measure pre-service teacher attitudes toward handheld technology use. Second, it aims to gather initial information about how to effectively and appropriately integrate handheld technology in pre-service education in order to better prepare teachers to use handheld technology in their middle and high school teaching, *and convince them of the importance of doing so*. It is also designed to fill a void in research in social studies education by focusing on technology integration in social studies methods courses and its effects on pre-service teacher attitudes toward technology integration, social studies, and social studies education.

CHAPTER III: METHODOLOGY

As discussed in Chapter I, this research study consisted of two segments, a pilot study to test the survey instrument and the main study which investigates pre-service teacher attitudes toward handheld computers. The current chapter provides an in-depth discussion of the methodological approaches taken in each, supported by their respective theoretical frameworks. Research questions and hypotheses are also presented.

Pilot Study

Sample

Data collection for the pilot study took place during the 2003-2004 academic year. The total number of students surveyed equaled 104, but through attrition over time the number of students who participated in all three surveys was 94, including 43 males and 51 females, with ages ranging from 20 to 52 years of age (M = 23.9; SD = 6.3). Participants came from four sections of a secondary social studies methods course (n = 58), two sections of a secondary math methods course (n = 24), and one section of a secondary language arts methods course (n = 12). All students were in their final year of their pre-service program, seeking initial licensure to teach in grades 7-12. They were not compensated for their participation.

Setting

All participants were enrolled in one of three (Social Studies, Math, and Language Arts) senior-level methods courses in the College of Education of a university in the Great Lakes region. Students in these courses spent time in traditional classroom and computer lab settings. They also participated in a 96-hour intensive field practicum which is a program requirement, and is spent at the students' future student teaching site. The practicum runs parallel to the methods courses.

Theoretical Framework

Even though there have been disagreements about the definition of the construct "attitude", most researchers would agree that it consists of positive or negative dispositions toward someone or something (Aiken, 1980; Ajzen, 1989, Fishbein & Ajzen, 1975). Since the early 1930s, research in social psychology has evaluated the use of attitudes as predictors of behavior, and initial attempts found only weak correlations between changes in attitudes and changes in behavior (Festinger, 1964, LaPiere, 1934; Wicker, 1969). It wasn't until the 1970s that studies found that *under the right conditions* attitude can predict behavior, as researchers theorized that beliefs lead to attitudes, which then lead to behavioral intentions and eventually the behavior itself (Ajzen, 1989; Fazio, 1986; Fishbein & Ajzen, 1975). In turn, the behavior may cause a person's beliefs to change, creating a feedback loop. This has been postulated by Fishbein and Ajzen (1975) as the theory of reasoned action.

For educational technology this theory implies that positive attitudes toward (handheld) computer use could lead to intention of use followed by actual use. In addition, use could in turn lead to a positive change in beliefs toward educational (handheld) technology. Therefore, it is important for educational research to identify and understand what these attitudes are (Laffey & Musser, 1998), in order for them to be appropriately addressed and cultivated in teacher education programs to the extent that pre-service teachers will enter the profession not only ready but also willing to use (handheld) technology. In fact, as early as the 1980s, Lawton and Gerschner (1982) and

Stevens (1980) concluded that successful use of technology in the K-12 classrooms can be highly dependent on teacher attitudes.

Consequently, there have been many attempts to measure (pre-service) teacher attitudes toward computers. Ahl (1976) and Lichtman (1979) pioneered studies in this field. Based on their descriptive studies, Ellsworth and Bowman (1982) developed a "Beliefs About Computers" scale, while Reece and Gable (1982) developed and validated a general attitude scale. These early attempts were followed by a variety of instruments utilizing the Likert Scale, such as Raub's Attitudes Toward Computers (ATC, 1981), Maurer's Computer Anxiety Index (CAIN, 1984), the Computer Attitude Scale (CAS) developed by Gressard and Loyd (1984), and the Blomberg-Lowery Computer Attitude Task or BELCAT (Erickson, 1987), which is a combination of the other three. A study comparing these scales concluded that the CAS and BELCAT are the recommended instruments for research that includes the constructs these two instruments measure (Gardner, Discenza, & Richard, 1993; Woodrow, 1991a), such as anxiety, confidence, and liking. Finally, there is the Bath County Computer Attitude Scale (BCCAS), which was developed and tested by Bear, Richards, and Lancaster (1987) and further validated by Pike, Hofer, & Erlank (1993), Francis and Evans (1995), and Moroz and Nash (1997).

The CAS has been used with a wide variety of adult populations in the field of education, including college students (Bandelos & Benson, 1990; Busch, 1995; Carlson & Wright, 1993; Hunt & Bohlin, 1993; Koohang, 1987; McEneaney, Soon, & Sprague, 1994; Pope-Davis and Vispoel, 1993; Szajna, 1994; Woodrow, 1991b), in-service teachers (Kluever, Lam, Hoffman, Green, & Swearingen, 1994; Loyd & Gressard, 1986; Mertens & Wang, 1988; Nash & Moroz, 1997b), high school counselors and administrators (Bennett, 1995; Stone, Thompson, & Lacount, 1989), and adult basic education students (Massoud, 1991). It has also been translated and tested in such countries as Israel (Francis, Katz, & Jones, 2000), Korea (Kim, McLean, & Moon, 1994; Moon, Kim, & McLean, 1994), Mexico (Nash, 1994), and Turkey (Berberoglu & Calikoglu, 1993).

Based on the research related to attitude scales and their use with college students, the survey instrument of choice for this research study is the 40-item version of the CAS, as developed by Loyd and Gressard (1984, 1986; Loyd & Loyd, 1985; see Appendix A), and refined by Nash and Moroz (1997a), with a redefinition of the factor structure and the addition of a learning activity factor. This scale has been widely accepted by scholars as a valid and reliable instrument, and is one of the more popular instruments to measure attitudes toward computers. Both content and construct validity have been assessed by experts in the field (Cronbach & Mehl, 1955; Gardner et al., 1993; Massoud, 1990). Internal consistency for the overall survey has been estimated by using Cronbach's Alpha, and has consistently been reported as high, examples including coefficients of .91 (Massoud, 1990), .92 (Gardner et al., 1993), and .95 (Kluever et al., 1994; Loyd & Loyd, 1985). In addition, various studies have examined the internal reliability of the CAS subscales. Loyd and Loyd (1985) calculated subscale reliabilities between .82 and .90, and Kluever et al. (1994) found similar values between .72 and .91. Bandelos and Benson (1990) reported values between .90 and .93. Finally, several studies that have examined the factor structure of the CAS have concluded that these factors explain about 50% of the variance (Bandelos & Benson, 1990; Kluever et al., 1994; Loyd & Gressard, 1984; Loyd & Loyd, 1985; Woodrow, 1991a).

To better fit the purposes of the current research and update the survey to contemporary developments in educational technology, the term “computer” was replaced with the phrase “handheld computer” in each of the items. Because of this change, validity and reliability for the instrument, now called the HCAS, had to be re-established. Hence, a pilot study was conducted.

Instrument

Data were collected using a modified version of the four-subscale CAS as described by Loyd and Loyd (1985). The forty items were ordered using a table of random numbers. Two versions were developed to minimize the effect a participant’s answer on an item may have on his/her answer on the next item. The modification from CAS to HCAS consisted of replacing the word “computer” in each item with the phrase “handheld computer.” Consistent with the CAS, a five-point Likert scale was used for student responses: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree. In addition, information regarding gender, age, and prior handheld computer use were gathered. For the latter, students indicated whether they had used a handheld computer “never”, “once or twice”, “weekly”, or “daily” within the last month, for activities including basic functions such as calendar or address book, word processing, multimedia presentations, spreadsheets or databases, drawing, Internet access, email, games, playing music, or taking pictures (Appendix A).

Procedures

The HCAS was administered to participants in August, November, and February of the 2003-2004 academic year, following approval by the university’s Institutional Review Board to commence with the research. The August survey was administered during the first week of classes, the November one three weeks before the end of fall semester, and the February survey was given about a week before the start of student teaching. Each time the survey was administered at the end of a class session. For each administration, all participants were surveyed within a one-week time span. Students were provided with an explanation of the rationale for the survey as well as general directions. The surveys were collected by the researcher during the class period in which they were administered.

All survey data were entered in SPSS 12.0 (2003). Negatively worded items on the HCAS were reverse-coded so that a higher score on any item means a more positive attitude toward handheld technology. Participants who missed one or more survey administrations were removed from the sample.

Research Questions and Hypotheses

Before using the HCAS for the main study in this research project it needed to be tested for validity and reliability. The following research questions and associated hypotheses were developed to do just that.

Content validity

One of the first concerns when examining an instrument is its content validity, which can be determined through the use of a subjective content review (face validity) or a more systematic and rigorous examination of the contents (logical validity; Allen & Yen, 1979). Even though logical validity is deemed more appropriate for tests that measure carefully defined content domains than vaguer constructs like attitudes, the HCAS was examined for logical validity using the four hypothesized constructs as the domains to be measured. The following research question and associated hypothesis were developed:

Research question. To what extent does the HCAS measure pre-service teacher attitudes toward handheld computers?

Null hypothesis. $H_0: I_{ik} = 0$, where I_{ik} equals the item-construct congruence score for any item i on any construct k.

Explanation. A panel of experts determined whether or not the HCAS measures what it proposes to measure, i.e. pre-service teacher attitudes toward handheld computers by asking questions about the constructs handheld computer confidence/anxiety, handheld computer liking, handheld computer usefulness, and learning activities related to handheld computers. The expert panel consisted of three researchers with expertise in the areas of educational technology and measurement. Panel members were given a list of the HCAS items and asked to match each of them with one of the four constructs. The judges' scores were then used to calculate item-construct congruence using the formula

$$I_{ik} = (N/2N\text{-}2)(\mu_k - \mu)$$

where N is the number of constructs, μ_k is the judges' mean rating of item i on the kth construct, and μ is the judges' mean rating of item i on all constructs (Crocker & Algina, 1986).

