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Acquisition and Distribution

Outsourcing and Consulting

The Financial Workforce

Entrepreneurial Success

Integrating Metadata

Concepts with GIS Curricula

The UCGIS Model Curricula Project

Certification and Ethics in GIS

Bonus: The GISCI Certification



Introduction to the Special Issue on GIS Education

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How we should learn and teach about geographic information systems (GIS) and science (GIScience) has been a topic of discussion among academics for well over 30 years. In the same span of time, a still ill-defined profession has emerged within those who practice the application of this technology. Given the traditional lack of communication between academics and professionals, bridging the gap between the academic view of what should be learned and the professional view of what skills and knowledge are needed continues to be a challenge. This special issue on GIS education brings together reports on a number of current efforts aimed at defining the profession and satisfying its educational needs.

This issue of the URISA Journal marks a second publication collaboration between the Urban and Regional Information Systems Association (URISA) and the University Consortium for Geographic Information Science (UCGIS). UCGIS was founded in 1994 with a mission of serving as an effective, unified voice for the geographic information science research community; fostering multidisciplinary research and education; and promoting the informed and responsible use of geographic information science and geographic analysis for the benefit of society (see www.ucgis.org). Membership in UCGIS is conferred at the institutional level rather than the individual level and now includes 62 universities or university consortia, 4 professional organizations, and 10 affiliate members.

The first collaboration between URISA and UCGIS produced a special issue of the URISA Journal (Spring 2000) that focused on GIS application areas as motivators for pioneering GIScience research. In that issue, challenging and unresolved issues arising from application areas important to URISA members (crime analysis, emergency management, public health, transportation, water resources, and urban and regional planning) were examined as potential research opportunities for UCGIS members and other researchers in the larger GIScience community. This type of partnership between URISA professionals and UCGIS academics benefits both groups. Research motivated by real needs develops new methods and techniques relevant to practical applications that later diffuse into professional practice.

In this second special issue, we focus on education as another area of partnership between the professional and academic communities. Professionals have much to contribute to the design of both traditional academic programs and continuing education opportunities, and academic programs benefit by responding to the user community. Likewise, given the rapidly evolving technologies, professionals need to know how to take advantage of various education opportunities and to become informed consumers of educational products.

GIS education began in the 1970s, largely as the preserve of graduate programs in very specialized universities (perhaps most famously in the United States, the Graphics Lab at Harvard Uni-

versity). As the algorithmic and software foundations of the technology advanced, GIS education gradually became more formalized as undergraduate courses and now, in some cases, as full university degree programs (e.g., the Bachelor of Science degree in GIScience offered by Texas A&M University-Corpus Christi). Similarly, as use of the technology became more widespread, the need for professional and continuing education was recognized and individual courses and certificate programs emerged in University extension programs. A full spectrum of GIS education opportunities now exist – GIS is now even being taught at the pre-school level!

While much of the early design of GIS education was motivated by university academics, the emergence of the GIS profession has provided impetus to the need to build education opportunities that truly reflect the demands of the employment market. The articles and reports in this issue explore this circumstance from several different perspectives. These include: the need to identify the full set of competencies, knowledge, and skills required by professionals in the workplace (through efforts to define necessary competencies and appropriate university curricula); the appropriate design of education programs and exploration of emerging delivery mechanisms (designing curriculum content and providing distance learning opportunities); and the question of quality control among both professionals and educational opportunities (through certification and accreditation).

To set the context for the formal articles, this issue begins with two brief reports on significant initiatives of UCGIS and URISA that are responding to these workplace needs. The first report provides an update on the URISA Professional Certification initiative and the second on the UCGIS Model Curricula project.

Developing the procedures and organizational infrastructure for the certification of GIS Professionals is an important and very active URISA initiative. A vote by the Board of Directors taken in October 2001 to support the initiative recognized the efforts of the large URISA Certification Committee, which has been slowly developing the foundations for professional certification in GIS for more than 5 years.

The Certification Committee is a mix of private and public sector GIS professionals and academics. They have been laboring over a very controversial proposal. The road to consensus among Committee members has sometimes been difficult and reflects the differing views of professionals and academics. During the past year, the Committee has made available for public comment a number of evolving versions of the proposal (see the URISA web site for more information and to view the Guestbook, which is a record of comments received). Community participants have not been shy in submitting their views to the Guestbook. Widespread and sometimes acrimonious comment of these versions has led to significant revi-

sions. The current version represents the best efforts of the Committee to account for the wide range of concerns noted, and it is now ready for a pilot program which will be undertaken in 2003.

While intended to recognize the qualifications of GIS professionals, rather than casual GIS users, the proposed process is based on a self-documented portfolio and a point system that assigns points for education, experience, and contributions to the profession. No examination is proposed due to the diversity of the field and the difficulty of defining a single suitable examination. In the first report in this issue, William Huxhold, Chair of the URISA Certification Committee and former President of both URISA and UCGIS, summarizes the status of this certification initiative.

