Technology and the Prospective Teacher: Exploring the Use of the TI-83 Handheld Devices in Social Studies Education

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Abstract

Using technology to enhance student learning in social studies has become an important area for discussion and study within the field of social studies education. Handheld devices are one of the recently emerging technologies. This article describes an initial study of the TI-83 handheld device in the education of preservice social studies teachers. In particular, this study examined data collected from one group of preservice teachers to determine how they viewed the TI-83 handheld device and how they used the handheld technology in their social studies teaching. Data was collected from surveys, interviews, lesson ideas, and observations. Some findings suggested that the design of the tool and the programs for it played a strong role in the preservice teachers' views of and uses of the tool in lessons.

Until fairly recently, the use of technology in social studies education and research in the area of technology have been low priorities (Berson, 1996; Martorella, 1997). A variety of factors have limited the use of technology, including limited access, a lack of knowledge and training related to hardware and software, and a lack of expectations for use in social studies (Ehman & Glenn, 1990). However, as the role of technology becomes more pervasive in society, social studies educators must teach with and about the latest technology to give their students "the knowledge, skills, and attitudes required ... to be able to assume 'the office of citizen'" (National Council for the Social Studies [NCSS], 1994, p. 3). For example, with the rising use of the Internet and the explosion in data collection, processing, and storage capabilities, there is a more pressing need for social studies educators to teach students how to find, sift, process, and analyze data and make meaning of it all.

With this environment, it is increasingly important for social studies teachers to help students acquire the skills to deal independently and effectively with massive amounts of information (Fitzpatrick, 2000; Rice & Wilson, 1999; Risinger, 1998; Saye, 1998; see also Doolittle & Hicks, 2003, for an overview). In addition, because of the nature of the content they teach, social studies educators should help students consider the impact of technology on society and their lives (Ross, 2000). As social studies teacher educators, therefore, it is our responsibility to address the importance of technology use in social studies by preparing preservice teachers to integrate technology in their teaching.

At the same time the role of technology in social studies classrooms has gained importance as a topic of research and discussion (e.g., Berson, Lee, & Stuckart, 2001), handheld computers are increasingly being used in classrooms across the United States and by the general public. Initial evaluation reports and research indicate that handheld computers can positively impact student learning. These tools can motivate students, allow them to collaborate and communicate in different ways, and help them represent their knowledge in different ways (e.g., Roschelle & Pea, 2002; Soloway et al., 2001; Vahey & Crawford, 2002, p. iii).

Handhelds are slowly making their presence felt in social studies classrooms and can be used for a wide variety of activities, including brainstorming, writing, research, data collection, and multimedia projects. The development of handheld hardware and software currently enables users to take pictures, shoot video, create and carry sound files, and do multimedia presentations, as newer handhelds have ever-faster processors and virtually unlimited memory through the inclusion of expansion slots. As has been the case with previous developments in instructional technology for social studies education, little research is available as of yet. The available literature tends to focus on integration of handheld technology into the curriculum; examples include a general overview of handheld technology for social studies (Whitworth, Swan, & Berson, 2002), the use of graphing calculators to explore social studies topics such as monetary policy in the Populist era (Lee & Robinson, 2003), and the use of handheld devices in a stock market simulation during the Great Depression (van 't Hooft & Kelly, 2004).

Texas Instrument's TI-83 is an example of one handheld device that can be used in the social studies classroom. Although this device has been commonplace in mathematics and science education for years, its use as well as research on its use in social studies education is quite limited. In 2003, three projects were funded through a strategic alliance between Texas Instruments and NCSS to investigate the use of this particular handheld device in social studies education. This paper contains the findings of one these projects.

Methodology

Research Questions

Since little research has been conducted in the area of handheld technology in preservice social studies teacher education, this project focused on establishing some baseline descriptive information about preservice teachers' views of handhelds and their uses of the device. In particular the researchers asked,

- What are preservice social studies teachers' views of the TI-83 handheld device?
- How do preservice social studies teachers use handheld technology in their social studies teaching?

Context

To investigate possible answers to these questions, the integration of the TI-83s and the data collection focused intensively on one set of preservice teachers enrolled in a series of social studies education courses during their final year at a large Midwestern U.S. university. During this academic year, prospective teachers took a social studies education course coupled with a 96-hour field component in the fall and a second social studies education course in the first 5 weeks of spring, immediately followed by 10 weeks of student teaching. Several forms of technology, such as a class Web site, the Internet, and computer software, were infused into all of these courses.

The study focused on one section of the fall social studies education course. Seventeen students were enrolled in the course, 12 male and 5 female students, with an average age of 24.3 years (15 students were 24 years of age or younger, 1 was 32, and 1 was 48) and hailing from lower-middle to middle class backgrounds. Four students indicated that they owned and had used handheld devices in the past, one of them more actively than the other three. Based on classroom observations during the first few days of class, students as a whole seemed comfortable with technology, in general, and one was already using handheld technology (a Palm OS device).

Delimitations and Limitations

The results of this study may be useful for secondary social studies methods instructors, because the study was conducted within a methods course, but more specifically because the mobile tools used in the study were configured for use in social studies classrooms. However, the study was not designed to determine preservice social studies teachers' views of and experiences with technology as a tool for education, in general.

There are some limitations that should be taken into consideration, as well. First, survey data should always be analyzed with caution, given the fact that they are self-reported data. Second, variables not controlled for in this study include age, gender, and instructor. Third, only one preservice teacher used the TI-83 handheld devices in his classroom, limiting the conclusions that can be drawn from this part of the study. The case study should, therefore, be interpreted as anecdotal evidence only.

