Using Handheld Technology to Promote Elementary Students' Geospatial Inquiry

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ABSTRACT

This paper introduces and provides a way to use geospatial technology to educate preservice elementary students to integrate math, science, social studies, technology and health curricula. It also provides examples of ways that Preservice teachers worked in co-teaching pairs and in collaborative teaching teams to implement a project with sixth graders to introduce them to the Global Positioning System and a Geographic Information System. The project's outcomes suggest potential knowledge gains of integrating such content specific subjects in meaningful technology learning experiences with preservice teachers. Additionally, project outcomes point to subsequent learning experiences for observant inservice teachers.

Keywords: teacher preparation, technology education, preservice teachers, GIS/GPS in schools.

INTRODUCTION

Teachers often use technology as an instructional tool to facilitate students' content knowledge acquisition. Additionally, many new technology applications and devices are now available for students' hand-held use and application. Placing technology into students' hands to advance their own learning is very different than teachers solely using technology to guide their planned instruction. Hand-held technology provides students with a way to individually operate a data collecting and analyzing device while walking, talking and going beyond the classroom walls (Broda & Baxter, 2003). Implementing new technologies for students' use, however, requires that teachers learn new knowledge and skills themselves (McClurg & Buss, 2007). Research has shown that such professional development can be time consuming for teachers (Leonard & Leonard, 2003) and innovative approaches to facilitating inservice teachers' new knowledge and skills acquisition is becoming increasingly important. Therefore, this reported inquiry investigated ways that preservice elementary teachers could serve as change agents to facilitate elementary students' and inservice teachers' (a) knowledge of a geographic information system and (b) skill using hand-held geospatial technology devices.

PRESERVICE TEACHERS AS CHANGE AGENTS

Many teacher preparation programs have purposively established school-university partnerships to simultaneously facilitate preservice and inservice teachers' knowledge gains (Chiero, Sherry, Bohlin & Harris, 2003; Theobald & Rochon, 1999). Simultaneous Learning Layers Theory (S2L) identifies preservice teachers being uniquely positioned to facilitate elementary students and host teachers' knowledge acquisition concurrently. The S2L theory suggests that preservice teachers may be able to implement elementary students' learning activities while host teachers observe and, whether conscious or not, may begin to develop new content knowledge (Stratton, Rombach & Shi, 2007). Therefore, this inquiry was grounded in S2L Theory and as such, sought to reveal ways that preservice teachers potentially act as change agents to advance elementary students' and inservice teachers' use and understanding of GIS and GPS technology.

WHAT IS GIS AND GPS?

A Geographic Information System or GIS provides a systematic way of collecting, retrieving, analyzing and viewing sorted datasets that can be referenced to any location on Earth. For example, GIS can provide a way to visually represent locations of roads, buildings and vegetation while also showing area population. The power of GIS is with the ability to pictorially overlay variables onto their specific geographic locations. Such graphic representations often help viewers analyze data with specific consideration given to their respective locations. Global Positioning System or GPS is a navigational satellite system that can be accessed by using small hand-held devices often referred to as GPS receivers. GPS receivers are used outdoors to retrieve and calculate satellite signals to identify latitude and longitude location coordinates and users' travel direction and speed.

PLANNED INQUIRY

To enhance preservice teachers' preparation for teaching elementary students, elementary students and their teachers were invited to visit a university campus to participate in an activity planned to integrate curricula by using GIS and GPS technology. This activity was planned to impact preservice teachers, inservice teachers and elementary students related knowledge gains and skill acquisition. Prior to their visit, a series of related learning activities were implemented with preservice teachers to determine and strengthen their content knowledge about latitude and longitude coordinates, GIS and GPS information. Afterward, preservice teachers were assigned to work in teaching teams consisting of two co-teaching pairs. Teaching teams worked

cooperatively to plan a series of connected GIS and GPS lessons for elementary students.

Preservice teachers utilized free, Internet-accessible Google Earth to prepare to introduce intermediate students to a GIS and learned to use Garmin Rhino 120 GPS Navigators to implement hands-on technology with elementary students. As a subsequent goal, preservice teachers' implemented lessons were to be observed by inservice teachers, providing potential opportunities for inservice teachers' knowledge gains and skill acquisition.

On-campus discussions led preservice teachers to realize that curricula could be easily integrated into their lesson plans. Through their inquiry, they realized that their GIS/GPS lesson could be used to connect social studies, science, math, language arts, health and physical education curricula.

Social Studies Content

When brainstorming key vocabulary terms elementary students would need to know to do well with the planned activities, Preservice teachers recognized that they had many misconceptions about geography terms themselves and had to relearn key information. For example, when preservice teachers began planning to teach about longitude and latitude coordinates, they collectively realized that they did not know where the measurements had been derived. Such a discovery was not surprising because according to prior research, students "graduate thinking that geography is the memorization of states and capitals and is usefully only for reading a road map" (Broda & Baxter, 2003, p. 150-60). Preservice teachers were instructed on the coordinates' measurements and their origins and worked to identify ways that they could visually represent such facts to elementary students. Some preservice teachers created 3-D models and others drew pictures to represent origins of latitude and longitude angle measures. Perhaps most constructive, however, was preservice teachers' inquiry into geospatial technology. For instance, discussions about using GPS receivers led preservice teachers to identify key questions they wanted elementary students to answer while using the hand-held devices including (a) Where are we?; (b) Where will we go?; (c) What direction should we move?; and (d) When will we arrive? By posing these questions, it became evident that the planned discussions and activities would likely contribute to elementary students' geographical conceptual awareness of location and place.