Construct validity

As discussed in the first section of this chapter, existing research on the CAS shows that items can be grouped using four constructs (computer anxiety/comfort, computer liking, computer usefulness, learning activities related to computers). In order to test if these groupings are maintained for handheld computers on the HCAS, the instrument was tested for construct validity (Gorsuch, 1983), or the extent to which it measures the underlying constructs or traits designed to measure (Allen & Yen, 1979). Five questions were developed to test the instrument's construct validity. The first four were used to determine if certain items could be grouped together, while the fifth question examined the extent to which the four hypothesized factors were different from each other:

Research question 1. Is there a relationship between items 1, 4, 6, 9, 12, 14, 15, 16, 18, 22, 24, 28, 30, 33, and 40 on the HCAS (handheld computer anxiety factor)?

Null hypothesis. $H_0: ?_{i_j i_k} = 0$, where $i_j i_k$ equals any pair of items in the handheld computer anxiety factor.

Research question 2. Is there a relationship between items 2, 7, 11, 19, 25, 27, 31, 35, 36 and 37 on the HCAS (handheld computer liking construct)?

Null hypothesis. $H_0: ?_{i_l i_m} = 0$, where $i_l i_m$ equals any pair of items in the handheld computer liking factor.

Research question 3. Is there a relationship between items 3, 8, 13, 17, 21, 23, 32, 34 and 38 on the HCAS (handheld computer usefulness construct)?

Null hypothesis. $H_0: ?_{i_p i_q} = 0$, where $i_p i_q$ equals any pair of items in the handheld computer usefulness factor.

Research question 4. Is there a relationship between items 5, 10, 20, 26, 29 and 39 on the HCAS (learning activities related to handheld computer training construct)?

Null hypothesis. $H_0: ?_{i_r i_s} = 0$, where $i_r i_s$ equals any pair of items in the learning activities related to handheld computer training factor.

Research question 5. Are any of the four constructs (handheld computer anxiety/comfort, handheld computer liking, handheld computer usefulness, learning activities related to handheld computer training) on the HCAS related to each other?

Null hypothesis. $H_0: ?_{c_j c_k} = 1$, where $c_j c_k$ equals any pair of the four proposed constructs.

Explanation. Confirmatory factor analysis using a maximum likelihood approach was used. This type of analysis tests the nature and fit of hypothesized factors. More specifically, it extracts predefined factors and then determines if the variance in the residual matrix is still significant (Gorsuch, 1983). It also yields chi-square statistics that can be tested for statistical significance and are additive in nature. Therefore, multiple models can be compared to determine which one provides the best model-data fit. In this case two models were tested, one without any common factors at all and the other consisting of the four hypothesized factors.

To prepare the second model with the hypothesized structure consisting of four factors, $f^2 + 1$or $4^2 + 1= 17$ parameters were defined in the second model to yield a restricted solution. Based on prior research, the factors were assumed to be correlated at least to some extent (i.e. the off-diagonals in the R_{ff} matrix cannot be set to 0). However, factor loadings of variables that were supposed to load on certain factors were set to a value of 1. In addition, because confirmatory maximum likelihood factor analysis is driven by existing theory related to the factor structure of the HCAS, it provides results that can be interpreted directly without rotation of the factors (Gorsuch, 1983).

Internal-consistency reliability

To determine internal consistency of an instrument, an examination of the average correlations among its items is appropriate. If the items on the instrument have a wide range of scoring weights (Crocker & Algina, 1989), calculating Cronbach's Alpha is an appropriate approach. When the instrument consists of scales measuring different traits as is the case with the HCAS, internal consistency coefficients need to be calculated for each scale individually (Dimitrov, Rumrill, Fitzgerald, & Hennesey, 2001; Gliem & Gliem, 2003). Because prior calculations of Cronbach's Alpha have been high, and research in educational technology generally expects reliability levels of instruments to be at .80 or higher, a directional hypothesis was used here.

Research question. Are the handheld computer confidence/anxiety, handheld liking, handheld usefulness, and attitudes toward learning activities related to handheld computer training subscales on the HCAS internally consistent?

Null hypothesis. $a_i = .80$, where *i* equals any of the four HCAS subscales on any of the three instrument administrations.

Explanation. If the items on the instrument have a wide range of scoring weights (Crocker & Algina, 1989), calculating Cronbach's Alpha is an appropriate approach. When the instrument consists of scales measuring different traits, as is the case with the HCAS, internal consistency coefficients need to be calculated for each scale individually (Dimitrov, Rumrill, Fitzgerald, & Hennesey, 2001; Gliem & Gliem, 2003). Because prior calculations of Cronbach's Alpha have been high, and research in educational technology generally expects reliability levels of instruments to be at .80 or higher, a directional hypothesis was used here.

Test-retest reliability

Besides internal consistency of the items, it is also important to establish if an instrument is stable over time.

Research question. Are scores on the HCAS consistent over time?

Null hypothesis. $H_0: ?_{a_j a_k} = 0$, where $a_j a_k$ equals any pair of survey administrations.

Explanation. Correlation analysis was performed on the overall instrument as well as the individual subscales, comparing data from all three survey administrations. Spearman correlations were used to analyze the ordinal data in order to detect statistically significant correlations between administrations.

There was no particular treatment assignment for the pilot study, as it was conducted to gather data for purposes of testing the instrument. Students in one of the social studies methods sections were exposed to handheld integration, while most students in the math methods courses have worked repeatedly with handheld calculators for purposes of learning how to integrate them into the curriculum. Intact classes were used.

Main Study

Sample

Data were collected from students in two sections of a secondary social studies methods course (N = 42, with n = 20 and 22). Students who did not complete all three surveys were removed from the sample, leaving a total of 36 students. Demographics for the sample were similar to those of the pilot study sample, consisting of 20 males and 16 females, with an age range of 21 to 36 years of age (M = 23.0; SD = 2.7). Students were not compensated for their participation.

Setting

The social studies methods course is taught in the same College of Education as those used in the pilot study. While the pilot study examined student attitudes in three different content areas, the main study focused exclusively on pre-service teachers in the area of secondary social studies education. Students spent time in a traditional classroom as well as a computer lab while enrolled in the methods course. They were also engaged in a 96-hour field practicum that runs parallel to the methods courses.

Theoretical Framework

Teacher education research has shown that when it comes to preparing pre-service teachers for the integration of instructional technology in their future classrooms, their beliefs and attitudes toward the integration of technology in the classroom play a crucial role. Therefore, pre-service teacher educators should make a conscious attempt to understand these beliefs and perceptions and effectively model appropriate technology integration in their courses to raise interest levels and better prepare future teachers for their profession (Becker, 1991; Pajares, 1992). This idea is based on the arguments that beliefs and attitudes towards teaching are formed during pre-service training (Hardy, 1998; Wallinger, 1997); positive attitudes towards technology are easier to create and maintain at this time; and they are much more difficult to alter once teachers enter the profession (Pajares, 1992). In addition, research has shown that the teacher is the most important factor determining the success of technology integration in the classroom (Beaudin & Grigg, 2001; Bell, 2001; UNESCO, 2003; Wellburn, 1996; Willis, 1997).

What influences pre-service teacher attitudes toward technology use? Discussed more broadly in chapter II, the quality of experiences with computer technology in the college classroom is crucial (Crowe, 2003; Crowe & van ‘t Hooft, 2004; Rosen & McGuire, 1990). Important elements of these experiences include effective modeling (Keiper, Harwood, & Larson, 2000; Milman & Heinecke, 2000); time to practice (Keiper; Harwood, & Larson, 2000; Mason & Berson, 2000); a safe environment where students do not have to be afraid to make mistakes; and instructor and peer support (Crowe, 2003; 2004). These elements become even more important when one considers that learning to integrate technology often includes learning how to use a new form of technology, period. Developments in computer technology such as the latest trends in the area of mobile devices and handheld computers happen so quickly that trying to keep up with educational technology and associated best practices for use has been described as trying to hit a moving target (Cooper & Bull, 1997; Snider, 2003).

In sum, besides trying to teach future educators to effectively integrate technology into their teaching and learning, it is essential that they are convinced of the importance to do so. Beliefs and attitudes can be deciding factors when making choices about teaching practices. Therefore, pre-service educators need to make a conscious effort to get a feel for their students’ mindsets when it comes to technology, and adjust their own teaching practices to cultivate positive attitudes toward technology integration.

Instrument

The instrument used for this part of the study is the HCAS, which was derived from the CAS, developed in the 1980s (Loyd & Loyd, 1985), and tested for reliability and validity in the pilot phase of this research study. In addition to the attitudinal items, the HCAS includes items to collect demographic information such as age and gender, as well as levels of prior experience with computers and handheld computers.

Procedures

The study examined pre-service teacher attitudes using two intact sections of a secondary social studies methods course. In one section students experienced handheld integration throughout the Fall and Spring (until the beginning of student teaching) semesters (n = 20, yielding 17 surveys), while in the other section they did not (n = 22, yielding 19 surveys). The same instructor taught both sections in the fall semester. In the spring she only taught the section that used handheld computers.

During the fall semester, both classes met in a computer lab in the College of Education. Technology that was used most often by both groups included *PowerPoint* presentations and especially WebCT, an online course management system that includes a variety of tools such as email, discussion boards, assessment modules, and file sharing. Both methods sections also did a technology project and shared their ideas with each other. Finally, all students did an electronic simulation during the last week of classes.

Besides the technology used by both methods sections, students in the handheld class were loaned a handheld computer for the entire semester. The instructor showed students the basic operations of the device before using them to create concept maps using the handheld version of *Inspiration*. She also showed students how to share *PowerPoint* files using the beaming feature (i.e. transferring files from one device to another using an infrared beam, analogous to using a remote control with a television). In addition, the instructor encouraged students throughout the semester to use the handhelds for activities they were engaged in in class with other technologies, using *Microsoft Excel* for spreadsheets in particular. During the final week of classes, students used *Lemonade*

Tycoon, a business simulation that can be used to teach economics concepts, when discussing electronic simulations in social studies teaching.

In the spring, the instructor used the handhelds during the second half of the five-week methods course that precedes the student teaching phase. This class met in the computer lab again, while the other section was taught by a different instructor in a regular college classroom in the same building. Students in the handheld class learned how to use *Sketchy*, a graphical tool that can be used to illustrate concepts in both picture and animated formats. They also explored possible uses of this tool to increase conceptual understanding of social studies concepts that are difficult to learn by merely reading about them. Next, student groups designed *Sketchy* slideshows to illustrate a few social studies topics that are standard in most curricula, such as how a bill becomes a law, and the story of the American colonies leading up to the Revolution. Finally, students designed an activity that integrated handhelds and *Sketchy* for one of their classes.

