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A quantitative investigation of American history software on middle school student achievement scores

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A QUANTITATIVE INVESTIGATION OF AMERICAN HISTORY SOFTWARE

ON MIDDLE SCHOOL STUDENT ACHIEVEMENT SCORES

by

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ABSTRACT

A Quantitative Investigation of American History Software on Middle School Student Achievement Scores

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The purpose of this quasi-experimental study was to examine whether student use of the Ignite! Early American History software significantly affected student outcome achievement scores on a standards-based assessment. Students in three urban middle schools were divided into experimental and control groups with both groups being taught by the same teacher. Experimental group students used the Ignite! history software as a supplement to their regular American history curriculum, and students in the control group did not use the program. The study also examined how students with limited English proficiency (LEP) and students with special needs scored on the standardized test as compared to regular education students. Statistical analysis of test results indicated that overall, students who used the Ignite! American history software scored significantly higher than students who did not use the program. These statistical differences were not

apparent, however, when comparing students with LEP and students with special needs to regular education student test scores.

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CHAPTER 1

INTRODUCTION

Purpose of the Study

Technological innovations have dramatically transformed the worlds of work, leisure, and education for Americans living in the twenty-first century. As information technology and interactive multimedia become increasingly integrated into everyday classroom activities, there is a growing expectation that these technologies will improve, perhaps even revolutionize, content area teaching and learning. Because information technology (IT) and computer-mediated communications (CMC) are rapidly transforming the practice of teaching and learning, scholars and practitioners are continually seeking to pinpoint the most effective ways of implementing computer-enhanced instruction. While there is a body of literature that discusses technology integration in schools and classrooms, there remains a lack of data-based research specifically addressing the issue of the effectiveness of educational software (Crosier, Cobb, & Wilson, 2002; Cuban, 2000; Forcier, 1999; Mills, 2001; Williams, Boone, & Kingsley, 2004) in relation to student achievement outcomes. With this in mind, the current study investigated the effectiveness of social studies learning as a result of utilizing the Ignite! early American History (2003) software program to augment textbook and lecture materials for seventh-grade middle school history students in an ethnically and linguistically diverse urban school district. Teacher and student activities, pretest and posttest scores, and instructional methods for experimental and control conditions were documented in order to provide a comprehensive understanding of the results.

This study described four outcome-related aspects of the use of a history software program in four seventh-grade classrooms in three different middle schools. First, the study examined whether students who used the Ignite! early American history program scored higher overall on an assessment instrument as compared to students who did not use the program. The second research question examined the test scores on an item-by-item basis to determine whether students using the Ignite! program scored substantially higher on particular topics or concepts in American history, as compared to students who did not use the program. The third and four research foci explored how students identified by their teachers as having limited English proficiency (LEP), or identified by their teachers as having special needs, respectively, scored on the pretest-posttest instrument as compared to students with LEP and those with special needs who did not use the program. All students were enrolled in inclusive, mainstreamed seventh-grade history courses.

Teaching History and Social Studies

The National Council for the Social Studies calls for teaching and learning that is exciting, motivating, and relevant to students' lives: instruction that is "meaningful, integrative, value-based, challenging, and active" (as cited in White, 1999, p. 9). Antithetically, there is mounting evidence suggesting that students generally find social studies dull and unimportant, that they have difficulty understanding their textbooks, and that overall, they remember very little of what they "learned" (Ciborowski, 2005; Schug, Todd, & Berry, 1984; Stetson & Williams, 2005; White, 1999). In fact, according to Shaughnessy and Haladyna (1985) and Lounsbury (1988), social studies and history are rated by middle school students as two of the least liked subjects in the curriculum, with only English receiving more negative reviews about the teaching of its content. Why is the subject of social studies so unpopular with students? Perhaps the problem lies less with the subject itself than how it is taught. In American schools throughout the 20th century, teacher-directed, textbook-centered, fact-based approaches have dominated the teaching of social studies in general, and American history in particular (Evans, 2004; Hope, 1996; Trinkle & Merriman, 2000). Rather than allowing students to ask their own questions and seek their own answers (Brooks & Brooks, 1993), K-12 teachers overwhelmingly present American history from a conservative, Eurocentric perspective based on patriotic ideals, beliefs, and values (Loewen, 1995; Marciano, 1997; White, 1999; Zinn, 2003). This traditional, mimetic approach to the subject does little to promote relevant classroom discourse in which students are encouraged to engage in reflective thinking or to draw meaning from the social studies curriculum. Lounsbury suggested that part of the reason for the unpopularity of social studies is teachers' failure to articulate meaningful objectives and make the topic relevant to students' lives.

Fortunately, the nature of teaching and learning for all school subjects, including social studies, is evolving. In recent years, researchers and educators have identified instructional and motivational strategies that can move social studies and history teaching beyond what Lounsbury (1988) decried as "dates, deeds, dullness, battles, biographies, and boredom" (p. 116) to make social studies interesting and relevant. Educational technology and interactive multimedia play an increasingly essential role in efforts to move social studies from the rote memorization of dates and information toward a more student-centered, hands-on, authentic learning experience (Bitter & Pierson, 2005; Means & Olsen, 1994; Rose & Ferlund, 1997; Trinkle & Merriman, 2000).

Educational technology can create new possibilities for learning that conventional teaching does not readily provide. Using interactive multimedia, educators can now conceptualize teaching and learning structures that incorporate simultaneous visual images, music, text, and other media as mechanisms to teach higher-level thinking, decision-making, and collaboration. The instructional software evaluated in the current study, Ignite! Learning's early American history course, is an interactive multimedia program designed to teach middle school students through video, song, animation, text, and other media to develop critical thinking skills while acquiring knowledge of required content strands (Ignite! Learning, 2003). The teacher's guide accompanying the software describes the program this way: "based on research-based learning methodologies and aligned to curriculum standards, the courseware allows teachers to make powerful connections with students, engage hard-to-reach learners … and helps improve standardized test scores" (p. 3). Figure 1 features a screen shot from the program showing typical subject choices available to students exploring Unit 3, which discusses the rise of tensions preceding the Revolutionary War. Figure 2 shows a typical media selection screen contained within a chosen topic. Students are able to choose whether to view a video clip, listen to a song or story, depending on which icon they select.

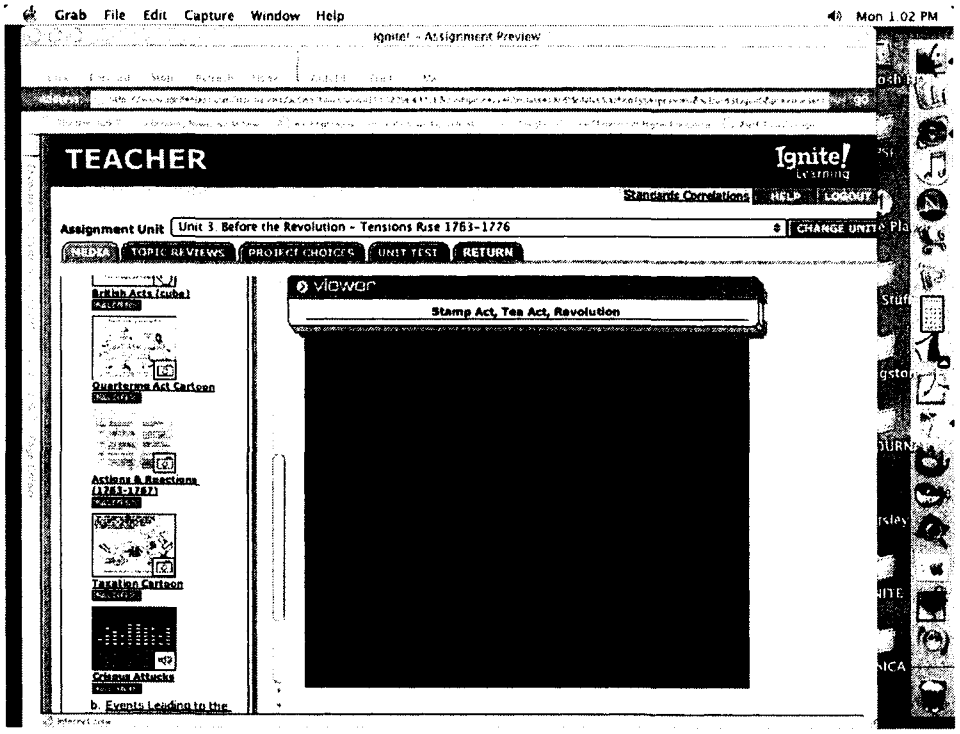


Figure 1. Screen displaying the sub-topics available in Unit 3.

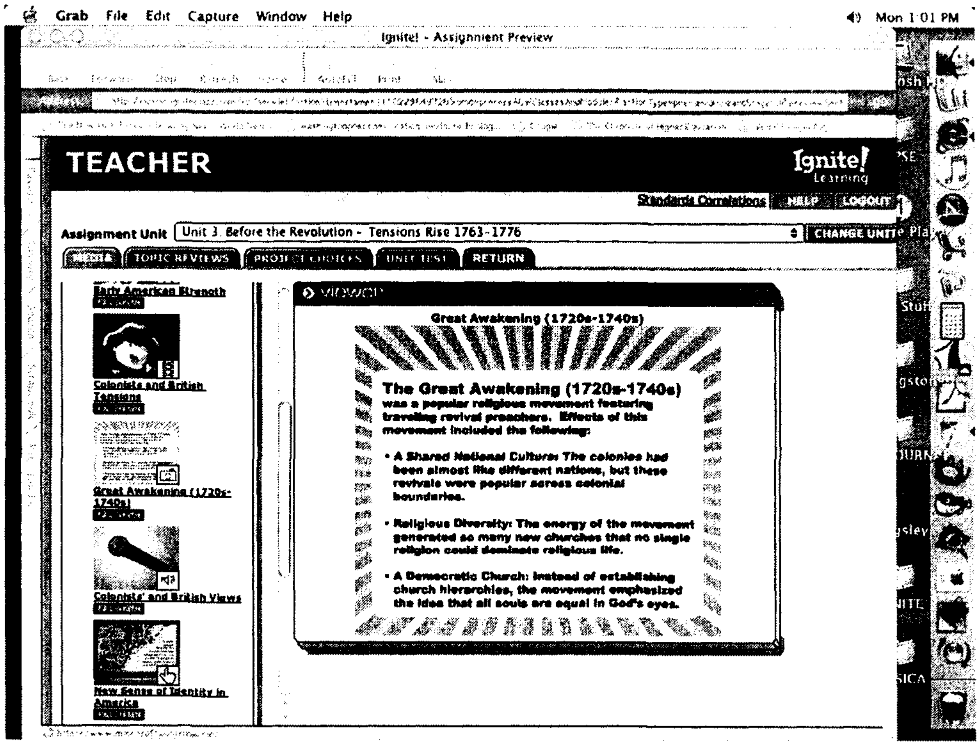


Figure 2. Screen displaying media choices contained in Ignite! software.

Standardization and High Stakes Assessment

Since passage of the No Child Left Behind (NCLB) Act of 2001 (PL 107-110), standards-based assessments have increasingly become a major focus of K-12 education throughout the U.S. Not surprisingly, the state where the current study was conducted also emphasizes student achievement on mandated standardized assessments as indicators of learning. The present study was conducted with grant funding earmarked to assist district administrators in deciding whether to purchase the Ignite! history software for district-wide use. Regardless of whether teachers and administrators in the school district agreed with federal legislation mandating standardized assessments as the ultimate indicator of student achievement, they were expected to meet the challenges presented by state law and NCLB. Amid growing calls for evidence-based research on student achievement, the overarching goal of the present study was to compare achievement scores for students who used the Ignite! history software as part of their coursework with the scores of students who did not use the program.

Conceptual Models

This study drew from several different, and sometimes disparate, theoretical and conceptual frameworks related to the use of technology for teaching and learning, for researching and assessing student achievement in technology-enhanced classrooms, and for social studies education. These themes and conceptual frameworks are outlined and described in the review of professional literature contained in next chapter.

Significance of the Study

The four main research foci of this study attempted to document the effects of a multimedia software program on content area student achievement. First, the study provides an overall assessment of the effectiveness of the Ignite! American history program on achievement scores for middle school students in order to assist school administrators in deciding whether or not to adopt the program. District personnel were well aware that the vast potential market posed by children, their parents, and their schools is not lost on software vendors, who invest far more in the marketing of their educational software than in research related to whether the programs actually help students learn (Jesdanun, 2004; Shade, 1996; Sugar, 2001). Even with the rapid proliferation of educational computer programs for learners of all ages, there remains a dearth of research literature on the effectiveness of educational technology for classroom learning, particularly in the area of educational software (Caftori, 1994; Kelley & Ringstaff, 2002; Mills, 2001; Sugar, 2001; Williams, Boone, & Kingsley, 2004). In fact, the National Research Council (2002), which provides scientific and technological advice to the federal government, and others (Campbell, 1969; Cook, 2001) have found repeatedly that although most educational software is commercially produced, "those with commercial interests are not expected by educators, policy makers or the public to use research to support what they sell" (National Research Council, 2002, p. 96). As a result, the National Research Council (NRC) explains, "educators are unlikely to draw on scientific knowledge to improve their practices in any meaningful way" (p. 96). Undoubtedly, research investigating whether or not a software program significantly boosts student test scores is vital because it can directly impact educational funding decisions at local, state, and national levels. Perhaps more importantly, evaluation of the effectiveness of educational software is needed to assist legislators, administrators, and practitioners in making informed decisions about how and where to invest time and limited resources in ways that best serve their students.

The current study also explored how use of the Ignite! American history program affected achievement scores for students identified by their teachers as English Language Learners (ELLs) with limited English proficiency (LEP). Because today's classrooms are comprised of a growing number of students who are culturally and linguistically diverse from one another and from their teachers (Banks & Banks, 2005; Delpit, 1995; Nieto, 2004), including many learners whose first language is not English (Gunderson, 2000; Hammerberg, 2004), more empirical research is needed into which instructional practices and tools, including software programs, can assist language minority students in mastering content area information.

Additionally, the study examined how use of the Ignite! American history software affected test scores for students with special needs. Since 1975, the number of students identified as learning disabled (LD) has tripled, with the largest percentage increase in students aged 12 to 17 (Turnbull, Turnbull, Shank, Smith, & Leal, 2002; U.S. Department of Education, 1999). As a result, mainstream middle school and secondary classrooms increasingly include students with learning disabilities, most of whom struggle with low-level reading and comprehension skills. When identified properly, these students qualify for special education services and are eligible to receive individualized assistance and/or pull-out instruction for math, reading, and language arts. However, for other subjects such as science and history, students with disabilities are frequently placed in inclusive classrooms without the benefit of modified or individualized instruction or adapted textbook materials. With so many special needs students facing in-school challenges, investigating technological possibilities that might provide special education students with opportunities to learn and gain independence is particularly important. The last area of inquiry for the current study measured whether mainstreamed students identified by their teachers as having special needs who used the Ignite! history program showed significant achievement increases on a standardized assessment instrument as compared to special education students in mainstreamed classrooms who did not use the program.

There is an absence of supported data measuring whether educational technology affects outcome scores when used with students (Cuban, 2000; Kelley & Ringstaff, 2002; Williams, Boone, & Kingsley, 2004). This study adds to the professional literature examining technology integration for student learning by providing quasi-experimental results of the effectiveness of an educational software intervention on student outcome scores. This investigation adds to the small body of studies utilizing a rigorous, scientifically-based research (SBR) (NCLB, 2002) methodology to examine student outcomes as a result of a technology intervention within a school setting (Poggi, 2003).

Although this study served to provide answers to basic questions related to achievement on a standardized assessment for students with diverse backgrounds using a multimedia program, the results undoubtedly underscore the need for further applied educational research into each of the four areas investigated. Clearly, the outcomes from this research may serve as the basis for future quantitative as well as qualitative investigations related to the effectiveness of educational software for content area learning for diverse middle school learners.

Research Questions

This study investigated the following questions:

1. Is there a significant difference between pretest and posttest achievement scores for students who used the Ignite! early American history program as compared to students who did not use the program?
2. Are there specific concepts represented on the pretest-posttest instrument for which students scored significantly higher than students who did not use the Ignite! program?
3. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program and LEP students who did not use the program?
4. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having learning disabilities (LD) who used the Ignite! program and LD students who did not use the program?

CHAPTER 2

REVIEW OF RELATED LITERATURE

This study investigated the effectiveness of an educational software program on student outcome achievement scores. To provide a foundation for the research, this chapter examines the professional literature related to several conceptual frameworks, each of which is relevant to the current study: (a) integration of educational technology into the classroom, including use of interactive multimedia for teaching and learning, (b) social studies teaching and learning, including the use of technology, (c) instructional technology to support English language learners, (d) instructional technology to support students with learning disabilities, and (e) Gardner's (1983) theory of multiple intelligences. A summary of the review concludes this chapter.

Information and Communication Technologies for Learning

Recent years have seen hundreds of millions of federal and state funds flowing into technology for schools, fueling calls for more research and evaluation of technology in educational settings (National Forum on Education Statistics, 2003; Salpeter, 2002; Sandholtz, Ringstaff, & Dwyer, 1997). However, this colossal investment in technology for learning is not without its critics, who point out that whatever its benefits, technology creates a drastically different, more complex, demanding environment that requires significant shifts in beliefs and practices at all levels.

There are some data indicating positive effects for computers in some educational settings (Elliot & Hall, 1997; Means & Golan, 1998; Roblyer, 1999; Sandholtz, Ringstaff, and Dwyer, 1997). However, there remains an absence of research-supported data for much of the application of technology, including educational software,that is used in schools (Sugar, 2001; Williams, Boone, & Kingsley, 2004). As the amount of technology for instructional purposes continues to increase, Mills (2001) emphasized the growing need for more research and more effective techniques for evaluating computer-based instruction and educational software. According to Mills, computer-based training and educational programs are frequently used without being properly tested or evaluated, and may not be meeting instructional objectives.

Interactive Multimedia for Learning

The term *multimedia* describes any system that combines two or more media into a single product or presentation, such as a software program or a Web page. Although interactive multimedia capabilities have grown enormously and become very common in recent years, research on interactive multimedia as an instructional approach is not yet extensive (Alessi & Trollip, 2001; Lockard & Abrams, 2004). According to Mayer (2003), a multimedia instructional message is "a presentation consisting of words and pictures that is designed to foster meaningful learning. Thus, there are two parts to the definition: (a) the presentation contains words and pictures, and (b) the presentation is designed to foster meaningful learning" (p. 128).

