Online and Hybrid Delivery for GIS in the Information Systems Curriculum

Daniel Farkas, Ph.D.
Pace University, dfarkas@pace.edu

ABSTRACT

The expansion of Geographic Information Systems into most disciplines has driven the need to provide graduate and undergraduate curriculum in these areas. As many universities strive to reach wider audiences by offering a combination of completely online and partially online (hybrid) offerings, it becomes particularly challenging when the content involves learning techniques best suited to the hands-on laboratory environment. This paper describes delivery options for a GIS foundations course that successfully combined different techniques for online delivery, applied IS principles and to educate students in Information Systems, Information Technology and Computer Science masters programs.

KEYWORDS

Geographic Information Systems, Online Education, Distance Education, Information Systems

1. INTRODUCTION

There are many forces driving universities to increase their web-based programs including community reach-out, economics, marketing, etc. The issues, pros and cons, and discussion of effectiveness have also been debated. The reality, however, is that distance education programs and courses are here to stay and will expand over the next decade [2, 19]. The challenge is how each discipline addresses effective delivery of their content. In computing, for example, there may be the need for hands-on labs with detailed instruction [6, 8, 9, 10, and 13]. Geographic Information Systems, at least at the introductory level falls into this category.

The challenge in developing graduate and undergraduate GIS curriculum was how to instruct students in the use of sophisticated software (e.g. ArcGIS Desktop), Internet databases (e.g. Statistical Abstract), and data conversion techniques (e.g. Excel to shapefile) in a primarily online environment.

2. THE UNIVERSITY ENVIRONMENT

Pace University is a multi-campus institution with main campuses 50 miles apart in downtown New York City and suburban Westchester County. Students primarily take courses on their home campus, but in recent years, many courses (and programs) have been combined to increase the number of students from both campuses in one course. While the main advantage is to draw on a larger and more diverse population, traditional delivery is difficult. Students must travel beyond their home campus, the faculty must alternate campuses, or a video-conference setting must be used. We have found the latter to not be very effective given the available VC technology at the University. The available of a robust online course management system makes distance education a better option.

3. GIS AND THE IT CURRICULUM

First and foremost, this was a course in the information technology disciplines (computer science and information systems). There have been a number of reported uses of geographic information systems as a teaching tool in traditional disciplines (e.g. geography, environmental science) where the learning of GIS is part of learning the discipline [3, 4, 5, 12, 14, and 16]. However, it can also be used in non-traditional courses and situations such as social studies [1], computer science [11], economics [17], and teacher education [18]. Information Technology is in a sense non-traditional. Data, often viewed and presented as non-spatial, is in fact most suitable for geospatial analysis. Furthermore, GIS systems have a close relationship to IS hardware, software, systems development, database management, telecommunications and the internet concepts [7].

> *Hardware.* In addition to servers, PC's and mainframes, GIS systems use specialized hardware for scanning, displaying and gathering data.
>
> *Software tools.* A wide variety of software tools have to be downloaded, installed and used. These include the GIS system development environment (e.g. ESRI ArcGIS Desktop), GPS download/upload utilities, conversion tools and Excel for modifying, importing and exporting data.
>
> *System Development.* GIS systems go through a similar analyses phase as other IT systems. In particular it is necessary to interact with users to determine requirements, design system functions and ultimately implement them.
>
> *Data and Databases.* Geospatial information is stored in databases and tables which are searched (queried) and combined (joined) to provide higher levels of analysis using Sequel type languages. Furthermore, enterprise GIS systems interface with industry databases such as Oracle and DB2. Existing data repositories come in a variety of compatible and unfortunately incompatible data types which may require several steps to convert into GIS usable data.
>
> *Telecommunications and the Internet.* While IT applications involve creating new information either via observation or research (e.g. surveys), some data may already exist in public and private repositories. For example in the United States there is a freely available collection of base maps which detail roads, rivers and lakes as well as demographic data in areas such as population, housing, economics, and ancestry. Most of this data is available for download (sometimes requiring conversion), over the Internet.

For example, suppose the problem is to find towns in New York State that have more male university graduates than female who live in proximity to a particular highway for the purposes of marketing a graduate program specifically to women. All of the above concepts must be employed:

1. Download map data from the internet
2. Download demographic data from the internet
3. Convert from Excel to GIS compatible format
4. Manage the data to build the solution (join, select)
5. Publish the map

4. COURSE DELIVERY

This course was a graduate elective in the computer science, information technology and Information systems masters programs. It was offered online so that participants from both campuses could take the course. There were several scheduled meetings for those who could attend. The course used the University Blackboard system for class management, posting assignments, discussion, email, and posting grades. While there are real-time collaboration tools (e.g. chat), this was kept to a minimum. One part of the course divided the students into teams to go into the field to collect data, share it, convert from Excel to shapefiles, analyze in ArcGIS desktop and create a presentation.

