Ann B. Johnson[1], Karen K. Kemp [2], Brandon Plewe[3], Ann Luck[4], Michael DeMers[5]

DEVELOPING GIS CURRICULA – UCGIS MODEL CURRICULA BODY OF KNOWLEDGE 2006

[1]ESRI, California, USA
[2]Independent Scholar, Hawaii, USA
[3]Brigham Young University, Utah, USA
[4]Pensylvania State University, Pennsylvania, USA
[5]New Mexico State University, New Mexico, USA

ABSTRACT

Academic research has been a major force in the development and use of geographic information system (GIS) and related geospatial technologies. Courses and programs at universities in geographic information science and technology (GI S&T) have increased rapidly as the need for well educated and trained graduates has grown in the industry. Many efforts have been made in the past to help educators develop GI S&T programs. The University Consortium for Geographic Information Science (UCGIS) Model Curricula Project and the subsequent development of a GI S&T domain Body of Knowledge is an effort to assist educators in the development of effective curriculum for GI S&T programs. The Body of Knowledge (BoK) will be published by the Association of American Geographers (AAG) in the summer of 2006. The BoK is partitioned into 10 Knowledge Areas (KA) representing the domain knowledge for GI S&T. Each KA is further partitioned into Units, then Topics. Each Topic is defined by a set of Educational Objectives. While this first edition of the BoK is expected to help educators build GI S&T curricula, it will be expanded and revised to better reflect the domain of GI S&T in future editions. The BoK is also proving to be useful to the geospatial industry and related organizations for purposes not strictly related to curriculum development.

Key words: GIS, Curricula, GIScience, UCGIS, DACUM, GI S&T, geospatial

1 GI Science and Technology Curriculum

1.1 Overview of Efforts

Academic programs within the United States that focus on geographic information systems (GIS) progressed from a handful of institutions doing research at the graduate level in the 1970s to the present time where hundreds of institutions offer courses, certificates and degree programs incorporating the use of geographic information science and technology (GI S&T). There have been many efforts by academia, professional organizations and industry to define the content of programs related to GI S&T. One of the earliest efforts in the United States was the National Center for Geographic Information and Analysis (NCGIA) Core Curriculum in GIS.

1.1.2 NCGIA Core Curriculum

The US National Science Foundation (NSF) initially funded the NCGIA in 1988. A small part of the NCGIA's program of activities was the development of the Core Curriculum in GIS (Goodchild and Kemp, 1990). It is a set of 75 lecture notes organized into three courses. While this was called a Core Curriculum, the materials are more appropriately seen as a set of teaching materials from which individual instructors constructed their own courses. First distributed in 1990, it has been translated into many languages and continues to be used by educators. Later efforts to update and expand the curriculum have been less successful due to the widespread availability of teaching materials making it less critical as a resource. The latest version is available at http://www.ncgia.ucsb.edu/giscc/. Another effort to develop more technology

related curricula was the "Core Curriculum for Technical programs" which was also funded by the NSF. This effort helped spread the technology into lower division programs, but it has not been maintained or updated since 1999.

1.1.3 Increasing Interest in GI S&T and Support for Curriculum Development

Expanding use of GI S&T and related technologies has lead to several efforts by US governmental agencies, educational institutions and professional organizations to define the industry, determine the skills and competencies necessary for a successful workforce, and develop curriculum to meet those needs. Funding for some of these efforts has come from the US Department of Labor (DoL), the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA), among others. Collaborations and individual efforts have also taken place among professional organizations, government and universities including NASA and the University of Southern Mississippi (Gaudet, 2003) and the University of Mississippi (Institute for Advanced Education in Geospatial Sciences (IAEGS). One current effort supported by the DoL includes the Geospatial Information and Technology Association (GITA), the Association of American Geographers (AAG) and the Wharton School. A draft report on the First Phase of the process is available from the AAG web site (AAG, 2006, www.aag.org/giwis). Other professional organizations that have been active are the Urban and Regional Information Systems Association (URISA) and the American Society for Photogrammetry and Remote Sensing (ASPRS).

Two year colleges in the US have been active in curriculum development for GI S&T and several have used the DACUM (Developing a Curriculum) process. The DACUM process brings together GI S&T practitioners with a facilitator to identify tasks they perform and then determine skills and competencies needed to perform those tasks. A discussion of curriculum development for two year colleges is included in a Workshop Report from the National Council of Geographic Education (NSF, 2005, http://www.ncge.org/publications). The United States Geospatial Intelligence Foundation (USGIF) education committee has been active in supporting development of curriculum for Geospatial Intelligence Analysts programs. The USGIF hopes to create an accreditation program through an Academy to accredit programs that meet the needs to prepare Geospatial Intelligence Analysts (Kalweit, 2006). Detailed discussions of the above efforts are beyond the scope of this paper, but are summarized in the UCGIS GI S&T Draft Body of Knowledge 2006 discussed below.

1.2 UCGIS and the Model Curricula Project

The UCGIS was founded in 1994 to promote GIScience (see http://www.ucgis.org). In 1997, the UCGIS outlined a number of Education Challenges including one related to developing a Model Curricula (MC). In 1998 Professor Duane Marble agreed to lead the UCGIS project, based on his previous efforts and on other highly successful projects to define curricula for Computer Science and Information Systems. The MC project focused on development of an undergraduate curriculum. It encompassed the three subdomains GIScience, GIS (geospatial) Technologies, and Applications of Science and Technology under the umbrella acronym of GI S&T. After several years of committee meetings, input from academia and industry, and funding support from GIS vendors, the preliminary Strawman Report was published on-line in 2003 (Marble, 2003). The Strawman Report included an outline of a Body of Knowledge for GI S&T, divided into 12 Knowledge Areas which were subdivided into Units and Topics (Marble, 2003).