Instructional multimedia methodologies can include tutorials, hypermedia, drill and practice software, simulations, games, tests, and Web-based learning (Alessi & Trollip, 2001). A major advantage of interactive multimedia is that it transcends the sequential, linear limitations of traditional educational tools and communications media by operating in a *hypermedia* environment. In the present context, *hypermedia* refers to the ability to move about, using a series of nodes or links, within an environment without linear, sequential restrictions. Written information in such an environment is termed *hypertext*, which links to one or more other pages or screens of text. *Hypermedia* is the integration of computers and multimedia to produce interactive, nonlinear environments containing some combination of interlinked graphics, sound, text, and video. The terms hypermedia and interactive multimedia (IMM) are often used interchangeably. Clarke (2001) defines hypermedia as "multimedia based on a hypertext system in which users navigate their way through the material by clicking on links which are provided by individual words or phrases" (p. 124). According to Falk and Carlson (1992) IMM is the best "single-set of technologies to promote among teachers to improve the way they educate students" (p. 96). Although claims such as this one elicit varying responses among scholars and educators, some research appears to indicate that IMM can indeed provide learning benefits.

Mayer's (2003) review of research on the design of multimedia methods and their effectiveness found (a) a multimedia effect, in which students learned more deeply from words and pictures than from words alone in both book-based and computer-based environments, (b) a coherence effect, where students learned more deeply when extraneous material was excluded rather than included, in both book-based and computer-based environments, (c) a spatial contiguity effect, in which students learned more deeply when printed words were placed near rather than far from corresponding pictures, in both book-based and computer-based environments, and (d) a personalization effect, in which students learned more deeply when words were presented in conversational rather than formal style, both in computer-based environments containing spoken words and those using printed words. Mayer concluded that the media itself did not cause learning, because the instructional media promoted the same kinds of cognitive processing in both computer-based and book-based environments. Rather, Mayer concluded that cognitive processing caused learning to occur, and that if an instructional method promotes the same types of cognitive processes across different media, then it results in the same benefits across media (p. 137).

Kozma (1994) stressed the unique contributions that multimedia brings to the learning experience, an assertion supported by Bagui's (1998) finding that multimedia capabilities are unique because both sensory stimulation and user navigation in interactive multimedia (IMM) parallel students' natural ways of learning. It is important to note here that underlying teaching strategies can influence whether instructional multimedia produce positive learning outcomes (Lockard & Abrams, 2004). On the other hand, Roblyer (1999) asserted that the multiple channels through which multimedia communicates to the learner seem to be the source of its benefits.

Davidson-Shivers, Shorter, Jordan, and Rasmussen (1999) studied fifth graders' uses of learning strategies, encoding processes, and navigation decisions in hypermedia lessons. They found tremendous variation in the number and types of learning strategies used by students with high, average, or low achievement scores. Higher-scoring students used more and more varied learning strategies and appeared to have greater consistency in navigation, whereas the lower-scoring students used fewer strategies and made more errors in encoding the information. Cradler and Cradler (1999) argued that students did indeed learn more from multimedia projects, as evidenced by their students' performances. After their students completed multimedia projects in language arts and social studies, the researchers noted significant increases in student research skills, organizational skills, interest in the course content, and their ability to transfer their knowledge to new, authentic learning situations. However, Heller (1990) cautioned that the inherent flexibility of hypermedia environments may be inappropriate for children below middle school age because students often tend to browse hypertext environments using simple techniques rather than developing more effective searching strategies.

The sound, images, animation, and interactivity in electronic books have also been shown to increase motivation and comprehension scores as compared to students' reading of printed texts (Greenlee-Moore & Smith, 1996; Labbo, 2002; Mathew, 1997). However, the educational potential of electronic stories can be diluted if teachers fail to supervise their use; young children are especially prone to distraction, and if not properly supervised could use the software solely for entertainment purposes.

Integration of Educational Technology

Planning for Instructional Technology

Effective integration of technology to support learning requires the strategic acquisition, use, and expansion of technology in educational settings. Creating or adopting an existing technology plan is the first step in the process of successful instructional technology implementation. According to the North Central Regional Technology Consortia's (NCRTEC) Technology Plan Task Force (1997):

> A technology plan serves as a bridge between traditional established standards and classroom practice. It articulates, organizes, and integrates the content and

> processes of education in a particular discipline with appropriate technologies. It facilitates multiple levels of policy and curriculum decision-making, especially in school districts, schools, and educational organizations that allow for supportive resource allocations (¶ 6)

As NCRTEC and others (National Forum on Education Statistics, 2003; Newby, Stepich, Lehman, & Russell, 2000; Roblyer, Edwards, & Havriluk, 1997) pointed out, a technology plan provides a type of road map to maximize the potential of educational technology while concomitantly addressing the challenges of its implementation. In their publication entitled *Basic Principles of Technology Planning* (2001), the North Central Region Technology in Education Consortium (NCRTEC) outlined basic principles for technology planning. According to their model, technology planning for education should:

1. Be an organized and continuous process, use a simple straightforward planning model, and result in a document that improves how technology is used for instruction, management, assessment, and communications.
2. Take into account the mission and philosophy of the organization and be "owned" by that organization, its administrators, and instructors.
3. Be broad but realistic in scope, with economical and technically feasible solutions.
4. Involve all the stakeholders – including administrators, instructors, staff members, students, parents, community leaders, and technology experts – with experience in education.

5. Identify the strengths and weaknesses of the organization and how each will impact the implementation of technology.
6. Formalize the procedures and methods for making technology decisions, including the setting of priorities and the purchase, evaluation, upgrading, and use of technology.
7. Be driven by educational goals and objectives rather than by technological developments.

Others (Lever-Duffy, McDonald, & Mizell, 2005; Roblyer, Edwards, & Havriluk, 1997; Smaldino, Russell, Heinich, & Molenda, 2005) emphasized additional aspects of instructional planning for technology, such as researching and comparing examples of plans that have already been developed, ensuring that planning occurs at the district as well as school levels, continually critiquing and assessing a plan once it is implemented, and the importance of on-going teacher training. It is also important to note that technology is but one component of an instructional activity, a tool to be integrated into efforts to address unmet needs, or to make education more efficient, motivating, and successful. In other words, technology is most effective not when treated as an isolated component, but rather as one element embedded within the larger process of school change and incorporated into the fabric of educational settings to help achieve the objectives of educational reform (Honey, Culp, & Carrigg, 1999).

Professional Development

The rapid proliferation of new instructional technologies has not been accompanied by adequate professional development opportunities for teachers to learn about recent innovations and how to incorporate them into day-to-day classroom activities (Cuban, 2000; Mouza, 2002-2003; National Forum on Education Statistics, 2003; President's Committee of Advisors on Science and Technology, 2000; Sandholtz, Ringstaff, & Dwyer, 1997). Although ideally teachers would use technology seamlessly as an integral part of teaching and learning, this is not and has not been the case (Cuban, 2000; Sandholtz, Ringstaff, & Dwyer, 1997) in most educational settings. While the majority of teachers now have access to at least one computer in the classroom, in many cases these computers are not used for instruction due to teachers' inexperience or lack of training with computers for teaching and learning (Becker, Ravitsz, & Wong, 1999; Grove, Strudler, & Odell, 2004; Trotter, 1999). The problem is compounded by the fact that one of the most pressing concerns for educational administrators and policymakers is pinpointing the skill levels of their teachers and what skills teachers still need (Honey, Culp, & Carrigg, 1999; Nellen, 2001; North Central Regional Educational Laboratory, 1997; West, 2003). Moreover, no consensus exists as to what type, or how much professional development is appropriate to fulfill the promise of technology in education. Recommendations for teacher training and professional development time range from 20% of teacher's work time up to the 50% advocated by the National Education Association (as cited by North Central Regional Educational Laboratory, 1997). The No Child Left Behind Act of 2001 requires 25% of technology funds be devoted to educator training and professional development, including technology-using administrative and support staff. Most stakeholders agree, however, that ongoing teacher education plays a vital role in "producing technology-capable students" (International Society for Technology in Education, 2000, p. 1).

Constructivist Teaching with Technology

Constructivist, student-centered forms of learning employ learner exploration and knowledge construction through higher-level thinking, problem solving, and learner reflection (Cantu, 2000; Crocco, 2001). According to constructivist learning theory, knowledge is constructed, individually or socially, rather than being received from outside (Alessi & Trollip, 2001; Cantu, 2000; Cognition and Technology Group at Vanderbilt, 1992; Milman & Heinecke, 2000; Molebash, 2002; Papert, 1980; Rose & Fernlund, 1997). Crocco asserts that

> … the importance of technology lies in its ability to leverage constructivist approaches to … teaching … The chief value of technology lies, therefore, in providing the leverage so urgently needed for moving … instruction away from passive [teacher-centered] approaches emphasizing recall and regurgitation toward active, student-centered forms of learning demanding critical and conceptual thinking from all students at all levels (p. 387).

Facilitating students' construction of knowledge while providing authentic, technology-rich learning experiences is particularly aligned with the constructivist paradigm (Leu 2000a, 2000b, 2002). Becker (1999) and Karchmer (2001) have found that teachers who embrace Internet technology for classroom instruction tend to have constructivist beliefs. However, Leu and others (Cantu, 2000; Coiro, 2003; Smolin & Lawless, 2003; Unsworth, 2001; Zong, 2002) are concerned that educators have been slow to adopt constructivist pedagogies and information technologies, despite the rapid proliferation and far-reaching implications of computer-based technologies in our society as well as within education. Fortunately, a significant benefit of the process of integrating multimedia and other technologies into the curriculum is that it requires educators to reflect on their pedagogical objectives and practices in order to utilize them more effectively (Igartua, 1998).

Increased Comprehension

Research on technology use for increased comprehension is also encouraging. Several studies over the years have found that achievement scores of students using computer-assisted instruction (CAI) are equal to or greater than scores from those not using CAI. The research encompassed learners from the lower grades through college level (Christmann & Badgett, 2000), and included meta analyses of overall achievement (Fisher, 1983; Khalili & Shashaani, 1994; Krein & Maholm, 1990; Kulik, 1994; Roblyer, Castine, & King, 1988) as well as specific subject areas such as science (Bayraktar, 2001-2002; Soyibo & Hudson, 2000), basic skills (Glenn, 1988; Mann, Shakeshaft, Becker, & Kottkamp, 1999), reading (Blok, Oostdam, Otter, & Overmatt, 2002), writing (Baer, 1988), vocabulary development (Boling, Martin, & Martin, 2002), math (McLeod, 1988; Morrison, Ross, & Baldwin, 1992; Reglin, 1990; Wenglinsky, 1998), and problem solving (Cardelle-Elawar & Wetzel, 1995; Hatfield, 1991; Tyler & Vasu, 1995). There are, of course, any number of ways to incorporate CAI into classroom teaching and learning. However, recent research indicates that in many instances interactive multimedia technology for content area learning appears to show the most promise (Labbo & Reinking, 1999; Leu, 2002; Leu & Kinzer, 2000; Mayer, 2003).

Technology for History and Social Studies Learning

Despite movements within the social studies to promote student computer use to facilitate reflective inquiry, decision-making, and problem solving (Center for Civic Education, 1994; Evans, 2004; National Council for the Social Studies, 1994), social studies education for the most part continues to focus on traditional, teacher-directed, lecture-and-textbook-based approaches and activities (Berson, 1996; Diem, 2000; White, 1999). As a result, the research base on the effectiveness of technology as an instructional component for teaching social studies remains quite limited (Cantu, 2000; Diem, 2000).

Nonetheless, there are data indicating that when integrated effectively, multimedia technology can support history and social studies learning by promoting student-centered instruction, increasing learner motivation, and extending and deepening understandings of historic and civic concepts (Beisser, 1999; Fabos & Young, 1999; Ferretti, MacArthur, & Okolo, 2002; Molebash, 2002; Saye & Brush, 1999). For example, Milman and Heinecke (2000) researched the use of technology in an undergraduate history course in which students employed a variety of technologies. The students utilized email, databases, digital cameras, and word processors on Macintosh, Windows, and Unix computer platforms. They also digitized photographs, obtained information and images from CD-ROMs, and used graphic software to modify digitized images and to create images for Web pages that they created in groups of four students each. Through analytic induction (Erickson, 1986), the researchers formulated three assertions regarding the role of technology in this history course.

1. Professors actively seeking to reform instructional practice found a powerful ally in current technologies resulting in meaningful, constructivist student learning experiences.

2. Technology affected the roles of professors and students by shifting the center of attention from the instructor to the students and the technology being utilized, fostering the social construction of knowledge.

3. Technology, in a variety of forms, facilitated the shift from students as passive receivers of authoritative knowledge to students as active constructors of knowledge who conducted historical research (who "do history") p. 553.

As the course instructors, Milman and Heinecke found that the use of technology promoted learning in ways that were "incomparable to [their own] previous experiences teaching traditional lecture courses" (p. 553). The students had engaged in constructivist learning that included searching for primary historical sources, analyzing historical data, and working together to present their findings and interpretations in a cohesive manner on Web sites they created collaboratively. The technology provided a "demanding, open-ended constructivist learning experience in that all students interpreted and presented their subjects, and assembled all of the pieces (e.g., census data, databases, diaries, images, letters, text) into one web site that had a consistent theme" (p. 556). The professors provided more guidance, encouragement, and support than actual instruction as the students constructed their knowledge through interactions with their peers and with technology.

In another study of technology use with preservice social studies and history teachers, Keiper, Harwood, and Larson (2000) found that in general the teachers regarded the use of computers as beneficial to their learning by promoting more dynamic instruction, allowing for hands-on use of information, and preparing them with computer and problem solving skills that they could use in the future. The teachers listed the following benefits from their computer use: (a) data collection, including accessing lesson plans, databases, and content resource pages, (b) improved computer skills, including logic and problem solving, keyboarding, and increased familiarity with content area software and the Internet, (c) dynamic sounds and images including video clips, photographs, maps, graphs, and sound files, (d) instructional variety that allowed them to learn information autonomously, from multiple sources using different strategies and tools, and (e) communication tools, including the use of email, chat rooms, and threaded discussions that allowed them to communicate quickly with one another and with the teachers.

Not surprisingly, the benefits experienced by the preservice teachers in Keiper, Harwood, and Larson's (2000) study were accompanied by several obstacles to effective implementation of technology in the classroom. The problems included (a) a lack of accessibility to computers, such as older hardware and software and slow and/or undependable Internet connections, (b) differing ability levels among students, and between the students and the teacher, (c) an inability to depend on equipment, particularly when hardware or networking connections were not working properly, and (d) a need for more supervision to keep students from accessing inappropriate or harmful Web sites or from becoming distracted. Because there will always be obstacles to computer use in the classroom, it is important for teachers to view these difficulties as surmountable problems, far outweighed by the benefits to student learning. Keiper et al.

suggest that if computer use is viewed by teachers as simply an additional duty with limited benefits for students, they will be far less likely to perceive technology use as viable than if they view it as integral to the curriculum, where learning is enhanced and expanded because of the technology. It is unfortunate that policy makers and school administrators too often require technology use by teachers in order to justify expenditures for it, resulting in additive, superficial uses of classroom computers by both teachers and students (Cantu, 2000; Cuban, 2000).

In another study, Brooks (2001) created an undergraduate pre-service Web-enhanced history course requiring email and Web usage by his students. He found that the course (a) increased student access to course materials and student interaction with the course, (b) made resources available that were unavailable in traditional classroom environments, and (c) improved students' computer skills in ways that intensified their educational experience and enhanced their career prospects. Brooks formulated the following guidelines for Internet usage in technology-enhanced courses:

1. Internet usage should be a requirement, rather than an option for the course.
2. Internet enhancements should add something that the class would otherwise not have available: in this case, the Internet History Sourcebooks, the Avalon Project, and the Chateau de Versailles Web sites.
3. Internet projects need to be designed so as not to disadvantage students who do not own computers or have access to them at home.

Brooks was careful to gather and continuously monitor information about student backgrounds, their ability to access computers and the Internet, their past experiences with technology and the World Wide Web (WWW), and their use of the Internet throughout the course. In particular, Brooks carefully avoided enhancing the course in ways that might disproportionately alienate or disadvantage those students with limited access to computers and the Internet. The benefits realized by the students in this course were attributed to several considerations, including mandatory Internet usage, assignments that were appropriately tailored to students' skills and access, early verification or improvement of students' technology skills, and close monitoring of Internet usage and student satisfaction with its use. Among the most commonly available and frequently used programs in the social studies are drill-and-practice computer applications (Berson, 1996; Chan, 1989; Ehman & Glenn, 1991). In their literature review, Ehman and Glenn found modest positive outcomes for several studies that reported using drill-and-practice and tutorial programs for the practice of social studies skills. In a study with ninth grade social studies students, Higgins, Boone, and Lovitt (1996) found that hypermedia study guides resulted in positive gains in student recall, comprehension, and attitudes.

Not all studies of technology's impact on student learning in the social studies produced positive results; some investigations have led to negative or inconclusive findings on the benefits of computer use in this content area. For example, in a study with seventh and eight grade students, Ruef and Layne (1990) found no difference in student achievement in U.S. history classes when students used a computer database simulation versus a traditional book-based instructional method. Moreover, Ruef and Layne found that the computers appeared to complicate the learning process and disrupt students' normal instructional routines, and that many students preferred the traditional print-based materials over computer-assisted instruction. After examining their findings, Ruef and Layne concluded that the cost differential between computer-based and book-based approaches, coupled with the additional prep and training time for teachers and students did not justify the technology integration. This finding is supported by Leutner's (1993) research with 64 seventh graders using a computer simulation program and a pretest-posttest to measure domain knowledge, game knowledge, and functional knowledge. The students were divided into four randomly assigned groups: (a) one group completed the simulation program without modification, (b) the second group completed a tutorial program presenting domain-specific knowledge prior to using the simulation program, (c) a third group used adaptive advice while using the simulation program to help them focus on relevant aspects of a given problem, and (d) a fourth group used the simulation program with both the domain-specific tutorial and the adaptive advice in place. Results of the experiment showed that use of adaptive advice assisted in the development of general verbal domain knowledge, but restricted the acquisition of functional skills to perform the simulation. Leutner repeated the experiment with university students, and after reviewing both studies, concluded that the instructional effectiveness of computer-based simulations is minimal unless the instruction provides learner-requested, fixed background information or system-initiated, variable advice.

