Running Head: RESEARCH ON GEOSPATIAL TECHNOLOGIES

Coming of Age:
Research and Pedagogy on Geospatial Technologies within K-12 Social Studies Education

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Introduction

Throughout the decades, technology use within education has gone through numerous iterations with each new technology promising a transformation for learners, instructors, and classrooms. From the audiovisual movement in the 1930s, the computer-assisted instruction movement in the 1970's and 1980's, and the Internet era of today, the field of educational technology is continually striving to understand how to best integrate technology within educational contexts in order to enhance instruction and learning – a goal that has not been realized. The lessons that researchers within the field of educational technology have learned from the past are that no technology is a panacea for education and that teachers will always be an important factor in better understanding how technology can influence learning (Roblyer, 2000; Clark, 1983, 1985, 1991, 1994).

This trepidation about investment in and research about educational technology is also echoed within the field of social studies education. In the late 1990s, Martorella (1997) strongly urged social studies educators and their research communities to tap into the power of technology for supporting and transforming social studies teaching and learning. Although the research community has responded with a small sampling of research, the potential of technology, specifically geographic information systems (GIS), within social studies education has not been realized (e.g., Bednarz & van der Schee, 2006; Freeman, 2003). Ross (2000), editor of a special issue of technology in social studies within *Theory and Research in Social Education* noted, "until longitudinal in-depth studies incorporating technological and social studies instructional precepts are conducted, technology will only be given a brief nod of acceptance as something that is nice to think about but not a necessity within the social studies community" (p. 500). Furthermore, in response to Martorella's (1997) comment that technology within the social

studies is a "sleeping giant," Bolick (2004) argues that the "giant is waking" in certain areas within the social studies and calls for collaboration between social studies teacher educators, instructional designers, and technology specialists in order to realize the potential of technology within social studies education. We agree with Bolick that this type of cross-discipline collaboration is necessary if the affordances inherent within and through the use of geospatial technologies (hereafter GTs) in the field of social studies education are to be realized. Specifically, GTs have great potential to enhance the teaching and learning of geography. We believe this vision of a fully awake and functioning "giant" can be a reality through taking to heart and understanding the lessons learned about technology integration from the field of learning technologies and from using theoretical frameworks focused on pedagogy as guides for future social studies educational research.

In this chapter, we focus our discussion on technology research within the social studies by highlighting the lessons learned from the field of learning technologies, discussing the disconnect between theory and practice, discussing the current research on GT integration within the social studies, and finally, suggesting frameworks for future research on GT integration in K-12 contexts.

Lessons from Learning Technologies

We fully recognize that most often research does not tend to cross disciplines. However, the field of learning technologies can inform the field of social studies education. Through the lessons learned in the field of learning technologies, we believe that learning technologies research on pedagogy and technology can inform social studies educational research.

Within learning technologies, educators and researchers tend to hope for widespread transformations in education because technological advancements have brought about such

pervasive impact in numerous other areas of society in the past (Bull et al., 2005). For example, in 1922 Thomas Edison proclaimed that the "motion picture is destined to revolutionize our education system and that in a few years it will supplant largely, if not entirely, the use of textbooks" (Brooker, 1947); Seymour Papert (1984) asserted the computer as "a catalyst of deep and radical change in the educational system"; and Cisco Systems Inc. CEO John Chambers noted that "education over the Internet is going to be so big it is going to make e-mail usage look like a rounding error" (Friedman, 1999). The expectation that technological innovations will and should redefine the educational landscape is still rampant (e.g. Federation of American Scientists, 2006), even though history has shown that these grandiose visions about technology in education have not come to fruition (Cuban, 2001). Additionally, the convincing historical evidence presented by Russell (2001) further illustrates that technology has not transformed teaching and learning. Since 1928, 355 research studies found "no significant differences" in media comparison studies. Media comparison studies are those studies that compare student outcomes across two media (e.g. face to face and distance delivery courses). In other words, these studies found that the two media being compared are no different in terms of student outcomes.

The media debate (Clark, 1983; 1994), albeit dated, is alive and well today as evidenced by the content of journal articles throughout learning technologies and content-specific subjects such as social studies (Robinson & Nathan, 2001). On the one hand, some educational researchers are referencing the debate to support why their research is moving away from media-comparison studies and shifting to focusing on the affordances of effective pedagogy with technology in the classroom (Doering, 2006; Cronjé, 2006). On the other hand, within social studies education, researchers conduct classroom technology research using cross-media

approaches (e.g. Journal of Geography). If we continue to study GTs in this manner, neither the pedagogical nor the technological affordances of GTs will become apparent. As a result, GTs may not be utilized effectively inhibiting its full potential within the classroom. *We must therefore shift the focus of social studies educational research to investigate the most effective pedagogies using GT (e.g. GIS) in the ways it was developed – as a constructivist tool.*

Disconnections: Theory, Geospatial Technology Affordances, and Practice

We view GTs as 'constructivist technologies' or 'mindtools' (Jonassen, 1995; 2000). Inherently, the GTs do not possess any content value, but the value comes from the student taking the role of a geographer and the teacher taking the role of an instructional designer (Dexter, 2002). GTs were designed for agency and industry use, therefore, students learn not *from* GTs, but *with* GTs (Jonassen, 2000).