A necessary component of professional certification is a Code of Ethics. Largely the result of untiring effort by William Craig, also a former President of both URISA and UCGIS, a GIS Professional Code of Ethics has been prepared by the URISA Certification Committee. As a result, professionals seeking URISA certification will be required to study and pledge to adopt the Code in their professional endeavors. The Code includes ethical standards that are both general (relevant to any professional) and specific (of particular relevance to the practice of GIS professionals). Craig summarizes the Committee process and the proposed Code in the first report.

Academic members of the URISA Certification Committee, including the two editors of this issue, found many of the Guestbook comments about the relative value of traditional education versus the value of professional experience to be humbling. Many GIS professionals expressed skepticism about the relevance of traditional education, suggesting that academics have a distorted view of what is really important in practice. The efforts of the UCGIS to address some of these recognized deficiencies in traditional GIS education are the focus of the second report in this issue.

Over the past several years, the UCGIS Model Curricula Task Force has been working to develop a foundation for the design of undergraduate degree programs in Geographic Information Science and Technology (GIS&T). Recognizing that students following GIS&T undergraduate programs have many different objectives and goals, a curriculum designed from the Model Curricula framework would be built from a selection of hierarchically organized knowledge areas, units, and topics, and associated cross-cutting themes. Currently, the Task Force effort is focused on defining this Body of Knowledge for GIS&T. Karen Kemp, a Task Force member, a past Board member of UCGIS, and the Education Editor of the URISA Journal, reports on progress on this project on behalf of the Task Force.

Within the context of these active and dynamic URISA and UCGIS efforts, the regular articles in this issue represent a sampling of associated efforts and ideas flourishing in the community. Each article exemplifies a different response to the tension between the academic and the professional views of what GIS professionals need to know and how they should learn it.

The first regular article in this issue presents a very different approach to defining what GIS professionals need to know from that being used by UCGIS. Working from a workforce development research model, Cyndi Gaudet and Heather Annulis from the Geospatial Workforce Development Center at the University of Southern

Mississippi have undertaken a rapid-turnaround NASA-sponsored study to identify the roles and necessary competencies needed in the geospatial technology workforce. Competencies are the success factors for excellent performance within a given role. A combination of roles make up the tasks performed by a single worker. The research design used a combination of focus groups of members of the geospatial community and extended interviews with role experts.

The resulting Geospatial Technology Competency Model identifies 12 distinct work roles (e.g., applications development, marketing, and data management) and 39 competencies (e.g., cartography, creative thinking, conflict management, and geospatial data processing tools). This Competency Model is defined with a much broader brush than the UCGIS Body of Knowledge. Whereas the UCGIS Body of Knowledge seeks to identify those areas of knowledge that are unique or fundamental to the GIS&T domain, this Competency Model seeks to identify the full range of competencies needed by a working professional and thus encompasses 29 generic business, technical, analytical and interpersonal competencies that are independent of the GIS domain. The importance of this research is not what it found out about GIS knowledge requirements – the incompleteness of which is acknowledged by the authors – but rather what it found out about the set of non-GIS-related professional competencies needed.

Taking yet another approach to defining what a GIS professional needs to know, the next article in the issue considers in detail some of the issues involved in determining how one particular topic – metadata, one of the cross-cutting themes in the UCGIS Body of Knowledge – should be placed within academic programs. Here, Margo Berendsen and Jeff Hamerlinck (University of Wyoming) and Linda Wayne (principal of GeoMaxim and Metadata Education Coordinator for the Federal Geographic Data Committee) take a careful look at how metadata education can and should be diffused throughout an entire curriculum. Metadata has emerged as an important component of GIS practice. The authors argue that the traditional short course, 1-day training seminar, or on-the-job training are not sufficient for GIS professionals to appreciate that metadata should not be viewed “merely as a content standard or software application, but rather as a philosophy of how to approach information management and decision-making tasks.” The authors outline a pedagogic framework that shows how metadata concepts might be integrated into a broad range of components in a GIS curriculum.

Seen as a set, these three projects – the UCGIS Model Curricula, the Geospatial Competency Model, and the University of Wyoming project to define strategies for integrating metadata into a curriculum – illustrate the complexity and difficulty of completely specifying what needs to be taught. While the Geospatial Workforce Development Center project did a commendable job of highlighting the need for generic skills in the competency set of GIS professionals, a fully elaborated GIS curriculum will need serious attention to the GIS&T Body of Knowledge being specified by UCGIS. As well, in any full implementation of a curriculum, the question of how important cross-cutting themes such as metadata, scale, and uncertainty can be consistently and deeply incorporated must be considered.