Similarly, in a study with eighth grade social studies students, Benenson, Braun, and Klauss (1992) studied computer usage to facilitate decision-making and communication skills. Students were randomly assigned to treatment and control groups; the groups were further divided into small discussion groups. Students in the treatment group were given direct instruction in decision-making skills prior to using a computer simulation program called Decisions, Decisions. Analysis of the conversations of treatment group students indicated that the direct instruction did not benefit the students' decision-making capabilities. The researchers also found that students' self-directed learning and use of higher order thinking skills were higher when computers weren't used for instruction in decision-making and effective communication skills. Clearly, in order for information technology to facilitate, rather than impede learning, it must be carefully planned for and strategically employed.

Guidelines for Technology Use in History and Social Studies Education

Examination of the research on technology-enhanced history and social studies courses reveals some important insights for successful technology infusion, and has led to the development of philosophical and pedagogical guidelines for its use.

CUFA Technology Guidelines

Mason et al. (2000) developed technology integration guidelines for the College and University Faculty Assembly (CUFA) of National Council for the Social Studies (NCSS). The CUFA Technology Guidelines describe how instructional technology should be used in the teaching of social studies methods to preservice teachers, outlining specific principles for the appropriate infusion of technology in teacher preparation programs. The CUFA principles include:

1. Extend learning beyond what could be done without technology.
2. Introduce technology in context.
3. Include opportunities for students to study relationships among science, technology, and society.

4. Foster the development of the skills, knowledge, and participation for good citizenship in a democratic society.
5. Contribute to the research and evaluation of social studies and technology.

In other words, it is imperative that researchers evaluate how technology influences learning and teaching, while developing "exemplary models for the infusion of technology within social studies methods of instruction" (Mason et al., 2000, p. 114).

Technology Use With English Language Learners

Positive effects have been found in the areas of reading and writing not only for mainstream students, but also for English Language Learners (ELLs). Kroll (1990) found that using technology to support the writing process was an effective approach for second language learners, a finding supported by Peregoy & Boyle (2001), who found that technology supported not only writing for students with limited English proficiency (LEP), but also helped to promote other aspects of second language acquisition. Butler-Pascoe (1994) examined university-level technology-enhanced writing classes and found significant improvement in writing skills as well as greater control over targeted grammatical forms. Butler-Pascoe and Wiburg (2003) identified several other advantages of computer-based writing for students with LEP:

1. Students' estimates of their own writing ability improved significantly.
2. Word processors allowed students to easily revise and edit their compositions, helping to avoid time-consuming recopying and increasing student enjoyment of the writing process.

3. Students demonstrated pride in producing a legible, professional looking paper and in developing word processing skills which they viewed as very valuable.
4. Student enthusiasm for writing with word processors resulted in their spending additional time on revisions outside of class hours.
5. Instructors could view students' writing on the computer monitors without interrupting them as they composed.
6. More class time and teacher attention could be devoted to writing tasks because students were developing their computer skills in the computer lab, outside of class.
7. There was an increase in student interaction and oral communication as students collaborated on word processing and on-line database projects.
8. Writing pen pals via a telecommunication network provided students an authentic audience and acted as a motivating force for revising and editing

(p. 150).

Cohen and Reil (1986) had similar findings, reporting that computer networks provided authentic audiences for student writing as well as increased motivation. Berens (1986), and Piper (1987) found that technology-enhanced writing processes lead to a reduction in anxiety, while Phinney (1989) and Engberg (1986) found that students with LEP showed improvements in pride of authorship and motivation. Research by Padrón & Waxman (1996), and Lee (2000) supports findings that technology use can help build the confidence of learners with LEP. Burgess and Trinidad (1997) found that in addition to confidence building and increased autonomy, technology use with learners with LEP increased learner responsibility, promoted a nonsexist environment, encouraged cooperation with peers, and helped in decision-making processes. Moreover, Forcier and Descy (2005) argued that computers are a very valuable tool for teaching reading and listening comprehension for students with LEP because they received engaging feedback and were free to express themselves in ways that reflected their cultural and/or linguistic backgrounds. Murray and Kouritzin, (1997) found that competent computer use helped to prevent academic and social marginalization of students with LEP by giving them more control over their time, speed of learning, and topic choice. When selected and deployed thoughtfully, educational technology can contribute to a rich learning environment that can extend language skills and provide prompt feedback and tailored instruction for language learners. By scaffolding their efforts to work autonomously or to interact with peers, strategic technology implementation can foster student self-confidence, boost productivity, and contribute to the overall success of students with LEP in content area classrooms (Hoven, 1992; Svedkauskaite, Reza-Hernandez, & Clifford, 2003).

Technology for Special Education Students in Social Studies Classrooms

Students with mild disabilities who are mainstreamed often struggle to meet the increased curricular demands in content-area classrooms, particularly in social studies courses (Deshler et al., 2001). Many of these students lack the academic skills to read grade-level texts, as well as the study and organizational skills to compensate for low-level reading and comprehension skills (Mastropieri, Scruggs, Spencer, & Fontana, 2003). Moreover, readability studies have consistently shown that social studies textbooks in particular are more difficult for students to read and comprehend than textbooks in many other subject areas, and can vary as much as four or more years in reading difficulty from one passage to another, even within the same text (DuVall, 1971; Hill & Erwin, 1984; Johnson, 1971, 1975, 1977; Sellars, 1988; Stetson & Williams, 2005; Turner, 1968; Wait, 1987). It is not surprising, then, that research reflects failure rates for reading social studies textbooks ranging from a low of 50% (Wait, 1987) up to 92% (Sellars, 1987/1988). Of the approximately 70% of students with disabilities who are able to participate in learning in regular classrooms and resource rooms, around 44% have learning disabilities (Salend, 1997). Mainstreamed special education students bring a repertoire of abilities to class, but there is little doubt that they struggle to read and comprehend social studies textbooks, just as their mainstream peers do.

According to Readence, Bean, and Baldwin (2000), teacher adaptations to regular classroom assignments and textbooks can support comprehension for students with disabilities. However, Vaughn, Schumm, Klingner, and Saumell (1995) found that although middle school and secondary students with learning disabilities overwhelmingly agreed that textbook adaptations such as study guides, graphic organizers, and listening guides would help them better learn content material, these sorts of adaptations were happening very infrequently.

Fortunately, computer-assisted instruction (CAI) has been shown to help students with and without disabilities in recall and comprehension (Ferretti, MacArthur, & Okolo, 2001; Higgins, Boone, & Lovitt, 1996). Multimedia technology has been shown to improve comprehension, spelling, and collaborative practices, as well as boost motivation for students with mild to moderate disabilities (Fitzgerald & Koury, 1996). Gan (1999) found improved motivation, self-confidence, learning attitudes, and achievement in at-risk students who engaged in cooperative learning computer search activities. According to Sharp (2002), students with special needs were motivated to spend more time working on assignments and to achieve at school because they could control the rate at which they learned, and were not afraid to try something new and fail.

Gardner's Theory of Multiple Intelligences

Because the history program examined in the current study purports to weaves "[Gardner's] Multiple Intelligences (MI) Theory into the fabric of [the] courseware" (Ignite! Learning, 2003, p. 8). , a discussion of Howard Gardner's (1983) theory of multiple intelligences is included in this review of the research literature.

The teacher's manual accompanying Ignite!'s Early American History courseware states that the program is "[b]uilt on research-based learning methodologies" (Ignite! Learning, 2004, p. 3); however, no specific research or methods are explicated within the manual itself. However, Ignite! Learning's online publication *Teaching Students In The Ways They Learn Best: The Ignite! Method of Instructional Design* (Ignite! Learning, 2003) specifies that the American history program is "informed by educational research on how humans learn" by "integrating a constructivist approach to some of the activities" by providing "the tools needed to make learning meaningful, enjoyable, and successful for all students" (p. 3). The article cites a study by Jackson and Davis (2000) funded by the Carnegie Corporation as the basis for the standards underlying Ignite!'s learning environment "that enables teachers to teach more effectively and empowers students to capitalize on their natural gift for learning" (p. 5). The Ignite! document explains: "Howard Gardner's Multiple Intelligences (MI) Theory has heavily influenced the way we present educational content, guiding our creation of stories, poems, songs, diagrams, animations, interactive simulations, and other instructional media" (p. 6), citing Gardner's (1991) *The Unschooled Mind* and his proposed seven different intelligences.

According to Gardner (1983, 1991), all people posses separate and distinct types of intelligence that include (a) linguistic, or the ability to create and manipulate sounds and words, (b) logical/mathematical, or rational skill in identifying patterns, cause-and-effect relationships, and other logical sequences, (c) visual/spatial, or the ability to perceive and create accurate mental images of objects in two and three dimensions, (d) musical, or the ability to produce and recognize melody and rhythm, (e) bodily/kinesthetic, or physical coordination, dexterity, and tactile sensitivities, (f) interpersonal, or the ability to perceive and interpret other people's moods, emotions, and desires, and (g) intrapersonal, or the ability to access one's own emotions and feelings. Gardner later added an eighth intelligence, naturalist, which described people who are highly sensitive to the natural world of animals, plants, and natural geography and objects such as rocks, weather, and celestial objects. Several pages of Ignite!'s online publication are devoted to the implications of Gardner's MI Theory for education as well as for their history program. According to Ignite! MI theory both "reveals education's shortcomings and offers a clear direction for improvement" (p. 8), based on Gardner's (1991) assertion that "an education built on multiple intelligences can … make the standard curriculum accessible to a wider range of students" (p. 81). The Ignite! publication also provides a table illustrating how its software addresses each of the multiple intelligences in the history program.

As the focus of hundreds of books, workshops and conferences, journal articles, and lesson plans for public schools, Gardner's (1983) theory of multiple intelligences (MI) has inspired educators throughout the world (Armstrong, 1994; Kornhaber, Fierros, & Veenema, 2004; Silver, Strong, & Perini, 2000). In their book highlighting elementary schools that used the MI framework to construct their curricula, Kornhaber, Fierros, & Veenema (2004) asserted that MI theory has become contemporary education's most popular idea (p. xiv). Kornhaber et al. described a survey they conducted of 41 educators in 18 different states and one Canadian province where nearly four-fifths of the MI-using schools reported improvements in standardized test scores, with nearly half of the educators at those schools associating the improvements directly with MI. Interviews with teachers at the schools revealed that the educators believed MI contributed to improvements in test scores, student discipline, parent participation, and in helping students with learning disabilities. All but seven were elementary schools, and all but two were public schools. Kornhaber et al. found that MI provided students with meaningful choices for learning and for demonstrating knowledge, which fostered engagement for all students, including those identified as having learning disabilities.

Campbell, Campbell, and Dickinson (1996) provided a framework for using Gardner's different intelligences in the classroom, as well as assessments and specific lessons teachers have learned from MI-based teaching. The authors described several different MI programs implemented in various schools as well as how to transfer Gardner's work from theory into practice. Armstrong (1994), Campbell and Campbell (1999), and Hoerr (2000) have each written books describing MI theory with examples of how it can be applied to curriculum development, classroom management, assessment, special education, teacher education, and educational reform. The lessons and activities stem from the MI assertion that all children have strengths, all children can learn, and that different intelligences should be valued equally.

Proponents of MI-based learning stress that there is no one correct way to implement it: an attractive feature of the model, but also one of its liabilities. Since its inception, scholars in the field of cognitive science have questioned MI's status as a scientific theory, as well as the core claims upon which MI theory rests (Chen, 2004; Gottfredson, 2004; Mathews, 2004; Willingham, 2004). When Gardner presented his theory, he did not present new research designed to test it, although there was an expectation that over time, specific tests "experimental or otherwise, would be conducted of the theory, and when such tests were well under way, it would then be possible for both theorist and critics to become more concrete" (Sternberg, 1994; p. 561). According to Hickey (2004), MI theory is promising as a template for long-term instructional strategies, although she emphasizes that there are few specific examples in the literature describing MI-based instructional units, and even fewer depicting MI-based units for middle grade learners.

Other critics view MI theory with considerably more skepticism, denouncing it as an incorrect theory of the mind (Willingham, 2004) that oversimplifies the criteria for intelligence. Willingham takes issue with, among other things, Gardner's claim that the eight intelligences are independent, self-sufficient, modular abilities. Willingham cites psychometric evidence that intelligences such as mathematical and spatial are not separate, but instead are overlapping processes. He also discredits Gardner's criteria for defining an intelligence, pointing out that although the criteria appear to be quite rigorous, they are weakened by Gardner's claim that only a majority of the criteria be satisfied, and that some are rather easy to satisfy. According to Willingham, the psychometric criterion, the most rigorous of the criteria, is largely ignored by Gardner himself, while the remaining criteria are "so weak that they cannot restrain a researcher with a zest for discovering new intelligences" (What are intelligences section, ¶ 6).

Like Hickey (2004), Willingham (2004) notes that few hard data exist to describe exactly what teachers do in the classroom when implementing MI-based lessons. More important, Willingham revealed that in the study of 41 schools conducted by Kornhaber et al. which reported standardized test score increases in 78% of the schools, the researchers did not indicate whether the increase in each of the schools was statistically significant. Additionally, there was no control group in that study to serve as a basis for comparison for other schools in the district not using MI-based curricula. Without a control group or other baseline measure, it is impossible to determine to what extent changes in the MI-using schools were a direct result of MI implementation, rather than, for example, new statewide standards, enthusiasm surrounding the adoption of Gardner's theory, or other unknown factors.

Gottfredson (2004) concured with Willingham's critique of the stability and validity of performance claims associated with MI-using schools. Like Willingham, Gottfredson and others (Carroll, 1993) doubted whether the abilities described as intelligences by Gardner were indeed independent faculties, and whether they might instead be simply special talents, some of which fall outside the cognitive realm. For example, Gottfredson suggested that Gardner's interpersonal and intrapersonal intelligences may be matters of personality, while the bodily/kinesthetic intelligence is largely a reflection of psychomotor strengths such as eye-hand coordination. According to Gottfredson, "[n]one of the assessments that schools currently use to identify students' multiple intelligences would satisfy the standards for testing jointly promulgated by the three major professional organizations in the field" (p. 40-41). Gottfredson refers to Kornhaber's own publication (2004), where Kornhaber describes evaluating three major methods for identifying gifted students in terms of multiple intelligences, but then admits that they are not "technically strong enough to withstand modest scrutiny" (as cited in Gottfredson, p. 41). For example, some methods use checklists that seem to assess interests rather than abilities, and "none have clear enough procedures for raters to agree on who is gifted or in what way" (Gottfredson, 2004, p. 41).

A final criticism of Gardner's MI theory is that it is not a theory at all, nor does it relate to intelligence; rather, it is simply a conglomeration of commonly accepted constructivist pedagogical principles and concepts – that teachers should recognize and appreciate students' different strengths and weaknesses, use various modes and materials to present information such as songs or stories, and that all students are capable of learning (Gottfredson, 2004; Willingham, 2004). Gottfredson decries that these ideas are described "as if they were the hallmarks of the multiple intelligence approach alone" (p. 41). Moreover, she believes MI theory's proponents "link harmful, distasteful, and patently false beliefs with IQ – for example, that IQ is immutable, environments do not affect learning, some children cannot learn, and IQ is a measure of human worth" (p. 41), and that "multiple intelligence theories may do little more than squander scarce learning time and significant opportunities for improvements in the quality of American schooling (p. 45). On the other hand, Chen (2004) defends Gardner by asserting that theories in the social sciences are "rarely proved or disproved decisively, regardless of the methodology used to test the theoretical construct" (p. 22), and that the value of a theory depends instead upon its contribution to understanding and praxis. Chen believes that the value of MI theory has indeed been clearly established in the field of education.

After consideration of all of the arguments for and against Gardner's theory of multiple intelligences, perhaps it can be said that MI theory might have positive implications for promoting a balanced, constructivist approach to classroom instruction (Hickey, 2004) outside of a conclusive demonstration of its validity as a theory or its effects upon student learning.

Conclusion

As information technology establishes its place in the practice of teaching, educators need to ensure that they and their students have the knowledge of and comfort levels with classroom computers needed to create and utilize multimedia, and to effectively harness the potential of the World Wide Web for both teaching and learning. This will require faculty and students to continuously update their computer skills, and educational institutions to continuously update their staff development to reflect the rapid changes in hardware, software, and communications technologies. Teacher training in technology and Internet use, with follow-up computer support, must become well-established practices in schools -- the norm, rather than the exception. This training should include not only hands-on experience with creating and utilizing multimedia, but also in operational issues related to computers such as copyright protections, acceptable use policies, online safety and etiquette, learning theory, media literacy, and the design and evaluation of computer-based learning materials.

Clearly, thoughtful and strategic integration of digital technology into classroom teaching and learning can provide engaging, motivating possibilities for teachers and their students. The following chapter will outline the research design of the current study to evaluate the effectiveness of a computer-based instructional program to support social studies learning for seventh-grade middle school students.

CHAPTER 3

METHODOLOGY

This study addressed four different, yet related questions. The first research question measured the overall effectiveness of social studies learning using student pretest and posttest scores on a multiple-choice, criterion-referenced assessment instrument as a result of student utilization of the Ignite! early American history program. The second question examined student progress for each item on the pretest-posttest instrument to identify statistically significant improvements in student scores for particular concepts, regardless of whether the overall scores between treatment and control groups are found to be significant. The third research focus compared the achievement scores of students identified by their teachers as having limited English proficiency (LEP) who used the program with the scores of students with LEP who did not use the Ignite! program. The final question examined the achievement scores of students identified by their teachers as having special needs who used the program with the scores of students with special needs who did not use the Ignite! program. The overarching question for the current study, then, was whether use of the Ignite! history program raised student achievement scores, and to determine whether there were notable score increases experienced by general education students, those with limited English proficiency, or students with special needs.

The specific research questions that guided this study follow.

1. Is there a significant difference between pretest and posttest achievement scores for students who use the Ignite! Early American History program as compared to students who do not use the program?
2. Are there specific concepts represented on the pretest-posttest instrument for which students make significantly more progress than students who did not use the Ignite! program?
3. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program and LEP students who did not use the program?
4. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having learning disabilities (LD) who used the Ignite! program and LD students who did not use the program?

The Ignite! Early American History Software

According to the publisher's promotional materials, the Ignite! early American history program is an online middle school curriculum designed to help students learn the content and skills specified by state and national academic standards in a student-centered, multimedia-rich manner appealing to a wide variety of learning styles and interests (Ignite! Learning, 2003). The Ignite! software is a type of computer-aided instruction (CAI) that blends networked multimedia technologies for content delivery with tools to aid teachers in tracking student progress and designing individualized instruction based on the program's assessments. The program itself is Web browser-based, but is self-contained in that it prevents access to the Internet and World Wide Web while the program is running. The software contains fifteen goal-oriented units that use multiple modalities to meet the learning objectives of each unit. These instructional modalities include songs, animation, short video clips, text, matching problems, stories, maps, illustrations, documents, timelines, and interactive games to teach students.