Towards the end of the second methods course, students participated in a few other learning activities that integrated handheld devices, including using handheld assessment software such as *Quizzler*, and making concept maps using *Picomap*. Students created concept maps of everything they had learned in both the fall and spring methods courses. Finally, the class discussed grant writing opportunities to acquire handheld devices for use in secondary classrooms.

Students completed the HCAS three times, once at the beginning and end of the Fall 2004 semester, and once during the Spring 2005 semester, immediately before the student teaching phase. Surveys were administered during class time, toward the end of a session. Students were provided with a rationale for the survey, as well as general instructions for completing the questions. Survey data were entered in SPSS 12.0 (SPSS, 2003) for analysis. Only participants who participated in all three survey administrations were retained.

Research Questions and Hypotheses

Based on previous findings, the following research question and associated hypotheses were developed for the main focus of this research study.

Research Question

What is the effect of handheld technology integration in a Social studies methods course on pre-service social studies teachers' attitudes toward technology use in social studies education?

Null Hypothesis

H_0: $\mu_{1_{adj}} = \mu_{2_{adj}}$, where $\mu_{1_{adj}}$ and $\mu_{2_{adj}}$ equal the adjusted population mean vectors for each of the groups (Stevens, 2002).

Explanation

Due to the nature of the data collected (survey data using Likert-scale items on four constructs measuring student attitudes toward handheld computers), the analysis consisted of a repeated measures, non-parametric MANOVA (Stevens, 2002). The data set was checked to ensure that the assumptions were met (observations are independent; dependent variables have a multivariate normal distribution, and the population covariance matrices for the dependent variables are equal; Stevens, 2002). The raw subscale scores were changed into rank scores in order to use them for calculation of the non-parametric variant of the MANOVA procedure. Next, Pillai-Bartlett's trace statistic was calculated and adjusted, using a simple transformation described by Zwick (1985). This entails recalculating Pillai-Bartlett's V as $(N-1)V$ and comparing the resulting statistic to the chi-square distribution using $P(K-1)$ degrees of freedom where P equals the number of dependent variables and K equals the number of groups; in this case 4 and 2 respectively).

Initial power analysis indicated that a two-group research design with one independent and four dependent variables should yield acceptable results. With alpha levels set at .05 and group sizes expected at about 21 each, the MANOVA should have a power level of about .70 for large effect sizes and .90 for very large effect sizes (Stevens, 2002). These are conservative estimates, given the fact that using a repeated measures design tends to increase power levels.

Design

The main phase of the research was quasi-experimental in nature because the groups under study consisted of intact classes. A two-group univariate design was used. Handheld integration was the independent variable of particular interest, and the four subscales of the HCAS (handheld computer anxiety/comfort, handheld liking, handheld usefulness, and learning activities related to handheld computer training) made up the dependent variables. The design also employed repeated measures in that the survey was administered three times, using the first survey as a covariate to control for pre-existing differences between the treatment and control groups.

Delimitations and Limitations

The results of the main study are only generalizable to pre-service teachers in undergraduate teacher education programs in the area of secondary social studies education. In addition, the sample was drawn from the teaching training program at a university in the Great Lakes region where enrollment seems to include a disproportionate number of students from lower-middle-class backgrounds when judged by income. This observation is based on the amount of financial aid distributed to students, which averaged $7,250 during the 2003-2004 academic year (Author, 2004). Therefore, the sample may not be a true representation of all pre-service teachers. Also, the fact that students were not randomly selected from the university's total student population may have had an effect on attitudes towards technology usage and integration. Moreover, due to the fact that this research deals with attitudes, which tend to be situated rather than general (Aiken, 1980; Ajzen, 1989), generalizability of results should be approached with caution.

There are several limitations to this study. First, the use of self-reported data on an attitude scale may skew the data due to the fact that participants may not have reported their true attitudes all the time, but rather what they thought the researcher would like to see. Second, no intervening variables were controlled for by building them in as additional independent variables. Such variables that might affect the results are age, gender, access to a computer at home, level of prior computer use, and preferred learning style (Busch, 1995; Levine & Donitsa-Schmidt, 1997; Loyd & Gressard, 1984; Marshall & Bannon, 1986; Nash & Moroz, 1997b; Nichols, 1992; Popovich, Hyde, & Zakrajsek, & Blumer, 1987; Violato, Hunter, & Marini, 1989). These variables could be built into future research, given the availability of larger sample sizes.

CHAPTER IV: RESULTS

Pilot Study Results

Following the data collection phase of the pilot study, the survey data was analyzed using SPSS 12.0 (SPSS, 2003), and tested for construct and content validity as well as internal consistency and test-retest reliability. Results of the analyses are discussed below.

Construct Validity

Before performing the confirmatory maximum likelihood factor analysis to establish construct validity of the HCAS for the pilot data set, the underlying assumptions of univariate and multivariate normality of the variables was tested for the second and third survey administrations (Gorsuch, 1983). Univariate normality is a necessary condition for multivariate normality of the items and items were examined for skewness and kurtosis, using any values larger than two standard deviations of the Standard Error of Skewness (SES; in this case SES = .498) and Standard Error of Kurtosis (SEK; in this case SEK = .986) as the cutoff, which equals an alpha-level of .05 (Tabachnik & Fidell, 1996). Analysis of items for each survey administration yielded the following results for skewness (Table 1) and kurtosis (Table 2).

As the data reveal, roughly half of the items were skewed in statistically significant ways for each of the three survey administrations, while kurtosis was not really an issue. Upon further examination of individual item histograms, items that showed statistically significant skewness were all negatively skewed, indicating the potential for a ceiling effect in the data. When items deviate from normality the

Table 1

Skewness of HCAS Items for Pilot Test Data

Survey Administration	Skewness Range	SES	# of items in violation
2	-1.322 - .415	.249	17 of 40
3	-1.245 - .376	.249	20 of 40

Table 2

Kurtosis of HCAS Items for Pilot Test Data

Survey Administration	Skewness Range	SEK	# of items in violation
2	-.708 - 1.786	.493	3 of 40
3	-.818 - 1.429	.493	2 of 40

recommendation is that they are removed from the analysis, and that only in cases where the sample size is large (n > 200) and the number of variables is small (5 or less), the maximum likelihood procedure is relatively insensitive to non-normality (Gorsuch, 1983). In this case, however, the sample size was substantially below the recommended minimum of 200, with a high number of variables (40) to be included in the analysis. In addition, removing all items that showed non-normal distributions was not an option, as doing so would have the potential of deleting entire constructs.

To address the violation of assumptions for a factor analysis using a maximum likelihood approach a variety of alternatives was considered, including increasing the sample size, grouping items using item parceling (i.e. grouping small sets of items together and considering them as one variable; West, Finch, & Curran, 1995), and exploratory factor analysis. Due to the fact that increasing the sample size was not viable and potential interpretation problems with item parceling outweighed its potential advantages (multiple factors can underlie each parcel), exploratory factor analysis was used, more specifically principal component exploratory factor analysis with varimax rotation.

Exploratory Factor Analysis

As the term indicates, exploratory factor analysis is open-ended in nature, and the factor structure of the HCAS was unclear at this point in the analysis. Therefore, items were left free to vary in the principal component analysis. In addition, varimax rotation was applied in order to achieve the best possible factor loadings. Because the treatment (handheld use) was not administered until after the first survey administration, the factor analysis was performed on the second and third survey administrations only. Because the original research questions created to test the construct validity could no longer be used, a new, more general research question was developed for the exploratory analysis:

What traits underlying handheld computer attitudes are being measured by the HCAS?

Kaiser-Meyer-Olkin's (KMO) Measure of Sampling Adequacy and Bartlett's test of sphericity were used to test the assumptions underlying the principal components analysis. KMO test scores range from 0 to 1; the closer the test statistic is to 1, the better correlations between pairs of variables can be explained by other variables, yielding distinct and reliable factors (Field, 2000; Norussis, 1985). For the pilot data set, a statistic of .861 was calculated for the second survey administration, and .881 for the third, which can be rated as very good (Field, 2000; Hutcheson & Sonofriu, 1999). Bartlett's test of sphericity was used to test whether or not the correlation matrix was an identity matrix, where all diagonals equal 1, and all off-diagonals equal 0. Because items need to be correlated to some extent if factor analysis is to yield any interpretable results, this test needs to be significant. In this case, Bartlett's test of Sphericity produced a test statistic of $?^2(780, N = 94) = 2661.697$, $p < .000$ for the second administration and $?^2(780, N = 94) = 2715.299$, $p < .000$ for the third one. Both assumptions were therefore met. The subsequent exploratory factor analyses yielded a three-factor solution, accounting for about 60% of the variance in attitudes toward handheld computing (Tables 3, 4, 5, and 6).