Unlike traditional uses of instructional software that is produced and then delivered *to* students, GTs enable students to be in the designer's seat as they construct meaning. In this vein, we must remember that constructivism is a theory of learning, not a theory of teaching. Thus, both education and research utilizing GTs should center on students constructing their own knowledge and participating in the solving of problems based on authentic contexts. This constructivist approach to learning within educational technology has become very prominent in the literature within the field of learning technologies at the college level (Duffy & Cunningham, 1996), but questions remain about what is actually transpiring within K-12 classrooms. Is there a disconnection between the inherent design of GTs, the theoretical approach encouraged within the classroom, and the actual use of these technologies within the classroom?

In general, many educators would argue that current educational practice does not follow from theory as a result of issues such as standards testing, the investment of time, the individual

learning paths of students, and the difficulty of assessment when each student is truly constructing his/her own knowledge (Polin, 2004). Although the use of GTs has been noted to assist learners in meeting *all* of the National Geography Standards (Audet & Paris, 1995; Bednarz, 1995) and integration of them in K-12 schools is growing, integration is still not at a rate that educators and software developers had once hoped (C. Fitzpatrick, personal communication, 2006). In addition, state integration of geography and GIS are at best uneven and under-represented across the U.S. (Milson & Roberts, this volume).

Numerous reasons have been noted within the literature for this disconnect and the continued slow integration within the K-12 classroom including the lack of a research agenda in K-16 GIS education, a lack of quality research, and need for more trained researchers (Baker & Bednarz, 2003). Charlie Fitzpatrick, Co-Manager of K12 Education for the Environmental Systems and Research Institute, the company that develops GTs such as ArcView and ArcExplorer Java Edition for Educators, commented, "[the integration of GIS] is behind where we would like to see it. We know there are people who are doing a great deal with it, but it isn't necessarily that the technology as a whole is behind, but the implementation of it is behind." (personal communication, 2006). Fitzpatrick also discussed the need for models of pedagogy and social contexts that support the technology. He further commented, "some people are able to do more powerful things. They are in a situation where the administration supports the use of it. There are a number of people who are following a strict set of lessons and others who are encouraging students to go off exploring. Some teachers are going to do what is right and those that are going to do what they are told." This disconnection between the affordances of the technology and its slow integration in K-12 classrooms is common throughout schooling when it comes to constructivist technologies. Teachers require both freedom and support to create

learning environments within their classrooms that support constructivist learning with GTs. This can be a tall order in today's K-12 schools.

How do we get to the point where teachers are teaching and students are learning in this fashion? We do so through advancing the research about what works and does not work pedagogically when using GTs in the K-12 classroom. In other words, an articulation of training and research designs are needed.

Research "Light" in the Social Studies

In an overview of the research in social studies education regarding the use of technology, Friedman and Hicks (2006) comment that the field can be "criticized as being 'research light'" (p. 251). In order to shed this criticism, geospatial, K-12 social studies research should be situated within positivistic, interpretive, and critical paradigms so that findings can 1) be generalized across populations (if possible) and 2) provide rich descriptions of pedagogical practices and methodologies so practitioners and researchers can inform practice.

To obtain a more holistic perspective of past and current research on GTs within social studies education, we searched digital databases, (i.e. Education Full Text, Education Resources Information Center (ERIC), and Digital Dissertations), limiting our search to peer-reviewed articles published between 2000 and 2006. We also examined various handbook chapters and conference proceedings from technology and social studies conferences. Additionally, leading research and practitioner journals in social studies education were consulted including *Theory and Research in Social Education* and *Social Education.*

On the whole, the research on GTs within social studies education has been described as "adolescent" (Berson & Balyta, 2004). The research appears thin and exploratory in nature; articles and papers typically identify no methodological or theoretical frameworks; offer

rationalizations of the use of GTs; introduce and describe online geospatial software; make recommendations on the use of GTs and proposals for integrating these into the curriculum; and propose uses and benefits of geospatial software in research and the classroom. Our examination of the literature also indicates a general lack of concern for rigorous empirical examination of how GTs may impact learning. As exemplified by Baker and Bednarz (2003), research on GIS in education needs to involve a research agenda, with suitable research questions, designs, data, and methodologies. We emphasize the need for rigorous research in this area because we observed methodological and research design limitations in the published manuscripts that we reviewed.

