INTERNET MAPPING CURRICULUM TO PRODUCE EDUCATED AND SKILLED INTERNET CARTOGRAPHERS

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Abstract: *Many universities and employers are finding it difficult to educate and train cartographers who produce map products for the Internet. This paper will analyze three education models of Internet mapping education:*
1. Geography Model. Students will be required to take a majority of classes in geography specialties with only a small number of computer and geospatial science courses.
2. Geospatial Science Model. Students will take a triad of courses in computer and geospatial sciences and geography.
3. Technical model. This model will have only a small number of geospatial science classes and majority of computer science classes.
The analysis of the three models will be based on the skill set of the students in relation to the amount of employer training needed once hired. The skill set needed is based on NASA Geospatial Science Workforce Report, URSIA certification standards and Missouri, USA state job descriptions.

INTRODUCTION

Internet mapping in some form or another has been around nearly as long as the Internet itself. During most of this time individuals who have been working with maps on the Internet were self-taught. The self-education model has led to a wide array of ideas and creative solutions to many challenges encountered by the mapping community. A plethora of ideas and technologies have been tried and either used or thrown away.

- Image files
    - GIF
    - TIFF
    - JPEG
- Printable files
    - PDF
    - RTF
- Interactive Formats
    - VRML
    - Flash
- FTP
- Gopher
- WWW
- Programming
    - Plug-ins
    - JAVA
- Formats
    - HTML
    - DHTML
    - XML
    - GML

This list is not an exhaustive list of concepts and technologies used on the Internet, but it is useful when one thinks about how to create a formal education curriculum for students interested in maps and the Internet.

The intent of this research is to examine Internet mapping and develop a curriculum that will prepare students to enter the workforce with analytical and technology skills to progress through a career path in cartography. In the current employment market most people switch professional tracks during their employment career. People working in cartography

most likely will leave cartography for another career at some point. Career changes occur for many reasons: interest, opportunities, physical location, technological changes, health and financial reasons just to mention a few. Cartography has already gone through a major change in the last 30 years based on technological changes from the photomechanical period to the computer mapping period. One could argue that advancing computer mapping to Internet mapping is just as significant as the previous cartography revolution. In this research, a view that Internet mapping is a natural evolution of computer mapping and that many of the skill sets used in both are similar will be taken. Another issue when looking at planning a university education curriculum is the question of balance between educating the person or giving them contemporary skills. For universities this is a constant challenge. Students want the contemporary skills to be employed in a well paid job at the end of their studies. Most of them are looking at the short-term goal of employment. This research will attempt to consider both the short-term goal of post-graduate employment and the long-term goal of career path and life long learning.

This research is divided into three main parts. The first task is the identification of three distinct curriculum models that can be used by universities for educating students in Internet mapping. The second task is to identify both technical skills and life long analytical skills needed by students. The last of the three tasks is to evaluate which curriculum model teaches which skill set and how the resulting skills fit into current employment descriptions. At the end of these three tasks the following research question will have an answer:

- How does a university structure a curriculum that will educate students in Internet mapping to meet the current workforce demands while giving them a life long career path?

EDUCATIONAL MODELS

There are an unlimited number of educational models that one could create for Internet cartography. In this research three models were examined.

1. Geography
2. Geospatial Science
3. Technical

All three models are based on the incorporation of courses from the fields of Geography, Geospatial Sciences and Computer Sciences. Figure 1 illustrates the relative proportion of course work from each field.

The geographic model is the most traditional design. As a model, its central philosophy states that students with a detailed understanding of the discipline of geography can use this knowledge to lead and direct internet mapping projects. Students coming from academic programs that use this approach will need a significant amount of job training.