Having explored the question, however inconclusively, of what GIS professionals need to know, we next turn to consideration of themes related to the URISA Professional Certification initiative reported earlier in this issue. As noted, certification is a highly contentious topic. If GIS professional certification becomes a reality, any number of related issues assume sudden importance. Here we consider two of these. David DiBiase explores the specter of accreditation – if certification depends upon recognition of educational credentials, how do we assess the quality and comparability of various education opportunities? Francis Harvey then reflects upon how professional certification, once implemented, may lead the profession toward licensing.

In the article by David DiBiase of Pennsylvania State University, a member of the URISA Certification Committee, it is noted that certification is a process of assuring that individuals have the required knowledge and skills that comprise “competency” in a profession. However, while certification can be granted by a professional organization (e.g., URISA), academic institutions and private sector organizations also confer “certificates.” It is this second use of the word certification that raises concern. Many academic institutions now offer GIS Certificates, taught both within regular academic programs and within continuing education programs, and in regular classrooms or via distance learning. There is a wide but uncertain variation in the quantity and quality of education provided across these institutions. Thus, the best current advice for professionals seeking GIS education is “buyer beware.”

There are a number of ways that higher education is held accountable for the quality of their courses and programs. The most common way is through “accreditation” of programs and departments. The Accreditation Board for Engineering and Technology (ABET) may be familiar to URISA members. DiBiase describes several processes of accreditation used by professions. Geography departments, the source of the majority of GIS courses in universities, have not historically taken part in an accreditation process and are likely to be resistant to such a change. As an alternative, DiBiase makes a strong and compelling argument for a “peer review” process for both courses and programs. The accreditation process would be a voluntary one that emphasizes self-evaluation and peer review through a new journal, likely on-line. Such a process would help inform consumers of GIS education about the quality of courses and programs, improve the quality of courses through evaluation and peer review, and provide academics with the reward of a peer-reviewed publication arising from their efforts to be good teachers that may be equivalent to the academic reward provided by the publication of a research paper.

Just as there is considerable variation in the meaning and value of a certificate, there is some confusion about the distinction between licensing and certification. It is this apparent confusion that led Francis Harvey from the University of Minnesota to focus on a consideration of the relevance of public safety concerns – the motivation for licensing – to GIS certification. Legally, certification is the recognition by an awarding organization that a person has met specified requirements, while licensing is an exercise of police power that empowers the government to restrict an individual's

freedom in order to protect the public health, safety and welfare. This article reviews two case studies of licensing that emphasize the political, philosophical, and scientific dimensions of licensing and certification. Through this review, Harvey comes to the question, “is there a test that assures GIS certification fulfills public safety concerns?” If this question cannot be affirmatively answered, Harvey argues, then certainly licensing, and perhaps certification for GIS professionals, is premature. Despite the answer, Harvey suggests that the relevance of public safety issues to the practice of GIS implies that consideration of this topic should immediately become incorporated into GIS curricula preparing individuals for future professional careers.

The final article in this issue touches on the very large question of how we should teach GIS. In 1997, the UCGIS developed a set of Education Challenges for the GIScience community. One of these gave rise to the Model Curricula Project reported earlier. Another of these challenges was entitled “Emerging Technologies for Delivering GIS Education.” Over the next few years, discussions around this topic led to elaboration of a White Paper on “Challenges and Opportunities in Distance Education for Geographic Information Science” (available on-line at <http://dusk.geo.orst.edu/disted/>). While distance education is in no way unique to GIS, the opportunity it provides both to share our responsibilities for keeping course materials as current as possible in light of rapidly evolving technologies and to incorporate our technologies into other learning experiences must be explored. The final article illustrates this latter theme.

In their article on a recent project to teach environmental sustainability through an on-line seminar, Ryan Kelsey and Mark Becker of Columbia University describe an innovative approach to using GIS as a core technology for distance learning. As the authors point out, many courses offered via distance learning are sequential in design – students complete one module before moving onto the next, often progressing from basic knowledge to more specific learning objectives. The on-line seminar described in their article takes a different approach. Nine faculty from Columbia University present nine different perspectives on the issue of environmental sustainability. Students (both degree students and outside adult learners) explore these perspectives through a set of modules arranged in a hub-and-spoke style, rather than in a set sequence. Aiding them in this loosely structured exploration of the topic is an interactive GIS application used to access and explore a dataset of international environmental indicators.

By ending the issue with an article exploring GIS for education rather than GIS education itself, a kind of closure is achieved. As we grow in our understanding of the fundamental educational needs of GIS professionals through our efforts at certification and defining the core body of knowledge contained within the domain, we will be better able to articulate what GIS itself can bring to the education experience in general. Just as the Geospatial Workforce Development Center sees technical writing and conflict management as core skills for GIS professionals, perhaps others will begin to recognize the conceptualization of space and exploratory spatial data analysis as generic competencies in their fields.