It should also be noted that a number of authors recognized and accounted for the importance of pedagogy in their manuscripts. For example, Baker and White (2003) and Ramos, Miller, and Korfmacher (2003) utilized a problem-based learning approach; Beckett and Shaffer (2005) employed a pedagogical praxis stance; and Wiegand (2003) engaged students in collaborative learning activities with GIS acting as a supportive tool. Although Baker and White (2003) compare a group of learners using a collaborative GIS and a group of learners using paper maps, they recognize that the positive effects observed for the GIS group cannot be wholly attributed to the technology. Further, we believe that the affordances provided by the media supplied to the two groups are inherently dissimilar, making comparisons between the two groups perilous. Yet, these four studies appear to use technology as a supportive tool in learning activities as proposed by Jonassen, Campbell, and Davidson (1994) by considering pedagogy and learning theory prior to implementing a GIS solution.

We propose that the research on GTs in K-12 classrooms needs to push through its adolescence and come of age. “Research needs to be research” (Baker & Bednarz, 2003, p. 233), regardless of epistemological paradigm (i.e. positivistic, interpretive, or critical).

Frameworks for Future Research

Based on the lessons learned from the fields of learning technologies and social studies education, it is time to take advantage of the strengths of the "giant" within social studies education. To achieve this vision, we offer several frameworks to guide research on GTs within the social studies. These frameworks are focused on pedagogical, methodological and theoretical research models. Pedagogical models are important because they can reveal the most effective ways to teach with technology in social studies. Pedagogy-centered frameworks have the potential to simultaneously spur innovations in social studies instruction and new directions in research surrounding technology use in social studies teaching and learning. Social studies and geography instruction has changed little in decades despite the additions and possibilities offered by technology (e. g. Martorella, 1997; Diem, 2002; Glenn, 2002; Bednarz & van der Schee, 2006). Therefore, as Glenn (2004) suggested, GTs themselves are not the problem, it is social studies instruction that is problematic, which is a *philosophic* issue, "what must be confronted at some point are social studies educators' beliefs about knowledge, teacher and student roles, and fundamentals of learning" (Glenn, 2004, p. 181). Establishing methodological frameworks is important because they provide systematic approaches to studying a phenomenon of interest. As such, the use of commonly accepted methodologies allows for consistency across, and comparability and replicability between studies. Finally, theory informs practice and aids us in applying our ideas to the real world. We need good theory "in order to bridge the gap between description and design" (Mishra & Koehler, 2006, p. 1045).

There are multiple frameworks that can guide future research on the use of implementation of GTs. We advocate the use of the following pedagogical, theoretical, and methodological frameworks to guide future social studies research: 1) *models of geospatial*

pedagogy; 2) *geography technological pedagogical content knowledge* (G-TPCK) (Doering and Veletsianos, 2006) based on Shulman's (1986) initial work on pedagogical content knowledge 3) *constructivism* to understand how students can effectively construct knowledge with technology (Jonassen, 2000); and 4) *design-based research* in order to truly understand learning in context (Brown, 1992; Collins, 1992).

Geospatial Pedagogical Models

As noted by the previous research within learning technologies, research in social studies education needs to not focus on comparing the presence of technology versus the absence of technology, but rather on the most effective pedagogies to teach with technology, specifically GTs. Little research has been done within this area for notable reasons. First, to accomplish quality research within the social studies related to GTs, researchers need money. Historically, the majority of government funds have been funneled to math and science. Currently, geography is the only core academic subject recognized in the No Child Left Behind legislation that does not have dedicated federal funding. Second, to research multiple pedagogies, researchers need a large number of participants within the study to statistically compare both between and across group membership; this situation most likely will not happen without grant money to fuel the research for large-scale studies.

An example of geospatial pedagogical research is proposed by Doering (2004) who designed three pedagogical models for teaching preservice teachers how to learn and teach GIS within their future K-12 classrooms. Three pedagogical models – basics first, structured problem solving, and guided generation – were developed as part of an online learning environment to be used within a preservice teacher education program and the K-12 classroom. These models included a traditional instructionist approach (basics first), constructivist scaffolded approach

(structured problem solving), and a constructivist exploratory approach (guided generation). Students learned significantly more when instructed using the structured problem solving model retaining both declarative and procedural knowledge significantly better two weeks after instruction.

The benefits of Doering's (2004) research that is pedagogically-focused are that it may provide teacher education programs with guidelines on how to effectively teach technology to preservice teachers and it assists pre- and inservice teachers who have not been trained with GTs by providing models and strategies to teach GTs within their future classrooms. However, the research should not stop here. In addition to these pedagogical models, teachers need to develop geography technological pedagogical content knowledge (Doering and Veletsianos, 2006).