Preservice teachers also needed instruction on Geographic Information Systems and its powerful applications in the social studies classroom. Their preparation included instruction on what GIS is, how it can be used throughout the world and why it might be used in elementary classrooms. Although preservice teachers learned about additional variable dataset layering possible with some GIS applications (such as viewing nations' oil consumption and international flight patterns), using common data variables such as roads, building locations and terrain seemed more developmentally appropriate for elementary students' conceptual awareness and were therefore used.

Mathematics Integration

Additionally, preservice teachers inquired into how GPS receivers 'know' where they are. One student asked, "But how does it [GPS receiver] know where we are?" This question led to a mathematical discussion about satellite signals traveling at the speed of light (186,000 miles per second) and that GPS receivers have a built-in clock that keeps track of how long it takes to receive satellite signals (often in microseconds). The GPS receivers use a common formula in math to determine distance:

Rate (speed) x Time = Distance

The rate is 186,000 miles/second x ___ time = Distance from the satellite.

Three satellites are needed to completely determine where the GPS receiver is located. Some of this math seemed difficult for the preservice teachers to fully understand to teach this information to elementary students. Therefore, preservice teachers investigated this information online; they discovered and played an online learning game that helped to plan and teach the mathematical content involved with GPS receivers. The site is: Public Broadcasting System's Nova Online http://www.pbs.org/wgbh/nova/longitude/gps.html. This online game was overwhelmingly identified as having value for facilitating preservice teachers' mathematical content knowledge regarding GPS receivers.

Physical and Health Curricula Integration

Preservice teachers had to plan where elementary students would practice using hand-held technology and determined that it would be best if elementary students stayed on predetermined paths. Therefore, preservice teachers utilized the college's walking paths, identified as the 'Walking for Wellness Trails'. The college offers five walking trails, ranging from 0.4 miles to 2.3 miles and was designed for community use. When planning for using the hand-held technology outdoors, preservice teachers began to discuss the physical education connection to their activity. One student suggested that perhaps one of the more beneficial outcomes of their lesson would be the physical activity necessary for task completion. By design, GPS activities are dependent on the user's movement and this was identified as an important benefit for elementary students' overall health, physical and emotional well-being. In short, preservice teachers believed that the GPS activity would serve as a motivator for elementary students to exercise.

Science Integration

Preservice teachers determined that they wanted students to locate specific places on campus and wanted elementary students to have a reward for their efforts. Therefore, the preservice teachers selected locations along the walking paths such as ball fields, residence

halls, dining facilities, bus stops, the student union and academic halls as places of interest. Students planned to use this part of the activity as a walking tour to introduce elementary students to the college campus while simultaneously completing the GPS activity. Near each of the destinations, a small box with 'jewels' (charms/beads) was minimally hidden so elementary students could find and take the treasures representing coordinates' locations.

As preservice teachers planned for activity, they came to realize that they would also need to review observation skills with the elementary students because they realized that the GPS receivers only identified locations with up to 25 feet of accuracy. Therefore, elementary students would need to use observation skills to try to identify whether the treasure might be hidden around campus in a tree stump, behind a bush or next to a pile of sticks.

Pedagogical Planning

Preservice teachers were instructed to design their GIS/GPS lessons by aligning their planned activities to Gardner's Multiple Intelligences. Prior research on integrating GIS/GPS lessons with elementary students has suggested that such alignment can provide powerful curricular connections (Broda & Baxter, 2003). Preservice teachers identified alignment with Gardner's linguistic, logical/mathematical, spatial, interpersonal and naturalist intelligence. Preservice teachers were also instructed to preplan essential guiding questions to be used during teaching. Such questions were to be aligned to Bloom's Taxonomy to promote higher order thinking (Broda & Baxter, 2003).

Prior to teaching, all preservice teachers' planned pedagogy and included subject matter was reviewed and revised if needed to ensure content accuracy.

LESSON IMPLEMENTATION

Preservice teachers implemented three hours of on-campus GIS and GPS instruction using co-teaching methods. Two co-teaching pairs were grouped together as teaching teams to educate small groups of four elementary students. Although preservice teachers were able to utilize team-selected pedagogical methods, each team implemented pedagogical practices that were very similar. Implemented lessons consisted of two complementary lessons, one on GIS information and one on GPS information. Each co-teaching pair implemented their own instruction while their partnered co-teaching pair provided individual instructional support for elementary students.

