Challenges and Lessons Learned in Teaching an Online GIS Course

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Abstract

This presentation describes the challenges and lessons learned from teaching a totally online, semester-long GIS course. The course was the first offering in a planned online Masters in GIScience degree. The online course is compared to a similar on-campus course in several areas, including methods of content delivery, assessment of student learning, and lab exercises using ArcGIS. The lessons learned from this first experience with online instruction will guide the development and delivery of future online courses.

Introduction

Northwest Missouri State University (Northwest) is offering a new online Master of Science degree in Geographic Information Science (GIScience). This new program, which focuses on applied GIScience for business and government, is housed in the Department of Geology/Geography. The degree program includes coursework on such topics as GIS database design, modeling with GIS, geostatistics, cartographic design, and project management. The target population for the online Master's degree consists of people working in business or the public sector who seek advanced education in GIScience but who do not wish to leave their current employment and return to school in a traditional on-campus Master's program. The first group of students will be admitted to the online program for the fall 2003 term.

The online Master's in GIScience builds upon extensive online education experience at Northwest (www.northwestonline.org) and the Department of Geology/Geography's strength in GIS. The Department teaches introductory and advanced undergraduate courses in GIS, cartography, and remote sensing and offers a GIS minor jointly with the Department of Computer Science/Information Systems.

"Principles of GIS" is a foundation course in the online Master's program for those students with a limited background in GIS. The course is intended to give students the knowledge of fundamental GIS concepts needed to take the other graduate-level courses in the Master's program. Although the online Master's program officially begins in fall 2003, "Principles of GIS" was first taught during spring 2003. Students who took the course in spring 2003 were junior, seniors, or graduate students in departments other than Geology/Geography who had no prior instruction in GIS.

This paper compares teaching the online "Principles of GIS" course with teaching a similar on-campus GIS course. After brief descriptions of Northwest's on-campus GIS courses and the delivery mechanism for "Principles of GIS", the two courses are compared in detail. Challenges of teaching an online GIS course and lessons learned from this experience are discussed as part of this comparison.

On-campus GIS Courses

For undergraduate students seeking education in GIS, the Department of Geology/Geography teaches a three-course sequence of "Maps and Map Interpretation," "GIS," and "Advanced GIS." The three courses are requirements for the GIS minor. In "Maps and Map Interpretation," which is a prerequisite for the other two courses, students learn basic mapping concepts, including but not limited to scale, generalization, projections, coordinate systems, and terrain representation. The "GIS" course is an introductory course that covers such topics as the vector and raster data models, GIS data input and output, basic GIS data analysis functions, and data quality. Approximately half of the course consists of lectures on GIS concepts. The other half consists of hands-on laboratory work and exercises using ArcGIS. The "Advanced GIS" course expands students' knowledge of GIS concepts and analysis functions and requires students to conduct an original GIS project. The Department of Geology/Geography also teaches on-campus courses in introductory and advanced cartography, remote sensing, and digital image processing, which are taken by many students seeking the GIS minor.

The online "Principle of GIS" course covers almost the same content as the on-campus "GIS" course. There are two content areas in which the courses differ. First, because "Principles of GIS" has no prerequisites, it includes material on basic mapping concepts, such as scale, projections, and coordinate systems, that on-campus students learn in "Maps and Map Interpretation." Second, "Principles of GIS" provides more detail on the structure of shapefiles and ArcInfo coverages, which is reserved for "Advanced GIS" in the on-campus courses. To cover these additional topics, online "Principles of GIS" moves at a faster pace than the similar on-campus "GIS" course. Because graduate students in the online Master's program are the target audience for "Principles of GIS," it is assumed and expected that they will be able to keep up with the faster pace without having taken a prerequisite course.

In the remainder of this paper, "Principles of GIS" is often referred to as "the online course" or "Principles." To avoid confusion with the generic term GIS, the on-campus course entitled "GIS" is referred to as the "on-campus course."

Delivery of "Principles of GIS"

All online courses taught at Northwest, including "Principles," are developed and taught with course authoring and delivery software from eCollege, of Denver, Colorado. eCollege's software provides an easy to use, point-and-click interface for an instructor to create a course and for a student to navigate through a course. There are tools for creating and posting course units and content items, setting up the gradebook, creating and grading exams, conducting threaded discussions, and sharing documents. Other tools include email, chat rooms, and dropboxes for turning in assignments. Content items may include word processing documents, spreadsheets, Powerpoint presentations, graphics files, and various multimedia files.