Technology Integration

Recent studies have shown that merely adding technology to one's curriculum is not enough to bring about instructional reform in social studies education. There is a need for "thoughtful curriculum development, and careful instructional design based on the thorough and on-going explication of assumptions about society, learners and learning, as these are critical to the productive use of technology as to any other teaching mode" (Shaver, 1999, p. 27). In particular, effective technology integration in teaching should create a bond between technology and instructional content and process skills through "innovative and imaginative applications" (Diem, 2000, p. 494), which aim to take students in directions that would not be possible without technology. Preparing preservice teachers to do so requires both training in how to use technology in appropriate ways and continuous technical support (e.g., Diem, 2000). In addition, research has shown that the technology should be an integral part of the preservice curriculum, with clear instructions and time to practice with the technology (Mason & Berson, 2000); effective modeling of technology integration (Milman & Heinecke, 2000; Keiper, Harwood, & Larson, 2000); and practice teaching, including how to teach students to use technology if they lack the knowledge or skills (Keiper, Harwood, &

Larson, 2000). Other studies have shown that for preservice social studies teachers to begin to use technology in their teaching, they need to see it modeled and be able to experience success with the technology before they are willing to risk trying it independently (Crowe, 2004). Based on this knowledge, it was important that the TI-83 be integrated into the class in a meaningful manner.

During the fall social studies education course, the instructor began on the first day of class by providing each student with a copy of the April 2003 issue of *Social Education* that focused on technology and included an article on the use of the TI-83 in a high school classroom. On the second day, she introduced the TI-83 Silver Edition and provided each student with a device, a cradle, a keyboard, and software. She then demonstrated how to use NoteFolio and transfer files, and used them during activities in class, suggesting that students keep notes and enter their discussion questions from the reading for the next day on the TI-83. On the third day, she explained the Technology Integration assignment and posted sign-up sheets for groups based on the four applications to be used: TImeSpan, NoteFolio, StudyCards, and CellSheet.

The instructor continued to call for students to use the tool to take notes during small group work, whole group lessons, or when reading at home and acknowledged those who did. During small group activities she encouraged students to use the tool to record their work and then share it with each other so all had a record. The instructor also assisted any preservice teachers in learning the basic skills needed to operate the device. She gave examples of the way the tool could have a positive impact on student learning by demonstrating the ability to easily integrate graphing to help students visualize relationships. In addition, between days five and six of the class the instructor held two 1-hour tutoring sessions for students who needed or wanted more guidance using the TI-83 device. Six students took advantage of this opportunity.

After using the handhelds in initial lessons in their fall class, the prospective teachers were assigned a technology integration project. This project had been used in the course before and was being used with three other sections. However, only the section under study here focused on the TI-83s for the activities portion of this project. The focus of this investigation was to develop answers to two questions: (a) How can technology impact student learning of social studies, and (b) How can I incorporate technology into my social studies classroom to enhance social studies learning? The preservice teachers critically read and analyzed a minimum of six articles to help develop answers to the two questions, and in small groups of three or four they developed model activities or lessons that integrated the handheld device for use in their practicum setting. Students were divided into four groups, and each group prepared a presentation around a lesson modeling one particular piece of software, including CellSheet, TImeSpan, StudyCards, and Sketchy. The choice was made not to use NoteFolio because it had been used in the beginning of the course by the instructor. On days 1 2 and 13 of the course, the preservice teachers showcased their model lessons.

Data Collection

To develop answers to our research questions, quantitative and qualitative data collection techniques were employed, including (a) a survey administered three times to the preservice teachers across the social studies courses, (b) observations of the first university course, (c) interviews with select preservice teachers, (d) artifact collection, and (e) observations of preservice teachers using the devices in high school classrooms. Data collection took place throughout the 2003-2004 academic year and was collected by the two researchers and the instructor's graduate assistant.

To answer the first question (What are preservice social studies teachers' views of the TI-83 handheld device?) data was collected by means of a survey, interviews, and observations of the university classroom. A survey was created based on an existing instrument (Computer Attitude Survey; Lloyd & Gressard, 1984), and entitled the Handheld Computer Attitude Survey (Appendix A). The survey contains 40 items distributed over four factors, including handheld computer comfort/anxiety (15 items), handheld computer liking (nine items), handheld computer usefulness (10 items), and learning activities related to handheld computers (six items). It was administered three times, once at the beginning of the first social studies education course (August), once at the end of that course (December), and once near the end of the second course (February). The first administration was included to provide a baseline for the preservice teachers' attitudes before they were exposed to the TI-83s, the second administration took place relatively soon after students had completed their technology integration projects, and the third administration occurred later in the academic year to see if after time and more learning, student attitudes about the devices had changed.

The survey provided breadth related to the preservice teachers' general views toward handheld use. To complement the survey data, either one of the principal investigators or the instructor's graduate assistant collected observational data in September and October through videotape and field notes, and interviews were conducted with select preservice teachers. Six out of 17 students were interviewed at the beginning of October, four males and two females. They were purposefully chosen to represent those who appeared to be interested in using the device, those who seemed to resist its use, and those who were not either actively resistant or clearly ready to use the technology. This decision was made in order to capture a wide range of thoughts related to the device and experiences with the device.