Co-Teaching Pair #1: Implementing GIS

Preservice teachers used Google Earth to introduce GIS to elementary students. They began by showing elementary student a birds-eye-view of their elementary school and community. Google Earth was new to nearly all elementary students and the visual representation served as a motivational hook for activities that followed. Google Earth software provides latitude and longitude coordinates for all of Earth's locations so elementary students were directed to begin by recording their school's coordinates on paper. Linking their school's coordinates to other places' coordinates provided elementary students with a point of origin and this promoted elementary students to begin to consider how coordinates change when moving from place to place. Then, elementary students used the 'go to' feature on Google Earth so elementary students could virtually drive from their home school to the college campus. Again, coordinates were documented to record elementary students' specific location on campus. Subsequent virtual excursions had elementary students 'visit' some common places of interest including the nearby locations of New York City and The Statue of Liberty and faraway destinations including Paris, France and The Eiffel Tower. Preservice teachers showed elementary students Google Earth's swooping animated navigation to move from outer space to the students' school and to final destinations, which provided a point of reference for the elementary students. Location coordinates continued to be recorded. During these events, many elementary students mentioned that they had never traveled outside of their birth city; virtually visiting the photo-realistic images seemed very exciting for them. As preservice teachers took elementary students to different virtual locations, they used Google Earth's layering feature to introduce GIS concepts. Layers such as roads, 3-D buildings, borders, and terrain were selected for viewing.

Once different coordinates had been recorded for each place of interest, preservice teachers asked about longitude and latitude measurements. Elementary students were unable to identify what the measurements actually measured so preservice teachers continued by providing homemade model representations. The models consisted of paper drawings, Styrofoam balls with a quarter sectional cut out representing the Earth and it's pinpointed core, and an elaborate digital image of Earth sliced open to identify longitude and latitude measurement origins. Upon initially observing preservice teachers using these teaching aids, it was thought that the models would provide more concrete understandings of latitude and longitude measurements if they had been introduced first in their lessons. However, preservice teachers wanted the GIS technology to serve as a motivator for increasing elementary students' interest in their lessons; after observing their interaction with Google Earth and then following up with the models, preservice teachers seemed valid in their argument to begin instruction using Google Earth's abstract coordinates' first and move to their concrete models afterward. The combination of abstract and concrete models seemed to complement each other well when teaching this concept to elementary students.

Co-Teaching Pair #2: Implementing GPS

Co-Preservice teaching partners began their lessons by asking elementary students what they already knew about GPS receivers. A few of the students mentioned that their parents had cell phones that had GPS devices built in, but when asked what that meant, none of the elementary students could provide answers. Therefore, preservice co-teaching pairs implemented a few of the many features of Garmin Rhino 120 hand-held GPS receivers with the elementary students. Implemented features included loading predetermined coordinates into the GPS receivers, selecting preprogrammed coordinates to go to specific locations, using an electronic land marker to relocate specific landmarks, using straight line distance destination measurements, a directional compass, travel speed, estimated time of arrival and actual time of arrival. Once instruction on the hand-held devices was complete, preservice teaching teams (grouped in fours) came together, establishing five different teaching teams. Each teaching team's elementary students were led by their respective preservice co-teaching pairs to walk on predetermined walking trails. While on their walk, the preservice teachers provided the elementary students with a brief campus tour, identifying buildings and other locations and determined where they would leave a hidden 'treasure' for another group of students. After 3 treasures were hidden, the groups returned to their initial destinations, exchanged coordinates and were led on another walking tour to learn more about the college campus and to find hidden treasures. While on the tours, students used the aforementioned GPS receiver features to better identify their location, movement and hidden treasures.

Once all treasures had been identified, students reviewed and listed all selected coordinates and located them accurately on a campus map using latitude and longitude coordinates.

Inservice Teachers' Involvement

During lesson plan implementation, inservice teachers were asked to participate in group activities with the anticipated outcome of inservice teachers learning about GIS and GPS technology. While some inservice teachers did participate fully with Google Earth lessons, they did not all participate in the walking tour of campus and using the GPS devices. This was believed to be due to fatigue and inclement weather. However, those who did participate showed enthusiasm learning about the technology by wanting to have a hand-held device to use during the lesson, assisting students with data/coordinates entry, and asked to borrow the GPS receivers for subsequent lessons in their own elementary classrooms. All teachers mentioned that they had not used GPS receivers in the past and were interested in learning how to use them.

CONCLUSION

Using technology in classrooms to facilitate students' learning is not a new teaching practice. What is new to elementary education instruction, however, is going outside of classroom walls to use handheld technology to develop students' understanding of location and place. The reported activity demonstrates a way that preservice teachers can contribute to elementary students and inservice teachers knowledge and skills about new technology applications and devices. The contextual placement of this activity is with preservice elementary teacher education. However, inservice elementary educators have been identified as benefiting from preservice teachers' implemented lessons also. Geospatial technology is a relatively new field that can offer all teachers a systematic way to help students gather, analyze and display data (Reed & Ritz, 2004; Watkins & Wagler, 2005). This could potentially increase students' conceptual awareness of science, social studies and mathematics topics. In addition, when geospatial tools are utilized, students can gain a more holistic understanding of the impact and influence that technology has in our world.

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