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Discovering Hidden Treasures with GPS Technology

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"I found it!" Addison proudly proclaimed, as she used an iPhone and Global Positioning System (GPS) software to find the hidden geocache along the riverbank. Others in Lisa Bostick's fourth grade class were jealous, but there would be other geocaches to find. With the excitement of movies like *Pirates of the Caribbean* and *Indiana Jones* in the popular culture, who doesn't like the thrill of clues leading to hidden treasure? The recreational activity of geocaching offers exactly that.

It can be a challenge to help upper elementary students apply critical thinking skills as they use technology. Many students may already have an iPhone, iPad, or other hand held device, or they know another child or an adult who does. But many students may not have thought about how technology can go beyond game playing and person-to-person communication.[1]

We were invited to collaborate with teacher Lisa Bostick at NSU Elementary Lab School, a K-5 school located on Northwestern State University's campus in Natchitoches, Louisiana. The three of us planned two activities in which the students would learn about GPS, geocaching, a local park, and have some fun outdoors.

In a game of geocaching, participants navigate to a specific set of GPS coordinates and then attempt to find a geocache (container) hidden at that location. As a learning activity, geocaching reinforces the concepts of latitude and longitude while getting students outside of the classroom. It also helps students better understand issues of scale from the GPS screens and the cardinal directions when moving in the field to find these caches.

Global Positing Systems

Among the ten themes of the social studies standards is **SCIENCE, TECHNOLOGY, AND SOCIETY**.[2] Before discussing what GPS is with the fourth graders, We challenged the students to think about how science and technology have influenced people's lives in the past and today. The fourth graders in Lisa's classroom had already been learning how advances in technology changed or influenced America history. They learned about the growth of telegraph and the railroads during the 1800s.

The students shared thoughts with their shoulder partners. Whitt raised his had to repeat what he told Cooper. "The telegraph and train helped people move from the east to the west, and today cell phones help us talk with people."

We explained to the fourth graders that the U.S. military first developed the technology for GPS back in the 1960s, and the technology was refined in the 1980s. In 1983 President Ronald Reagan ordered GPS to be available for free to the public after the tragic deaths of 269 people aboard a plane that strayed into Soviet airspace, and after being mistakenly identified as a hostile aircraft, was shot down. This reform allowed commercial airplane pilots, and not just the military, to use this new navigation technology, and it opened up the possibility of GPS devices that could be used in ship, in cars, and by pedestrians. The first commercial GPS satellite was launched in 1989. Today, there are 31 GPS satellites that orbit about 11,000 miles above the Earth, with five more planned for deployment the near future.[3]

At first, the U.S. military, afraid that smugglers or terrorists might use GPS to cause harm to others, limited the accuracy or

GPS to about 333 feet or so. In 1996, President William Clinton ordered that GPS signals for the general public be improved, as he was convinced by arguments that the benefits to citizens and businesses would far outweigh any risks. In 2000 the accuracy of GPS was improved to 66 feet, and public use of GPS has seen a tremendous growth since then. (A typical GPS device can describe your location with an accuracy of 66 feet.)

The fourth graders wanted to know how GPS works. "How does this device know where I am at?" asked Hannah as she was holding one of the Garmin eTrex handheld devices loaned from the state geographic alliance.[4] I explained to Hannah and the class that 31 satellites, in orbit high above the Earth, keep track of exactly where you are. They can also send a signal to your GPS device, which needs to receive three signals in order to determine where it is located on the ground. The use of three or more signals to determine location is called "triangulation." Indeed, we use three points (zero, x, and y) to locate any point on a graph. A fourth signal is needed to determine your height above sea level. I demonstrated for the students how the GPS unit was searching for a signal. Within a few seconds, the Garmin GPS device reported that it was receiving not just three, but five satellite signals.

I also showed students on the Smartboard how two points (x and y) are needed to define a line, and three points are needed to define a triangle. If we "escape from flatland," we can locate a point in the room a few inches above the board. This short demonstration showed that it takes multiple points, or multiple measurements, to be able to describe where we are in space. I reminded students of how these concepts are reflected in the x and y axes on a piece of graph paper, and in the latitude and longitude lines on a globe.

"How does the GPS get into our classroom?" wondered Caleb. I explained that a GPS satellite transmits a continuous radio signal that tells its position, as well as the time the signal was sent. The signal can have trouble getting from the satellite to the GPS device if the signal is deflected or blocked by heavy precipitation or by thick walls of cement and metal. I explained that we were receiving clear satellite signals because the multiple windows in the room allowed those radio signals to pass through easily.

The GPS device in my hand, now receiving five satellite signals, was able to report my latitude, longitude, and elevation. I explained to the students that their school was about 118 feet above sea level.

Exploring Close to Home

For the first activity, we divided the class into four groups, with each group having a GPS device. On the Smart Board, I placed four sets of numbers, latitudes and longitudes, for the students to input into their Garmin eTrex navigators. "Hey, this is like texting my Mom," shouted Madison. Then I showed the students various sizes of containers that a geocache might be hidden in. The cache (the plastic container) can range in size from that of a pencil eraser to a shoebox. I told the students that they would be searching for a camouflaged pill bottle. "I can find these," Jonathan stated. "Not so fast," I countered. "We will see how well every team does." I further added that the cache might be hidden near the ground or might even be above their heads. (To make it challenging but not too tough, I had earlier that morning placed four caches near ground level in various locations around school grounds.) Finally, I assigned each team with a unique set of coordinates with which to begin their search.