Interview questions focused on learning more about preservice teacher perceptions of general technology use, perceptions of the TI-83, the learning experience they had just undergone in the university course, and the likelihood of their use of the tool in the future (for the general interview questions see Appendix B). Interview sessions were conducted by one of the two researchers or the graduate assistant. A semistructured format was used, meaning that a predetermined list of questions was used but follow-up or probing questions could follow leads provided by the person interviewed. The sessions were either audio or video taped and transcribed, and field notes were taken. Interview transcripts were read and analyzed for themes common across students.

To more fully answer the second question (How do preservice social studies teachers use handheld technology in their social studies teaching?), we examined the activities created for the technology project and then focused on examining the efforts of one student who began to use the TI-83 devices at his field placement site. Data was collected to develop a case-study of his experience, including classroom observations of him teaching in the field, journals, notes, e-mails, lesson plans, informal conversations, and a post-student-teaching interview.

Analysis and Findings

Analysis of the various data sources yielded the following results. The findings from the survey are provided first, findings from the interview second, findings from the artifact collection section, and the case study last.

Survey Data Analysis and Findings

Descriptive analysis of the survey data showed general patterns reflecting a downward trend for all four factors: handheld computer anxiety/comfort; handheld computer liking; handheld computer usefulness; and learning activities related to handheld computers. More thorough statistical analysis was conducted using the Wilcoxon matched-pair signed-rank test ($p = .05$), due to the ordinal nature of the survey data and the fact that the comparisons involved dependent samples. Z-scores for all items combined were not statistically significant between any of the comparisons, or for any of the factors as a whole, except for the anxiety factor in the August-February comparison ($Z = -2.239$; see Table 1). However, certain individual items did show statistically significant changes over time. Tables 2 through 6 provide the Z-scores for the individual items for each of the four factors.

Table 1
Wilcoxon Test Statistics for the HCAS (Overall and by Factor)

Comparison	Overall	Anxiety	Liking	Usefulness	Learning Activities
Aug – Nov	-1.038	- .627	- .191	-1.336	-1.115
Nov – Feb	-1.191	-1.225	- .312	-1.075	- .871
Aug – Feb	-1.605	-2.239*	-0.412	- .095	-1.798
*p < .05					

Table 2
Wilcoxon Test Statistics for the HCAS Handheld Computer Anxiety/Comfort Factor (items 1, 4, 6, 9, 12, 14, 15, and 16)

Comparison	Item							
	1	4	6	9	12	14	15	16
Aug – Nov	- .073	- .707	- .686	-1.937	-1.997*	- .359	-2.496*	-1.100
Nov – Feb	-1.069	-1.725	-1.136	-1.387	- .265	- .284	-1.613	-1.613
Aug – Feb	- .812	-1.406	.000	- .525	-1.467	- 0.61	- .905	-.333

Table 3
Wilcoxon Test Statistics for the HCAS Handheld Computer Anxiety/Comfort Factor (items 18, 22, 24, 28, 30, 33, and 40)

Comparison	Item						
	18	22	24	28	30	33	40
Aug – Nov	-1.561	- .758	- .054	-2.153*	-1.310	- .647	- .548
Nov – Feb	-1.155	- .632	-1.155	-1.155	-1.000	- .333	-2.326*
Aug – Feb	- .587	-1.310	-1.066	-1.098	-2.271*	- .741	-2.111*
*p < .05							

Table 4
Wilcoxon Test Statistics for the HCAS Handheld Computer Liking Factor

Comparison	Item									
	2	**7**	**11**	**19**	**25**	**27**	**31**	**35**	**36**	**37**
Aug – Nov	-2.812*	-2.437*	-2.506*	-.921	-.486	-2.456*	-1.897	-.884	-1.072	-2.804*
Nov – Feb	-2.491*	-2.308*	-1.732	-1.732	-2.124*	-2.351*	-1.184	-1.998	-1.081	-.905
Aug – Feb	-.812	.000	-.775	-.977	-1.408	-.420	-.250	-.765	-.047	-2.320*
*p < .05										

Table 5
Wilcoxon Test Statistics for the HCAS Handheld Computer Usefulness Factor

Comparison	Item								
	3	**8**	**13**	**17**	**21**	**23**	**32**	**34**	**38**
Aug – Nov	-2.722*	-2.708*	-2.506*	-2.299*	-.458	-2.165*	-.604	-.632	-1.394
Nov – Feb	-1.941	-2.140*	-2.060*	-.359	.000	-1.186	-.277	-1.027	-.992
Aug – Feb	-1.232	-1.100	-.577	-1.558	.000	-.513	-.265	-.905	-.237
*p < .05									

Table 6
Wilcoxon Test Statistics for the HCAS Handheld Computer Learning Activities

Comparison	Item					
	5	**10**	**20**	**26**	**29**	**39**
Aug – Nov	-2.274*	-.491	-1.186	-.184	-1.406	-.368
Nov – Feb	-2.215*	-1.095	-.832	-.491	-.535	-2.126*
Aug – Feb	-.568	-1.134	-.574	-.333	-.333	-1.999*
*p < .05						

Analysis of the Z-scores indicated the strongest downward trends in items related to handheld computer liking and handheld computer usefulness, especially when considering the August-November comparison. This was the time period in which the TIs were most heavily used, and when attitudes would have been most heavily affected. For handheld computer liking, items 2, 7, 11, 27, and 37 showed statistically significant differences between August and November, with Z-scores ranging from -2.812 for Item 2 to -2.437 for Item 7 (Table 4; see Appendix A for item descriptions). For the handheld computer usefulness factor items 3, 8, 13, 17, and 23 yielded statistically significant differences for the same time period (Table 5; see Appendix A for item descriptions). However, these differences do not seem to have held up over time, as the number of statistically significant differences dropped when looking at the November-February comparison. In addition, the overall comparison from August to February shows even fewer statistically significant items (Table 7).