According to Paterson, Henry, O'Quin, Ceprano, and Blue (2003) and others (Becker, 1992a, 1992b; Leu, 2002; Maddux & Willis, 1992; Sherry, 1990; Smaldino, Russell, Heinich, & Molenda, 2005), integrated learning systems (ILSs) are networked programs that provide individual instruction on skills important to different subject areas delivered by computer-based instruction. They contain management software to track student progress, record student scores on assessments, generate a variety of reports, and assist teachers in providing individualized instruction to learners. Additionally, ILS lessons are integrated, meaning that each lesson is connected with the next, and each lesson corresponds with a set of learning objectives. The quizzes, tests, and other assessments match the lessons and objectives. The Ignite! history program performs all of these functions and contains all of these features, and is considered for the purposes of this study, to be a small-scale ILS. However, most ILS programs provide detailed, comprehensive instruction spanning several grade levels, and are tied to the standard curricula in major subject areas such as mathematics, reading, or language arts. In contrast, the Ignite! history program is unlike typical ILS software in that the subject area and topical coverage of the program are quite narrow, covering only the period of early

American history from 1492 through 1877 (Reconstruction). At present, it is unknown whether there are learning implications related to the smaller scale of the Ignite! ILS compared to typical larger-scale ILS programs.

Research Design

The decision of which research method(s) to use, what questions to be asked, how the research is to be carried out, and how the results are to be interpreted depend on what the researcher seeks to find out (National Research Council, 2002; Silverman, 2001). A review of the appropriateness of various paradigms and achievement measures for evaluation research led to the decision to utilize a quantitative methodology to measure effectiveness of the Ignite! history program for the current study. The use of quantitative methods is supported by previous studies of how educational technology is used (Becker, Ravitz, & Wong, 1999) and the conditions under which instructional technology has been shown to increase student achievement (Mann, Shakeshaft, Becker, & Kottcamp, 1999; Chang et al., 1998; North Central Regional Educational Laboratory, 2004; Wenglinsky, 1998). Classical education research models view the evaluation of programs as similar to that of a standard scientific experiment, wherein a hypothesis is tested (Bennett, 2003; National Research Council, 2002; Stake, 1986). Because this study sought to determine the effect of software use on student outcome scores, this investigation tested a causal hypothesis: that use of the Ignite! software would significantly raise student achievement scores on a criterion-referenced, standards-based test. With a total sample size of 184 students, analyses of data from student test scores utilized descriptive and inferential statistical procedures to interpret the outcome-oriented test results. Pretest and posttest scores for students in control and experimental groups were compared using a two-tailed *t* test with unequal variance. A two-tailed *t* test with unequal variance was implemented because two groups with unequal variances were being compared to one another, but it was unclear at the time of comparison which direction test score means would shift, and because a two-tailed *t* test is more sensitive to changes than a one-tailed *t* test.

For the question investigating student progress on individual items and/or concepts on the assessment instrument, cumulative scores from students in the treatment and control groups were obtained for each question, then examined to see if there were specific topics or concepts for which students made statistically significant improvements. Where results indicated that there were areas in which students that used the Ignite! program outperformed or underperformed those who did not use the program, the researcher scrutinized both the assessment instrument and the media in the Ignite! program for patterns that might explain the increased outcome scores for specific items or concepts on the assessment instrument. For the third question in this research study, the pretest-posttest scores for students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program were compared to the scores of students with LEP who did not use the program. The final research question examined pretest-posttest scores for students identified by their teachers as having special needs who used the Ignite! program as compared to the scores of students with special needs who did not use the program.

This study was designed and conducted in consonance with principles for school reform as specified by the No Child Left Behind Act (NCLB) of 2001 for scientifically based research (NCLB, 2002). The question of which studies are included under the umbrella of scientifically based research (SBR) as defined by NCLB has far-reaching implications for educators, researchers, and policymakers. One of the more significant NCLB mandates is the requirement that all school reform programs adopted to assist in meeting standards outlined by NCLB be supported by evidence-based research that conforms to the standards set forth for SBR (NCLB, 2002). After a review of the professional literature on NCLB's criteria for SBR (Dawson, 2004; Margolin & Buchler, 2004; NCLB, 2002; Poggi, 2003), this study adopted definitions regarding SBR found in Dawson's (2004) *A Foundation for Understanding and Evaluating Scientifically Based Research.* According to Dawson, NCLB outlines six key components of scientifically based research, which include:

1. Empirical methods are used to carry out the research, which is conducted in a systematic and consistent manner, with keen attention to detail.
2. Data collection and analysis are rigorously conducted to ensure that the data are collected, analyzed, and interpreted correctly.
3. Measurements or observational methods that provide scientifically valid and reliable measurements across many different measurement points and observations are used.
4. The studies employ experimental or quasi-experimental methodology to optimize the researchers' ability to answer the questions under investigation.
5. Enough data and description should be provided so that future researchers can attempt to replicate the findings by conducting a study using the same methods and instruments.

6. An independent, objective, and rigorous external review of the research has taken place (p. 5).

The present study meets all criteria for methodology, data collection, analysis, description, and peer review for SBR as specified by NCLB.

According to the National Research Council (2002), a federal government science and technology advisory council, research designs attempting to show causal effects must establish a cause-and-effect relationship. In order to establish whether a treatment causes a particular result, randomized field trials are normally used (Campbell & Stanley, 1963; Caporaso & Roos, 1973; Gay & Airasian, 2000). However, practical considerations precluded random sampling of teachers and students within the participating public schools. The study's evaluation design instead used what Campbell and Stanley call "The Nonequivalent Control Group Design", where a pretest and posttest are administered to experimental and control groups without pre-treatment sampling equivalence. This design is widely used by education researchers implementing quasi-experimental designs (Jones et al., 2004-2005). Experimental and control samples are composed of naturally assembled collectives or cohorts, such as such as existing classrooms within a school (National Research Council, 2002). For the current study, each teacher chose one intact class as a control group, and another, similar class as a treatment group. Quasi-experiments attempt to "approximate the underlying logic of the experiment without random assignment" (Gay & Airasian, 2000; National Research Council, 2002, p. 112). According to the National Research Council (2002):

> In some settings, well-controlled quasi-experiments may have greater "external validity" – generalizability to other people, times, and settings – than experiments

> with completely random assignment (Cronbach et al., 1980; Weiss, 1998). It may be useful to take advantage of the experience and investment of a school with a particular program and … design a quasi-experiment that compares the school that has good implementation of [a] program to a similar school without the program … In such cases, there is less risk of poor implementation, more investment of the implementers in the program, and potentially greater impact. The findings may be more generalizable than in a randomized experiment because the latter may be externally mandated (i.e., by the researcher) and thus may not be feasible to implement in the real-life practice of education settings. The results may also have stronger external validity because … [r]andom assignment within a school at the level of the classroom or child often carries the risk of dilution or blending of the programs (p. 114).

It is important to note that researchers cannot claim a causal effect without accounting for influential contextual factors within the inquiry process, and in deciding the extent to which the findings of the study can be generalized (National Research Council, 2002). Descriptions of the setting, participants, and activity to be measured can be critical to interpreting scientific and quasi-scientifically-based research results. Therefore, some qualitative data was gathered throughout the course of the study in order to acknowledge, or rule out alternative explanations for the results, and to document possible influences from contextual factors upon the quantitative outcomes.

Complementary Qualitative Data

Although the fundamental research questions in the present study were answered using a quasi-experimental design, the researcher also utilized in-depth qualitative methods to obtain data that might illuminate important nuances, help to identify possible counter hypotheses affecting the results, and to provide additional evidence for supporting any claims for the generalizability of the results. This approach is supported by the National Research Council (2002), who add that "because the U.S. educational system is so heterogeneous and the nature of teaching and learning so complex, attention to context is especially critical for understanding the extent to which theories and findings may be generalizable to other times, places, and populations" (p. 5). The qualitative data was obtained through informal and semi-structured interviews with participating teachers and students, and through focused on-site classroom and computer laboratory observations throughout the 7-month treatment period. Technology researchers have often recommended qualitative methods to enhance data collected from quantitative measures (e.g., Estep, McInerny, Vockell, & Kosmoski, 1999; Miller & Olson, 1994; Venezky, 1983). Research also supports the view that qualitative methods can provide information for further quantitative inquiry (Paterson et al., 2003; Tashakkori & Teddlie, 1998). The National Research Council (2002) contends that research designs can often be "strengthened considerably by using multiple methods – integrating the use of both quantitative estimates of population characteristics and qualitative studies of localized context" (p. 108).

Classroom and computer laboratory observations were conducted an average of once per week for each participating teacher over a seven-month period. During these on-site visits, conversations with the teachers and the students in the computer lab were common, with questions to students usually aimed at what they were learning about, which media pieces of the Ignite! program they were using and why. Field notes from these observations and conversations were transcribed within 24 hours. Additionally, there were occasional visits with the teachers during their prep period in order to have time for more lengthy discussions of how they were using the Ignite! history program, what they kinds of activities they did with the control group students who were not using the program, what was working with regard to the history software, and any problems and observations the teachers had when using the software with their students. Participating teachers also completed a brief general survey about their teaching education, experience, and background that established their levels of formal education, age, gender, and years of teaching prior to commencement of the study.

After several weeks of classroom observations and informal interviews with the participating teachers, more focused observations (Spradley, 1980) were begun to confirm or disconfirm patterns in student and teacher behavior and activities in the classrooms and computer lab settings. Inquiries about these focused observations were made to the teachers, and on occasion, also to students. Many students readily expressed their thoughts on the history software, and most were not shy about expressing both positive and negative opinions about the program. However, the researcher talking with the students and asking them questions while they used the history program appeared to make one of the participating teachers quite nervous: she constantly asked what questions were being asked of the students and what their responses were. When it became apparent that this teacher was not comfortable with the idea of direct conversations between the researcher and the students using the Ignite! program, the decision was made in this case to talk primarily with the teacher, and less with her students in order to maintain a comfortable working relationship with her. The participating teachers were eager to discuss the Ignite! program, how they used it with their students, and to share the difficulties involved in attempting to incorporate its use into their existing curriculum.

Participants

Subjects were seventh-grade students enrolled in public middle schools in a large urban school district in the southwestern United States. Students in eight separate sections of seventh-grade history, taught by four different teachers in three different middle schools participated in this study. Prior to using the Ignite! history program, each participating teacher designated one of her classes to be a treatment group, and another, similar class as a control group of students. In all cases, the treatment and control classes were inclusive, general education seventh-grade history courses. The experimental group of students received treatment (i.e., use of the Ignite! program) in addition to textbook and lecture-based instruction for all units of early American history study. The control group received textbook and lecture instruction only, but did not use the Ignite! program. During both instructional conditions, the same teacher administered textbook and lecture based instruction in presenting the same information to both groups of students. The overall sample size was 184 pretests and posttests, obtained from an experimental group comprised of 93 students, and a control group comprised of 91 students.

Participant training

At the start of the school year, all participating teachers attended mandatory introductory training that provided an overview of the Ignite! history program and familiarized the teachers with available content and media options. The one-day training session, facilitated by a representative from Ignite! Learning showed teachers how to construct assignments, select assessments, create new sections for each class using the program, create student logins and passwords, and how to locate and use the multimedia options. There was also discussion and demonstration of the various assessment and administrative options, followed by guided hands-on time for the teachers to gain general familiarity with the program and its content. Throughout the period of program implementation, follow-up support via telephone and email were available from Ignite! Learning for all participating teachers. In several instances, the company also sent a personal representative to help the teachers in initially setting up course sections and assignments, and to assist the schools' computer support specialists in properly configuring the server and client computers to run the Ignite! program. On at least three occasions, the company sent a technician to the school to assist in resolving problems with the software and server computers after the teachers had been using the program for several weeks.

At the start of the school year, the teachers conducted an orientation session to show students in the experimental groups how to log in to the program and how to set their passwords, and to demonstrate the program's content options and navigational aids. At that time, the students were given teacher-facilitated hands-on time to familiarize themselves with login procedures and with program's interface, functionality, and media choices prior to commencement of actual instruction. Additionally, each student in the experimental and control groups received an overview of the history textbook to be used in the course, an outline of the seventh grade history curriculum, and a syllabus for the entire history course.

Setting

The setting for this investigation was a large, culturally and linguistically diverse urban school district in the southwestern United States. Covering over 7,910 square miles and with more than 260,000 students, the district contained five distinct operating units, each with its own administrative staff. Of the 46 middle schools in the district, three participated in the current investigation. The population of public school students is increasing very rapidly in this district, the fifth largest in the United States. Nearly 20% of students attending school in the district have limited English proficiency, with over 35% qualifying for free or reduced lunch.

The diverse student population varied within and between regions within the school district. For example, some schools in the district had affluent and/or middle class, more homogenous student populations, while other schools had higher populations of low socioeconomic students and English Language Learners (ELLs), and more students with limited English proficiency (LEP). With these variations in mind, participant samples were drawn from middle schools distributed throughout the district. Every effort was made to select equivalent teachers and students for the treatment and control groups who were also representative of the district's typical student population.

Eligibility for School Participation

In selecting the sites for the present study, participation was limited to schools with adequate infrastructures, computer facilities and interested teachers. This decision was made after reviewing findings from a pilot study (Kingsley, 2003) to determine potential difficulties and problems associated with implementing the program in the middle schools on a larger scale. Results from the pilot study indicated that schools lacking high-speed, high-capacity server and networking capabilities were frequently plagued with server and work station crashes, software freezes and crashes, very slow response time, and/or inability for students to run all of the media segments contained in the program. Since random selection of participating schools was not feasible, the decision was made to follow Stake's (1994) rule of thumb that in some cases, the opportunity to learn from a site should take priority over a concern for its typicality or representativeness of an entire population.

A powerful, high-speed network server, ample computer lab time, and an adequate number of available stand-alone computers were the basic physical requirements for school participation in the study. Specific hardware criteria for school participation follow.

1. School District to District ISP Multiple Mbps (based on number of users).
2. District to School 1.54 Mbps
3. School to Classroom/Lab Switched 100 MB/sec full duplex
4. Bandwidth Load per student to Internet 12 Kbps
5. Bandwidth Load on LAN per student 357 Kbps = 345 Kbps + 12 Kbps

6. Total Bandwidth on LAN per 30 students 11 Mbps = (345 Kbps streaming video x 30 students)+(360 Kbps)

Individual workstation requirements follow.

1. PC PII 450 MHz or Mac G3
2. RAM 64MB (128MB recommended)
3. Headphones/Speakers 1 set per user, or set of speakers
4. Sound Card 16-Bit
5. Video Card 16-Bit
6. Monitor Colors 16-Bit
7. Monitor Resolution/Display Settings 1024x768
8. Network Card 10 MB/sec full duplex

Also needed were sufficient numbers of computers to accommodate the students in each of the experimental groups. Interviews with teachers utilizing the program during the previous year's viability pilot study (Kingsley, 2003) indicated that middle school history class sizes were comprised of between 30 and 40 students, necessitating the need for at least 30 computers in the labs. All participating schools had computer facilities with the required hardware and equipment and had sufficient numbers of computers to run the Ignite! program.

Most of the participating schools and teachers had used, or at least tried out the Ignite! program during the previous school year during the exploratory pilot study (Kingsley, 2003) where potential problems related to integrating the Ignite! program in the middle schools on a larger scale were identified and evaluated. The majority of technical difficulties encountered by teachers during the preliminary pilot study were related to school server computers that lacked the speed and computing power to run the Ignite! program with ease in a networked laboratory environment. The resulting computer crashes and lock-ups necessitated teachers at these schools having to create back-up, alternative lesson plans on days they planned to use the Ignite! software, in the (likely) event of a hardware malfunction. After observing and talking with all of the teachers in the pilot study, it was clear that only teachers in schools equipped with high-speed, sophisticated network server computers equipped to handle high levels of multimedia, including audio and video would be able to participate in the larger-scale investigation that is this research study.

Data Collection

Procedure

A standard quasi-experimental design was used to investigate the relationship between student achievement scores and use of the Ignite! history program. In quasi-experiments, the researcher attempts to manipulate conditions before an effect is measured, and then makes inferences based on those measurements. These inferences may be less compelling than those from a completely randomized treatment, as quasi-experimental control groups may differ from the treatment condition in ways other than the treatment effect (Shadish, Cook & Campbell, 2002). Therefore, a compelling need existed to address factors that might lead to erroneous causal and generalizable conclusions. These factors are identified and addressed later in this chapter.

One major problem in conducting quasi-experimental research within public school settings is that it is not possible to conduct a rigorous, double-blind study in which neither the student participants nor the teachers know whether a treatment or placebo condition is being used. The current study attempted to implement experimental conditions to the greatest extent possible within public school environments (Gay & Airasian, 2000). It is hoped that by controlling for as many extraneous variables as possible, the study has produced results that might be, to a limited degree, generalizable to some groups and environments outside of the experimental setting.

Teachers used the textbook and lecture while teaching students in both treatment and control conditions. However, with the treatment group students, teachers reserved a minimum of 20% of the instructional time, or approximately one day per week, for use of the Ignite! history software program. Regular textbook instruction consisted of using either *The American Journey* (Appleby, Brinkley, & McPherson , 2003), or *The American Nation* (Davidson, Castillo, & Stoff, 2002). Both district-approved books are similar in content, scope, and sequence of information. The textbooks include graphic organizers and other visual aids such as timelines, photographs and illustrations, and political maps, as well as highlighted vocabulary words, chapter outlines, and chapter summaries. Participating teachers supplemented book-based instruction with online and offline auxiliary activities provided by the textbook publishers, as well as with their own materials, worksheets, and selected Web sites. No other instructional software programs were used for history instruction during the study. As specified by district policy, students had a copy of their history textbook at home, and each classroom had another set for student use at school. Students were unable to access the Ignite! program from home; they could only enter the program through the school server. In both the experimental and control groups, the curriculum requirements were identical, and were based on the state history standards scope and sequence (see Appendix A).