Table 3

Variance Explained by HCAS (Second Administration; Rotated Solution)

Factor	Total	% of Variance	Cumulative %
1	8.077	20.192	20.192
2	7.175	17.937	38.129
3	8.440	21.099	59.227

Table 4

Variance Explained by HCAS (Third Administration; Rotated Solution)

Factor	Total	% of Variance	Cumulative %
1	9.222	23.054	23.054
2	9.368	23.419	46.473
3	6.524	16.311	62.784

Table 5

Factor Loadings for Rotated Solution for Each Factor (Second Administration)[a]

Item[b, c]	1	2	3
22. I think using a hh computer would be very hard for me.	.875		
24. Hh computers make me feel uneasy and confused.	.850		
33. Working with a hh computer would make me very nervous.	.847		
40. Hh computers make me feel uncomfortable.	.832		
18. I am not the type to do well with hh computers.	.807		
16. I would feel comfortable working with a hh computer	.746		
6. I'm no good with hh computers.	.621	.365	.368
30. I have a lot of self-confidence when it comes to working with hh computers.	.589		.314
28. I feel aggressive and hostile toward hh computers.	.534	.463	.412
14. I get a sinking feeling when I think of trying to use a hh computer.	.417		.396
1. Hh computers do not scare me at all.	.311		.482
23. Learning about hh computers is worthwhile.		.816	
21. I can't think of any way I will use hh computers in my career.		.793	
34. Working with hh computers will not be important in my life's work.		.759	

38. I will use hh computers in many ways in my life.		.646	.341
3. Learning about hh computers is a waste of time.		.640	
13. I'll need a firm mastery of hh computers for my future work.		.598	
32. Knowing how to work with hh computers will increase my job possibilities.		.596	.369
8. I expect to have little use for hh computers in my daily life.		.522	.389
17. Anything a hh computer can be used for, I can do just as well some other way.		.238	
35. When there is a problem with a handheld computer that I cannot immediately solve, I would stick it out until I have an answer.			.751
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.		.326	.711
26. I could get good grades in hh computer courses.	.457		.545
7. The challenge of solving problems with hh computers does not appeal to me.	.365	.315	.486
31. Figuring out hh computer problems does not appeal to me.			.452

37. Once I start working with a hh computer, I would find it hard to stop.			.442
5. It wouldn't bother me at all to take hh computer classes.	.329	.471	.348
2. I would like working with hh computers.*	.326	.307	
4. I do not feel threatened when others talk about hh computers.*			.751
9. Generally, I would feel OK about trying a new problem on the hh computer.*	.303	.362	.584
10. I would feel at ease in a hh computer class.*	.685		.383
11. I think working with hh computers would be enjoyable and stimulating.*	.327	.611	
12. I don't think I would do advanced hh computer work.*		.200	
15. I am sure I could do work with hh computers.*	.419		.355
19. I don't understand how some people can spend so much time working with hh computers and seem to enjoy it.*		.362	.567
20. I am sure I could learn a hh computer language.*	.592		.425
27. I will do as little work with hh computers as possible.*	.383	.405	.450
29. I do not think I could handle a hh computer course.*	.499		
36. I do not enjoy talking with others about hh computers.*			.833

39. It's important for me to do well in a hh computer class.*		.437	.546

[a]Factor loadings < .300 are not reported, unless the highest loading is < .300.

[b]Hh = "handheld"

[c]Items marked with a "*" were deleted from the instrument.

Table 6

Factor Loadings for Rotated Solution for Each Factor (Third Administration)[a]

Item[b, c]	1	2	3
24. Hh computers make me feel uneasy and confused.	.843		
40. Hh computers make me feel uncomfortable.	.828		
14. I get a sinking feeling when I think of trying to use a hh computer.	.810		
33. Working with a hh computer would make me very nervous.	.759		
1. Hh computers do not scare me at all.	.754		
22. I think using a hh computer would be very hard for me.	.745		
28. I feel aggressive and hostile toward hh computers.	.698		
16. I would feel comfortable working with a hh computer.	.678		.366
6. I'm no good with hh computers.	.647	.323	
18. I am not the type to do well with hh computers.	.606		
30. I have a lot of self-confidence when it comes to working with hh computers.	.322		

21. I can’t think of any way I will use hh computers in my career.		.781	
34. Working with hh computers will not be important in my life’s work.		.737	
13. I’ll need a firm mastery of hh computers for my future work.		.728	
8. I expect to have little use for hh computers in my daily life.		.703	
23. Learning about hh computers is worthwhile.		.699	
38. I will use hh computers in many ways in my life.		.544	
32. Knowing how to work with hh computers will increase my job possibilities.		.535	.468
3. Learning about hh computers is a waste of time.	.300	.443	
17. Anything a hh computer can be used for, I can do just as well some other way.		.440	
5. It wouldn’t bother me at all to take hh computer classes.	.329		.733
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.			.686

35. When there is a problem with a handheld computer that I cannot immediately solve, I would stick it out until I have an answer.	.351	.366	.603
7. The challenge of solving problems with hh computers does not appeal to me.		.507	.404
26. I could get good grades in hh computer courses	.487		.397
37. Once I start working with a hh computer, I would find it hard to stop.		.734	.341
31. Figuring out hh computer problems does not appeal to me.	.489		.316
2. I would like working with hh computers.*	.431	.342	.381
4. I do not feel threatened when others talk about hh computers.*			.751
9. Generally, I would feel OK about trying a new problem on the hh computer.*	.592		.332
10. I would feel at ease in a hh computer class.*	.645	.331	.346
11. I think working with hh computers would be enjoyable and stimulating.*	.389	.463	.444
12. I don't think I would do advanced hh computer work.*		.410	
15. I am sure I could do work with hh computers.*	.630		.555

19. I don’t understand how some people can spend so much time working with hh computers and seem to enjoy it.*		.695	
20. I am sure I could learn a hh computer language.*	.577		.412
27. I will do as little work with hh computers as possible.*	.326	.455	
29. I do not think I could handle a hh computer course.*	.758		
36. I do not enjoy talking with others about hh computers.*		.734	.341
39. It’s important for me to do well in a hh computer class.*		.471	.543

[a]Factor loadings < .300 are not reported, unless the highest loading is < .300.

[b]Hh = “handheld”

[c]Items marked with a “*” were deleted from the instrument.

The results of both analyses also revealed that the three-factor structure consisted of a total of 27 items (Tables 5 and 6). Based on the content of the questions and previous research on the factor structure of the CAS, the three factors were named handheld computer anxiety, handheld computer usefulness, and working with handheld computers. While the first two factors are similar to the anxiety and usefulness factors as described in the original four-factor structure (both in meaning and items included), the working with handheld computers factor can be defined as working with or learning about handheld computers, including troubleshooting, and is broader in meaning than the original construct named learning activities.

Items were assigned to factors based on the factor loadings for both survey administrations. If factor loadings did not provide a clear answer, the extent to which the content of the question matched a particular construct was taken into consideration as well. If both factor loadings and question content did not provide a clear answer, the item was deleted from the instrument. The resulting make up of individual factors is as follows: handheld computer anxiety includes items 1, 6, 14, 16, 18, 22, 24, 28, 30, 33, and 40; handheld computer usefulness is comprised of items 3, 8, 13, 17, 21, 23, 32, 34, and 38; and the construct working with handheld computers includes items 5, 7, 25, 26, 31, 35, and 37.

As Tables 5 and 6 indicate, the first two factors are the strongest, which was to be expected, as they closely resemble constructs that have been extensively tested as parts of the CAS. Items were put into either the anxiety or usefulness factor primarily based on their factor loadings, with the third survey administration providing a clearer picture than the second administration, which could be related to the timing of the administrations of the survey being at the end of November and February respectively. However, the few items that did not load cleanly on a factor during one administration did so on the other one (e.g. items 1, 6, 11, 14, 28, and 30 for the anxiety factor; and items 3, 8, and 32 for the usefulness factor), or the content of the question clearly indicated under what construct an item belonged. An example of the latter is item 6, "I'm no good with handheld computers," which is obviously an item that measures anxiety. Another illustration of this is item 32, "Knowing how to work with handheld computers will increase my job possibilities," indicating a dimension of usefulness.

The third factor, working with handheld computers, is made up of seven items, and although it explains about the same amount of variance as the other two factors individually, factor loadings were not as clear-cut. Based on the factor loadings, items 25 and 35 were included in this factor, while items 5, 7, 26, 31, and 37 were added based on a combination of high factor loadings on at least one of the two survey administrations, as well as the content of the questions. A good example of this is item 37, which loaded only on the third factor for the second survey administration, loaded on the second and third factor for the third survey administration, but whose content ("Once I start working with a a handheld computer I would find it hard to stop") fits better under a "working with" construct than a "usefulness" construct. As this is a new factor, it should be empirically tested with similar - and ideally larger - samples to determine its robustness.

The remaining 13 items (2, 4, 9, 10, 11, 12, 15, 19, 20, 27, 29, 36, and 39) were eliminated from the instrument for various reasons. Some items did not load clearly on one factor on either one of the survey administrations, and upon further examination, their content was somewhat ambiguous in nature. Items that were deleted for this reason include numbers 2, 9, 10, 11, 15, 19, 20, 27, 36, and 39. Item 2 ("I would like working with handheld computers') is a prime example. The item loaded fairly evenly on two factors during the second survey administration and three factors during the third, and based on the content of the question the case could be made that it could load on the anxiety as well as the working with handheld computer factors. A second group of items was deleted because they loaded on the "wrong" factor, i.e. while the content of the question indicated item-construct fit under one factor, the item loaded strongly on another one. These items include 4, 12, and 29. Based on its content, item 4 ("I do not feel threatened when others talk about handheld computers") should load on the anxiety factor, but for both survey administrations it loaded strongly (.751 both times), on the working with factor. Obviously, it should be mentioned here that decision of inclusion or omission of individual HCAS items was not completely objective, as these decisions were made after weighing a variety of information. Therefore, any future testing of the HCAS with different samples should include all 40 items at the outset.

Based on these new factors and the fact that about 30% of the items were removed from the survey the exploratory factor analyses were performed again to recalculate the factor loadings and variability explained by the revised, 27-item instrument. The results are provided in Tables 7 through 10. Assumptions of sampling adequacy (KMO = .864 and .881 respectively and sphericity ($?^2$ (351, N = 94) = 1579.582, $p < .000$ for the second administration and $?^2$(351, N = 94) = 1655.622, $p <$ .000 for the third one) were both met. Note that after removal of the 13 items, total variability explained by the three factors increased from 59.227 to 66.222 for the second survey administration (Table 7), and from 62.784 to 66.540 for the third survey administration (Table 8), indicating an improvement in the measurement characteristics of the instrument.

Table 7

Variance Explained by HCAS (27 Items, Second Administration; Rotated Solution)

Factor	Total	% of Variance	Cumulative %
Anxiety	6.721	24.892	24.892
Usefulness	6.167	22.919	47.812
Working With	4.970	18.411	66.222

Table 8

Variance Explained by HCAS (27 Items, Third Administration; Rotated Solution)

Factor	Total	% of Variance	Cumulative %
Anxiety	6.734	24.940	24.940
Usefulness	7.527	27.878	52.819
Working With	3.705	13.722	66.540

Besides total variance explained by the three factors, the exploratory factor analysis was performed again in order to determine the factor loadings for the remaining items after removal of the aforementioned 13 items. The results are provided below for the second survey administration (Table 9), as well as the third one (Table 10). In both tables the items are organized using the three-factor structure consisting of handheld anxiety, handheld usefulness, and working with handhelds. When analyzing the factor loadings, the first and second factors remained relatively strong, with the possible exception of item 30 on the anxiety factor and item 3 on the usefulness factor, while items on the third factor had a tendency to want to load on the second factor (e.g. items 25, 31, 35, and 37), even though the content of the questions warranted keeping the third factor intact, as defined following the initial exploratory factor analysis. At this point, no more items were removed from the instrument, in an effort to avoid a vicious cycle of exploratory analysis followed by item removal until very few or no items would have been left.