The online course site for "Principles" is organized with one course unit for each week of the term. The material for each week is posted as items under the corresponding course unit.

Students access the course site through a web browser, typically Internet Explorer or Netscape. They click on buttons or menus to display the course syllabus, find a list of textbook reading assignments, display or download course notes or exercises, submit assignments to a dropbox, take an exam, check their grades, or email the instructor. Besides browser access to the eCollege course site, students in "Principles" must also have access to ArcGIS for lab exercises.

Course Comparison

As stated above, the content for "Principles" is very similar to the on-campus introductory GIS course. Table 1 lists the major components for both "Principles" and the on-campus course.

Table 1: Components for Online "Principles of GIS" and On-campus "GIS" Courses

Components	Online Principles of GIS	On-campus GIS course
Textbook	Bolstad (2002)	Heywood, Cornelius, Carver (1998)
Supplemental readings	Yes, each is 1-4 pages in length. Some readings are selections from the ArcGIS online Help.	No
Lectures	No; students are responsible for reading the textbook and supplemental readings on their own.	Yes; approximately half of the class meetings are lectures. Lectures cover GIS concepts.
Term paper	No	Yes
Exams	3 exams on textbook and supplemental readings	3 exams on lectures and textbook
Lab exercises	3 modules from ESRI's Virtual Campus course Learning ArcGIS I; 12 instructor-written ArcGIS exercises (11 are almost identical to exercises for the on-campus course.)	11 instructor-written ArcGIS exercises

Similarities and differences between the two courses are described in greater detail in the following paragraphs.

Course Readings and Lectures

Both the online and on-campus courses use an introductory GIS textbook. For the on-campus GIS course, lectures cover some of the material in the textbook plus additional GIS concepts not found in the text. Because the online course does not have in-person lectures, online students

must read the textbook and supplemental readings to learn the conceptual material of the course. Unlike some of their on-campus peers, online students cannot simply come to class, listen to the lectures, and absorb some of the conceptual material without ever opening the textbook. Thus, selection of a textbook and/or other readings is more critical to successful learning in the online "Principles" course than in the on-campus GIS course, where it is simple for the instructor to lecture on concepts not covered adequately in the textbook. For similar reasons, online students also must be self-directed learners if they are to be successful in an online course.

For the online "Principles" course, I have written supplemental notes where necessary to convey additional conceptual material not found in the textbook. Most of these notes are 1-4 pages in length. For selected topics, students are also assigned portions of the ArcGIS online help to read. To date, I have not included lecture videos in the online course, which could be used in place of written supplemental notes. Not all students have fast Internet connections. Downloading large video files over slower Internet connections could seriously disadvantage some students and add an unnecessary level of frustration to their ability to access course material. However, in the future, short videos may be tested as another means of communicating selected course concepts.

ArcGIS Software Access

A major consideration for students in any GIS course is access to GIS software. Students taking on-campus GIS courses at Northwest have access to a GIS lab with 16 PCs running ArcGIS and its extensions. With the exception of 12-15 hours a week when classes are held in the lab, students have free access to the lab from 8 AM to 5 PM. Under certain conditions, students may also obtain a key to the lab for evening and weekend work.

Students in the online "Principles" course are required to have access to ArcGIS 8 and the Spatial Analyst and 3D Analyst extensions for the course lab exercises. There are basically four options for obtaining access to the software:

1. Students may license their own copy of ArcGIS and its extensions at their own expense.
2. Students may purchase ESRI's book *Getting to Know ArcGIS Desktop*, which comes with a 180-day trial version of ArcGIS. Although this option may be viable for students taking one or two online GIS courses, this option is not practical for students who may be enrolled in an online Master's program for several years.
3. Students who work for an employer with ArcGIS may be able to make arrangements to use their employer's software for their coursework
4. Students within commuting distance of Northwest may use the GIS lab on campus. However, students in the online Master's program generally will not live within commuting distance.

Most students in the online Master's program will obtain ArcGIS access through options 1 or 3. Licensing a personal copy of ArcGIS and purchasing maintenance are significant expenses borne by online students that their on-campus peers do not have. Thus, educational software discounts are an important factor for the success of any online GIS course of study.