The procedure for both instructional groups from pretest to posttest conditions lasted approximately seven months, from September 2004 through March 2005. Classes consisted of 50-minute block periods encompassing daily review, learning objectives for the day, presentation of new information, and in some cases independent practice. On days that the Ignite! software was used by students in the treatment groups, class sessions generally consisted of allowing students to navigate through the assigned lesson in any order that suited his or her learning needs, provided that they viewed all of the media contained in the assigned module. After viewing the media pieces for the assignment, students completed a Topic Review: a six-item multiple-choice assessment built into each lesson. Scores from the Topic Reviews were not used for the current study; rather, they served as a focal point for students when they were using the program. In each 50-minute class period where the Ignite! software was used, students were usually able to finish one full lesson and its accompanying Topic Review. Upon completion of the early American history portion of the history course, student participants were given the 50-item posttest to measure their knowledge and recall of major concepts related to the period of American history from 1492 to 1877 (i.e., Reconstruction).

Regular site visits to each of the participating teachers' classrooms and school computer laboratories were conducted throughout the seven-month period of early American history during which the Ignite! program was used. Classroom and computer lab observations noted the topic(s) being studied, methods and materials used for instruction, student behaviors and responses to the methods and materials used, and generally ended with a short conversation between the teacher and researcher before and/or after class. Detailed descriptions of the demographics of each school in the study are presented in Table 2 in the Results chapter.

Instrument

To assess whether the Ignite! program raised achievement scores for students who used it, an independent instrument was vital. Because the quizzes and topic reviews contained in the Ignite! program were closely tied to the software, they were not used as a measure of achievement for the current study. Rather, a 50-item, independent, criterion-referenced pretest, was administered to all participating students at the onset of the seventh-grade school year. A similar instrument served as the posttest. An abridged sample of the test instrument is included in Appendix B. Material on the pretest consisted of knowledge required to master the seventh-grade history curriculum as outlined by state standards. The full pretest instrument consisted of 50 multiple-choice questions that correspond directly to the state scope and sequence history standards. An identical posttest was administered at the conclusion of the seven- month instructional period. Scores for students were then compared to determine whether students in the experimental group showed significant increases from their pretest to posttest scores, as compared to students in the control group.

The multiple-choice pretest-posttest instrument included questions drawn from a test bank of 4500 questions accompanying *The American Journey* history textbook, as well as questions created by several history teachers in the participating middle schools. Because multiple-choice tests tend to focus on basic facts, and are rarely good measures of higher level cognitive processing (Becker, 1992b), some multiple-choice questions on the pretest and posttest were adjusted slightly to address problem-solving, decision-making, and/or higher order thinking skills related to the concepts covered in the history knowledge being tested. The pretest-posttest instrument was compiled by three researchers (one Professor and two doctoral students) with experience in designing and conducting education research and evaluation, and who were familiar with this research project. Reliability checks on the instrument were conducted independently by the test designers, and discrepancies were discussed and assessed to obtain 100% agreement. The instrument's concurrent validity with questions from the test bank of questions drawn from the district-approved textbook *The American Journey* was checked, and obtained a high validity coefficient (.87). The instrument was pilot tested with a small sample of doctoral students before the study began. It was then examined and approved by the district technology coordinator who holds a Ph.D. in instructional technology, the district social studies coordinator, and two of the most experienced participating history teachers for construct validity to ensure high correlation with the scope and sequence of American history content as specified in the state curriculum standards.

Mitigating Potential Threats to Validity

Measurement of student achievement and growth is a critical issue in technology research (Cuban, 1993, 2000; Forcier, 1999; Sandholtz, Ringstaff, & Dwyer, 1997). This measurement can be difficult and complicated, however, because educational settings involve many different parties and conditions that may influence the outcomes of research. Research protocols must consider differences in the willingness of teachers, students, and/or parents to adhere to rigorous standards in order to control for extraneous conditions that may impact the results of the study. Since the purpose of school-based research is to inform educational practice and aid in decision-making and policy formation, researchers must adhere to strict principles for rigor by anticipating possible threats to the validity of the results. The current study involving the implementation of a networked instructional program within a public school setting was subject to myriad difficulties and confounding variables. Foreseeable difficulties related to this type of intervention research are addressed below.

Within participating schools, levels of teacher motivation, local philosophies, support from computer educational specialists (ECSs), and the technology orientation of the principal were factors that could potentially create some participation bias. To minimize confounding factors related to participating teachers' educational backgrounds and teaching experiences, instructional and classroom management styles, and technology expertise, the study used the same teachers for both the experimental and control conditions. Students in the experimental and control groups were very similar in number, demographics, and aptitudes, yet not so similar as to forego administration of the pretest. Students for both groups were drawn from the same student population attending the same school, with the same history teacher. This helped to ensure that the samples were homogeneous representatives of the population at each of the schools, mitigating to some degree confounding factors and sampling bias related to students' previous knowledge, aptitudes, gender and demographic status, and previous technology experiences.

To compensate for the potential problem of treatment and control samples that might not be representative of the student population at the schools and within the district, the study utilized a sample of clusters from schools located throughout the district. District administrators helped in the selection of participating schools to ensure comparable socioeconomic levels and other student demographics. District administrators also provided information about participating teachers' backgrounds in education, experience, instructional styles, and levels of comfort with technology. The researcher and the district administrators attended the same training sessions conducted by Ignite! Learning that the teachers attended.

Another plausible threat to validity was the potential for unreliable treatment implementation. A well-defined methodology was described and communicated to all participating teachers. However, teachers were given some degree of freedom to exercise their own discretion as to how the Ignite! program was used in their classes. In circumstances such as these, there is always the possibility that some teachers might deliberately or inadvertently present supplemental information beyond the scope of the actual treatment or control condition, such as providing supplemental instruction or sharing background information with students beyond the standard curriculum. Moreover, some teachers may have decided not to implement certain units or lessons in the program due to time constraints or other factors related to classroom management or computer laboratory conditions. To monitor variations from the standard curricula such as these, teachers in both control and treatment classes were required to specifically document additional or subtractive changes such as those just described. Site visits were made to classrooms and computer labs at each of the schools on several occasions throughout the period of investigation to document classroom activities, instructional methods and materials, and other contextual factors. Ideally, any unreliable treatment potential was dispersed randomly across all treatment conditions.

Combating the effects of participant maturity and history can be a major challenge when providing treatment to a group of participants such as seventh-graders. Historical threats occur when events that are not part of the experimental treatment, but that affect the dependent variable (in this case, the test scores) occur. Maturation, which includes the natural physical, emotional, and intellectual changes that occur in participants over time, can also present a validity problem. Children of this age are prone to many developmental changes (Rice, 1996; Rice & Dolgin, 2002; Slavin, 2000) and must be monitored closely to be sure that treatment effects are the result of treatment implementation and not personal development of skill during a traditionally high growth period. Additionally, the adaptability to technology resources presents validity threats of a maturation nature. Individuals that have little prior experience with computer technology may rapidly progress in the application of their computer skill. The relatively short duration of the study, approximately seven months, served to mitigate maturation validity threats. In addition, judiciously selected statistical controls were used during data analysis to address these confounding factors.

Mortality, which in the present context refers to attrition or the loss of participants that drop out of the research project over the course of the study, may also present a validity threat. The average rate of school district transience for middle school students was 39%. Students often transfer to and from schools within the district; others leave the district permanently. The average student attendance rate in middle schools was 93%. The number of student participants in the study was limited more by the levels of permission required by the school district for research with children than by student transience. The scores of many students who were in either the control or experimental groups were unusable for purposes of research because the students either failed to return the permission form signed by the students and by one parent, or elected to not have their test scores used in this evaluation study.

It was also important to ensure that the participating teachers had full access to computer labs when scheduled (at least once per week), without concerns of preemption from other teachers or administrators for testing or other endeavors. Arrangements were made at each school in conjunction with principals, educational computing specialists (ECSs), and participating teachers to ensure regular access to the computer labs for use of the Ignite! program. In-service training and technical support for participating teachers was provided by each school's (ECS) and by Ignite! Learning. Teachers used this support both during lab time while using the program and also when planning for its use. ECS staff also helped the participating teachers learn basic troubleshooting skills, including how to unfreeze and/or restart computers, reassign login Ids and/or passwords for the Ignite! students, and how to use the LED overhead projection panel in conjunction with the teaching computer to present whole-class demonstrations of Ignite!'s lessons and assignments. Teachers provided information about their levels of comfort with technology at the start of the study, as well as information on any technical support they needed and received throughout the duration of the experiment.

Research has documented the importance of professional development to assist teachers in creating technology-rich classrooms (Becker, Ravitz, & Wong, 1999; Ertmer, Gopalakrishnan, & Ross, 2001). Van Dusen & Worthen (1995) cite Sherry (1990) as suggesting one to two weeks minimum of in-service training for teachers preparing to implement an Integrated Learning System (ILS); however Sherry found that fewer than ten percent of teachers in schools adopting an ILS have even five days of training in its use. As noted earlier, the scope of the Ignite! program is considerably smaller than that of typical ILS programs. Ignite! Learning provided one day of hands-on training for teachers, plus follow-up telephone and email support from the company throughout the implementation period. The one-day training session, designed and delivered by a representative from Ignite! Learning, was presumed by district administrators and this researcher to be sufficient for teachers planning to use the history program. The training session allowed teachers to try out the program, including where to find materials, how to construct individualized lessons for students, and how to access and interpret the student progress reports generated by the program. This last component is particularly important in light of Van Dusen & Worthen's (1995) finding that over 80% of teachers utilizing ILSs did not, at least initially, use the ILS reports. Teachers stated that they found the printouts difficult to obtain and even harder to interpret due to the vast amounts of information in the reports.

In order to realize the achievement and growth benefits expected from the Ignite! program, teachers needed to properly integrate the program into their teaching. According to Van Dusen & Worthen (1995), Paterson et al. (2003), and Smaldino et al. (2005), the most serious problem with ILS software is teachers' inability to integrate it effectively into the curriculum. Ignite! Learning provided all teachers using its program with a comprehensive outline identifying the objectives of each topical unit, descriptions of the materials and media included for each lesson, and supplementary activities and materials to assist in implementation of the program. The teachers also had copies of state history curriculum standards to assist them in selecting relevant modules from the Ignite! software. In anticipation of possible difficulties for teachers in matching the content of the Ignite! program with the state's history curriculum scope and sequence, a comprehensive matrix outlining each of the early American history standards and the corresponding units contained in the history textbook *The American Journey* (Appleby et al., 2003), and the Ignite! program (for an excerpt see Appendix C) was prepared. Detailed information on the materials used and teaching styles of each participating teacher were documented through focused observations and interviews with participating teachers throughout the period of program implementation.

Another concern during this research was a possible lack of time for participating teachers to prepare lessons and familiarize themselves with the program and how it corresponded to the history curriculum. Teachers' workloads made this difficult, but all teachers had a preparation period where they could plan individually, or meet with other history faculty at their school to plan for implementation of the Ignite! program. All participating teachers agreed to plan for and consistently integrate the Ignite! software into their history curricula as seamlessly as possible. It was equally important to ensure that students used the computer program for sufficient amounts of time to assure accurate assessment of its impact. The program is promoted by Ignite! Learning as either a supplement to or a full replacement for the history textbook for middle school learners. Following the recommendations of Ignite! training personnel, participating teachers used the program with treatment group students for at least one full class period per week, the equivalent of 20% of instructional time.

Role of the Researcher

All researchers exert varying amounts of influence and effect on the settings that they visit (Merriam, 1998). The researcher in the current study worked with several of the participating teachers during the previous school year on a pilot study (Kingsley, 2003) to determine the viability of implementing the Ignite! history software in middle schools in the district on a larger scale such as the present study. During this period, the researcher planned and coordinated the pilot study as well as the current study in conjunction with the district social studies coordinator and district technology coordinator.

As much as possible during the study, the researcher remained a passive participant observer in the classrooms and computer laboratory settings. A passive participant is present at the scene of action but does not participate or interact with other people to any great extent (Spradley, 1980). As the study progressed, the researcher asked questions of the teachers and students using the Ignite! program in order to more fully understand the program and its content, limitations, instructional design, and assessment tools. Further, as themes were identified from field observations, the researcher conducted informal interviews with teacher and student participants to record their experiences using the program.

Data Analysis

To answer the research four questions, descriptive and inferential statistics, including mean, standard deviation, and *t* tests were used on the pretest and posttest scores for students in the experimental and control groups. Statistical analyses were completed using the Statistical Product and Service Solutions (SPSS) software to determine the statistical significance of variables related to each of the research questions. According to Valdez (2004) educational researchers, especially those who have conducted meta-analyses agree that when used appropriately, technology can improve education in the effect-size range of between 0.30 and 0.40 (Kulik, 2002; Waxman, Connell, & Gray, 2002). According to Cohen (1977), an expert in the use of effect sizes in the social sciences, effect sizes of around 0.2 are classified as small, around 0.5 are moderate, and around 0.8 are considered large. In order to obtain a power rating of .80 with an effect size of .50 (moderate effect), there needed to be at least 50 students in each of the control and treatment groups, assuming use of a two-tailed test with an alpha of .025 (Gay & Airasian, 2000). With the sample numbers of more than 50, it was possible to measure lesser effects. Two-tailed *t* tests were used, since it was unknown whether effects from using the Ignite! program would be positive or negative. Graphical representations of the data and results are presented in the following chapter.

Measurement of Student Achievement

The instrument used to measure the intervention's effect was a criterion-referenced multiple-choice test designed to evaluate student knowledge of early American history. It is important to describe how knowledge, assessment, and achievement are defined within the context of the current study. In order to do this, one must scrutinize the educational and political contexts in which the researcher, teachers, and students in the current study found themselves.

High Stakes Assessment

The movement toward standardized testing and accountability in the U.S. underscores the growing focus by policy makers and legislators on essentialist teaching approaches "where all participants in the education process … focus on high test scores and minimalist 'essential elements' as the ultimate goal for education" (White, 1999, p. 7). School accreditation, administrator salaries and stipends, and teacher evaluations are often tied directly to how students perform on standardized tests (Bracey, 2004; Evans, 2004, White, 1999). Like policymakers at state and national levels, district administrators where the present study was conducted wished to explore how a substantial investment in an intervention such as Ignite!'s history software might impact student achievement. Facing cuts in education dollars (including technology programs) throughout the state, district administrators requested a rigorous, evidence-based study through the local university to gain insight into how, and how well, Ignite!'s history software worked, and to obtain recommendations about whether or not to invest in the program on a district-wide scale. Achievement outcomes are often measured by assessments that place a high value on standardized assessments, which usually contain questions that can be responded to in right or wrong answers (Sacks, 1999). Conversations with the participating teachers, examination of the history textbooks and syllabi for the seventh-grade history courses, and perusal of the Ignite! history program indicated that historical knowledge, as measured by standardized test instruments, refered in this case to how well students could acquire, arrange, sequence, and accurately recall traditional historical facts, and students' ability to understand and appreciate causes and effects of the course of events in the founding and building of the American republic, as well as the development of its political framework.

The district-approved textbooks and the materials contained in them were the main sources of historical information provided for students, supplemented by other teacher-selected books, publications and materials, and/or Internet resources. Although in some instances the history textbooks included activities encouraging students to consider historical events from differing perspectives, examination of the state history standards and assessments used by the history teachers suggests that for the most part, the expectation for history learning for the school district's seventh-grade students was predominantly based upon the learning (memorization) of content facts transferred from teachers, textbooks, and other media, as opposed to knowledge constructed or interpreted, individually or collaboratively, by the students. Historical knowledge in the current context, then, was measured primarily by standardized tests designed, administered, scored, and interpreted based on a single, correct answer to each test question. For this reason, a multiple-choice assessment instrument similar to those already in place in district middle schools and provided by the textbook publishers was used to measure student achievement for purposes of the present study.

CHAPTER 4

RESULTS

This study examined the effectiveness of social studies learning as a result of student utilization of the Ignite! early American history software program to augment textbook and lecture materials for seventh grade middle school history students.

Four research questions guided the study:

1. Is there a significant difference between pretest and posttest achievement scores for students who used the Ignite! early American history program as compared to students who did not use the program?
2. Are there specific concepts represented on the pretest-posttest instrument for which students scored significantly higher than students who did not use the Ignite! program?
3. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program and LEP students who did not use the program?
4. Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having learning disabilities (LD) who used the Ignite! program and students with LD who did not use the program?

All of the participants in this study were in mainstreamed seventh grade history classes in middle schools throughout a large urban school district. The period of investigation spanned the fall and spring semesters of the 2004-2005 academic school year.

Descriptions of the student and teacher participants, along with results for the current study are presented in four parts. Each part presents the results of the pretest and posttest scores for treatment and control groups related to the four research questions.

Part I presents data related to the first research question: Is there a significant difference between pretest and posttest achievement scores for students who used the Ignite! early American history program as compared to students who did not use the program?

Part II presents data related to the second research question: Are there specific concepts represented on the pretest-posttest instrument for which students scored significantly higher than students who did not use the Ignite! program?

Part III presents data related to the third research question: Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program and LEP students who did not use the program?

Part IV presents data related to the fourth research question: Is there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having special needs who used the Ignite! program and students with special needs who did not use the program?

Description of Participants

General Description

Four female teachers participated in the study. The teachers worked at three different participating middle schools, collectively teaching a total of 637 seventh grade students in American history. Each participating teacher taught an experimental group (i.e., one full class) of students in which the Ignite! history software was used as an instructional supplement, as well as a control group (i.e., a different class) in which the Ignite! software was not used. Ensuring that both control and experimental group students had the same teacher helped to reduce the chance of sampling bias. The total sample of pretests and posttests was 368; the total number of student participants in the study was 184. The average age of the teachers was 35 years, with an average of 9.5 years of teaching experience. Descriptive information about the participating teachers (names of teachers and schools are pseudonyms) obtained through surveys and interviews is shown in Table 1. Table 2 provides information about the schools attended by students participating in the study for each teacher (names of teachers and schools are pseudonyms).

Table 1

Descriptive Data for Participating Teachers

Teacher Name	Middle School	Age	Years Teaching	Highest Degree
Romero	Samuels MS	30	5	B.A.
Gage	Hawthorne MS	55	26	M.A.
Smith	Hawthorne MS	31	7	M.A.
Brown	Jackson MS	24	0	B.A.

The study was conducted in a rapidly-growing school district in which approximately 40.4% of seventh grade students qualified to receive free or reduced lunch, 14.92% of seventh graders were non-English proficient or had limited English proficiency, and 11.1% received special education services under an individualized education plan (IEP). The district's student population was approximately 14% African American, 33.4% Hispanic, and 43.9% Caucasian. However, two of the three schools included in this study had a much higher rate of seventh graders eligible to receive free or reduced lunch: 50.7% and 61.8%, with minority populations of 61.6% and 56.2% respectively.