One challenge is that GIS concepts are not always intuitive, and ArcGIS desktop, while rich and robust can be daunting to a beginner. In a traditional class lab environment with an instructor, it is possible to give assignments and work them through with the students. Questions, mistakes, special techniques can be imparted in an interactive way. The online environment doesn't provide for this immediacy. Email, chat, and the telephone are available but are asynchronous and one-on-one. The challenge is to present material and assignments in such a way that individual interaction on assignments and the need to repeat explanations of difficult concepts is minimized while providing a student centered environment for learning. In other words, the goal is to try to answer most questions before they arise.

This is done in two ways. One type of activity involves a detailed assignment that has step-by step instructions. This is then followed by an independent problem related to the detailed one. Another method is to create "video instruction" modules that use real-time screen and audio capture. These modules can be posted and students can download and use them to learn advanced (or not so advanced) topics.

5. CURRICULUM AND ASSIGNMENTS

All students were required to purchase a single-user educational license for ArcGIS Desktop. Because the course was online, it was necessary to construct assignments that provided instruction both in GIS tools (e.g. ArcGIS Desktop) and concepts (layers, topography, analysis, selection, etc.). The topics were constructed to build on skills learned in previous assignments. Students first learned how to create maps with existing base maps and data, then manipulated and analyzed the data, and finally created data sets of their own. Additional topics included Geocoding, global positioning, and publishing maps on the web. Figure 1 contains a topical outline.

Figure 1. Topical Outline

1. Basic GIS Concepts
2. Using ArcGIS
3. Navigating Maps in ArcGIS
4. Gathering GIS data from public repositories (e.g. Census Bureau)
5. Creating maps for presentation
6. Using feature data sets; select, query and join
7. Developing data sets
8. Creating and manipulating features in ArcGIS (points, lines and polygons)
9. Geocoding
10. Using Global Positioning to collect data
11. Publishing maps
12. Web-based GIS Systems (Google Earth, ArcGIS Server)

Each Assignment had an instructional lab with step by step instructions. This was followed by an additional lab problem that the student had to complete using the techniques used in the instructional portion of the assignment. Appendix 1, 2 and 3 show the three parts of a weekly instructional lab. Appendix 4 contains the advanced problem.

6. VIDEO

Sometimes it is necessary to demonstrate how a particular concept or software function is implemented. One solution is to offer the class in a hybrid mode meeting on 1 or 2 occasions to cover material requiring greater interaction. However, in an all online class, this may not be possible since students may come from different geographic areas. One way to overcome this obstacle is to create a video of the lesson, concept or technique and post it. Here the instructor demonstrates the technique using a PC, with a voice over. When the video is played back, the student hears the instructor and sees the demonstration in "real-time".

A commercial product to do this is called Camtasia (http://www.techsmith.com/camtasia.asp). An alternative open source package is CamStudio (http://camstudio.org/). A library of these video's created by an instructor in the Pace University chemistry department can be viewed at http://webpage.pace.edu/MMinnis/GIS [15].

7. SUBMITTING ASSIGNMENTS.

In a traditional class students can demonstrate their GIS models to the instructor either in the lab, or on the student's laptop. If this isn't possible, there are basically three ways to submit student work.

1. Snapshots of the maps. Either by printing maps, or using screen shots, an assignment showing various stages of creation can be built. For example, students can be asked to "export" the map as an image (jpeg), and then cut and paste into a word processing document. This is simple, effective, but static.

2. Using ArcGIS Desktop publishing extension. In this method, students collect their data and map documents and by publishing, create a portable collection of files that are "zipped" and sent to the instructor. They can then be viewed.

This method has significant drawbacks. Firstly, it is not as straight forward as it would seem. Students must know how to create analyses and map elements for publishing, furthermore good naming conventions are required to help the instructor navigate the map. While a good technique, its use for submission of assignments can be difficult. Secondly, sending published maps to the instructor involves the transfer of significant amounts of data. Some email programs will not allow large transfers and it places a significant burden on the Blackboard course management system.