Table 7
Number of Statistically Significant Differences Per Factor

Comparison	Factor (Number of Items)			
	Anxiety/Comfort (15)	Liking (10)	Usefulness (9)	Learning Activities (6)
Aug – Nov	3	5	5	1
Nov – Feb	1	4	2	2
Aug – Feb	2	1	0	1

In addition, weak downward trends could be detected in items measuring handheld computer confidence/anxiety and learning activities related to handheld computers (Table 6). Again, the negative changes in attitudes toward the handhelds were the strongest between August and November, when the handhelds were actually used, but this downward trend became weaker over time. It should be noted that for all four factors, different items were statistically significant at different times, and any interpretations of the data should be done with caution (tables 2-6).

Interview Analysis and Findings

Interview transcripts and tapes were analyzed for recurring themes and triangulated with survey and observational data. Both researchers examined the data for these themes using a constant comparative method, eliciting and refining themes throughout and following the time period in which the interviews took place (as recommended in Glaser, 1978). The researchers agreed that student comments fell under two broad themes: technology use and learning to use technology. In terms of technology use, the preservice teachers brought up several consistent ideas.

First, preservice teachers emphasized the importance of using technology in social studies education, if done right. One preservice teacher indicated that "when I think about education and technology use, the first thing I think of is the negatives, the troubles that a lot of teachers get in because they use it, you know, 'hey this is fun,' and nobody gets a thing out of it." The preservice teachers also cautioned against overuse. One stated, "I think it's useful, but I think it can also hinder the learning ability, I think teachers rely too much on it," while another agreed by saying "I don't think that it's something that should be exclusively done, because you still need to rely on paper or pencil a little bit, but I think it enhances learning." They did, however, convey a sense of understanding the potential of the TI-83 for social studies to enhance learning due to its portability and availability of the software, thinking about "how much better it can make my lesson plans and how much more engaging and motivated I can have the students be." One preservice teacher provided an example of using StudyCards:

> I like the StudyCards as a good tool, especially if you're gonna go on a field trip. It's something you can take with you, I thought that was really good, or just like, organizing questions to ask them, like how we did the virtual field trip. I think it would be a good help aid to the lesson that you're gonna be doing.

Besides the potential uses of the handhelds, students also pointed out severe limitations due to the hardware configuration (small screen size and resolution, lack of color, buttons with calculator and text entry functions) in combination with the complexity of use of some of the software. Especially, Sketchy was targeted as being "hard for kids to use" and "a little bit too out there, complicated." These opinions were coupled with a general perception by many that the TI-83 is a calculator to be used in mathematics, not social

studies. One preservice teacher described his initial reaction: "When you handed out a TI, I'm like 'ahh, I hate these things." I'm like, it brings back math. So I was, that was my nemesis." Another compared the TI with other handheld devices, stating that she did not see them "as a calculator, but the TI is used for math only."

In general, there was the sense that the same things could be done better on a desktop or laptop. This was particularly the case when students compared specific functions, such as constructing data in spreadsheets:

> When I looked at CellSheet I saw Excel, and it's on a computer and the screen's bigger, and the data's easier to enter, and everyone knows how to use Windows, and everyone knows the shortcuts. Well, I shouldn't say everyone, but most people know the shortcuts. It's easy to graph. You can make all kinds of different colors and representations, and I mean, granted on here [the TI] you can make different representations, but you can't give the color to it and that's what really brings things out, I think, is if you can show kids a pie chart that's got blue and red and green, and and you can say this percentage of people, and it's in the blue and you really see it. And I didn't see that with CellSheet.

These trends seem to convey some of the reasons why there was a general downward trend in the attitude survey, and they were mirrored in classroom comments about the device.

Second, in terms of learning to use technology, the preservice teachers articulated an importance of learning by doing ("messing around with it, tinkering with it, seeing what's on there … really try to understand"), and learning with and from others inside and outside of class (peer support, group projects, and presentations). Another important consideration was having time to learn the technology, and not just during the methods course:

> This semester everybody's, it's a really busy semester to be going out in the field. Having more time would've, with it, … I probably would have accepted it even more, I would have done more with it. It's just the whole time thing, you know. If it was introduced early on maybe, like in our inquiry class, not that that's not a busy time, but the earlier I think you're introduced to something and then if it's reinforced in another class later, I think is helpful.

Some felt the curriculum was already overloaded and they did not feel that the device was important enough to be included. These preservice teachers felt that they needed to spend more time on the nuts and bolts of teaching social studies:

> We spent so much time on that technology. We were like, well we want to know what we need to do when we get out there and, you know, give us some ideas of how to teach this and that. And we felt like we spent a lot of time on, on the tech and the calculator, and, and, I don't want to say we felt short-changed, but we just, I guess we kind of worried that we spent a little too much time on, on that specific thing.

This feeling may be an indication of the preservice teachers not having come to a full understanding of technology as integrated in, as opposed to added onto, the social studies curriculum.

Analysis and Findings of Activities Created

For the Technology Project, preservice teachers worked in small groups of three to five to create activities or lessons that used their specific TI-83 APP (the term TI uses for the programs or applications on the TI-83). Each group created a variety of ways to use the tool and its particular APP. Trent, who would later use the TI-83s in his classroom during practicum and student teaching created the Electoral College simulation that utilized CellSheet. All activities were analyzed, first, in terms of how and by whom the TI-83 and accompanying APP were used and, second, in terms of the level of students' cognitive engagement (Figure 1).