Table 2

Middle School Student Demographic Information

Teacher	Middle School	% of LEP Students	% of IEP Students	% Eligible for Free or Reduced Lunch
Romero	Samuels	22.5	11.2	61.8
Gage	Hawthorne	17.5	12.0	48.6
Smith	Hawthorne	17.5	12.0	48.6
Brown	Jackson	6.7	12.2	31.7

Question One

The first research question in this investigation examined whether there was a significant difference between pretest and posttest achievement scores for students who used the Ignite! early American history program compared to students who did not use the program. Using the computer software program Statistical Product and Service

Solutions (SPSS), descriptive and inferential statistics were compiled from the pretest and posttest scores of students in control and experimental groups for four middle school teachers. The mean scores of control and experimental groups on pretests and posttests were calculated, and then compared using a two-tailed *t* test with unequal variance. In determining whether there were significant differences between two groups: (a) an experimental group of students who used the Ignite! history program as part of their coursework, and (b) a control group of students who did not use the program, a two-tailed *t* test was used to compare the two groups. A two-tailed *t* test with unequal variance was used because it is more sensitive to differences between groups than a one-tailed test, and also because the directional shift of test scores between the two groups was unknown at the time of comparison. The control group and experimental groups had unequal variances, therefore a two-tailed *t* test with unequal variance was implemented to measure the difference in mean test scores between the two groups of students.

For students in the pretest control group (n= 91), the average number of correct answers was 33.60 out of 50 total questions with a standard deviation of 5.30, while the average number of correct answers for all students in the pretest experimental group (n=93) was 30.95 out of 50 total questions, with a standard deviation of 6.12. In other words, students in the control group had a 67.2% pretest average for correct answers, while students in the experimental group had a pretest average of 61.9% for correct answers.

At the end of the instructional period being studied, the average number of correct answers for students in the posttest control group (n=91) was 36.66 out of a total of 50 questions with a standard deviation of 5.58, the equivalent of 73.32% correct, while the average number of correct answers for students in the posttest experimental group (n=93) was 37.04 of 50 total questions with a standard deviation of 5.51, the equivalent of 74.07% correct.

The mean posttest scores indicated that students who used the Ignite! history program, as well as those who did not use it, both increased their test scores from pretest to posttest conditions. However, examination of the percentage increase between pretest control and pretest experimental groups to posttest control and posttest experimental group revealed that students in the control group increased their mean test scores an average of 6.1%, while students in the experimental group increased their mean test scores an average of 12.2%, or approximately twice as much. This difference in mean test scores was statistically significant.

The significance level associated with the difference in test score results between the control and experimental groups was less than 0.01%, or less than 1 chance in 100. That is, the likelihood that the difference in test score results between the two groups occurred by chance or was due to some other unknown reason is very small. Also, the likelihood is significant that the 12.2% mean test score increase for students in the experimental group versus the 6.1% mean test score increase for students in the control group was attributable to the treatment.

Question Two

The second research question investigated whether there were specific questions represented on the pretest-posttest instrument for which students in the experimental group scored significantly higher than students in the control group. Statistical Product and Service Solutions (SPSS) software was used to perform an item analysis of each question on the pretest/posttest instrument for students in control and experimental groups for the four middle school classes. The average number of correct answers to each of the 50 questions in control and experimental groups on the pretest and posttest instrument was calculated. This was followed by calculation of the average change in correct responses from pretest to posttest in the control and experimental groups, and then another calculation to produce a numerical summary of how much improvement students in the experimental group made as compared to students in the control group. The formula used to calculate the level of improvement in terms of the average number of correct responses from pretest to posttest between the control group and experimental group students is shown in Figure 3.

(Avg ExpPost – Avg ExpPre) – (AvgCtrlPost – Avg CtrlPre) = Avg CR

where **Avg**=Average, **Exp**=Experimental Group, **Ctrl**=Control Group, **Pre**=Pretest, **Post**=Posttest, **CR**=average number of correct responses.

Figure 3. *Formula to calculate improvement from pretest to posttest between experimental and control groups.*

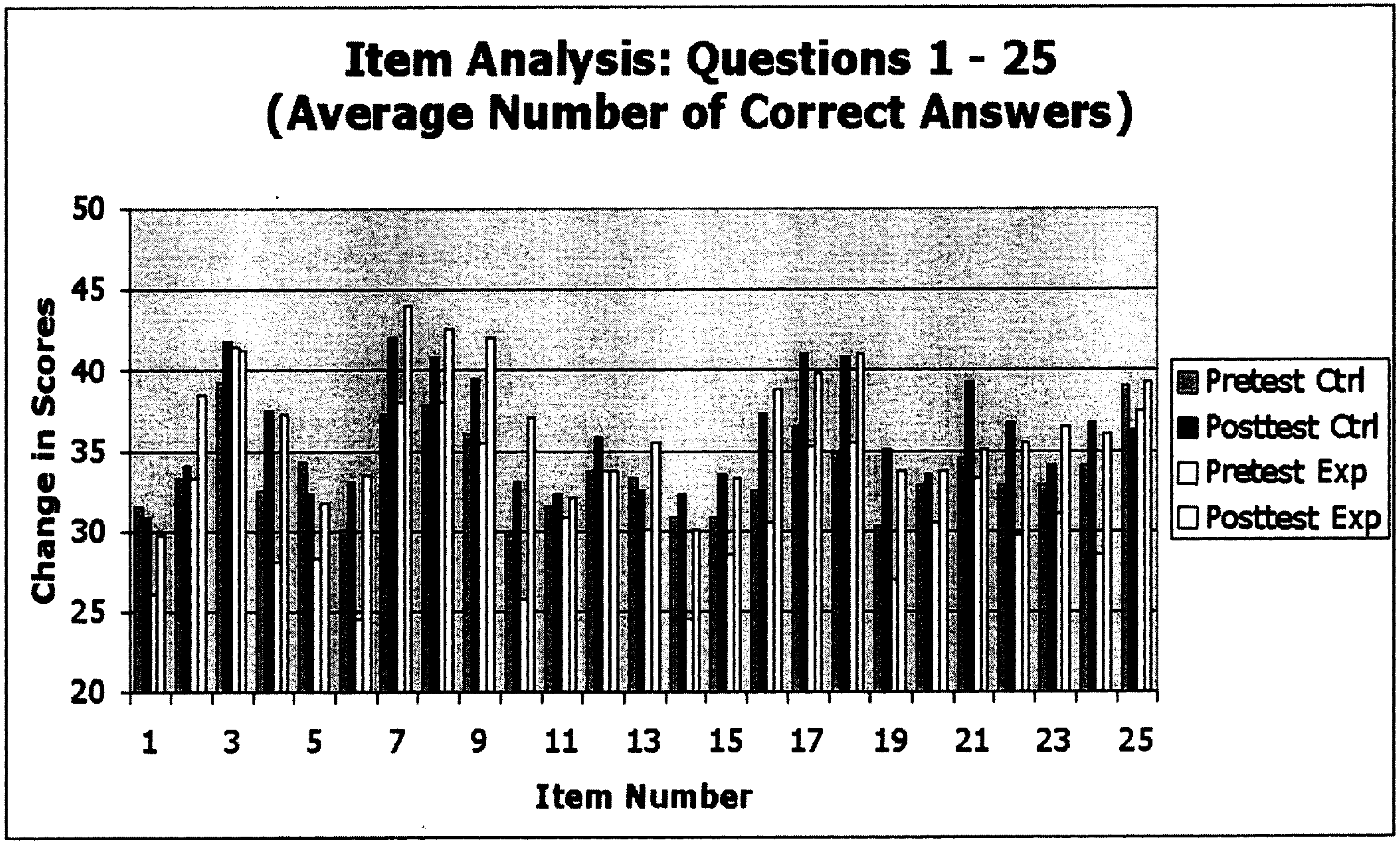
For example, to calculate the improvement students made on the first question from the pretest to the posttest in the control group (i.e., Avg CtrlPost – Avg CtrlPre =-0.75) versus the experimental group (Avg ExpPost – Avg ExpPre = 3.75), the formula was 3.75-(-0.75) = 4.5, indicating that students in the experimental group improved by an average of 4.5 correct answers compared to those in the control group, who actually scored an average of .75 correct answers *lower* on question number one on the posttest than on the pretest. Figure 4 and Figure 5 show an item analysis of the difference in the average number of correct answers between the control and experimental groups. The histogram in Figure 6 provides a numerical summary of the average increase in the number of correct responses for the experimental group for each of the 50 questions on the pretest/posttest instrument. Figure 7 is a similar histogram in which the absolute change in the average number of correct answers for each question has been sorted into natural groupings, in ascending order from the least to greatest number of correct responses for each question. Students' scores improved most on Question 49 on the exam, and showed the greatest decrease on Question 21.

Overall, the average number of questions answered correctly by students in the pretest control group of students was 33.60 (67.2%), while the average number of questions answered correctly by students in the pretest treatment group of students was 30.95 (61.9%). Overall analysis of the posttest items revealed that the average number of questions answered correctly by students in the control group was 36.66 (73.32%), while the number of questions answered correctly by students in the experimental group was 37.04 (74.07%).

Question Three

The third research question investigated whether there was a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the

Figure 4. Item analysis of Questions 1-25



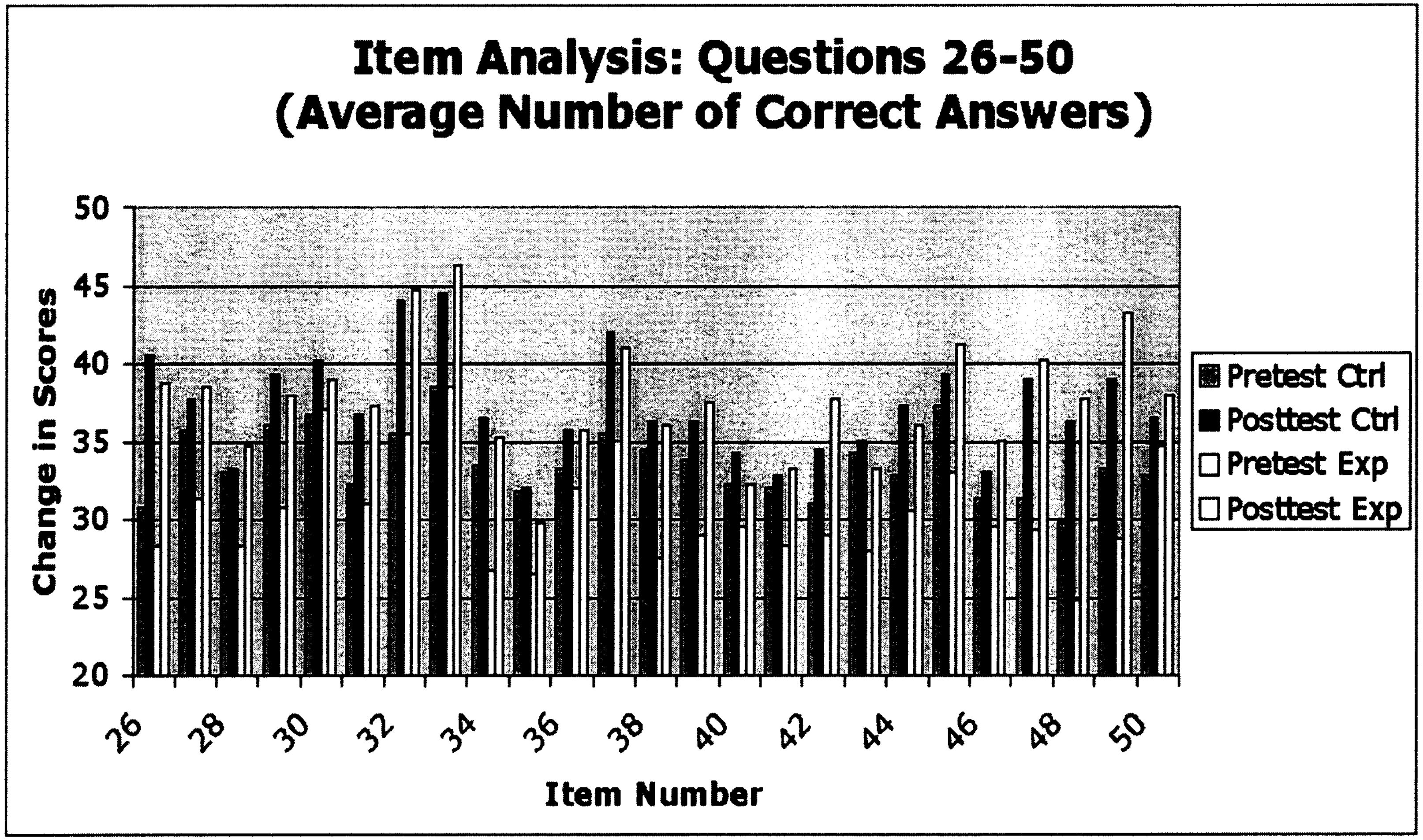


Figure 5. Item Analysis of Questions 26-50.

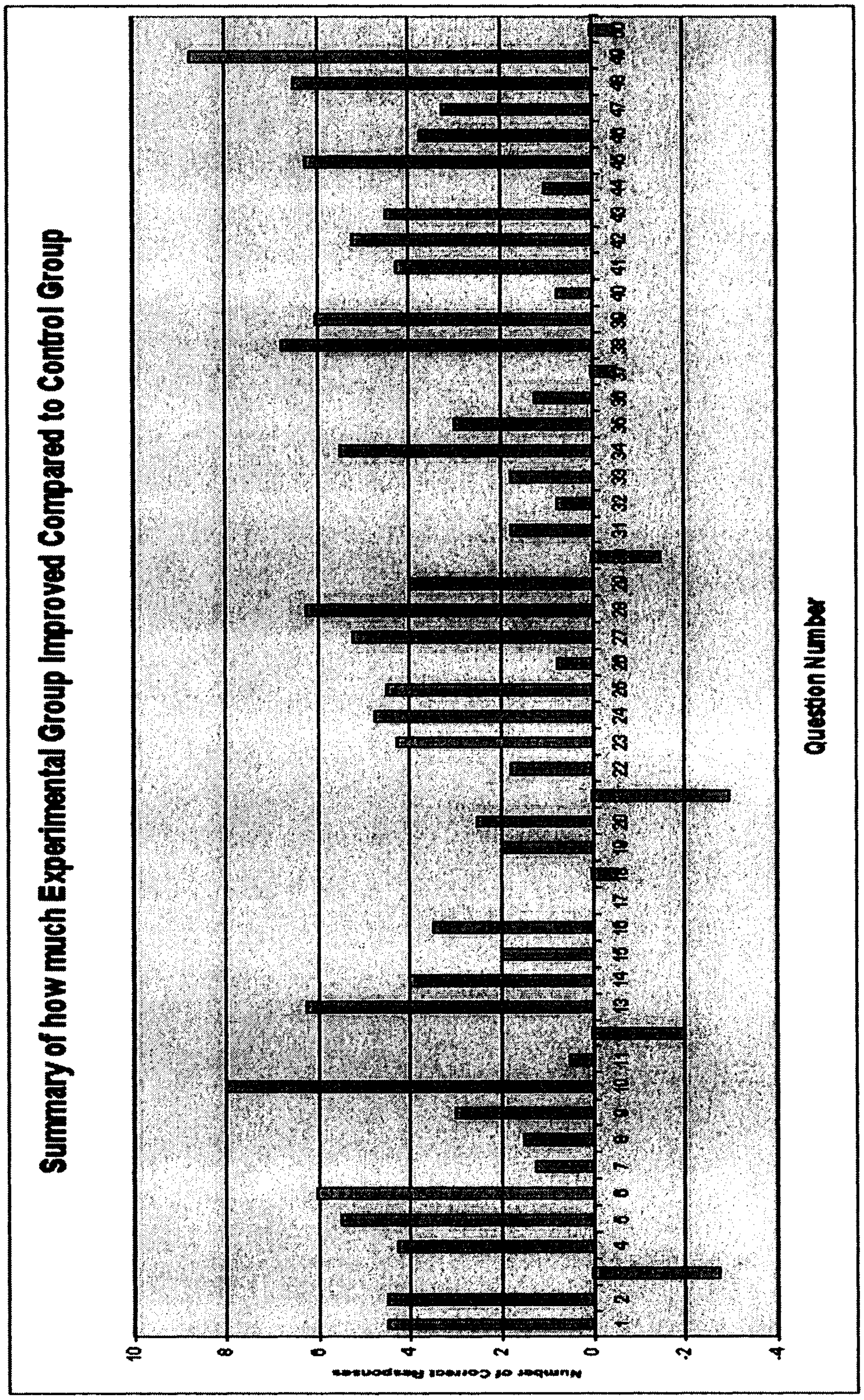


Figure 6. Summary Experimental group vs. Control Group Improvement.