Geography Technological Pedagogical Content Knowledge (G-TPCK)

Although the focus of teacher education historically has been on teachers' content knowledge (Schulman, 1986), there has been a vital shift to focusing on teachers' pedagogy (Ball & McDiarmid, 1990). Schulman (1986) provided an in-depth look at what he called pedagogical content knowledge (PCK), three components of teacher knowledge, and stressed the importance of not looking at these components separately. Hughes (2000) took pedagogical content knowledge (PCK) one step further by adding technology as another component of knowledge that is needed by teachers – technological pedagogical content knowledge (TPCK). Most recently, Mishra and Koehler (2006) have discussed the TPCK theoretical framework in greater depth while Hughes and Scharber (in press) discuss TPCK within the content area of English. Doering and Veletsianos (2006) discuss the need for social studies teachers to have geography technological pedagogical knowledge (G-TPCK). In this view, geography teachers understand more than technology alone (e.g. Google Earth), more than pedagogical models alone (e.g.

structured problem solving), and more than content alone (e.g. cultural geography). Rather, they understand the complex relationships and interconnections between and among all three of these components of teacher knowledge (see Figure 1).

--Insert Figure 1 About Here –

Constructivist Learning

If GTs are seen and used as constructivist tools, the result for students is constructivist learning. Although Armento (1986) identified constructivism as a promising research focus almost a decade ago, questions remain around how we should study this area of learning where students are engaged through constructing their own knowledge with the GT tool. Seixas (2001) states, "the ambivalent relationship of social studies to its component academic disciplines poses a problem for this research program. Without models drawn from the disciplines of history and the social sciences, potential frameworks for studying the development of students' ideas remain murky"(p. 546). Thus, not only do we need pedagogical models for guiding social studies learning and teaching, we need models for how to research the resulting constructivist learning.

The use of GTs as constructivist tools implies that conceptions of education need to change. Simply stated, our schools and classrooms need to focus on meaningful learning with technology – learning that is grounded in problem solving where students are learning *with* technology (Jonassen, 2003). This vision of education requires teachers to relinquish control as they assume the role of facilitators assisting students in learning with the GTs. For the students, this vision means they assume more authority in the classroom as they learn to articulate, reflect, and evaluate geographic problems using the technology (Alibrandi, 2003). In terms of learning with GTs, this vision means leading students to ask geographic questions, acquire geographic resources, explore geographic data, analyze geographic information, and act upon the geographic

knowledge they developed in concert with the technology and each other (Malone, Palmer & Voigt, 2002).

Design-Based Research

Design-based research (DBR) holds promise for research on GT in social studies. DBR can be characterized by educational interventions concerned with solving real-world problems (Wang and Hannafin, 2005). More formally, DBR is a multi-step methodological approach aimed at enhancing learning and teaching processes by means of theory development, research in authentic and naturalistic environments, and the sharing of knowledge amongst practitioners and researchers (The Design-Based Research Collective, 2003). In terms of the research process, DBR is interactive, iterative, and flexible (Wang and Hannafin, 2005) because data can be gathered before, during, and after the technological/pedagogical intervention and utilized to revise and refine both the intervention and the theory. Finally, DBR is situated and contextual because the research results are associated with the setting where the research was conducted, and multi- and cross-paradigmatic as researchers may need to utilize research methods from a variety of research paradigms.

The DBR framework is a worthwhile methodological endeavor to pursue in social studies educational research about technology use and integration because researchers need to move away from one-shot approaches to designing interventions, and instead examine ecologically valid learning and teaching processes. As emphasized previously, social studies education researchers need to focus on pedagogy and DBR appears to be well-suited for rethinking the pedagogy with which we learn and teach GTs in the K-12 social studies classroom. Furthermore, by collaborating with teachers and immersing ourselves in contextual and authentic environments, educational researchers and teachers together may be able to advance theory,

teaching, and learning with GTs in K-12 classrooms beyond its current "adolescent" stage (Berson & Balyta, 2004).

Summary

In this chapter we presented an examination of GT use and research within social studies, and proposed that focus should be directed on pedagogy rather than technology. We concluded by recommending four frameworks that we deem valuable for future GT research in social studies education.

We wrote this chapter in the hopes of assisting GT research within social studies to "come of age." We feel that focused and rigorous research (regardless of epistemological standpoint) will help advance integration of GTs in the K-12 environment, provide practitioners and researchers with exemplary teaching practices, and illuminate how students learn when using GTs in authentic, contextual, and ecologically-valid settings. Additionally, we hope to encourage an epistemological shift in how teachers and students think. We hold that knowledge cannot be viewed as a static artifact to be given or passed to students through osmosis. Rather, knowledge should be viewed as self –created, -relevant, -structured, and authentic. Given such a definition, we hope that we will provide the impetus for the awakening of the sleepy, yet mighty giant within social studies education.

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Figure Captions

Figure 1. Geographical Technological Pedagogical Content Knowledge (G-TPCK) – adopted and extended from Hughes (2000)