Treasure Hunting and Other Fun Science Labs with GPS/GIS: Geocaching Method of Introducing Modern Technology in the Classroom

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INTRODUCTION

Over the past few years, global positioning systems (GPS) and mobile mapping technology (or mobile GIS) have been introduced to the general populace and the associated hardware and software are being advertised in many places. GPS has been added to the curriculum for geography and geology courses and laboratories. As a faculty member who teaches geology, I believe students learn new concepts and technology easier and remember more when taught through fun, innovative, hands-on activities. I have developed two laboratories for my introductory geology course that teaches both GPS and GIS technology and concepts. I am currently developing several labs for biology and chemistry courses that teach the same concepts. Two of our institutional and program level learning outcomes for our students are to use technology effectively and to become life-long learners. Introducing GPS and GIS technology into the various courses accomplishes both these outcomes.

THE CONCEPT

For the past several years I have been thinking of ways to introduce GPS and GIS into my geology course but I did not want to purchase equipment or software that would be limited to either topic. We offer an ArcView course on campus, so GIS software was already in place. I decided to incorporate the workbook *Exploring the Dynamic Earth : GIS Investigations for the Earth Sciences* (with CD-ROM) by Michelle K. Hall, Robert F. Butler, Larry P. Kendall, Christian J. Schaller, C. Scott Walker into the laboratory portion of the class to introduce GIS with a practical, geological application. The workbook utilizes ArcView software for the projects. Students responded well to the activities and learned the functional use of GIS quickly.

I was still undecided about the GPS aspect until I attended an ESRI GIS and Health conference where I was introduced to mobile GIS and ArcPad software. The presenter used the software installed on a hand-held computer (PDA) with a GPS compact flash card attached to collect data in the field. That is exactly what I wanted for my courses; both hardware and software that would teach GPS, as well as GIS, and have a practical application for doing field research. I went home to plan, organize, write proposals for a budget, obtain the hardware and software and learn to use it all, and then finally, develop and implement the labs.

THE PLANNING, PURCHASING, DEVELOPING, AND IMPLEMENTING STAGES

It took me approximately two years after the conference to accomplish the four stages of planning, purchasing, developing, and implementing before I could introduce the concepts in my classroom. I first needed to decide exactly what software and

hardware I wanted, what would best suit the needs for the classroom, and what would be within a reasonable budget. I decided on the Dell Axim X50 hand-held, not top of the line but had many useful features and a Windows-based operating system. I chose this unit because most students are familiar with Windows and it is compatible with the ArcPad software. Then I looked for a compact flash-card type GPS unit. There are many different types available, all with about the same features and compatible with the Axim and ArcPad.

After getting quotes from the various companies I typed up a budget proposal to purchase 15 units with all the appropriate software and presented the request. Then I waited and the proposal was accepted. I waited again for the budget to become available and then purchased all that I needed.

Now the fun started! I put in many hours getting all the units up and operational and all the software installed. If one is very computer-literate, knows ArcView software, and has computer support, it may not take as long. I learned quite a bit through the experience. I also experienced a sharp learning curve in learning how to use the ArcPad and GPS software, how to install base maps, and how to work the GPS and ArcPad together.

Once I was comfortable using the software and hardware, I then started to develop the labs for students. As I was reading more about GPS, I became aware of a new recreational pastime called Geocaching. Geocaching is a new high-tech treasure hunting activity where one person hides the cache (treasure), posts the geographic coordinates on a website: www.geocaching.com , and then other people use their GPS units to find the treasure. I thought this is a great way to teach my students to learn GPS concepts and how to use the technology, so I developed one lab that takes the students geocaching.

I also wanted to teach the students that there was more to the technology than having fun and that it could be used for research. With my limited imagination, I developed several mini-research questions regarding our campus for the students to explore and answer. The research involves the students in walking around campus, discovering answers to their questions, recording geographic coordinates, and collecting data.

The first semester I implemented the labs I had a few problems, but all in all the students learned the software fast and were able to complete the labs during the allotted time period. Most students thought the labs were fun, easy to understand, learned about GPS and mapping, and wanted to continue using GPS on their own. The second semester worked more smoothly.

Upkeep of the equipment and software takes some time and effort. Once again, good computer (IT) support will be helpful, or some time on your part. After students use the units, they need to be checked to make sure they are shut off and no files were saved, lost, or corrupted. One thing I have found very helpful and time-saving is the purchase of cloning software such as SpriteClone. This software allows you to make a copy (clone) of one of the units, and then you can deploy that copy onto another unit. This process saves time in installing all the software individually on each unit and having to type in all the proper authorization codes. It is inexpensive software well worth the money.

THE LABS

I have incorporated the two labs I developed into my introductory geology laboratory course. I use five of the 15 labs per semester for the GPS/GIS technology. Early in the fall semester (weather dependent, spring semester I do this a little later) I introduce the geocaching lab after we have talked about mapping and introduced topographic maps. The next lab I introduce ESRI ArcView GIS software with an introductory GIS lab developed by another instructor. The following week we complete Unit 1 in the *Exploring the Dynamic Earth* workbook. These two weeks gives the students a good introduction to GIS and how to use the software. Then, the next week we do the mini-research lab that takes the students outside on campus (in the field) and then back into the computer lab to upload their data, produce a map of their findings through ArcView, and then write up a short 2-3 page report of their findings. The fifth week we complete the unit in the GIS workbook on earthquakes.