3. Using a server. Perhaps the best way for assignments to be submitted is to use a web-based map server. Each student gets a protected folder on the server, and using URL referencing, the data can be uploaded to the server after the application is developed, or assignment can be developed with data already on the server.

ESRI provides educational licensing and an attractive fee structure for ArcGIS Server. This provides an easy way for students with GIS projects (even simple ones) developed at the desktop to move their applications to the server so that the instructor can interact and evaluate them. In a second step, students can create a web application and share their projects on the Web. With the ArcGIS server application development wizard – the map application can be developed in a few minutes.

8. CONCLUSION

Several factors have been contributing to the increase in distance education courses and the rise in interest in Geographic Information Systems. From the University perspective, larger and more diverse audiences can be reached when offering online or hybrid courses than traditional courses. Furthermore academic interest in GIS has grown and diversified due to greater awareness of GIS applications. For example, while business applications are becoming prevalent (beyond GPS navigation services), the offering of GIS education in business schools and the study of the impact of GIS on organizations is just starting to take off.

For students, online education is both convenient and may be less expensive than traveling to campus 2 or 3 times a week. Lastly, the cost of entry for students and universities continues to decline making the offering of online GIS curriculum possible. While in the past it would have been necessary for students to come to a lab for access, students can purchase licenses for less than the cost of textbook and universities can deploy servers at reasonable costs.

9. REFERENCES

1. Alibrandi, M., Sarnoff, H. M. (2006, April), Using GIS to Answer the 'Whys' of 'Where' in Social Studies. Social Education, 70(3), 138-143.

2. Allen, I. E. and J. Seaman. *Growing by Degrees: Online Education in the United States, 2005.* Needham, MA: The Sloan Consortium, 2005. http://www.sloan-c.org/resources/survey.asp.

3. Bednarz, S. W. (2004), Geographic Information Systems: A Tool to Support Geography and Environmental Education? GeoJournal, 60(2), 191-199.

4. Broda, H. W., Baxter, R. E. (2002). Using GIS and GPS technology as an instructional tool. The Clearing House, 76(1), 49-52.

5. Drennon, C. (2005), Teaching Geographic Information Systems in Problem-Based Learning Environment. Journal of Geography in Higher Education, 29(3), 385-402.

6. Farkas, D., Murthy N., *Creating a framework for online hands-on technology classes: a virtual laboratory for Network Security*. Proceedings of the 1st Int'l Conference on Internet Technologies and Applications, Wrexham, Wales, September 2005.

7. Farkas, D., Murthy, N. (2007) Developing Sustainability Awareness using Geographic Information Systems (GIS). Third International Conference on Environmental, Cultural, Economic and Social Sustainability, Chennai, India, January 2007

8. Forinash, K.,Wisman, R., (2001). *The Viability of Distance Education Science Laboratories,* T.H.E. Journal 29 (2), 38,40-41,43-45 .

9. Gammon, T.,Sutton, J., (2003). *Quality Laboratories to Long-Distance Educational Programs,* USDLA Journal 17 (2), 71-81.

10. Kinkade, J., (2001). *Teaching Old Labs New Tricks,* College Planning & Management 4 (11), 24-25

11. Kurkovsky, A. (2006), Educational aspects of sustainable development analysis: Computational models and software. Journal of Computing Sciences in Colleges, 21(4).

12. Lane, K. (2004), The GISt of GPS. The Science Teacher, 71(5), 32-33.

13. Lemckert, C.,Florance, J., (2002). *Real-Time Internet Mediated Laboratory Experiments for Distance Education Students,* British Journal of Educational Technology 33 (1), 99-102

14. MacEachren, A. M. (2001), Progress reports Cartography and GIS: extending Collaborative tools to support virtual teams. Progress in Human Geography, 25(3), 431-444.

15. Minnis, M. M., *GIS Videos*. , Available: http://webpage.pace.edu/MMinnis/GIS

16. Padgett, D. A., Mignolo, A. (2000, April), Developing a GIS curriculum: The small liberal arts college experience. Geo Info Systems, 10(4), 36-39

17. Peterson Jr., K. D. (2000), Using a geographic information system to teach economics. Journal of Economic Education, 31(2), 169.

18. Sanders Jr., R. L., Kajs, L. T., Crawford, C. M. (2002), Electronic mapping in education: The use of geographic information systems. Journal of Research on Technology in Education, 34(2), 121-129.