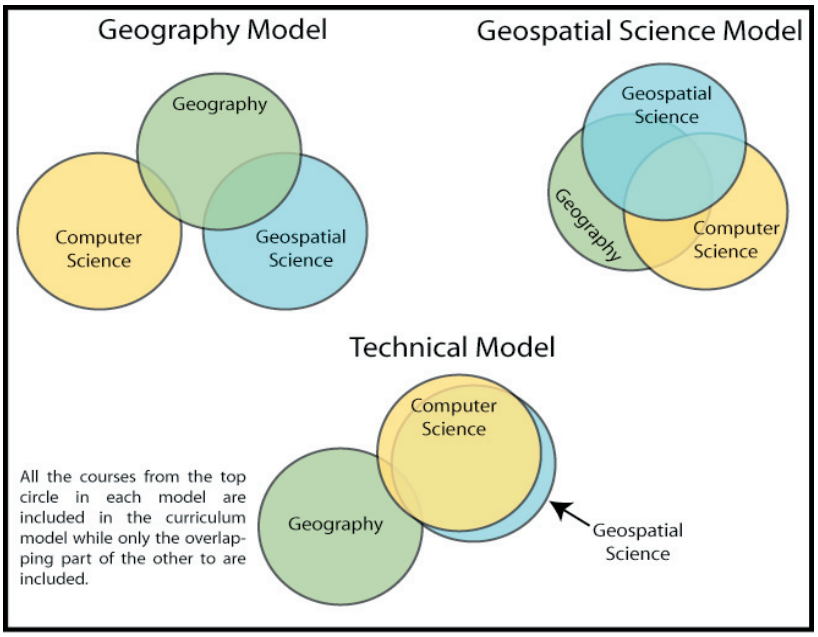

Figure 1: A graphic depiction of the composition of courses from geography, computer science and geospatial science in each curriculum model

The geospatial model starts from the thorough understanding of many components of geospatial science. Academic programs in this model will have a deep curriculum in cartography, geographic information science (GISc), remote sensing and global positioning systems (GPS). The amount of advanced course work in geography is reduced compared to the geographic model. In this model, computer science courses equal approximately 15 percent of classes a student might take while in school. The principle aim of this curriculum is to produce students who have some sense of the bigger geographic picture while enough contemporary skills to start working with only a small amount of job training.

In the technical model, students will have most of their course work in both computer science and geospatial science courses. Only the bare minimum of geography courses will be taken. The majority of the course work will come from the computer science department with nearly the same amount of geospatial science courses. The student might take two or three introductory courses in geography. Students coming from this type of program should only need some orientation once they arrive at the internet cartography job.

This section is a quick review of the prototypical USA university curriculum structure. Every university in the USA has a different academic structure but follow this set of general rules. An undergraduate curriculum is split into two parts with the first being the general education curriculum. All students must complete the general education curriculum as a part of their graduation requirements. The amount of general education work required at each university varies between 32 to 65 credit hours. Since most universities require around 125 credit hours to graduate, a student will take around 50 percent of their courses from general education. For the rest of this paper, this 50 percent number will represent general education requirements. Table 1 shows the three education models and the percentage of classes in general education, geography, geospatial sciences, and computer science.

Model	General Education	Geography	Geospatial Sciences	Computer Science
Geography	50%	35%	10%	5%
Geospatial Sciences	50%	10%	30%	10%
Technical	50%	5%	20%	25%

Table 1: Division of Courses for the Education Models

INTERNET MAPPING

Many of the new skills needed for internet mapping are the same as the skills needed to make maps on paper or multimedia cartography. For academic programs that have adapted to computer based mapping, including additional skills for internet mapping will not be an extreme change. In this section a set of skills will be identified. Some of these skills are already in most academic programs but many will need to be added if students are to meet the growing needs of the labor market. This list is not exhaustive for two reasons, one numerous technologies are currently being developed and will be in full use before a student can complete his or her academic program, and secondly many of the specific technical skill are used in isolated instances.

The skills needed for internet mapping are divided into four primary categories: geography, cartography, geospatial sciences, and computer science. This categorization is slightly different from the educational models. In this categorization the cartography component is separated from the rest of the geospatial science models. Principally this was done to focus on a specific set of cartographic skills. The skills in question are map use, interactions, and interfaces. Table 2 is a detailed list of skills that a student graduating would have based on which education model they are in.