Table 9

Recalculated Factor Loadings for Rotated Solution for Each Factor (27 Items, Second Administration)[a]

Item[b]	1	2	3
22. I think using a hh computer would be very hard for me.	.883		
33. Working with a hh computer would make me very nervous.	.874		
40. Hh computers make me feel uncomfortable.	.867		
24. Hh computers make me feel uneasy and confused.	.861		
18. I am not the type to do well with hh computers.	.820		
6. I'm no good with hh computers.	.706	.374	
16. I would feel comfortable working with a hh computer.	.703		
30. I have a lot of self-confidence when it comes to working with hh computers.	.591	.324	.394
28. I feel aggressive and hostile toward hh computers.	.585		.504
14. I get a sinking feeling when I think of trying to use a hh computer.	.426	.377	.561
1. Hh computers do not scare me at all.	.307		.740
21. I can't think of any way I will use hh computers in my career.		.763	
38. I will use hh computers in many ways in my life.		.711	

8. I expect to have little use for hh computers in my daily life.	.320	.689	
34. Working with hh computers will not be important in my life's work.		.623	.387
17. Anything a hh computer can be used for, I can do just as well some other way.		.562	
32. Knowing how to work with hh computers will increase my job possibilities.		.424	.559
13. I'll need a firm mastery of hh computers for my future work.		.362	.685
23. Learning about hh computers is worthwhile.		.341	.728
3. Learning about hh computers is a waste of time.	.309	.320	.601
26. I could get good grades in hh computer courses.	.490		.498
5. It wouldn't bother me at all to take hh computer classes.	.378		.488
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.		.752	.301
7. The challenge of solving problems with hh computers does not appeal to me.	.432	.411	.270
31. Figuring out hh computer problems does not appeal to me.	.332	.514	.317

37. Once I start working with a handheld computer, I would find it hard to stop.	.601	.231
35. When there is a problem with a handheld computer that I cannot immediately solve, I would stick it out until I have an answer.	.801	.036

[a]Factor loadings < .300 are not reported, unless the highest loading is < .300, or loading is needed to show fit with hypothesized factor.

[b]Hh = "handheld"

Table 10

Recalculated Factor Loadings for Rotated Solution for Each Factor (27 Items, Third Administration)[a]

Item[b]	1	2	3
24. Hh computers make me feel uneasy and confused.	.878		
40. Hh computers make me feel uncomfortable.	.824		
1. Hh computers do not scare me at all.	.800		
14. I get a sinking feeling when I think of trying to use a hh computer.	.797		
33. Working with a hh computer would make me very nervous.	.790		
28. I feel aggressive and hostile toward hh computers.	.743		
22. I think using a hh computer would be very hard for me.	.733	.367	
16. I would feel comfortable working with a hh computer.	.706	.387	

6. I'm no good with hh computers.	.595		.514
18. I am not the type to do well with hh computers.	.591	.313	
30. I have a lot of self-confidence when it comes to working with hh computers.	.306		.771
34. Working with hh computers will not be important in my life's work.		.794	
8. I expect to have little use for hh computers in my daily life.		.769	
21. I can't think of any way I will use hh computers in my career.		.731	
23. Learning about hh computers is worthwhile.		.706	
32. Knowing how to work with hh computers will increase my job possibilities.		.583	.349
38. I will use hh computers in many ways in my life.		.579	.436
13. I'll need a firm mastery of hh computers for my future work.		.539	.528
3. Learning about hh computers is a waste of time.		.411	.285
17. Anything a hh computer can be used for, I can do just as well some other way.		.474	.331

37. Once I start working with a handheld computer, I would find it hard to stop.		.346	.661
35. When there is a problem with a handheld computer that I cannot immediately solve, I would stick it out until I have an answer.		.512	.563
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.		.756	.329
26. I could get good grades in hh computer courses.	.481	.475	.325
7. The challenge of solving problems with hh computers does not appeal to me.	.334	.593	.241
31. Figuring out hh computer problems does not appeal to me.		.527	.214
5. It wouldn't bother me at all to take hh computer classes.	.411	.485	.050

[a]Factor loadings < .300 are not reported, unless the highest loading is < .300, or loading is needed to show fit with hypothesized factor.

[b]Hh = "handheld"

Content Validity

To explore the content validity of the HCAS, an expert panel composed of four researchers with expertise in the areas of educational technology and measurement was given the task of matching each HCAS item with one of the three constructs. The judges' scores were used to calculate item-construct congruence *I* using the formula

$$I_{ik} = (N/2N\text{-}2)(\mu_k - \mu)$$

where N is the number of constructs, μ_k is the judges' mean rating of item i on the kth construct, and μ is the judges' mean rating of item i on all constructs (Crocker & Algina, 1989). This yielded the item-construct congruence scores as listed in Table 11.

Table 11

Item-Construct Congruence for Individual HCAS Items (Three-factor, 27-item Version) as Determined by Expert Judges

Item	Anxiety	Usefulness	Work With
1	0.92	-0.58	-0.33
3	-0.75	0.50	0.25
5	0.00	-0.50	0.50
6	0.92	-0.58	-0.33
7	-0.17	0.08	0.08
8	-0.58	0.92	-0.33
13	-0.58	0.92	-0.33
14	0.92	-0.58	-0.33
16	0.92	-0.58	-0.33
17	-0.58	0.92	-0.33
18	0.92	-0.58	-0.33
21	-0.58	0.92	-0.33
22	0.58	-0.42	-0.17
23	-0.42	0.08	0.33

24	1.00	-0.50	-0.50
25	-0.25	-0.50	0.75
26	0.17	-0.58	0.42
28	1.00	-0.50	-0.50
30	0.67	-0.58	-0.08
31	0.00	-0.50	0.50
32	-0.58	0.92	-0.33
33	0.92	-0.58	-0.33
34	-0.67	0.83	-0.17
35	-0.08	-0.58	0.67
37	-0.42	-0.42	0.83
38	-0.58	0.92	-0.33
40	1.00	-0.50	-0.50

According to the rater scores in Table 11, the HCAS items can be categorized under the three factors as shown in Table 12. This table also shows how the raters' scores compare to the item fit according to the exploratory factor analysis. As can be deduced from the results, the raters agreed with the statistical analysis, with the exception of item 7, which was rated as fitting in the constructs handheld usefulness and working with handhelds; and item 23, which the raters put in the construct working with handhelds, while the factor analysis provided the strongest factor loading on handheld usefulness.

Table 12

Item-Construct Congruence for Individual HCAS Constructs (3 Factors, 27 Items)

Construct	Item fit according to content analysis	Item fit according to EFA[1]
Anxiety	1, 6, 14, 16, 18, 22, 24, 28, 30, 33, 40	1, 6, 14, 16, 18, 22, 24, 28, 30, 33, 40
Usefulness	3, 7[2], 8, 13, 17, 21, 32, 34, 38	3, 8, 13, 17, 21, 23, 32, 34, 38
Working with	5, 7[2], 23[3], 25, 26, 31, 35, 37	5, 7, 25, 26, 31, 35, 37

[1]Exploratory Factor Analysis.

[2]Item rated equally on two factors.

[3]Item rated on factor different from EFA.

Internal-Consistency Reliability

To investigate whether the three subscales of the HCAS were internally consistent Cronbach's Alpha was calculated for each of the subscales and for each of the survey administrations (Table 13). Based on previous research and expectations in educational technology of instrument reliability levels of .80 or higher, a directional hypothesis of a_i = .80 was used. Eight of nine coefficients were statistically significant. Based on this analysis, it should be safe to assume that the HCAS is indeed internally consistent.

Table 13

Cronbach Alpha Coefficients for HCAS Subscales across Administrations

Administration	Anxiety	Usefulness	Work With
August 2003	.92*	.87*	.80*
November 2003	.93*	.85*	.79
February 2004	.93*	.88*	.85*

**p* < .05

Test-Retest Reliability

To test the HCAS for stability over time, simple Spearman correlations on the overall instrument as well as the individual subscales were calculated, comparing data from all survey administrations (Table 14). The analysis revealed that for both the HCAS as a whole and each individual subscale, all correlations were statistically significant at $p < .01$, indicating that the HCAS is reliable when it comes to stability over time.

Table 14

HCAS Test-Retest Reliability (Simple Spearman Correlations)

Comparison	Full	Anxiety	Usefulness	Work With
1^{st} v. 2^{nd}	.753**	.789**	.580**	.620**
2^{nd} v. 3^{rd}	.828**	.781**	.759**	.803**
1^{st} v. 3^{rd}	.780**	.819**	.639**	.661**

***p* < .01

Main Study Results

In order to assess changes in attitudes toward handheld computers as measured by the three factors of the HCAS (anxiety toward, usefulness of, and working with handheld computers) over time for the experimental (n = 17) and control (n = 19) groups, a doubly multivariate repeated measures design was initially chosen. The design is considered to be *doubly* multivariate because correlations between dependent variables exist *within* and *between* each survey administration (Stevens, 2002). In order to calculate the non-parametric variant of the MANOVA procedure, the raw scores were converted into rank scores, and the resulting multivariate statistic was adjusted for interpretation (Zwick, 1985).

Prior to the analysis, the assumptions associated with multivariate repeated measures were tested, which include independence of observations, multivariate normality, and homogeneity of the covariance matrices. Testing for sphericity, which is an assumption related to repeated measures designs, is not necessary here, because multivariate tests estimate and account for the covariances between the dependent variables (Max & Onghena, 1999; Stevens, 2002). Survey administration procedures ensured that observations were independent, as participants in the study filled out the surveys individually, i.e. there was no discussion among them as they were answering the survey questions. In addition, time between survey administrations was long enough (about two months between first and second as well as second and third administrations) so that any discussion of questions after students took the survey would not have carried over to the next survey administration. Multivariate normality was tested indirectly by investigating univariate normality of individual items, as it is difficult to test directly.

Skewness and kurtosis coefficients for individual items were calculated, using two standard deviations of the respective standard errors as the cutoff point, which equals an alpha level of .05 (Stevens, 2002). The results of the univariate normality tests are reported in Tables 15 and 16.