There were 17 preservice teachers in the course and 18 activities described. Of these 18 activities, 7 activities involved the teacher using the APP to create an artifact for student use and 10 activities involved the student using the APP to either create an artifact or to process information. One activity was described as requiring both teacher and student to use the APP. The preservice teachers' activities showed different ways in which the TI-83s and the APPS could be used within a lesson. The activities fell into three categories.

TI-83 and APP used by teacher to create artifact to help students. Out of 18 activities and lesson ideas, eight focused on the teacher creating an artifact that the teacher or student could use to help in one part of a lesson. In particular, three activities were designed in which the teacher would use the TI-83s and the Study Cards APP to provide students with directions, four involved teachers using the TI-83s and an APP to share content with students (1 Study Cards, 3 TImeSpan), and one had the teacher use the TI-83 and an APP (Sketchy) to create an artifact to use as an attention getter for a lesson.

TI-83 and APP used by students to create a product. A total of six activities and lesson ideas were created that utilized the TI-83s and an APP for students to create a product during the lesson. For example, three activities asked students to use Sketchy to visually demonstrate an aspect of the lesson, two activities asked students to use TImeSpan to put their research in a chronological form, and one activity asked students to use the computer and the StudyCards APP to create content and the TI-83 to share the content.

TI-83 and APP used by students as integral part of the learning activity. Four activities and lesson ideas were designed to play an integral part in the learning activity. All four were designed for students to use Cell Sheet to input and manipulate data to better understand a concept.

Cognitive Engagement With the TI-83 and APP

The activities were also analyzed for levels of students' cognitive engagement with the TI-83 and APPs. It should be noted that the designations of low, medium, or high do not apply to the activity itself but only to the students' use of the TI-83 and APPs. Therefore, a lesson could involve a high level of cognitive engagement but very little cognitive engagement with the technology. On a continuum of cognitive engagement, activities and lesson ideas coded as having low cognitive engagement reflect activities in which students would have very little cognitive engagement with the TI-83 and accompanying APP. Such low engagement activities might include receiving information via the TI-83. Activities described as having medium cognitive engagement would require students to have some cognitive engagement with the TI-83 and accompanying APP. Students might be cognitively engaged by using the tool to represent or share what they had learned, for

example, by way of a student-created graph. Activities coded as having high cognitive engagement required students to use the TI-83 and accompanying APP for higher order thinking, such as processing and organizing information using the handheld device.

Activities designed for StudyCards were generally the least cognitively engaging. The StudyCards APP was integrated into activities in less cognitively engaging ways than the other three apps. Activities designed for TImeSpan were split between low and medium engagement, and activities designed with Sketchy were typically coded as medium. The activities using the CellSheet program involved the highest level of student cognitive engagement with the TI-83s and the APPs.

A Case Study: "Trent"

Two weeks after the preservice teachers designed and presented their model activities during the sixth week of classes in the fall semester, one student (to be named "Trent" hereafter) inquired about a set of TI-83s to use with his onsite, small group teaching lesson, a requirement of the practicum course. Trent had been searching for ways to improve the test scores of these students when he heard during class that using the TI-83s and StudyCards was one way in which a teacher had reached her social studies students with special needs. These special needs students had grown-up with GameBoys and other handheld video games and were motivated to learn using the TI-83 since it was a similar type of device. Trent chose to develop a lesson utilizing the software program StudyCards and began working with a small group of students with special needs and their intervention specialist. Although this was not the program he had focused on during the campus-based course, he had seen it demonstrated as a guide for a virtual field trip by his peers for their model activities. Trent created a set of test review cards for a group of students with special needs and then taught the lesson at his practicum site the following week.

With this initial attempt at integrating the TI-83 handheld technology in a small-group setting, Trent found the students to be motivated, and they spent more time reviewing for the test than usual. He encountered no problems when preparing and using the devices in class. After the test was graded, he was encouraged even further by the results of one particular student who consistently did poorly on tests (38 and 44 on the first two exams). The student earned a 74 on the test for which Trent had taught him how to prepare using a TI with StudyCards. The intervention specialist was also very pleased with the tool and wanted to write a grant to be able to use TI-83s on a larger scale, to see if they would help her students. The combination of these factors made for a very positive first experience in the high school classroom and helped Trent gain enough confidence to use the TIs in his 2-week unit later in the month.

The second time Trent used the handhelds occurred during the teaching of a 2-week unit on the Progressive Era, another requirement of the fall practicum. He developed lessons around the program TImeSpan, which allows users to look at timelines in a variety of ways. In Trent's unit, the electronic timelines provided context for the study of Constitutional Amendments related to the Progressive Era. He used the technology with all students in the sections he taught (160 sophomores). Again, Trent's experience was positive, even though his cooperating teacher seemed somewhat apprehensive about the use of the handheld technology. Trent's students were quite responsive. The students indicated on a survey which Trent administered that TImeSpan helped them understand the content better and that they would like to use them again. These two positive experiences with students and the tool seemed to be all the encouragement Trent needed to keep trying.

Near the end of the fall semester, Trent approached his instructor about using a set of TI devices during the student teaching phase. Trent was given a classroom set for the spring semester. Throughout the spring he used the TI-83s and the StudyCards program for all students with special needs and for every unit. At the same time, he searched for a place to use the devices in a whole-class setting. He wanted to find a unit that would be enhanced by the technology, rather than it becoming an add-on to be used because it was available. About 5 weeks into student teaching, he began to formulate a way to integrate the technology.