Learning the Basics of the ArcGIS User Interface

In the on-campus "GIS" course, the first lab exercise teaches students the basics of the ArcGIS user interface. These basics include creating a new map document, adding layers to a map, opening a layer's table, zooming and panning, classifying and symbolizing an attribute to create a thematic map, and creating a basic layout. Students learn these operations by working through the exercise with the instructor. As the instructor explains the user interface and does the exercise, students watch the instructor's work displayed on a large screen through the lab projection system and follow along, doing the exercise with the instructor. This method, supplemented by step-by-step written lab instructions, works very well for teaching the basic ArcGIS user interface in one class period (1 hour, 15 minutes). Later lab exercises focus on other functions, such as data entry, queries, and analysis functions.

For the online "Principles" course, a different method was needed for teaching the same basic operations. Rather than downloading and viewing a large video file of a demonstration of ArcGIS basics, students do three modules in ESRI's Virtual Campus course "Learning ArcGIS I." The three modules used are:

- Module 1: Basics of ArcGIS (students complete both Lessons 1 and 2)
- Module 2, Lesson 1: Displaying Data
- Module 6, Lesson 1: Introduction to Mapping (i.e., creating a layout)

Students may complete the other lessons and modules in the course, but other modules are not required for the "Principles" course.

The Virtual Campus course worked very well for teaching the basics of the ArcGIS user interface to students with no prior exposure to GIS. After completing the modules listed above, "Principles" students did the same exercise that is used to teach on-campus students the basic ArcGIS user interface. All of the online students completed this exercise without difficulty, even though they did not have the benefit of observing the instructor do the exercise. Given this success, I plan to continue using the Virtual Campus course "Learning ArcGIS I" to teach the basics of the ArcGIS user interface to online students.

Lab Exercises

The eleven ArcGIS lab exercises from the on-campus course are also used in the online "Principles" course. Utilizing ArcGIS exercises as a major component of the online course raised several issues that had to be handled differently from the on-campus course. These issues involve providing lab datasets to students, the need for more up-front planning for the online course, trouble-shooting student problems with the labs, and grading lab exercises. Each of these issues and their resolution are described below.

<u>Providing Datasets for Lab Exercises</u>

For the on-campus course, datasets for the lab exercises reside in a set of folders on each lab PC. For the online course, the lab datasets were written to CDs, and a CD was mailed to each student. This approach was taken so that students with slower Internet connections did not have to be

concerned with downloading large files. In addition, the CDs served as a backup copy of the exercise datasets, in case a student inadvertently deleted or corrupted a lab dataset copied to their hard drive.

More Planning for Online Course Labs

The lab exercises for both the on-campus and online courses contain detailed, written step-by-step instructions for the first usage of a specific ArcGIS function. In general, students are then given additional problems using the same function without detailed instructions. Because much time is needed to write and proof step-by-step instructions, it is easier in the on-campus class to elaborate and clarify lab instructions through in-class demonstrations, rather than add to the written instructions. Such demonstrations are especially useful when several students do not understand an operation or are having a similar problem. However, spontaneous software demonstrations are not possible with an online course. Instead, it is necessary to anticipate the types of problems that students may encounter or, based on past experience, know which GIS functions are most likely to give students difficulty. Additional written instruction can then be included in the lab exercises to clarify these difficult tasks. A short video could also be made to explain a specific function. However, adding to the written lab instructions or making a video requires more up-front planning and organization than giving a spontaneous software demonstration in the on-campus course.

Trouble-shooting Student Lab Problems

The previous point leads into the most challenging aspect of GIS exercises in an online class, which is helping students resolve problems with the exercises or decipher ArcGIS error messages. When a student encounters a problem with an exercise for my on-campus course, I can simply walk across the hall from my office to the GIS lab, where the student can show me the problem. A picture is indeed worth a thousand words when trying to describe an error, whether it is an operational error committed by the student, an unclear ArcGIS error message, or a software bug. It is much harder to help students with such problems in the online class when the problems must be described via email. If I am unavailable to respond to the student's email immediately, the student may exit from ArcGIS without saving their work, thus losing the immediate context of the problem and perhaps some details that would help to resolve the problem. Two aids that would help in resolving student problems would be more descriptive ArcGIS error messages and a "frequently encountered problems" list, which could be compiled for each exercise and posted on the online course site. Online students could help compile the list by adding their problems and solutions to it.

Grading Lab Exercises

Grading lab exercises for the online course was a fourth issue that required a modified approach compared to the on-campus course. The lab exercises for both courses require students to answer questions and, in many cases, create ArcGIS map documents or shapefiles to turn in for grading. For the online course, a digital dropbox on the eCollege course site was created for each exercise. Students copied files containing their lab results to the appropriate dropbox. However, eCollege dropboxes do not accept all file extensions. Although common extensions

for word processing documents, spreadsheets, text files, and common graphic formats are acceptable, map documents (.mxd files) and shapefiles cannot be copied to the dropbox. To work around this problem, students used WinZip to compress shapefiles into a .zip archive file, which could be placed in the dropbox. Rather than submit a map document file, students exported a layout to a .jpg file and copied the .jpg file to the dropbox. Creating .zip and .jpg files required additional instructions to be added to the lab exercises but was a simple accommodation for the online instructional environment.