Table 15

Skewness of HCAS Items for Main Study Data

Survey Administration	Skewness Range	SES	# of items in violation
1	-1.041 - 1.661	.393	6 of 27
2	-1.293 - .853	.393	6 of 27
3	-1.148 - .588	.393	2 of 27

Table 16

Kurtosis of HCAS Items for Main Study Data

Survey Administration	Kurtosis Range	SEK	# of items in violation
1	-.781 – 3.866	.768	3 of 27
2	-.678 – 2.349	.768	3 of 27
3	-.1.019 – 2.154	.768	1 of 27

Tables 15 and 16 indicate that skewness was more of a problem than kurtosis, especially in the first two survey administrations. However, even though univariate (and therefore multivariate) normality was violated for some items, the effect on Type I error and power in MANOVA analyses is negligible, even when the distributions are noticeably skewed (Stevens, 2002). Therefore, it was still appropriate to conduct a repeated measures MANOVA on the data set at hand, using group (handheld; no handheld) as the independent variable, and handheld anxiety, handheld usefulness, and working with handhelds as the dependent variables. Finally, the assumption of homogeneity of the covariance matrices was met, as the Box M statistic yielded a result that was not statistically significant (*F* (45, 3693.121) = 1.046, *p* = .388). This non-significant Box M test may also indicate that the violation of multivariate normality is not severe, as the statistic is very sensitive to nonnormality (Stevens, 2002).

To interpret the outcome of a MANOVA analysis a variety of statistics are available, including Pillai-Bartlett's Trace, Wilks' Lambda, and Hotelling's Trace. The Pillai-Bartlett's Trace statistic was used because it is most robust when assumptions are not met and sample sizes are small, and the Zwick (1985) transformation for non-parametric MANOVA can be applied to this statistic. This adjustment entails recalculating Pillai-Bartlett's V as $(N\text{-}1)V$ and comparing the resulting statistic to the chi-square distribution using $P(K\text{-}1)$ degrees of freedom (where P equals the number of dependent variables and K equals the number of groups; here 3 and 2 respectively).

Initial calculation of the test statistic yielded $V(3, 29) = .346$, $p < .05$, with a partial $?^2 = .346$ and an observed power of .756, which are both considered high. The Zwick transformation yielded an adjusted statistic of $V = 12.11$, $p < .05$ when using the $?^2$ distribution with $P(K\text{-}1) = 3$ degrees of freedom. The conclusion drawn here is that there is a statistically significant difference over time of the combination of the three factors across groups. Handheld use in a pre-service teacher social studies course has an effect on pre-service teachers' attitudes toward handheld computers over time.

Analysis of the changes in cell means for the three factors that make up the construct attitude towards handheld computers showed an ordinal interaction for the anxiety factor, and disordinal interactions for the usefulness and working with factors (Table 17; Figures 1, 2, and 3). However, only the factor handheld usefulness showed a statistically significant difference over time across groups with a sufficient level of power, with F (2) = 6.884, $p < .05$, with $?^2 = .168$ and an observed power of .912 (Table 18). Examination of the cell means for this factor shows that the difference is positive, i.e. pre-service teachers who used handhelds in a teacher education course came to see handheld computers as more useful over time as compared to pre-service teachers who did not use them.

Table 17

MANOVA Cell Means for Single HCAS Factors (Standard Deviations in Parentheses)

	Anxiety		Usefulness		Work With	
	Exp	Con	Exp	Con	Exp	Con
1	17.32	19.55	19.21	17.87	16.27	20.50
	(9.49)	(11.41)	(11.69)	(9.41)	(9.37)	(11.01)
2	21.50	15.82	17.85	19.08	13.32	23.13
	(9.71)	(10.60)	(11.26)	(9.82)	(7.77)	(10.43)
3	15.62	21.08	20.68	16.55	17.00	19.84
	(10.11)	(10.42)	(12.24)	(8.47)	(12.44)	(8.34)

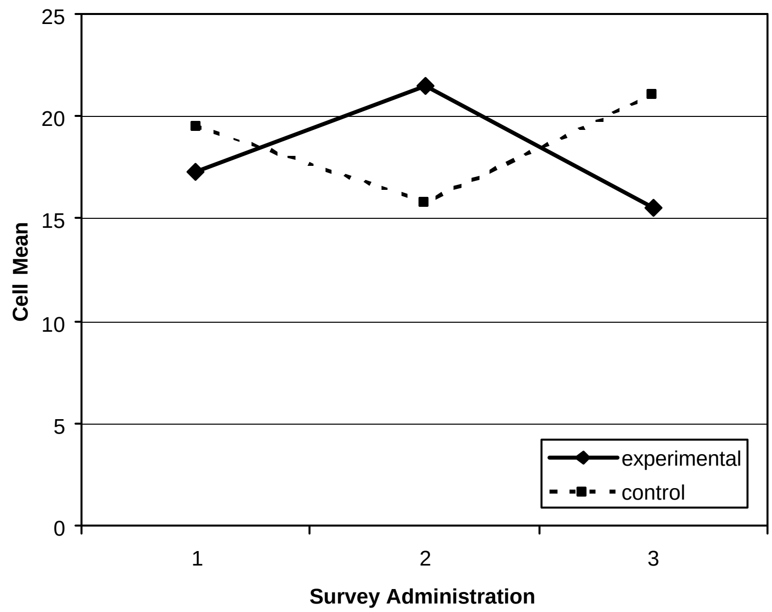

Figure 1. Handheld anxiety factor cell means for three survey administrations of the HCAS.

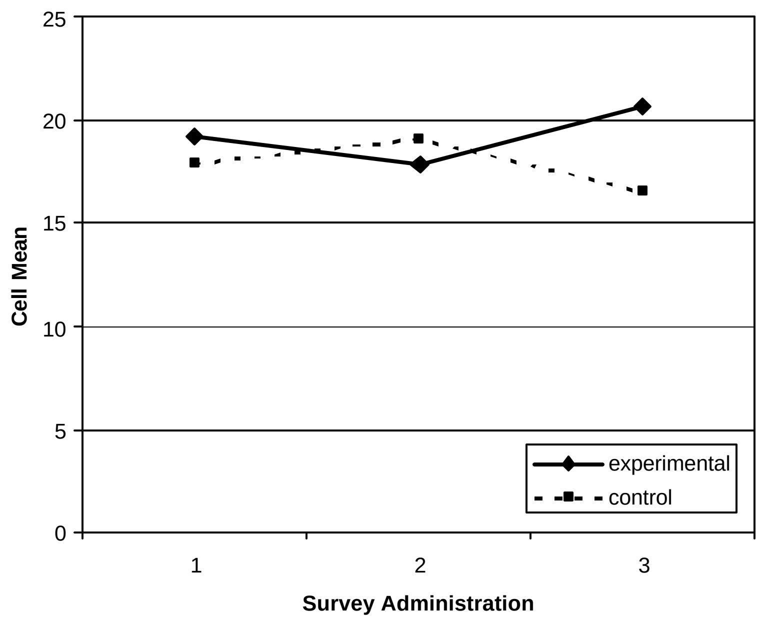

Figure 2. Handheld usefulness factor cell means for three survey administrations of the HCAS.

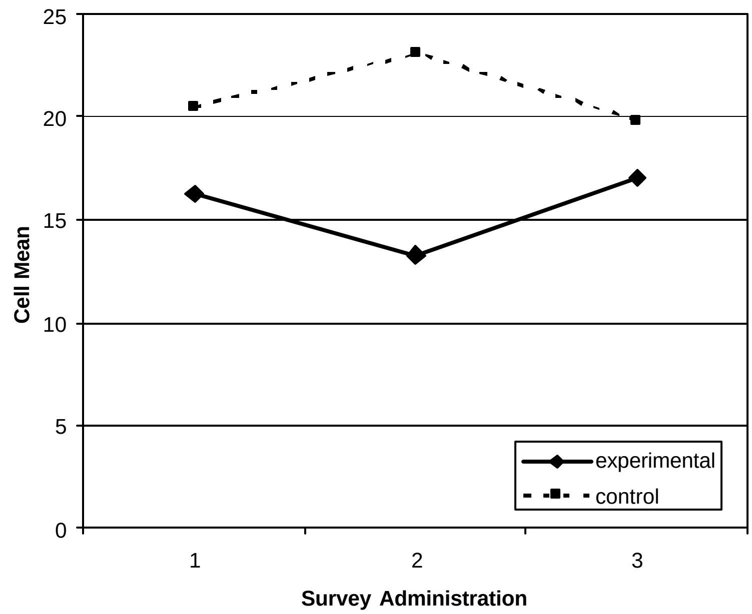

Figure 3. Working with handheld computers factor cell means for three survey administrations of the HCAS.

Table 18

Univariate Tests for Individual HCAS Factors

Factor	F	df	Partial Eta Squared	Observed Power
Anxiety	.760	2	.022	.174
Usefulness	6.884*	2	.168	.912
Work With	3.059	2	.083	.573

* $p < .05$

In sum, analysis of the HCAS survey data revealed that there is a statistically significant, positive difference over time of the combination of the three factors (handheld anxiety, handheld use, working with handhelds) across groups. This means that handheld use in a pre-service teacher social studies course has a positive effect on pre-service teachers' attitudes toward handheld computers over time. Univariate, post-hoc analysis showed that there is a statistically significant, positive difference over time for the factor handheld use only.

CHAPTER V: DISCUSSION

Current trends in education and educational technology make it evermore important for future teachers to learn about technology and how to integrate it in effective and meaningful ways into their curriculum. This skill is especially vital for social studies teachers whose duties include not only teaching *with* technology but teaching *about* the impact of that same technology on our society as well. The purpose of the current study was to investigate one of the more recent and innovative technologies, handheld computers, and the impact of their use in a secondary social studies methods course on the attitudes of pre-service social studies teachers toward using this type of technology. Below, implications of the findings from the pilot study, a validation of a revised instrument, are discussed, followed by an in-depth explanation of the findings from the main study, which asked the following question: what is the effect of handheld technology integration in a secondary social studies methods course on pre-service social studies teachers' attitudes toward technology use in social studies education? Suggestions for further study are also provided.