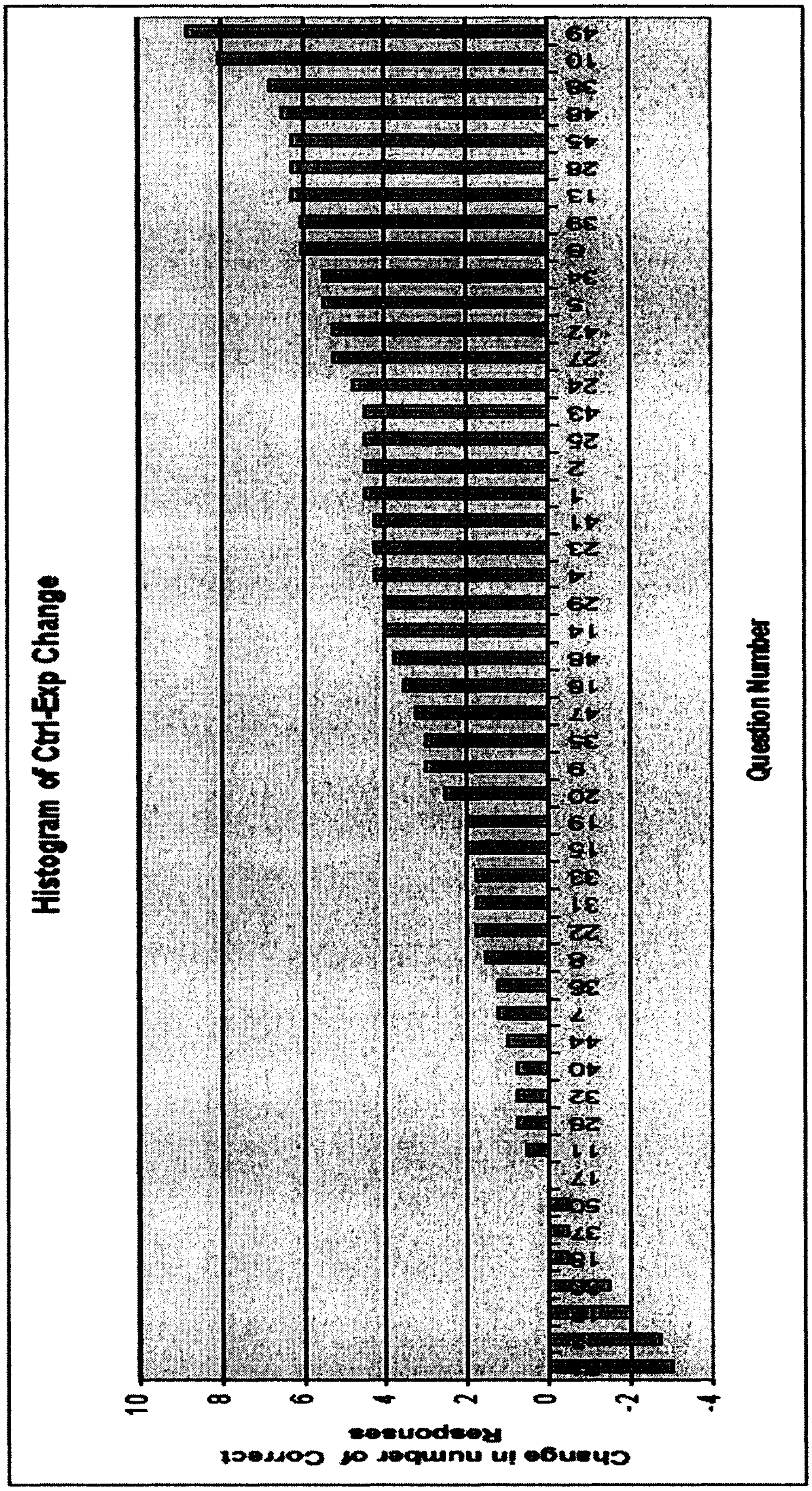


Figure 7. Changes in Experimental vs. Control Groups.

Ignite! program and students with LEP who did not use the program. SPSS was used to compare scores for LEP students on the pretest/posttest instrument for students in control and experimental classes for four middle school teachers. The average scores for students with LEP (n=37) in control and experimental groups on the pretest and posttest instrument were calculated, and the results were compared using a two-tailed *t* test with unequal variance. A two-tailed *t* test with unequal variance was used to compare the average increase in test scores by students with LEP in two groups, experimental (n=15) and control (n=22) classes with unequal variances, and at the time of comparison, the directional shift in test scores was unknown. Table 3 displays the number of students with LEP in the experimental and control classes taught by the four participating teachers.

Table 3

Number of LEP students Experimental and Control Groups

Teacher	Experimental	Control
Romero	5	5
Gage	0	6
Smith	5	9
Brown	5	2

The overall test average for students in the pretest control group of students with LEP was 39.73% correct, with a standard deviation of 1.63, while the overall test average for students in the pretest treatment group of students with LEP was 41.18% correct with a standard deviation of 1.25. Analysis of the posttests revealed an overall test average

40.27% correct, with a standard deviation of 2.11 for control group students, and an overall test average of 44.00% correct with a standard deviation of 1.32 for students in the experimental group. A two-tailed *t* test with unequal variance was run to determine the significance of the differences between the achievement scores of students in the control and experimental groups. Student scores in the control group improved by an average of 0.18 correct questions from pretest to posttest, with a significance level of 0.21, which was not statistically significant. In the experimental group, student scores improved by an average of 0.08 questions from pretest to posttest, with a significance level of 0.67, which was not a significant improvement. In summary, both control and experimental group students showed small, insignificant gains in the number of questions answered correctly from pretest to posttest, but the levels of improvement for students with LEP in this study were much lower than they were for the overall student sample using the Ignite! history software.

Question Four

The fourth research question in this investigation examined whether there was a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers needing special education services who used the Ignite! program and special education students who did not use the program. Only four students in the sample were identified as eligible for special education services, and three of the four students did not use the Ignite! history software. Valid statistical calculations were not possible with such a small sample size. Therefore, the decision was made to instead examine the raw test scores for these students and to discuss whether they improved from pretest to posttest.

Raw test scores for the student with special needs who used the Ignite! American history software improved from 15 correct answers on the pretest to 18 correct answers on the posttest. Converted to percentages, the student scored 30% correct on the pretest and 36% correct on the posttest, for a gain of six percentage points. This percentage increase was approximately equal to that gained by the larger group of students in the study who did not use the Ignite! software. The other three students with special needs did not use the history software, and had pretest scores of 17 (34%), 13 (26%), and 18 (36%) correct, and corresponding posttest scores of 18 (36%), 15 (30%), and 19 (38%) answers correct, respectively. These students' gains were between two and four percentage points, a little lower than that of the student who used the Ignite! software. This is an intriguing finding, and one that suggests further research with the Ignite! history software and students with special needs might yield some useful data. However, it is impossible to draw any conclusions about these results from such a small sample of students.

QUALITATIVE RESULTS

Reading and Comprehension Abilities

Qualitative data, including field notes and informal interviews with teachers and students, were collected throughout the course of the study. Analyses of transcriptions of field notes taken during classroom observations and of informal interviews with the participating teachers unveiled a major concern for all of the teachers, namely, that of trying to help their seventh graders to understand historical concepts that are abstract rather than concrete in nature. One example provided by a teacher described how most of her students understood who Sojourner Truth was and how she contributed to the abolitionist movement, but they had difficulty understanding more intangible ideas related to American history, such as the concepts of federalism, sovereignty, and implied powers in the Constitution.

Another example recorded in a classroom observation also illustrated students having difficulty with abstract historical ideas. The teacher attempted to draw parallels between the student council at the school and the first and second Continental Congresses formed by the American colonists. He described how the middle school student council and the Continental Congresses were both tasked with drawing up rules through consensus, and attempted to make the discussion relevant to the students' everyday lives by describing how students could voice their opinions through student council in much the same way as the colonists could express their preferences and grievances through the representatives at the Continental Congresses. However, when he asked students the following week about the purpose of the Continental Congress, they did not answer. Several students began skimming their textbooks for information on the Continental Congress, but they did not seem to remember the parallel drawn for them by the teacher the previous week. When asked why students did not remember the concept of Continental Congress, even after he had given the student council example, the teacher explained that students in his classes had difficulty with what he called non-concrete concepts. He elaborated by stating that although students understood concepts such as slavery and taxation without representation, they had a much harder time with more abstract ideas, such as the provisions of the Magna Carta, rights and responsibilities of the members of the Continental Congresses, or proprietary colonies.

Although many abstract concepts such as those previously described were highlighted as vocabulary words in the textbook for students to review, the textbook itself – containing 1052 pages, 11 major units, 32 chapters, multiple appendices, an index, and a glossary in English and also one in Spanish – proved intimidating to many students. A review of written field notes taken throughout the period of the investigation revealed that several students expressed during informal conversations that they did not like reading the book, and did not understand much of what it contained. For example, when asked for their thoughts about the history textbook, students responded with "it's awful, man, cuz it's too much stuff!", "it doesn't help us", "we can't find nothin' in there [the book]", and "it's too confusing. I can read it, but I don't understand it". This sentiment was corroborated in transcriptions of informal interviews with all of the participating teachers, who indicated that up to three-quarters of their seventh-grade history students were reading below grade level. When each teacher was asked what percent of their students could read at grade level, one teacher answered almost half, but the other three gave figures ranging from 40 percent to only 25 percent.

Further inquiry about reading level deficits revealed teachers' concerns that many of their students lacked content area literacy skills to help them skim for information, use the chapter reviews or indexes to find answers to questions on their worksheets, or to take notes or highlight main ideas in their textbooks. One teacher explained that when faced with reading two or three pages in their textbooks, several of his students could decode the words and read them aloud if requested, but did not comprehend what they had just read. When asked about a concept that they had read aloud only minutes before, these students often struggled to answer. The teacher described how at the beginning of the school year he had demonstrated some strategies to all of his classes on how to read a passage of text to glean the main ideas from it, and that some of the students continued to use these strategies. However, several other students still had trouble recapping the main idea from just one or two paragraphs of reading. All of the participating teachers expressed during informal interviews that they were very concerned about their students' low levels of reading with textbooks in general, and with reading for information specifically.

Two teachers were observed trying to supplement the textbook reading with small group discussions, but this did not work because the students would not remain on task. Students fared better when given worksheets to outline questions to guide their reading and their textbook searches; however, a surprising number of students observed during worksheet time were frustrated, and did not appear to know how to utilize the table of contents or index in order to pinpoint information. At the end of one class in which students used worksheets to guide their reading for the day, fewer than half of the students had completed their worksheet, although there were only six questions to answer. The teacher explained that this was typical, and that of those worksheets that were complete, several students had likely copied from another student at their table. This teacher explained that what really needed to be taught was reading and comprehension skills, but that there was not enough time to do that and cover the historical material required by the state standards. During conversations and informal interviews, all of the teachers expressed frustration that so many of their students were unable to read at grade level, but none seemed to blame the students; rather, they felt that students had simply been pushed through to the seventh grade regardless of their reading abilities.

Use of the Ignite! Program

Qualitative data was also gathered to determine whether the Ignite! American history software was used with fidelity by all participating teachers for the duration of the study. According to the recommendations contained in instructional materials provided by Ignite! Learning, the history program needed to be used for at least 20% of instructional time in order to show an effect on student outcome scores. This meant that participating teachers needed to use the program for a minimum of one class period per week, or the equivalent of that time. Weekly classroom observations were augmented by conversations and informal interviews with the teachers throughout the period of investigation. Transcripts from observations and teacher interviews revealed that each of the participating teachers used the program for the equivalent of one class period per week throughout the period of investigation.

In general, teachers used the program with their students in a computer lab where students had access to their own computer and were free to work through the assigned modules at their own pace. On occasion, the history classes were usurped by another group of students who needed to use the computer lab. In these cases the teachers usually requested an extra day the following week in order to recoup the missed lab time. On a few occasions when the computer lab was occupied on their assigned lab day, the teachers used the Ignite! program as a teacher-directed, whole-class instructional tool. In these cases, the teacher led a discussion of the materials, showed the media pieces to the students on a large projection screen in the class, and had students take notes or fill out an outline of the material covered. However, the vast majority of time spent using the Ignite! history program was weekly time in the computer lab with students engaged one-to-one with the program on a computer, working at their own pace and using the media pieces in whichever order they preferred.

There were a few instances in which teachers who wanted to participate in the study were unable to use the program consistently for 20% of their instructional time. When this became apparent in the weekly on-site observations, and the teachers were unable to recoup the missed computer time, the teachers were told that they could continue to use the Ignite! history software if they wished, but that the scores of their students would not be included in the analyses of the study. There were a variety of reasons why these teachers did not use the Ignite! program consistently, with the most common reason cited by the teachers was not having enough time to be able to plan for use of the program in addition to regular textbook lessons. Prior to commencement of the study, all of the participating teachers provided information about their experiences with technology in the classroom, their level of education, and the number of years of teaching experience. Analysis of the teachers' backgrounds revealed that teachers who had higher comfort levels with technology and more classroom teaching experience were more likely to use the program consistently and to remain in the study, while first-year teachers and those with overwhelming classroom behavioral issues were less likely to use the program with fidelity or to remain in the study.

CHAPTER 5

DISCUSSION

This study investigated whether middle school students who used the Ignite! Early American History program for approximately seven months during a 9-month academic school year scored higher on a multiple-choice, outcome-based achievement test as compared to students who did not use the Ignite! program. The following section includes a discussion of salient findings for the study and how they relate to the professional literature on research with technology-enhanced learning in classroom settings. Following this discussion, the implications of the findings, limitations of the study, and recommendations for future research are explicated.

Discussion of Research Findings

Question One

This section addresses the first research question: Was there a significant difference between pretest and posttest achievement scores for students who use the Ignite! Early American History program as compared to students who did not use the program? Results indicated statistically significant positive effects on overall achievement scores for students who used the Ignite! history program. Mean test scores for students who used the Ignite! history software improved by 12.2% and an average of 6.09 more correct answers from pretest to posttest, while mean scores for control group students improved by 6.1%, an average of 3.06 more correct answers from pretest to posttest. On a two-tailed *t* test of unequal variance, p=0.0000000337623, indicating a very high level of significance, where *p* represents the probability that the increase in mean test scores was attributable to something other than use of the Ignite! early American history program. The significance level in a statistical study is the risk associated with not being 100% confident that what was observed in an experiment or quasi-experiment was due to the treatment or what was being tested. In this case the treatment was student usage of the Ignite! early American history software program. Since a researcher cannot fully eliminate the impact of all other potential factors on the differences observed between outcomes of treatment and control groups, some level of probability (i.e., the *p* value) is assigned and reported. With such a small error probability level, it can be asserted with a high level of confidence that the positive difference in outcome scores for students in the experimental group was due to their use of the Ignite! history program.

The field of education is saturated with urgent calls by federal agencies (Coalition for Evidence-Based Policy, 2003; NCLB, 2002; U.S. Department of Education, 2005) and scholars (Beghetto, 2003; Fueur, Towne, & Shavelson, 2002; Shavelson & Towne, 2002; Margolin & Buchler, 2004) for research into interventions that improve student achievement on standardized assessments. There is an equally compelling need for research documenting student achievement and learning that is directly attributable to educational technology (Bull, Knezek, Roblyer, Schrum, & Thompson, 2005; Clements & Sarama, 2003; Cordes & Miller, 2000; Valdez, 2004). Another important consideration related to these calls for research on student outcomes and technology is the dearth of studies employing quantitative, scientific or quasi-experimental methodologies that include sufficient data on the conditions of the study (Waxman, Lin, & Michko, 2003), as well as the characteristics of the students, schools, and technologies investigated. This study concomitantly answers all of these calls by providing detailed, rigorous, evidence-based research on a successful, classroom-based, technology-enhanced educational intervention.

In addition to reporting outcomes and probability levels for errors, researchers conducting investigations adhering to the No Child Left Behind (2002) definition for scientifically-based research (SBR) must also report the effect size and statistical power of a study. Statistical power is related to the variance: the smaller the variation relative to each group (e.g., between the experimental and control groups), the larger a sample size must be in order to obtain a high power rating. The power of a statistical hypothesis test measures the test's ability to reject the null hypothesis when it is actually false – that is, to make a correct decision (Hinkle, Wiersma, & Jurs, 1998). Obviously, the higher the power rating, the more reliable the statistical test. The maximum power a test can have is 1, and the minimum is 0. Ideally, researchers would strive to have a high power, or a number close to 1. For the control group of students, the power was 0.965, and for the experimental group, the power was 1.00. In other words, there is a 96.5% statistical likelihood that the two-tailed *t* test was able to detect the effects for the control group of students, and a 100% chance that it was able to detect the effects for the experimental group. Consequently, it can be asserted with a very high level of confidence that the results of the two-tailed *t* test on both the control and experimental groups yielded valid results.

In summary, results of this quasi-experiment suggest a strong link between use of an educational software program and higher outcome achievement scores for middle school learners. Moreover, this inquiry provides evidence-based findings on the effectiveness of a technology-enhanced educational intervention that aligns with the standards set forth by the What Works Clearinghouse (WWC) and Institute for Education Sciences (IES) for judging the effectiveness of educational initiatives (Chatterji, 2004; Valentine & Cooper, 2003).

Question Two

This section addresses the second research question: Are there specific concepts represented on the pretest/posttest instrument for which students who used the Ignite! history software scored significantly higher than students who did not use the program? Students in the experimental group scored higher on the posttest than those in the control group on 42 of 50 questions, and they showed larger increases overall from pretest to posttest than control group students on the 42 items. For one question on the assessment instrument, scores in the experimental group did not move at all, and on seven of the 50 questions, students in the experimental group actually scored lower after using the Ignite! history software than students in the control group.

Questions for Which Student Scores Decreased

Examination of the test questions on which students who used the Ignite*!* history software scored lower than their control group counterparts revealed some possible patterns on the test questions that may have contributed to this phenomenon. Of the items on which experimental students scored lower, two questions specifically addressed

King George III of England's view of the American colonies. No other questions on the assessment instrument address this issue; therefore it is possible that students in the experimental group did not learn about King George of England from using the software or from their other instructional materials. Examination of the answers students provided to the two questions revealed disparate answers, which may suggest that students simply guessed at the answers to questions about King George III of England.

The remaining five questions on which students in the experimental group scored lower than their control group counterparts also appear to have something in common that may have contributed to students' incorrect answers. In this case, semantics may have factored into students' answers. For example, a question about the division of powers between the national government and the states provided the following possible answers: (a) local system, (b) feudal system, or (c) federal system. Analyses of transcriptions of field notes taken during classroom observations revealed that some students in all classes appeared to have difficulties with vocabulary words particular to the study of history, especially those that were not part of their everyday lexicon. It is possible that students who missed this question were unsure of the difference between a feudal system and a federal system. The two words look similar, and this could have been a source of confusion for the students.

In another example, a question asking students to name the process whereby the Supreme Court reviews other branches of government provided the following choices: (a) supremacy, (b) law review, or (c) judicial review. Once again, students may have been unsure of the difference between judicial review and law review, so they simply chose the first answer, supremacy, because it contained a word very similar to Supreme Court contained in the question itself. Analysis of the posttests revealed that supremacy was indeed the most popular answer selected by experimental group students for this question. Unsworth (2005) discussed some of the difficulties involved in students' understanding of functional grammar and specialized language of school science and history texts. According to Unsworth, even students who are confident in their use of spoken English may lack familiarity with the grammar, syntax, and/or semantics of the written form, while "the greater lexical density of school texts can contribute to comprehension difficulties." (p. 125). Additionally, Christie (1984) stated that at times the difficulty students experience with the written specialized language and vocabulary of particular subject areas, such as history, may be related to the students' lack of technical knowledge about the field. Unsworth pointed out that functional use of language in science and history courses "creates a different kind of discourse in these content areas – a highly technical discourse of school science and a relatively nontechnical but highly abstract discourse of school history." (p. 130).

It is possible that students' discomfort with using the textbook, coupled with the fact that many social studies textbooks do not present information clearly to readers (Armbruster & Gudbrandsen, 1986; Crismore, 1983; Stetson & Williams, 2005) contributed to students' inability to decipher the wording in the answers to questions on the written exam.