The lesson Trent developed looked at the Electoral College over time and used three close presidential races to facilitate discussion (Hayes/Tildon in 1876, Kennedy/Nixon in 1960, and Bush/Gore in 2000). Following a brief lecture introducing the topic, students looked at a TImeSpan timeline to locate the elections chronologically. In addition, students used a teacher-created spreadsheet in CellSheet to investigate the differences between popular vote and electoral votes, as well as the importance of choosing a running mate, debates, and political advertising. After small group discussion, each group defended its choice for a running mate for either Kerry or Bush for the upcoming Bush/Kerry election in 2004. Classroom observation data indicated that even though students did the Electoral College lessons right before spring break, they were actively involved in the small and whole group discussions, using the CellSheet data on the handheld to justify their choices.

Overall, Trent learned a great deal from this experience, and his positive experience has strengthened his interest in using technology to facilitate student learning. On one level, Trent found that students who had a record of being particularly difficult to engage in class activities and who he had worked with using the TI-83s and StudyCards (a) became more involved in class activities, even those not involving the TIs and (b) improved their test scores and overall class grades. On another level, he began to understand in very concrete ways that his students had different needs and that his job was to address those. He more clearly saw technology as a means to reach students and to represent information in different ways (for example, timelines that represent information and time spatially, which helps many students understand chronology better).

From Trent's experience we were given some insights into how students would respond to this tool in a social studies setting. We had not been looking to see how students would respond, but Trent found great success with using the tool with his students with special needs. In addition, he found that most of his students thought that by the using the TI-83 and the APPs TImeSpan and CellSheet the lesson was more interesting (43 of 47) and that many wanted him to use the tool again (38 of 46).

Conclusions and Implications

Where do the preliminary findings take us when considering the research questions that guided this study—that is, what are preservice social studies teachers' views of the TI-83 handheld device, and how do preservice social studies teachers use handheld technology in their social studies teaching? From the surveys alone, the preservice teachers did not seem to think highly of the handheld device, feel comfortable with it, or see its potential in a social studies classroom. When examining the interviews, it appeared that the problem was not technology, in general, or handheld technology, specifically, but the specific tool that was used, the TI-83. Many saw difficulties with the usability of the TI-83 and thought that a computer was just as easy to use.

When examining the interviews and classroom conversations in light of the surveys, the dislike for the handheld device surfaced for a variety of reasons, including but not limited to limitations of the hardware; the perception that the TI-83 device is a calculator with

specific uses for mathematics and science; and the perception that the time spent on learning the technology was taking away from time that should be spent on other parts of the curriculum, such as planning and assessment. In this perspective, Trent's success in integrating handhelds was more the exception than the norm and might be explained by the notion that he could be considered an early adopter when it comes to integrating technology (see Sandholtz, Ringstaff, & Dwyer, 1996).

When thinking about the preservice teachers' views of the TI-83, it is interesting to note the difference between the general trend in the surveys and Trent's survey. Even though modeling took place, preservice teachers were placed in small groups for support and tutoring sessions were available outside of normal class times, many of them did not like the technology given to them, which the survey data clearly show.

The strongest negative trends were visible in the August-November comparison. This is the period in which the preservice teachers used the handhelds most heavily. Once they were not exposed to them anymore on a regular basis, the negative attitudes seemed to be mitigated. However, when the overall experience was positive (including both the college classroom and practicum site), it did have an effect on their views toward the handheld device. Trent's survey responses reflect this, as his scores were the highest for the August-November and August-February comparisons. For him, these were the periods in which he used the handheld technology most, first as a student, later as a student teacher at his practicum site.

Although it is difficult to make general statements about attitudes based on the survey data from one respondent, the difference between his responses and those of his classmates warrants further investigation. Given Trent's experience, it would seem that having a safe environment at the university where one could be introduced to the hardware and software, as well as having a situation where one can see potential for success from the tool, are important elements to encourage the use of devices like the TI-83. Trent, for example, remembered one of the researchers mentioning that students now have grown up with GameBoys and other handheld electronic toys. This was enough for Trent to consider using the tool in his classroom. This, followed by success in the field, seems a good way to support preservice teachers' use of new technological devices.

Although the preservice teachers did not overwhelmingly adopt and begin to use the TI-83 and APPs in the classroom, they did create some interesting activities and lessons. These lessons give us insight into how preservice teachers envision the potential uses of the tool. Trent's experience also provides us with further insights. The preservice teachers created a wide variety of activities and lessons that required various levels of cognitive engagement with the TI-83. It seemed that the APP itself played a strong role in determining the level of cognitive engagement required of the students. StudyCards and TImeSpan, for example, cannot be altered through the handheld device. Based on their specific design, the creative actions with these two APPs can only occur at the desktop. However, when using Sketchy and CellSheet, students can directly manipulate information using the TI-83, which changes the relationship among the student, the tool, and the learning.

From Trent's experience, we saw that StudyCards and TImeSpan can provide an important supplement and that the behavioral engagement that the TI-83 can elicit can be important itself. Students with special needs were able to perform better on tests and in class after working with the TI-83 and StudyCards, and the use of TImeSpan with the whole class seemed to engage students. In the future, research should be developed to

examine the use of the tool in relation to student academic success, student learning, and student motivation. Although this data set is small, Trent's experience shows positive potential in all three areas.