Summary of Findings

Pilot Study

While not always feasible for logistic or economic reasons, subjecting new or revised instruments to a pilot test should be standard operating procedure in educational research. The pilot study conducted in this project is a good example of how things do not always materialize as expected, and why choices made concerning field testing instruments can make or break a research study. Initial research questions based on a proven four-factor solution for the HCAS (Bandelos & Benson, 1990; Gardner, Discenza,

& Richard, 1993; Kluever et al., 1994; Loyd & Gressard, 1984; Loyd & Loyd, 1985; Nash & Moroz, 1997a; Woodrow, 1991) had to be abandoned when it became obvious that confirmatory factor analysis was inappropriate given the characteristics of the sample at hand. Instead, exploratory factor analysis was used, yielding a new set of three constructs, handheld anxiety, handheld usefulness, and working with handhelds. In addition, the instrument was shortened by 13 questions. Content validity, internal reliability, and test-retest reliability were established for this new version of the HCAS.

In retrospect, what are the lessons learned from the instrument validation process? First, testing the strength of an instrument is an aspect of educational research that is often skipped or overlooked but extremely important. A researcher's choice and validation of an instrument can have a major impact on the outcome of the study. Second, instrument choice and validation are not completely objective, as a researcher makes many choices throughout the process. For one, the researcher needs to choose an instrument that fits the research project. Third, even instruments that have been tested extensively in the past need to be validated *for the sample at hand*. Just because an instrument works fine with one particular group of participants does not mean it will work for all groups it is being administered to. This also means that more testing of the HCAS is needed with samples of different types and sizes. Finally, with regards to the instrument tested here, the validation process yielded a shorter instrument that provides about the same amount of information as the full version, given the factor structure that was found by way of exploratory factor analysis.

Main Study

Statistical analysis of the data for the main study indicates that, over time, handheld use in the secondary social studies methods course has an effect on the combination of the three factors that make up the construct attitude towards handheld computers, and that this effect is mostly positive. Despite the precautions taken by conducting a pilot study, the findings from the main study still need to be interpreted with care, indicating that instrument validation is a necessary but not sufficient condition for obtaining unequivocal results. Aside from the relatively limited sample size, instruments that measure knowledge, skills, and attitudes towards a certain technology such as desktop computers, the Internet, or mobile devices may have a certain shelf life, and could potentially suffer from a ceiling effect, thereby rendering long-term research useless because initial scores are too high to detect statistically significant changes over time. If this is the case, a possible explanation is that technology develops to the point where it is so ubiquitous and engrained in our lives that we take it for granted, like writing or electricity (Weiser, 1991; Weiser & Brown, 1996). In this scenario, we tend to automatically assume that we are proficient in its use because we are so used to having it around us all the time, even if we really aren't.

The results also need to be interpreted within the context of the use of handheld computers in the social studies methods course as described in chapter 3. Informal conversations with the instructor indicated that she integrated the handhelds into the methods course more during the spring than the fall semester, at least proportionately. This may explain why positive changes in student attitudes toward using handheld computers (the only univariate test that was statistically significant) were visible between the second and third administrations and not between the first and second (Table 18, Figure 2). A similar trend is visible for the factor working with handheld computers (Figure 3), but oddly enough, survey scores for the handheld group were consistently lower than those for students who did not use handhelds.

Even though the survey data did meet the assumptions for repeated measures MANOVA, control group data showed unexpected trends. Because this group was not exposed to handheld computers, mean scores on individual subscales of the HCAS should have stayed relatively constant, and the outcome of the survey would have been much clearer. However, this was not always the case, especially when investigating the control group data for the anxiety factor (Table 17, Figure 1); for this group, handheld computer anxiety levels increased during the fall and decreased during the spring. This pattern in anxiety levels does not make sense in the context of the methods course as a whole either, because the closer control group students got to the student teaching phase, the less anxious they supposedly became. In contrast, students in the experimental group became less anxious over time during the fall and more anxious during the spring, potentially indicating that the increased use of handhelds in the spring (as compared to the fall) raised anxiety levels. Another possibility is that students in the experimental group became more comfortable with handheld computers as they were working with them in the fall, while during the spring semester the prospect of student teaching raised their anxiety levels in general, obscuring their real feelings of anxiety toward handheld computers.

Data associated with the handheld usefulness factor showed a pattern that is more in line with the study's expectations; in the long run students in the experimental group came to see handheld computers as more useful than students in the control group. This was the only factor that showed a statistically significant, positive difference over time. For the students in the handheld group the integration of mobile devices in a social studies methods course may have convinced them of the value of the technology's usefulness for teaching and learning in the social studies classroom.

Trends in the data for the factor working with handheld computers are similar to those of the handheld usefulness factor, the main difference being that the univariate test for the working with handhelds factor was not statistically significant. In addition, it should be noted that cell means for the control group were consistently higher than those for the experimental group. Combined with the data trends for the anxiety factor, it could be possible that students in the control group had a more positive outlook on matters of teaching and learning in general, but this cannot be ascertained here, as "general attitudes toward teaching and learning" was not included as a variable to be controlled for.

In sum, there should be room for cautious optimism when it comes to integrating handheld technology in a pre-service secondary social studies methods course. The statistical analysis indicates that, over time, handheld use in this course had an effect on the combination of the three factors that make up the construct attitude towards handheld computers, and that this effect is positive. However, when investigating the individual factors by themselves to determine which ones are the most influential, the picture becomes increasingly foggy. The handheld use factor showed a statistically significant positive increase, the working with handheld factor showed a positive increase, and the handheld anxiety factor showed a negative increase over time. The latter two univariate tests were not statistically significant, most likely because statistical power was too low to detect differences of the magnitude that were present.

Implications

Measuring Attitudes Toward (Handheld) Technology

The current study is an illustration of the difficulties associated with measuring attitudes toward technology. As previous research in instructional technology has shown, technology itself is a moving target that is difficult to pin down and define, and measuring related constructs such as best practices or, in this case, attitudes is tricky (Cooper & Bull, 1997; Snider, 2002). Given this context, adapting the CAS, a 20-year-old instrument that was originally intended to measure attitudes toward computers, may not have been the best way to go. It is possible that the revised instrument (the HCAS) may not have measured what it was intended to measure, i.e. attitudes toward handheld computers, due to the fact that the HCAS may not be a true reflection of the times we live in.

In addition, the questions on the HCAS may have been too general to measure attitudes toward mobile technology within the context of social studies education. While using an instrument more specifically tuned to pre-service social studies teachers would have limited the sample size of the pilot study to the pre-service social studies teachers available at the research site to 58, it could have provided more accurate and detailed measurements of attitudes toward handheld computers as related to teaching and learning in the social studies classroom. As is, sample size was a concern throughout the pilot and main phases of the study. For the pilot study, the initial sample size (N = 104) decreased by about 10% over time because a segment of participants either did not complete all three surveys or dropped out of the teacher education program altogether. Moreover, while the HCAS was tested with secondary social studies, math, and language arts students for purposes of the current study, the group sizes were too small to study each of the subject areas separately (*n* = 58, 24, and 12, respectively). During the main phase of the study, the quasi-experimental design required the use of only pre-service teachers in two sections of a secondary social studies education methods course with a combined enrollment of 42. Again, participants were lost during this part of the research due to failure to fill out all three surveys or withdrawal from the teacher education program.

Another issue related to measuring attitudes toward handheld computers is whether measuring attitudes toward handhelds will provide information related to attitudes toward handheld technology use for teaching and learning, as well as actual use of this technology by social studies teachers. While attitudes toward a particular technology such as the one under study here may be positive, this does not automatically translate into favorable views toward using the same technology in the classroom. With respect to the HCAS though, both attitudes toward mobile technology (handheld anxiety factor), and attitudes toward using handhelds for teaching (handheld usefulness factor) were measured, but more study is needed to determine how the two are related. Finally, the relationship between attitudes toward using handheld computers and actual use of the devices in social studies classrooms cannot be measured with the HCAS, and follow-up research would be needed to track actual use of handheld devices during student teaching as well as during the first years of teaching.

In sum, despite extensive pilot testing of the HCAS, there is a need for a better and more up-to-date instrument to measure pre-service teacher attitudes toward handheld technology use in social studies education. Such an instrument should measure attitudes toward handheld technology in general and its use for teaching and learning, as well as attitudes toward using handheld technology in social studies education specifically. In addition, this new instrument should be piloted with large and diverse sample sizes so that factor analysis can be used to measure its underlying constructs in a variety of situations. According to the existing literature, sample sizes of at least 200 subjects are needed in this scenario, especially given the relatively large number of variables that would be involved (Gorsuch, 1983).

Second, research should focus on the question of whether the factors measured by this new instrument are meaningful within the context of training secondary social studies teachers and getting them to appreciate handheld technology as a useful tool for teaching and learning. Other factors should also be considered. For example, given the increasingly ubiquitous presence of mobile devices, such as handheld computers, cell phones, and digital cameras, it would behoove researchers to include variables such as technology literacy and (length of) device ownership prior to a research study.

(Handheld) Technology Integration in Pre-Service Social Studies Education

What are the implications for teacher educators who are thinking about the integration of handheld technology into their curriculum? Historically, technology integration in social studies has often been hampered by teacher resistance, based on perceived hurdles that need to be overcome before one can effectively use electronic tools for the purpose of augmenting the existing social studies curriculum (Becker, 1998; Clark, 1992; Cuban, 1999; Ehman & Glenn, 1990; Pahl, 1996; Ross, 1988). While times have changed, technology integration in social studies education is still lagging behind other subject areas, especially at the secondary level (Martorella, 1997; Mason et al., 2004; White, 1997). Therefore, it is more imperative than ever that teacher educators in social studies education convince future teachers of the importance of teaching with and about technology in their classrooms, as technology is becoming increasingly ubiquitous (Fitzpatrick, 2000; Ross, 2000: Whitworth & Berson, 2003). Recent discourse among leaders in the field of preparing social studies teachers echoes this sentiment (Crocco, 2001; Doolittle, 2001; Mason et al., 2000).