Neither the ArcPad software nor the GPS unit comes with maps. You will need to obtain base maps either by purchasing programs such as TopoUSA, or free download maps from websites such as the USGS or Topodepot. I use free downloaded topographic and satellite 7.5' quadrangles that I have cropped in ArcView. Memory storage is limited on the hand-held units, so one needs to pay attention to the size and details of the maps. For both the geology labs I developed, I use a section of the quadrangle that shows our campus. Students either use the topographic map or the satellite view which shows the buildings in more detail.

<u>Geocaching</u>

The geocaching lab is the most fun and the most time-consuming lab for me to prepare and execute. First, the caches need to be made. I used small plastic storage boxes and placed various treasures inside, such as lollipops, small wrapped non-chocolate candies, raisins, pens, pencils, etc, along with a small notebook and pen to keep a log of finders. I also added a note stating why the box was there with my name and phone number on it. Second, the caches need to be hidden, the time-consuming part. I first went for a walk all around campus finding suitable places to hide the boxes, someplace partially hidden so it would not be too difficult to find, then I collected the geographic coordinates with ArcPad for those hiding places. Either the day before or the morning of the lab, I run around depositing the boxes at the designated locations. If your campus is large, you may want to restrict areas for hiding and searching. Third, I made sure I called our campus security to alert them that I was hiding boxes on campus for my class to find in case there was a report of a suspicious box on campus. Fourth is the collection of the boxes. I try to have the last student to find the box bring the box back, but that does not always go as planned, I then I need to retrieve the box. It is a bit of work and time, but it is fun and it gets both the instructor and the students out of the lab, exploring the campus, and getting some exercise.

The lab itself is written with instructions starting with how to turn on the hand-held unit, starting the ArcPad software, activating the GPS unit, inputting the coordinates, and how to use the GPS to move around to find the cache. I used the instructions from the ArcPad instruction manual for most of the lab and the students had little trouble following the instructions. Most trouble came with the hardware or software not acting

the way it should. I have found that some of the units are temperamental, and then take time to learn and fix all the possible errors and problems. The students work in groups of three and sign out the units, agreeing to bring the units back in working condition, then sign them back in when they return. They are required to fill out the log books in the cache, as well as, fill out a form explaining the location of the cache and what treasure they found inside.

Figure 1. The unit.

Figure 2. The cache

Figure 3. The fun! Students seeking their treasure.

Reasearch Lab

For this lab, the students know how to operate the units, how to use GPS and GIS; now they learn how to put it all together and conduct a mini-research project. The students are given several research questions regarding the campus such as 1) determining the number, location, and condition of outside tables and benches and determining if they are being used, if they are in sufficient quantity for students, and if they need maintenance; or 2) determining if there are a sufficient number of handicap parking spaces. The students take the units outside and collect data including the geographic coordinates of items such as benches or parking spaces. Instructions are given on how to set the shapefiles to edit and collect coordinates with the GPS unit working through ArcPad. It takes some effort for the instructor to set up the files to make data collection easy for the students.

When all is in good working order and students are paying attention to the details, the lab works well. They are given about one to one and a half hours to collect the data outside. Then, they come inside and have another 1 ½ hours to upload their data into ArcView on the desktop computers. Once the data is in ArcView the students can create a layout and print their map. They can edit and change the layout to their preferences. They are also required to type a mini-lab report explaining the research question, their procedure of collecting data, their results, and conclusions. The report usually is only about two pages. At the end of the three hour lab, they will sign in their units, turn in a print of their data, the map they produced, and the lab report.

Labs in progress

I currently have two non-geology science labs in process of being developed. I am taking two existing biology labs and incorporating the use of GPS and GIS in them. One lab is a tree identification lab that takes the students outside around campus locating and identifying the various types of trees based on leaves, bark, shape, etc. The modified lab will instruct the students to record the geographic coordinates at each tree and record their data into the handheld unit rather than writing on paper. The students will upload the data into the desktop computers and print the data, maps, and report. Along with introducing new technology into the course, the lab should make it easier for the students, and enable the instructor to compile data on the trees over the years.

The second biology lab that I am modifying is a stream study. Every spring semester on biology class visits a local stream to test and record various chemical, physical, and biological data. The students are asked write a formal laboratory report, including all data, graphs, maps, etc. At this point, students record all data and draw maps and graphs by hand. Incorporating the GPS/GIS technology will aid the students in all aspects of the study. Also, recording the geographic coordinates and data electronically, will allow the instructor to save the data year after year and eventually, be able to write a formal research report on the health of the stream over time. I am excited about the possibilities of this lab.

A third lab that I am modifying has nothing to do with GPS or GIS, but utilizes the hardware already purchased. I believe we should use the equipment we purchase to its fullest capacity. I have purchased several pH meter probes that fit into the flash card on the handheld units. Our chemistry labs always run short on pH meters so these units

increase equipment used in lab. These pH probes can all be brought out in the field to collect data for labs such as the stream study.

CONCLUSION

Although at times the work involved in planning, purchasing, developing, and maintaining these handheld units seems overwhelming, I believe it has been worth the time, effort, and expense. So far, the two labs developed for use in the geology course have proven successful and useful in teaching concepts relevant to the course. I am optimistic that the other labs and more future labs will also prove as successful.

Teaching relevant and current technology to our students is imperative to give our students that extra edge of knowledge when entering the workforce. Part of our jobs as educators is to help develop practical skills useful for employment as well as facts and theory; with the introduction of this type of technology into our regular courses we can accomplish that goal.

Another goal is to be able to use our equipment and our students to help other organizations in our community perform research studies. The possibility exists of turning our experience into various student internships to further their knowledge and work experience.

The possibilities for use of this technology are endless; they seem to be limited by our imagination and knowledge. I am enjoying this challenge of learning how to incorporate new technology into my classroom and I hope you will too.