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The students were excited and ready to go. However, before heading outside, they paired up, and we reviewed safety rules and guidelines for this modern-day "treasure hunt." Each cache container held little slips of paper. Once they found a cache, students were to take only one piece of paper from it, then close it tightly and place it back where they found it. Each team would need to collect four pieces of paper, one from each cache. Then we went over some basic rules: No running. Work together as a team (e.g., students should take turns holding the GPS unit during the four searches). Do not tell the other teams where any cache is hidden. And finally, have fun.

I reminded the students that, just because the arrow on the GPS unit shows that a cache is 50 feet away, it doesn't mean that we can walk through the school walls to get to it. Whitt laughed, "I can try." Then the teams set off with GPS units in hand, each going in a different direction. I monitored the students as they wandered around the grounds.

We were outside about a half hour when the teams started coming back. "This is so cool," said Addison. "I liked finding the cache located in the bush by the playground," stated Cooper. I asked the students to think about the four pieces of paper that they found. What hidden meaning might be in these pieces of paper? The teams of students sat down on benches near the front door and started to look at what was written on the four pieces of paper. When assembled in the correct order, the papers together spelled out the sentence, "Geocaching is a modern day treasure hunting game that is fun and exciting." This sentence served as an opening for students' written paragraphs about their experiences as members of geocache teams.

Discovering Geocaches in a Park

The next day I returned to Lisa's classroom and the fourth graders were excited to see me. "Can we do some more geocaching?" asked Madison. The fourth graders knew that another day of fun learning was in store. Using Lisa's Smart Board, I showed the students a geocaching website, **www.geocaching.com**.[5] On the main screen in the top right corner is a bar that allows the

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user to search by zip code or country. I typed in the school's zip code and hit "Search." Latitude and longitude measurements appeared along with a list of geocaches nearby, probably placed on the ground recently by geocache recreation clubs.

To the right on the screen was a link labeled, "Map this Location." Students could see on this map the locations of many geocaches in our area. Using the scale button, I zoomed in to the location of the school. "Hey, there is a geocache near our school," stated Hannah.

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On the left side of the screen, the different types of geocache containers are listed. I pointed out to Hannah and the fourth graders that the geocache near the school was a "traditional" cache. I further stated that the geocaches we found yesterday, pill bottles, are a "traditional" cache. Micro caches can be the size of a pencil eraser, whereas larger caches can be the size of a shoe box.

While millions of people around the world play geocaching games through the company Groundspeak, a teacher may use some of the same activities to help students learn curriculum material.[6] For example, we hid Tupperware cases around the grounds of a local park. Before we left the classroom, students first played with the Garmin eTrex to understand what buttons to push to get between the different screens on the hand-held unit. Then the students were given a list of coordinates that were saved in the GPS memory.

The first two points on the list led students to something nearby, as a trial run, so the teacher could assess their use of the GPS device. Students then began hunting for more distant locations, where they found geocaches within the bounds of the park. In each container they found a card with a vocabulary word card on one side and a number between 20 and 100 on the other side. Students walked about, gathering 6 to 8 cards over the course of a half hour, then returned to home base.

When the students had all gathered together at the end of their searches, we announced, "Today you have been enjoying the city park and discovering geocaches. Now our City's Parks and Recreation Department wants our help. In order to encourage more neighbors to use this land, what might you suggest to the planners in the city to add to make this park more friendly to students your age? What changes could be made to help 'market' this park, to make it more attractive, to other people your age? Let's think of some ideas. The vocabulary words on the cards in your hands may be of help."

Students then wrote a full paragraph using many of the vocabulary words they had found during the game. The idea of civic participation was discussed with the students so they would understand that government offices often solicit ideas or suggestions from the people they represent to make needed improvements.

The students practiced writing a positive letter, highlighting what they enjoyed about the park, offering a constructive suggestion of changes that could attract more visitors, and explaining why a proposed change might encourage other kids to use the park more often. Once students finished their letters, they were asked to think critically about what their suggestions would cost. Could volunteers with little equipment make these changes, or would it take lots of material, work hours, and professional expertise? If a new piece of play equipment were built, would there be any cost to maintaining it?

Then we invited students to flip over their cards and use the numbers on the back in a fanciful budgeting exercise. They could add any three numbers and multiply two numbers in any order to arrive at the biggest number they could. That number, in dollars, would be the budget they had to spend on their park's improvement plan.

Finally, the student groups were invited to share and critique each other's ideas for marketing their city park to other kids.

Making a Difference

As the fourth graders finished their letters, Caleb asked, "When can we do that again?" These activities called upon students to use all sorts of skills. Finding the Tupperware caches was tough, stated Copper. The fourth graders were able to apply their vocabulary words in a real-world situation to address an issue in their city: the use and improvement of public parks. They had a better understanding of some of the technology in popular use. They had to think critically about what they found to be of value in a park, and to write about that topic to public officials. The fourth graders enjoyed the "games" and using GPS devices, but they also enjoyed writing about how people their age interacted with the landscape. They had discovered some hidden treasures using technology.

Notes

1. B. Ortutay, "Apple Guides Shoppers Inside Stores with iBeacon," (Associated Press, 2013), abcnews.go.com/Technology/wireStory/apple-guides-shoppers-inside-stores-ibeacon-21120351.
2. National Council for the Social Studies, *National Curriculum Standards for Social Studies: A Framework for Teaching, Learning and Assessment* (Silver Springs, MD: NCSS, 2010).
3. "Official Government Information about the Global Positioning System," ww.gps.gov/students.
4. National Geographic Network of Alliances, education.nationalgeographic.com/education/program/geography-alliances/?ar_a=1.
5. There are several geocaching websites and apps for phones. Groundspeak, Inc. offers Geocaching, a website that allows for a quick search of nearby caches. www.geocaching.com.
6. Groundspeak, Inc., "Geocaching 101," www.geocaching.com/guide/default.aspx

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