Questions for Which Student Scores Improved

With the exception of the seven questions for which scores decreased, and the one question for which scores did not move, the majority (84%) of posttest scores for students in the experimental group showed improvement. Figure 4 provides a graphic representation of the changes in the number of correct responses from pretest to posttest

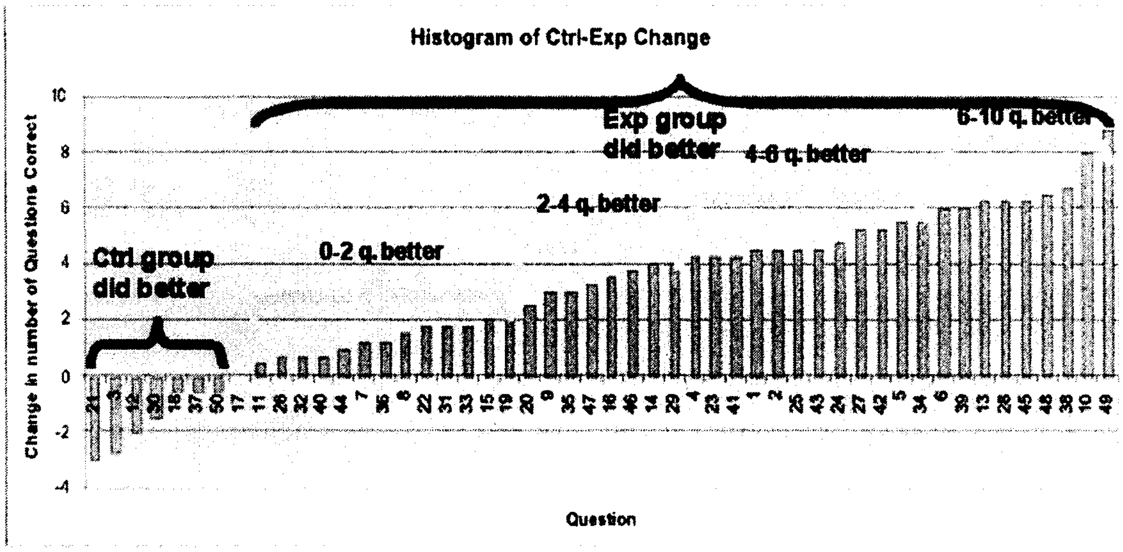


Figure 8. Histogram of Sorting of Natural Groupings of Questions.

for these questions. For example, average student scores improved the most for Question 49, a moderate amount for Question 29, and the scores remained the same for Question 17. A review of the questions on the test revealed that student scores reflected the most improvement on questions related to specific battles that took place during the Civil War, such as the Battles of Gettysburg, Shiloh, and Richmond. Moderate improvements were made on questions that were more inferential in nature, such as those asking why Southerners believed they had the right of secession from the Union, or what the main goal of the North was at the beginning of the Civil War.

In summary, students who used the Ignite! history software showed increases in posttest scores for 42 of 50 questions, decreases in posttest scores for 7 of 50 questions, and static posttest scores for one question.

Question Three

This section addresses the third research question: Was there a significant difference in student achievement as measured by pretest and posttest scores between students identified by their teachers as having limited English proficiency (LEP) who used the Ignite! program and students with LEP who did not use the program? Unlike students in the overall sample, students with LEP who used the Ignite*!* history program did not show a significant increase in mean test scores from pretest to posttest conditions. The sample size of students with LEP was much smaller (n=37) than the larger sample examined in the first research question (n=184). Results indicated that control group students with LEP (n=22) had a mean score of 39.73% on the pretest, and a mean score of 40.27% on the posttest, for an increase of 0.54%, or about half of 1%. Students with LEP who used the Ignite! history software had a pretest mean score of 41.18% and a mean score of 44% on the posttest, indicating a 2.85% increase in mean scores. Students with LEP in the control group correctly answered an average of 0.08 questions better on the posttest than on the pretest, while students with LEP in the experimental group improved the number of questions they answered correctly by 0.18. Significance levels from t tests were 0.21 and 0.67 for the control and experimental groups, respectively, indicating that the difference in improvement between the control group and the experimental group students with LEP was not significant.

A power analysis for the calculations for students with LEP yielded a very low power for this experiment. The power for the control group was 0.054 and for the experimental group the power was 0.057. This indicates that there was only a 5.4% chance or likelihood that the two-tailed t test revealed valid results about the control group of students, and only a 5.7% chance that the test revealed valid results for the experimental group of students. The reason for such a lower power for this test was the extraordinarily small sample size for this particular group of students. With this in mind, the lack of significance for the two groups may not truly represent the effects of use of the Ignite! history software with students with LEP.

It is unclear why the English language learners showed much lower improvement levels from pretest to posttest conditions than the larger group of mainstream students. Over the years, research has revealed many benefits of using educational technology with students with LEP (Butler-Pascoe & Wiburg, 2003; Svedkauskaite, Reza-Hernandez, & Clifford, 2003; Tornatzky, Macias, & Jones, 2002). Moreover, NCLB clearly states the expectation for students with LEP to meet the same high academic standards as all other students, and that all students, regardless of their background or socioeconomic status should be technologically literate by the eighth grade (NCLB, 2002). In the current study, quantitative measures determined that students with LEP did not make significant progress after using the history software, but situationally-based data about the students' backgrounds and educational contexts would be necessary to understand why. This conundrum is an example of the need for studies implementing both qualitative and quantitative research methodologies that sometimes overlap and may even mutually reinforce one another within the same research investigation (Chatterji, 2004). A causal analysis cannot be made without direct, focused observations of the relationships between students with LEP and their teachers, observations of the students' classroom and computer lab activities, and interviews with the English language learners and their teachers. Qualitative research into the reasons the students with LEP had lower achievement scores would be a logical next step.

Question Four

This section addresses the fourth research question in this investigation: was there a significant difference in pretest and posttest achievement scores between students identified by their teachers as having special needs who used the Ignite! early American history program as compared to students with special needs who did not use the program? Only four students who participated in the study were identified as receiving special education services. Three of the students did not use the Ignite! software, one student used it. The student who used the history software increased the number of correct answers by three questions, or approximately 6%, from pretest to posttest. A 6% increase represents the approximate gain made by control group of mainstreamed students from pretest to posttest. The three students receiving special education services who did not use the *Ignite!* history program showed an average increase of 1.33 correct answers from pretest to posttest, or 3%. With only four students in the special education sample, it was not possible to draw conclusions or make inferences regarding whether the Ignite! history software was an effective tool for raising standardized history test scores for students with special needs. However, it is interesting to note that scores for all students receiving special education services increased.

The possibility that the Ignite! early American history program might be helpful to middle school students with special needs is supported by research suggesting that in some instances technology has been instrumental in raising standardized test scores for seventh grade students with learning disabilities (Ross, Smith, & Morrison, 1991) and with autism (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Williams, Wright, Callaghan, & Coughlan, 2002). These previous findings suggest that a larger-scale study of students with special needs using the Ignite! program might be warranted.

It is important to note that there were more than four special needs students among the student population from which the sample for the current study was drawn. However, most of the students identified as having special needs either declined on their permission forms to allow their test scores to be used, or they simply failed to return the permission forms altogether. In a few instances the students did not attend class on the day the posttest was given, and in two cases students with special needs were sent out of class for disciplinary reasons during the posttest, rendering their scores unusable. Conversations with participating teachers revealed that near the end of the instructional period covering early American history, most of the students had taken the Iowa Test of Basic Skills and a Criterion-Referenced Test within a few weeks of when the Ignite! history posttest was administered. It is perhaps not surprising, then, that students receiving special education services, along with their regular education peers, were disinclined to take part in yet another standardized assessment.

Other Relevant Findings

Scientifically Based Research (SBR) in School Settings

This study began with 19 teachers from seven different middle schools who taught over 1300 students. At the conclusion of the research project 7 months later, only four (21.1%) teachers at three different schools remained in the study, with a total of 184 (14%) usable student test scores. This precipitous drop in participating teachers and students from commencement to completion of the project is a clear manifestation of a serious, larger problem for education researchers: large-scale, multi-school, multi-classroom, scientifically-based research endeavors spanning several months are vulnerable to inordinate participant attrition rates due to a multiplicity of factors. Scholars and practitioners conducting education research satisfying all requirements of the NCLB definition for scientifically-based research (SBR) face a complex, challenging process fraught with considerable practical and logistical difficulties. As Simpson, LaCava, and Graner (2004) assert, NCLB's interpretation of SBR "effectively restricts and even impedes methods of research" because "[W]hen methods for particular groups of students or subjects or needs are unavailable, unpalatable, or when they require complicated and difficult implementation steps, they will not be used and fidelity of implementation cannot be ensured" (p. 73).

A thorough review of transcriptions of field notes of classroom and computer lab observations, as well as formal interviews with the teachers indicated that the program being tested was used with fidelity. That is, the program was used by the participating teachers for at least 20% of instructional time, the equivalent of one day per week. However, the majority of students, especially those identified as having special needs or limited English proficiency (LEP) who were in classes of participating teachers either failed to return a signed permission form, or returned it having opted not to grant permission to use their test scores in the study. Test scores for 11 students with special needs and 52 students with LEP were obtained; but only four students with special needs and 37 students with LEP gave consent on the permission forms to allow their pretest/posttest scores to be used for this study. Simpson, LaCava, and Graner have raised an important issue regarding NCLB's tight restrictions on SBR: undoubtedly many students (and their parents) indeed found it unpalatable to have their standardized test scores scrutinized for purposes of the current study. The lack of signed and returned permission forms from students was by far the largest contributing factor precipitating the tremendous drop in the number of test scores that could be used.

Other obstacles to the research project became apparent after the investigation was well underway. Many of the teachers who dropped out of the study stated during informal and formal interviews that they did not receive the administrative and/or technical support they were promised when they agreed to participate in the study. As a result, they were unable to use the Ignite! history software for the 20% of instructional time recommended by Ignite! Learning. For example, although all participating teachers were assured by their principals that they would have unfettered weekly computer lab time for their students to use the Ignite! history software, all of the teachers reported during informal interviews that this was not the case. With each middle school having only one computer lab, the seventh grade history teachers were preempted on several occasions for testing or other special projects for sixth, seventh, and/or eighth graders at their school. For example, during one interview a teacher described how she had to drop out of the study when her fifth period experimental group class was bumped from their reserved computer lab time slot because a business computer class had been rescheduled to take place during fifth period. This occurred well into the fall semester, too late for the teacher to select a different class as an experimental group to begin using the Ignite! program regularly. During another informal interview, a different teacher at the same school described how she was bumped from her lab time for three weeks in a row, and how she had to exert serious pressure through e-mails and conversations with her principal to get permission for her class to recoup the missed computer lab sessions. In a follow-up informal interview, this teacher explained that she was successful in securing the lab time to make up for the lost computer sessions, and she remained in the study.

Because of all of the responsibilities the middle school teachers faced on a day-to-day basis, many of them reported during informal and formal interviews that they were unable to implement the Ignite! program with fidelity (i.e., the target 20% of instructional time) and simultaneously meet all of their other obligations to administrators, students, and parents. This view of the software program as yet another time-consuming obligation rather than a valuable learning tool is supported by Keiper, Harwood, and Larson's (2000) finding that if computer use is viewed by teachers as simply an additional duty with limited benefits for students, they will be far less likely to perceive technology use as viable than if they view it as integral to the curriculum, where learning is enhanced and expanded because of the technology. Four teachers, two males and two females, specifically cited overwhelming difficulties with student behavioral issues related to large class size as reasons for declining to remain in the research study. All of these teachers expressed during informal interviews that they and their students liked the program, and they recognized potential benefits from the program for their students, but stated that they needed classes with about half as many students (i.e., 20 instead of the 39 or 40 they currently had), or a teacher's assistant to help keep students on-task in the computer lab.

Limitations of the Study

Like all research endeavors the current study has limitations. One limitation was the ability to generalize its findings to other populations in similar settings. As Gall, Borg, & Gall (1996) point out, "Population validity is the extent to which the results of an experiment can be generalized from the sample that participated in it to a larger group of individuals, that is, a population" (p. 217). Sampling, according to Gay and Airasian (2000), is the process of selecting individuals for a study "in such a way that they represent the larger group from which they were selected" (p. 121). Research results from a well-selected sample will be generalizable to the population from which they were drawn. Because participants in this study were not randomly selected, but were instead part of a cohort, the generalizability of the results to similar student populations would be considered lower than if the sampling process had been completely random. Participants for the current study were enrolled in middle schools within the district equipped with high-capacity file servers and sufficient networking speed and infrastructure to make use of the Ignite! program possible. Additionally, each participating school was required to have a computer laboratory with a minimum of 35 computers in order to accommodate the average number of students in middle school classrooms in the district. Participating teachers each taught an experimental group comprised of students with whom the Ignite! program was used as part of their history studies, and a control group comprised of students with whom the Ignite! program was not used. Teachers designated the treatment and control groups, after being instructed to select two classes of students who were very similar in number, ability, and demographics. Access to the school's computer lab during the time a teacher had a particular class was a major determinant in the teachers' selection of the experimental groups. So that others may determine how applicable the findings from this study are to their situation, the researcher has defined and described the characteristics of the sample population in greater detail in the Results section of this paper.

Another possible limitation for the current study was the prospect that not all students in all of the experimental classes used the Ignite! program for sufficient amounts of time to affect their scores on the posttest instrument. Anticipating and acknowledging this possibility, prior to commencement of the study the researcher checked the promotional materials, both online and those accompanying the software and teaching materials, and also directly questioned two training representatives from Ignite! Learning Company about how the program should be used with students, and the frequency with which it should be used in order to see results from its use. Promotional materials and conversations with representatives from Ignite! Learning Company suggested that the program could be used either as a supplement or as a full replacement for middle school early American history textbooks. As a supplement, both of the Ignite! Learning Company representatives suggested that the program be used at least once per week with students in order to be effective, a recommendation that was implemented in the study.

From the start of the school year until the end of the unit on early American history, the researcher was present an average of twice per week in the classrooms and computer labs of participating teachers to ensure minimal variation in instructional strategies, supplementary materials, or frequency and/or usage of the Ignite! history program. An in-depth review of transcribed field notes from classroom and computer lab observations across several months suggested that the Ignite! program was used with high fidelity across all classrooms. Formal and informal interviews with the participating teachers, and with some students corroborated the field notes. Careful comparison of the data from focused on-site classroom observations and from interviews with teachers and students suggested that there were minimal variations in teachers' use of supplementary materials and frequency of operation of the Ignite! history program in classrooms.

A final possible limitation for this study is related to the first concern regarding the ability to generalize its findings. In addition to the non-feasibility of randomly selected students and teachers to participate in the study, there was also the issue of a smaller student sample size than had been hoped for, as well as the participation of fewer teachers, who were all female.

Implications and Future Research

This study was designed and conducted in compliance with criteria set forth in the No Child Left Behind Act (2002) definition of scientifically based research (SBR). With instructional technology playing an increasingly central role in the NCLB call for accountability in all academic areas, more research and more effective techniques are needed to document student achievement related to computer-based training and educational programs (Bull, Knezek, Roblyer, Schrum, & Thompson, 2005; U.S. Department of Education, 2005).

This study adds to the body of SBR literature on student achievement that is directly linked to the use of educational software. Bull et al. describe the compelling need for this sort of research by stating "[t]o date there have been no documented systemic increases in student achievement and learning directly attributable to technological innovation." (p. 218). They add, "[t]here is no area in which well-conceived and effectively implemented research could be of greater value than in the area of [educational] technological innovation." (p. 218). The current study responds to accountability calls from scholars, policymakers, and educators at all levels for rigorous evidence indicating whether technology investments can truly support student learning (Jones et al., 2004-2005) in educational settings. Furthermore, this study adds to the very limited body of research on the effectiveness of technology as a component for teaching social studies (Cantu, 2000; Diem, 2000).

The results of this study suggest several directions for further research. One possible avenue for further research aligns with Kirkpatrick and Cuban's (1998) finding that a major shortcoming of research on the efficacy of technology in education is that the research varies tremendously in methodology, sampling, and focus. Kirkpatrick and Cuban found studies with large variations in sampling, such as differences in student grade levels, socioeconomic classes, and aptitudes. The current study employed a quasi-experimental methodology that implemented all the NCLB specifications for SBR, included a disparate sampling of teachers and students from the school district, with a strong emphasis on the intervention being used with fidelity. However, a study employing in-depth qualitative and quantitative data collection would provide greater insight into the contextual factors surrounding the differences in student achievement, while also providing information related to how teachers integrate a new technology into their existing curriculum. The resources available for this study, and the time frame involved constituted constraints on the design and scope of the research. The prime considerations for this investigation were to allow the longest possible time for students to utilize the Ignite! software during their study of early American history, and to ensure fidelity of use of the program in all classrooms. However, a larger team of researchers would allow for more focused qualitative observations of each classroom and each teacher, and for the possibility of scaffolding teachers whose comfort levels with teaching and/or technology are limited, thereby possibly reducing the attrition rate of teachers. Additionally, a larger cadre of researchers would provide opportunities for a deeper understanding of the changes in instructional and epistemological processes related to teachers' integration of a multimedia program such as the Ignite! software into their day-to-day curriculum.

Clearly, use of the Ignite! American history program significantly raised student achievement scores on a standards-based, multiple-choice test. However, many questions about the effects of educational software on student learning remain unanswered. Another possible direction for further research would be to investigate gains in student achievement if the program were to be used with students for more than the 20% of instructional time implemented in this study. For instance, students who did not use the Ignite! history software showed an average mean test score increase of around 6%, while those who used the program had mean test score increases of about 12%, or twice as much. What could be expected if instructional time using the Ignite! history software were increased from 20% of instructional time to 25%, or to 50%? Would students continue to show exponential gains on standardized assessments, or would a point of diminishing returns be reached? If that point were reached, it would also be essential to explore how important the instructional time that is spent without using the Ignite! history software is for student learning.

A final direction for future research would be to explore whether test score increases attributed to use of the Ignite! early American history software would be significant within the real-world context of middle school history classrooms. In other words, would the gains made be enough to truly make a difference in whether or not students pass their seventh grade history course? Middle school students continue to struggle with the topic of American history. It would be interesting to explore whether the Ignite! history program truly changes how students feel about learning history, and whether the knowledge gained from use of the software would be transferable to more complex problem-solving scenarios outside the context of a standardized written examination.

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