In conclusion, the integration of TI handheld technology in social studies seems to have limited potential as a tool for social studies teachers to engage their students. In terms of helping new teachers learn to use this tool, teacher educators need to address issues related to the hardware and software, understand their preservice teachers' perceptions of the TI-83, and integrate the tool into class in ways that model high cognitive engagement with technology. Hardware and software limitations should be resolved by the manufacturers, based on feedback from research such as this, and instructors can help preservice teachers with a clear support system for problems they may encounter.

The overall findings indicate that much work remains to be done, and many issues need to be addressed. For one, how can we more effectively teach preservice teachers to evaluate the appropriateness of different technology tools for use in the teaching and learning of social studies? How can we train prospective teachers to keep up with the latest developments in educational technology, so that they do not shortchange themselves and their students in the long run? How much time is needed to learn how to use a new piece of technology and how to effectively integrate it in the curriculum without it interfering with the rest of the content taught? The question here becomes whether this can be done just in the content area courses. Based on our findings, the answer would be "no."

Moreover, how can potential issues with practicum and student teaching sites related to technology integration be resolved? None of the preservice teachers saw handheld technology of any kind being used at their practicum sites. This may help explain why only 1 out of 17 students was comfortable enough to try to integrate them during practicum. Many times colleges of education do not have the luxury of handpicking teaching sites, as they often have to use whatever sites they can get. This often leads to students being placed at schools where technology levels are low, where the cooperating teachers are not heavy technology users, or where technology is not a priority. According to existing research the cooperating teacher exerts a large amount of influence on the preservice teacher placed under his or her care (e.g., Doering, Hughes, & Huffman, 2003), and attitudes and beliefs related to teaching and learning are often formed or amplified at this time. Therefore, it is paramount that preservice teachers have been prepared prior to this time to deal effectively with this situation.

What can and should be done to convince preservice teachers that the area of technology use and its effects on society are an integral part of social studies education? Mason et al. (2000) have paved the way to some extent, providing preservice educators with guidelines for the integration of technology in preservice social studies education. Given these guidelines, more efforts need to be made to introduce and model the TI-83 technology in context, so that preservice teachers can see for themselves that this can be done and that technology can be used to extend learning above and beyond what can be done without it. The challenge will be to accomplish this both at the university and secondary education levels.

Preservice teachers also need to be given the opportunity to take a critical look at the use of technology in society (including in the schools in which they are going to teach) and its impact on its citizens (Ross, 2000). After all, this is one of the responsibilities of social studies educators, and preservice educators should "foster the development of the skills, knowledge, and participation as good citizens in a democratic society" (Mason et al., 2000, p. 2). In this respect, the Internet would be a good place to start, because it is one

of the most widely used technologies in social studies education. Finally, more systematic research needs to be done in the area of social studies and technology, as reviews of the existing literature (Berson, 1996; Whitworth & Berson, 2003) have repeatedly shown that we do not really know what impact technology has on teaching and learning in social studies.

References

Berson, M. J. (1996). Effectiveness of computer technology in the social studies: A review of the literature. *Journal of Research on Computing Education, 28*, 486-499.

Berson, M. J., Lee, J. K., & Stuckart, D. W. (2001). Promise and practice of computer technologies in the social studies: A critical analysis. In W. B. Stanley (Ed.), *Critical issues in social studies research for the 21st century* (pp. 209-230). Greenwich, CT: Information Age Publishing.

Crowe, A. (2004). Teaching by xample: Integrating technology into social studies education courses. *Journal of Computing in Teacher Education, 20*(4), 159-165.

Diem, R. A. (2000). Can it make a difference? Technology and the social studies. *Theory and Research in Social Education, 28*, 493-501.

Doering, A., Hughes, J., & Huffman, D. (2003). Preservice teachers: Are we thinking with technology? *Journal of Research on Technology in Education, 35*, 342-361.

Doolittle, P. E., & Hicks, D. (2003). Constructivism as a theoretical foundation for the use of technology in social studies. *Theory and Research in Social Education, 31*, 72-104.

Ehman, L. H., & Glenn, A. D. (1990). Interactive technology in social studies. In J. P. Shaver (Ed.). *Handbook of research on social studies teaching and learning* (pp. 513-522). New York: Macmillan.

Fitzpatrick, C. (2000). Navigating a new information landscape. *Social Education, 64*, 33-34.

Glaser, B. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, CA: Sociology Press.

Keiper, T., Harwood, A., & Larson, B. E. (2000). Preservice teachers' perceptions of infusing computer technology into social studies education, *Theory and Research in Social Education, 28*, 566-579.

Lee, J. K., & Robinson, K. (2003). The graphing calculator: Helping students explore social studies topics. *Social Education, 67*, 151-153.

Lloyd, B. H., & Gressard, C. P. (1984). Reliability and factorial validity of computer attitude scales. *Educational and Psychological Measurement, 44*, 501-505.

Martorella, P. H. (1997). Technology and the social studies – or: Which way to the sleeping giant? *Theory and Research in Social Education, 25*, 511-514.

Mason, C. L., & Berson, M. J. (2000). Computer mediated communication in elementary social studies methods: An examination of students' perceptions and perspectives. *Theory and Research in Social Education, 28*, 527-545.

Mason, C., Berson, M., Diem, R., Hicks, D., Lee, J., & Dralle, T. (2000). Guidelines for using technology to prepare social studies teachers. *Contemporary Issues in Technology and Teacher Education, 1 (1)*. Retrieved January 30, 2006, from: http://www.citejournal.org/vol1/iss1/currentissues/socialstudies/article1.htm

Milman, N. B., & Heinecke, W. F. (2000). Innovative integration of technology in an undergraduate history course. *Theory and Research in Social Education, 28*, 546-565.