Findings from the current study indicate that handheld technology integration in pre-service coursework may be an avenue for social studies teacher educators to follow on the road to creating new teachers with more positive outlooks on handheld technology and its use in the secondary social studies classroom. Research indicates that integrating and modeling technology in the pre-service teacher curriculum should happen as early as possible (Crowe, 2003; Crowe & van 't Hooft, 2004; Rosen & McGuire, 1990). Once students start observing classroom teachers and enter the student teaching phase, their beliefs and attitudes are no longer primarily shaped by what they learn in the college classroom, but rather by what they see and hear in schools. This has been referred to by Lortie (1975) as the "apprenticeship of observation," and often triggers future teachers' past experiences as high school students. Unfortunately, meaningful integration of technology, let alone handheld technology, is not the norm during these college or high school experiences, making it all the more important for teacher educators to provide alternative and more positive examples of what is possible.

However, more research is needed to determine how to effectively and meaningfully integrate handheld technology in the pre-service teacher education curriculum, and what types of learning activities are best suited for this purpose, both inside and outside of the college classroom. Because integrating a particular technology tool in teacher education to change pre-service teacher attitudes toward its use in secondary social studies classrooms is a lengthy process and attitude changes do not occur overnight, long-term research is needed. Ideally, such integration projects should last at least two years with the same participants, as it is often not until the second year that real impact can be detected.

Next, there is a need for qualitative data to supplement quantitative approaches, in order to fill in the gaps (Chatterji, 2004). While quantitative studies can be useful to determine whether or not handheld technology integration has an impact on student attitudes toward using such tools, qualitative data can help answer the question what worked or didn't work, and why. Having additional qualitative data would have been helpful in the current study, especially to help explain the anomalies in the survey data, but this was beyond the scope of the data collection process.

Finally, and most importantly, future research should include a focus on the impact of handheld technology integration during the student teaching phase. An important question to consider is whether pre-service teachers' attitudes can be made strong enough prior to the student teaching phase in order to counter potential barriers to using technology at the student teaching site, including cooperating teachers' attitudes or lack of access. Current research indicates that the latter usually gets the upper hand, a trend which forms a major obstacle on the road to change (Medcalf-Davenport, 1999; Strudel & Wetzel, 1999). Furthermore, research is needed that follows the same pre-service teachers from their pre-service training and student teaching to their first years on the job, to determine the impact of handheld technology integration in pre-service training and student teaching on actual practice in the social studies classroom. Questions to be asked should include: Are attitudes toward (handheld) technology use for teaching and learning shaped during pre-service training, and if so, how? How can this technology be effectively integrated in pre-service training? How are attitudes affected in secondary education settings, and is this different for student teachers as compared to new teachers? How do student teachers and new teachers respond to changes in attitude? Can new teachers overcome barriers related to (handheld) technology integration with a positive mindset toward integrating (handheld) technology, and how do they go about doing this? Hopefully this study is a first step in that direction.

APPENDIX A

Survey: Pre-Service Teacher Attitudes Toward Handheld Technology

Part I:

Directions: Please answer the following questions by putting a check mark with the appropriate response or filling in the information requested.

1. Gender ___ Male ___ Female

2. Age: _____

3. I have been using handheld computers for _____ years.

4. Do you have a handheld computer at home? ___ Yes ___ No

5. During the last month, how often have you used a handheld computer for the following (Check one answer per task):

Task	***Never***	***Once or twice***	***Weekly***	***Daily***
Basic functions such as calendar, address book, to do list, and note pad				
Word processing				
Multimedia presentations				
Spreadsheet or database				
Drawing				
Internet access				
Email				
Games				
Playing music				
Taking pictures				

Part II:
Directions: For each of the following statements, circle the number that corresponds with your answer (5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree).

Statement	***SA***	***A***	***N***	***D***	***SD***
1. Handheld computers do not scare me at all.	5	4	3	2	1
2. I would like working with handheld computers.	5	4	3	2	1
3. Learning about handheld computers is a waste of time.	5	4	3	2	1
4. I do not feel threatened when others talk about handheld computers.	5	4	3	2	1
5. It wouldn't bother me at all to take handheld computer classes.	5	4	3	2	1
6. I'm no good with handheld computers.	5	4	3	2	1
7. The challenge of solving problems with handheld computers does not appeal to me.	5	4	3	2	1
8. I expect to have little use for handheld computers in my daily life.	5	4	3	2	1
9. Generally, I would feel OK about trying a new problem on the handheld computer.	5	4	3	2	1
10. I would feel at ease in a handheld computer class.	5	4	3	2	1
11. I think working with handheld computers would be enjoyable and stimulating.	5	4	3	2	1
12. I don't think I would do advanced handheld computer work.	5	4	3	2	1
13. I'll need a firm mastery of handheld computers for my future work.	5	4	3	2	1
14. I get a sinking feeling when I think of trying to use the handheld computer.	5	4	3	2	1
15. I am sure I could do work with handheld computers.	5	4	3	2	1
16. I would feel comfortable working with a handheld computer.	5	4	3	2	1
17. Anything a handheld computer can be used for, I can do just as well some other way.	5	4	3	2	1
18. I am not the type to do well with handheld computers.	5	4	3	2	1
19. I don't understand how some people can spend so much time working with handheld computers and seem to enjoy it.	5	4	3	2	1
20. I am sure I could learn a handheld computer language.	5	4	3	2	1

Directions: For each of the following statements, circle the number that corresponds with your answer (5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree).

Statement	***SA***	***A***	***N***	***D***	***SD***
21. I can't think of any way I will use handheld computers in my career.	5	4	3	2	1
22. I think using a handheld computer would be very hard for me.	5	4	3	2	1
23. Learning about handheld computers is worthwhile.	5	4	3	2	1
24. Handheld computers make me feel uneasy and confused.	5	4	3	2	1
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.	5	4	3	2	1
26. I could get good grades in handheld computer courses.	5	4	3	2	1
27. I will do as little work with handheld computers as possible.	5	4	3	2	1
28. I feel aggressive and hostile toward handheld computers.	5	4	3	2	1
29. I do not think I could handle a handheld computer course.	5	4	3	2	1
30. I have a lot of self-confidence when it comes to working with handheld computers.	5	4	3	2	1
31. Figuring out handheld computer problems does not appeal to me.	5	4	3	2	1
32. Knowing how to work with handheld computers will increase my job possibilities.	5	4	3	2	1
33. Working with a handheld computer would make me very nervous.	5	4	3	2	1
34. Working with handheld computers will not be important in my life's work.	5	4	3	2	1
35. When there is a problem with a handheld computer run that I cannot immediately solve, I would stick it out until I have an answer.	5	4	3	2	1
36. I do not enjoy talking with others about handheld computers.	5	4	3	2	1
37. Once I start to work with a handheld computer, I would find it hard to stop.	5	4	3	2	1
38. I will use handheld computers in many ways in my life.	5	4	3	2	1
39. It's important for me to do well in a handheld computer class.	5	4	3	2	1
40. Handheld computers make me feel uncomfortable.	5	4	3	2	1

APPENDIX B

University Student Consent Form

The Effect of Technology Use in Pre-Service Social Studies Education on the Attitudes of Future Teachers Towards Technology Integration in Social Studies

I am conducting a study this year related to the effects of the integration of technology on your beliefs toward technology integration in social studies. I am specifically interested in studying how handheld technology makes pre-service teachers feel about using technology in the social studies classroom. To research this, I will ask you to participate in a short survey that will be administered three times throughout the academic year.

Confidentiality will be maintained through the use of project ID's and the elimination of other identifying information. I can think of no possible risks or negative effects related to your participation in this project. Participation is completely voluntary and you may withdraw at any time without penalty. Your decision to participate in this research project will in no way affect your grade in any portion of your work in the course. Although you may not benefit directly from this research, the research will be of future benefit to this program and to the education of future teachers. Findings of this research project will be shared at professional meetings and/or in publications. In all of these cases, confidentiality will be maintained.

I will be happy to answer any question you have regarding this research. I can be reached at (330) 672-5996 or by e-mail at mvanthoo@kent.edu. The project has been approved by Kent State University. If you have questions about Kent State University's rules for research, please call Dr. John West, Vice Provost and Dean, Division of Research and Graduate Studies at (330) 672-0700. If you agree to participate in the study described here, please sign the statement below and return it to me. You will get a copy of this letter for your own records.

Thank you for your participation,

Mark van 't Hooft
Tech Specialist/Researcher

Consent Statement

I agree to take part in this project. I know what I have to do and that I can stop at any time.

____

Print Name   Date

____

Signature

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VAN 'T HOOFT, MARK A., Ph.D., June 2005

Teaching, Leadership and Curriculum Studies & Educational Foundations and Special Services

THE EFFECT OF HANDHELD TECHNOLOGY USE IN PRE-SERVICE SOCIAL STUDIES EDUCATION ON THE ATTITUDES OF FUTURE TEACHERS TOWARD TECHNOLOGY INTEGRATION IN SOCIAL STUDIES (128 PP.)

Co-Directors of Dissertation: Shawn M. Fitzgerald, Ph. D.
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This study investigates the effect of handheld computer integration in a secondary social studies methods course on the attitudes of pre-service teachers toward technology integration in social studies classrooms. An existing instrument, the Computer Attitude Scale (CAS), was modified into the Handheld Computer Attitude Scale (HCAS), and pilot tested with a sample of 94 pre-service teachers in secondary social studies, math, and language arts training programs at a public university in the Great Lakes Region. During the 2003-2004 academic year, the HCAS was administered three times to this pilot sample, and was found to measure three underlying factors: handheld anxiety, handheld usefulness, and working with handheld computers. Both validity and reliability were established for a shortened, 27-item instrument.

The main phase of the study examined the effect of handheld computer integration on pre-service teacher attitudes toward technology integration in secondary social studies classrooms. Participants during this phase consisted of 36 pre-service teachers enrolled in two sections of a secondary social studies methods course at the same institution as the participants in the pilot sample. Participants completed the HCAS three times throughout the 2004-2005 academic year. Repeated measures MANOVA indicated

that there is a statistically significant, positive difference over time of the combination of the three factors (handheld anxiety, handheld use, working with handhelds) across groups. This means that handheld use in a pre-service teacher social studies course has a positive effect on pre-service teachers' attitudes toward handheld computers over time. Univariate, post-hoc analysis showed that there is a statistically significant, positive difference over time for the factor handheld use only.

The results emphasize the importance of validating instruments with a similar sample before actual data is collected. Moreover, the findings from the main study provide cautious optimism for the impact of handheld technology integration in teacher training programs on pre-service teacher attitudes toward technology integration in secondary social studies classrooms.