19. Vignare, K., Geith, C., Schiffman (2006). *Business models for online learning: an exploratory survey*, Journal of Asynchronous Learning Networks, 10 (2), 53-57.

APPENDIX 1. GATHER LAYERS AND BUILD BASE MAP

In this week's exercise we will look at demographic, economic, and social data for New York State. The objectives of the exercise are to go beyond data which is already geo-referenced and use Internet sources of demographic information.

Part I. Gather layers and build base map

1. New York State Data Center
   http://www.empire.state.ny.us/nysdc/download_intro.asp

2. For this example we will be downloading statewide data for New York.
3. Download the a county map of New York State
   a. Follow the link: *Download Census Data and Geographic Files*
   b. In the menus, select
      i. *statewide*
      ii. *county*
      iii. *geographic data*
      iv. *esri shapefile*
   c. *Submit*
   d. On the next screen click on the *statewide* link and download to a folder for this exercise (I call it *MappingExercise02*)
   e. This download a zip file which will contains a shapefile for the counties in New York State
4. Go back to the download page chose
   a. statewide
   b. county
   c. attribute
   d. general economic
5. Submit and download both the statewide data and the dictionary
6. Extract the files from the zip files
7. Create a new map in ArcMap
8. Using "Add Data" Add the statewide polygon shapefile - you should see a map of New York State.
9. Turn on the labels and you will see the county names
10. For the economic data you will see a dbf file (*NYSCTYECN.dbf)* Add it to your map. To see it listed you will have to go to the "source" mode. Look at the tab at the left bottom of the Table of Contents pane and click on *source*.

APPENDIX 2. <u>JOINING NON SPATIAL DATA TO GEOREFERENCED LAYERS</u>

<u>Part 2. Joining non spatial data to georeferenced layers</u>

1. Look at the attributes of the map (*right click -> open attribute table*) and you will see a feature for each county polygon and a field called *countyfp.* This is the county identifying value (standard in Census data).
2. Look at the attributes of the NYSCTYECN table (*right click -> open*) and you will also see a feature for each county and a field called *countyfp* Note the attributes are economic data associated with the county. You can see the key by looking in the dictionary file you downloaded.
3. Note that this data has no geometry (or location) associated with it. We are going to "join" it to the NYS county map.
    a. click on the county map to highlight it
    b. right mouse click and choose "joins and relates"
    c. select join
    d. Fill in the dialog box:
        i. 1. countyfp
        ii. 2. NYSCTYECN
        iii. 3. countyfp
    e. Note we are using a database operation and joining the two attribute tables around the county id field
    f. Select ok (if it asks to create an index click ok/yes).
    g. Check that the tables have been joined by right clicking the map layer and looking at the attribute table.
4. Save the map (*NYSAllCounties.mxd*).

APPENDIX 3. <u>CREATING MAPS AND ADDITIONAL LAYERS</u>

<u>Part 3. Creating Maps and additional layers</u>

1. Let's change the *symbology* to display economic information about the counties:
    a. right mouse click on the map layer, click on properties, and go to the symbology layer.
    b. In the Show pane select Quantities->Graduate Colors
    c. In the Fields pane select "NYSCTYECN.INFORMAT
    d. The "classes" field should be 5.
    e. Select "OK"
    f. Which counties have the most employees in the information industries?
2. In the "layout" mode, create a map with a title, scale, and compass. Export the map as a "jpeg" (*NYSAllCounties01.jpeg)*
3. Right click on this layer and select copy.
4. Right click on the "Layers" heading and click paste. You will have another layer.
5. In this layer chose one of the other attributes to display using *graduated color* symbology
6. Make this layer the current one (turn off the previous layer), create a map as above and export as a "jpeg" (*NYSAllCounties02.jpeg)*.

APPENDIX 4. <u>GATHERING EXISTING DATA AND CREATING THE MAPS ON YOUR OWN</u>

<u>Gathering existing data and creating the maps on your own</u>

1. Go back to the original NYS Data Center website and download Education data (and the dictionary). It's at the end of the "attribute" menu.
2. Create maps which show
    a. Distribution of total Bachelor, Master, and Doctorate degrees in the over 25 population (look in the dictionary for the fields).
    b. Each will be a different map (NYAllCountiesEdu01, NYAllCountiesEdu02, NYAllCountiesEdu03.
        i. Add the All County Base map again
        ii. Add the Education table
        iii. Copy the joined table twice
        iv. Use symbology to display the distributions above.
        v. Create and export maps with titles, scales and compass.