National Council for the Social Studies. (1994). *Expectations of excellence: Curriculum standards for social studies.* Washington, DC: Author.

Rice, M. L., & Wilson, E. K. (1999). How technology aids constructivism in the social studies classroom. *The Social Studies, 90*, 28-33.

Risinger, C. F. (1998). Separating wheat from chaff: Why dirty pictures are not the real dilemmain using the Internet to teach social studies. *Social Education, 62*, 148-150.

Roschelle, J., & Pea, R. (2002). A walk on the WILD side: How wireless handhelds may change computer-supported collaborative learning. *International Journal of Cognition and Technology, 1* (1), 145-168.

Ross, E. W. (2000). The promise and perils of e-learning. *Theory and Research in Social Education, 28*, 482-492.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1996). *Teaching with technology: Creating student-centered classrooms.* New York: Teachers' College.

Saye, J. W. (1998). Creating time to develop student thinking: Team-teaching with technology. *Social Education, 62*, 356-362.

Shaver, J. P. (1999). Electronic technology and the future of social studies in elementary and secondary schools. In M. R. Nelson, L. Monsen, & Y. Nordkvelle (Eds.), *Reform and change in social studies: 1998 Social Science Educational Consortium annual conference* (Research Report No. 47, pp. 24-37). Lillehammer, Norway: Lillehammer College.

Soloway, E., Norris, E., Blumenfeld, P., Fishman, B., Krajcik, J., & Marx, R. (2001). Log on education: Handheld devices are ready-at-hand. *Communications of the ACM, 44*(6), 15-20.

van 't Hooft, M. A. H., & Kelly, J. (2004). Macro or micro: Teaching fifth-grade economics using handheld computers. *Social Education, 68*(2), 165-168.

Vahey, P., & Crawford, V. (2002). *Palm™Education Pioneers program: Final evaluation report.* Menlo Park, CA: SRI International.

Whitworth, S. A., & Berson, M. J. (2003). Computer technology in the social studies: An examination of the effectiveness literature (1996-2001). *Contemporary Issues in Technology and Teacher Education, 2*(4), 472-509.

Whitworth, S. A., Swan, K.O., & Berson, M. J. (2002). Handheld computing in the social studies. *Social Education, 66*, 174-179.

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Appendix A

Survey: Preservice Teacher Attitudes Toward Handheld Technology

<u>Part I:</u>

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

1. Gender   ____ Male   ____ Female

2. Age: _____

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

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

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

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

<u>Part II</u>:

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

Statement	SA	A	N	D	SD
1. Handheld computers do not scare me at all.	5	4	3	2	1
2. I would like working with handheld computers.	5	4	3	2	1
3. Learning about handheld computers is a waste of time.	5	4	3	2	1
4. I do not feel threatened when others talk about handheld computers.	5	4	3	2	1
5. It wouldn't bother me at all to take handheld computer classes.	5	4	3	2	1

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

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

Statement	SA	A	N	D	SD
21. I can't think of any way I will use handheld computers in my career.	5	4	3	2	1
22. I think using a handheld computer would be very hard for me.	5	4	3	2	1
23. Learning about handheld computers is worthwhile.	5	4	3	2	1
24. Handheld computers make me feel uneasy and confused.	5	4	3	2	1
25. If a problem is left unsolved in a handheld computer class, I would continue to think about it afterward.	5	4	3	2	1
26. I could get good grades in handheld computer courses.	5	4	3	2	1
27. I will do as little work with handheld computers as possible.	5	4	3	2	1
28. I feel aggressive and hostile toward handheld computers.	5	4	3	2	1
29. I do not think I could handle a handheld computer course.	5	4	3	2	1
30. I have a lot of self-confidence when it comes to working with handheld computers.	5	4	3	2	1
31. Figuring out handheld computer problems does not appeal to me.	5	4	3	2	1
32. Knowing how to work with handheld computers will increase my job possibilities.	5	4	3	2	1
33. Working with a handheld computer would make me very nervous.	5	4	3	2	1

34. Working with handheld computers will not be important in my life's work.	5	4	3	2	1
35. When there is a problem with a handheld computer run that I cannot immediately solve, I would stick it out until I have an answer.	5	4	3	2	1
36. I do not enjoy talking with others about handheld computers.	5	4	3	2	1
37. Once I start to work with a handheld computer, I would find it hard to stop.	5	4	3	2	1
38. I will use handheld computers in many ways in my life.	5	4	3	2	1
39. It's important for me to do well in a handheld computer class.	5	4	3	2	1
40. Handheld computers make me feel uncomfortable.	5	4	3	2	1

Appendix B

Interview Protocol

- What is your perception of technology use in general?
- What is your perception of technology use in the social studies classroom?
- What have you learned about the TI-83 so far?
- How have you learned it?
- What have you done to learn how to use it?
- How have you use it so far?
- What do you like about the TI-83?
- What problems/issues have you encountered in the use of this tool?
- How did the activities we recently completed (in which you had to, as a group, plan some activities for the TI-83) help you learn about the tool?
- Did you learn more about it before or after you began work on the activities?
- Have the ideas from others given you ideas about how to use the tool?
- Do you think you can use this tool in a lesson?
  Why or why not?
- How would you use it?
- Do you plan on using technology in general in your teaching? If so, what would you use?
- If the technology was available to you, do you think you would use the TI in your teaching this fall or in the spring?
- What would encourage you to use this tool in your teaching?
- What discourages you from using it?
- How does this tool need to be changed to make it more useful for teaching and learning in social studies?