Table 2: Internet Mapping Skill Compared to Educational Model

	Geography	Geospatial Sciences	Technical
Geography			
Cultural			
Language	●	ɵ	○
Belief	●	ɵ	○
Ethnicity	●	ɵ	○
Customs	●	ɵ	○
Race	●	ɵ	○
History	●	ɵ	○

Urban			
Cities	●	ɵ	○
Demographic	●	ɵ	○
Income	●	ɵ	○
Education	●	ɵ	○
Structure	●	ɵ	○
Transportation	●	ɵ	○
Housing	●	ɵ	○
Physical			
Soils	●	ɵ	○
Landforms	●	ɵ	○
Weather	●	ɵ	○
Climate	●	ɵ	○
Weathering	●	ɵ	○
Biogeography	●	ɵ	○
Hazards	●	ɵ	○
Processes	●	ɵ	○
Cartography			
Location			
Datum	●	●	ɵ
Projections	●	●	ɵ
Coordinate	●	●	ɵ
Absolute	●	●	ɵ
Relative	●	●	ɵ
Abstraction			
Scale	●	●	ɵ
Selection	●	●	ɵ
Generalization	●	●	ɵ
Design			
Message	●	●	ɵ
Symbolization	●	●	ɵ
Map Type	●	●	ɵ
Map Elements	●	●	ɵ
Balance	●	●	ɵ
Contrast	●	●	ɵ
Vision	●	●	ɵ
Perception	●	●	ɵ
Map Type			
General Reference	●	●	ɵ
Thematic			
Choropleth	●	●	ɵ
Dot Maps	●	●	ɵ
Cartograms	●	●	ɵ
Isarithmic	●	●	ɵ
Graduated	●	●	ɵ
Multimedia Maps			
Animated	ɵ	●	○
Interactive	ɵ	●	○
Immersive	○	●	○
Geopatial Sciences			
Geographic Information Sciences			
Database			
Design	●	●	●
Development	●	●	●
Maintenance	ɵ	●	●
Model			
Vector	●	●	●
Raster	●	●	●

TIN	●	●	●
Spatial Analysis	ɵ	●	●
Query	ɵ	●	●
Proximity	ɵ	●	●
Remote Sensing			
Aerial Photographs	ɵ	●	ɵ
Multispectral	ɵ	●	ɵ
LIDAR	○	●	ɵ
Radar	○	●	ɵ
Classification	ɵ	●	ɵ
Processing	ɵ	●	ɵ
Taxonomies	ɵ	●	ɵ
Global Positioning Systems			
Systems	ɵ	●	ɵ
Error	ɵ	●	○
Devices	ɵ	●	○
Computer Sciences			
Database Management			
Models	○	ɵ	●
Relationships	○	ɵ	●
Building	○	ɵ	●
Maintenances	○	ɵ	●
Programming			
Objects	○	ɵ	●
Visual Basic	○	ɵ	●
C++	○	ɵ	●
JAVA	○	ɵ	●
Networking			
Client Server	○	ɵ	●
Peer to Peer	○	○	●
Internet Services	○	ɵ	●
Web Servers	○	ɵ	●
Web Protocols	○	ɵ	●
Hardware			
Purchasing	○	ɵ	●
Management	○	ɵ	●
Maintenance	○	ɵ	●

Depth of Instruction
○ No Instruction
ɵ Introductory Instruction
● Complete Instruction

The differences in topics for the three education models are mostly based on the limited number of instructional units for an undergraduate curriculum. It should be noted that this research in not advocating any increase in hours of internet mapping students or a reduction in general education contact. If a student wants detailed instruction in all these topics before entering the work force they will need to consider either graduate school or continuing education to meet this personal goal. Employers will also need to examine their own employee training program if they want comprehensively educated employees.