Assessment

The eCollege course authoring and delivery software contains tools for creating online exams with a variety of question types, including multiple-choice, true/false, short answer, and essay. Student access to an exam can be restricted by day and hour. Exams can also be timed, and the amount of time taken by each student is recorded. Students may be kicked out of the exam when their time expires or allowed to stay in the exam and continue working.

My exams for the on-campus course consist mostly of short answer questions, one or two essay questions, and a few problems to solve. The eCollege exam builder tools enabled me to use similar kinds of exam questions for the on-campus and online courses.

A major dilemma for any online course with remotely located students is the problem of cheating on closed-book exams. The solution used by some online instructors and the solution that I chose was to make all exams open-book and open-notes and to give students a limited time period to take the exam. When their time period was up, students were not kicked out of the exam but could continue to answer questions. However, I deducted 10% from their exam grade for each additional 30 minutes (or portion thereof) that they needed for the exam. Students were required to add a reference citation to any answer that included material copied from the textbook or supplemental notes.

The intent of timing the exam and deducting 10% for students needing more time was to encourage them to study the course material before the exam, rather than wait and see what questions were asked and then look for answers in the textbook or supplemental notes. This approach seemed to work well for the first exam, because most answers were written in the students' own words. However, in later exams, there was an increase in students quoting directly from the textbook or copying and pasting material from the supplemental notes on the course site. Thus, it is unclear if the later exams were a true test of the students' knowledge of the course content or a test of their ability to copy and paste. Although it is possible that the students knew the material well and simply chose to use words from the textbook or supplemental notes for their answers, a student who has mastered material will usually feel confident writing an answer in their own words.

This experience with giving exams online reinforced the importance of asking exam questions that require students to apply the concepts that they have learned, rather than simply restate material found in the textbook or other course materials. The same pedagogic practice is important for any course, whether online or on-campus. A challenge for teaching this class again

is to improve exam questions or utilize other assessment approaches that do a better job of evaluating what the students have learned.

Lessons Learned

For a first experience teaching an online course, I encountered relatively few problems teaching "Principles of GIS" that could not be resolved in an acceptable manner for both the students and me. The students seemed to enjoy the course and had few complaints. They quickly learned GIS concepts and the use of ArcGIS and did well in the course.

As described in this paper, there were several challenges that were encountered in teaching a GIS class online. These challenges and lessons learned can be summarized as follows:

- The fact that some students may have slower Internet connections must be kept in mind when deciding which materials, such as videos or large datasets, to post on the course site. It may be better to send students all datasets for a course on a CD, rather than expect students to download large files from the course site.

- Greater up-front planning and organization are needed for an online course, compared to an on-campus course. Additional material that can be added "on-the-fly" to an on-campus lecture or lab demonstration must be captured in a file, whether through typing, screen snapshots, scanning, video, or other means, and posted on the course site. Although some material like text files or screen snapshots may be added quickly to the online course site, the instructor also should notify students of the new material. Some students may have worked ahead and already done the unit where the new material is to be added.

- Helping students resolve problems with GIS lab exercises is a major challenge. A "frequently encountered problems" list should be posted on the course site.

- Students may need to convert files created in the lab exercises to a different format before submitting the files for grading.

- Online exams must be structured to avoid the problem of cheating on closed-book exams. Exam questions or other assessment methods should require students to apply the concepts they have learned. Questions that can be answered by copying and pasting from course material should be avoided.

- Some students may want to work ahead on course material for future weeks. In fact, one advantage of online courses is that a student can make a course fit his or her schedule, rather than vice versa. However, to enable students to work ahead, all the course material should be finalized and posted on the course site at the beginning of the course. This requires up-front course design and development, not development as the course progresses. Adding material to a course site from week to week limits those students who want to work ahead.

Online GIS education is an exciting frontier with great potential. None of the challenges encountered when teaching an online GIS course for the first time proved to be a significant impediment to the success of the course. The lessons learned from teaching "Principles of GIS" will be incorporated into future offerings of "Principles" and into new online GIS courses at Northwest Missouri State University.

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