ANALYSIS

With the three education models laid out, an evaluation of their merit should be undertaken. In this research three standards will be used to evaluate these educational models. These three standards are very different from one another so a brief discussion of them is needed along with an analysis of the educational models.

NASA Geospatial Workforce

The National Aeronautic and Space Administration (NASA) set out to develop a model of training a geospatial workforce (Gaudet, et al, 2003) under the National Workforce Development Education and Training Initiative (NWDETI). Currently the NWDETI has developed education and training programs based on competency models. A competency model identifies a group or individual competency that a employee must have to be successful within the work place. A competency is best defined as "behaviors that distinguish an effective performer from an ineffective one" (Dalton 1997). A view of competency comes from LeBleu and Sobkowiak (1995) that an individual possesses abilities that bear knowledge and skills for a job requirement. Zemke and Zemke (2000) suggest that a competency model better defines the workforce needs because they more broadly outline the employee who will succeed in a given job.
Gaudet, et al, (2003) identified 39 key geospatial competencies which are grouped into four categories: technical, business, analytical and interpersonal. This analysis will focus primarily on the technical and analytical competencies. As a side note, most of the competencies listed in the interpersonal set are a major part of most universities general education requirements. Table 3 lists both the technical and analytical competencies.

Technical Competencies	**Analytical Competences**
Ability to Assess Relationships among Geospatial Technologies	Creative Thinking
Cartography	Knowledge Management
Computer Programming Skills	Model Building
Environmental Applications	Problem Solving
GIS Theory and Application	Research Skills
Geology Application	Systems Thinking
Geospatial Data Processing Tools	
Photogrammetry	
Remote Sensing Theory and Applications	
Spatial Information Processing	
Technical Writing	
Technological Literacy	
Topology	

Table 3. The NASA Workforce Competencies

When comparing the NASA Geospatial competency model to the three educational model three points are clear. First the NASA Geospatial competency model appears to be missing any reference to Internet mapping. Second, each of the three educational models meet only a subset of the competencies in the technical and analytical. The final point is that none of the education models proposed covers the business competencies. All three educational models would address all analytical competencies. It appears that the Geospatial Sciences model would cover more of the technical competencies followed by the geography model and technical model. The technical model suitability would be better if the NASA geospatial competency model included more internet mapping topics.

URISA Certification

Urban and Regional Information Systems Association (URISA) has developed a GIS certification process(http://www.gisci.org). The issues of certification accreditation and licenses are continuing to be under review (Huxhold 1991, Goodchild and Kemp 1992, Obermeyer 1993, and Wikle 1999). Currently few employers require certification of employees but new research currently exists that indicates that there is a positive or negative trend in the field. The URISA certification is broken down into three parts, education, contributions, and work experiences. Students completing any of the three education models would meet the education requirement for the URISA certification. The URISA certification places much more weight on experience than education so a detailed look at different models is not useful.

Missouri Job Descriptions

The state of Missouri (USA) has five official job descriptions for GIS based jobs (http://www.oa.mo.gov/pers/ ClassSpecs/ List_G-O.htm). Within state employment a person working in Internet mapping would most likely be hired under one of these five job descriptions. All five are categorized as Geographic Information Systems. The individual subtitles are Technician I, Technician II, Analyst, Specialist, and Coordinator. All five jobs are focused almost solely on GIS skills. With this focus the Geospatial sciences model would best fit these jobs. Like the NASA and URISA standards Internet mapping is not directly covered.

CONCLUSION

Three different education models have been outlined for Internet mapping students. Based on the comparison of the three education models to three workforce standard (NASA, URISA and Missouri) the geospatial science model appears to meet most of the desired skills of employers. This conclusion can only be supported in part because none of the three employment standards make direct reference to internet mapping. Internet mapping has grown dramatically in the last five years and many of these standards predate this growth. In the future as employers re-evaluate employment standards to include internet mapping the technical model may meet more of the standards.

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