It was envisioned that the finished version of the Model Curricula would not be a static set of course contents, rather it would identify a set of core and optional Topics for all of the 12

Knowledge Areas with various mastery levels for each topic defined, plus a list of supporting topics and courses from other disciplines. Any of these could be selected and organized into various *curriculum pathways* appropriate to different curriculum outcomes. Thus, by specifying different Topics and supporting courses, the same Body of Knowledge could be drawn upon to support the creation of very different courses and curricula. Some examples of these pathways were to be included. This multi-path approach was designed to address the multidisciplinary nature of GI S&T. The vision for the original Model Curricula document also included discussion of cross-cutting themes, pedagogy, implementation issues, and integrative experiences that could be used (capstone, internships, etc.). Realizing that completing the full scope of the project as it was originally conceived required large financial support, the inability to attract funding from the NSF stalled the Model Curricula project in 2003.

1.3 New Plan for the Model Curricula Project

In 2004, the UCGIS Education Committee, under the leadership of David DiBiase, proposed a new Three Year Plan for the project. However, due to the increased interest in GI S&T, the industry requested consideration of an accelerated one year plan. A revised work plan was outlined that focused on the content of the Body of Knowledge (BoK) and necessitated delaying consideration of some elements of the original plan to a later time. Over a period of one year, under the direction of a small group of editors, the BoK underwent focused, intensive revision by an Advisory Board of scholars and experts. Given the expanding nature of the field, it was decided to broaden the scope to include content for graduate, post-baccalaureate and professional curricula. The editors also decided to reorganize the BoK into 10 rather than the original 12 Knowledge Areas. A draft is currently on line on the UCGIS website (www.ucgis.org). A final version was completed in February 2006 and will be published officially by the AAG in the summer of 2006.

2 Structure of the GI S&T Body of Knowledge

The 10 BoK Knowledge Areas (KA) encompass the domain of GI S&T. Each of the 10 KA is made up of Units that outline the concepts, methodologies, techniques and applications specific to that KA. Each Unit includes a title and brief description and, where applicable, includes cross-references to other KA. Core Units have been identified that should be covered at some mastery level in all certificate or degree programs. Units are further broken down into Topics. Each Topic includes a short descriptive title and a bulleted list of Educational Objectives to illustrate, but not necessarily exhaustively define, the Topic. An attempt was made to include Educational Objectives with various levels of mastery for each Topic.

More than 350 Educational Objectives in 75 units are included in 10 KA. The structure of each KA is:

Knowledge Area – two letter code and description of KA
- **Unit** – Number and Title with a brief description (references as applicable)
  - **Topic** – Unit number and individual number and descriptive title
    - At least one educational objective
- **Key Readings** – references to materials for the KA

3 Current and Future Use of UCGIS Body of Knowledge

The Association of American Geographers (AAG) has agreed to publish the BoK 2006 in the summer of 2006 in low-cost print and electronic versions. The BoK 2006 is intended to be the first stage of a continuing effort to refine the domain of GI S&T. It is hoped that work on a second edition of the BoK will be started as soon as possible. Supporting materials including exemplar pathways are also envisioned in the next phase of the Model Curricula Project. Other enhancements may include using new information visualization techniques such as concept maps, to examine relationships and overlaps between Knowledge Areas (Plewe, 2006).

3.1 Additional Uses of the Body of Knowledge

While the Model Curriculum was originally conceived as a tool primarily of interest to academics wishing to create a curriculum, it has become apparent that the BoK can serve many other purposes. Other applications beyond initial curriculum development include using the BoK to support curriculum review, program evaluation and assessment, accreditation, articulation, professional certification, employee screening, and program comparison by students. Interest in the document has also come from educators in Europe and Asia Pacific.

Suggested future efforts may include development of a tool for program self-assessment based on the BoK KA, Units, Topics and Educational Objectives. The Strawman Report version of the Model Curriculum has already been used as a course evaluation tool for the GIS Certification Institute's (GISCI) GIS Professional Certification process. The BoK 2006 will replace the Strawman Report for this purpose as soon as it is published. The BoK has also been used by the United States Geospatial Intelligence Foundation (USGIF) Academy to identify content that should be included in accredited geospatial intelligence analysts programs (Kalweit, 2006).

4 Conclusions

With continuing expansion of the use of geospatial technologies and the increasing ability for institutions to collaborate worldwide to create GI S&T modules and programs, the BoK should provide a common format and structure for sharing content and comparing programs. Thus, while the BoK was developed from a US needs perspective, it may serve as a starting point for other national and regional geospatial curricula efforts. The BoK will also serve as the basis for creating exemplary pathways that can be used to define discipline-specific geospatial and non-geospatial courses for many different workforce domains and educational disciplines. Continued participation and interest from government, educators, working professionals, professional organizations and industry related to defining the geospatial industry will also benefit from, and help build, new editions of the BoK as well as ancillary tools and materials. With ongoing review and input from all parties interested in GI S&T, the BoK should continue to be an excellent resource for geospatial technology educators, users and employers.

5 References

AAG, 2006, Draft Phase I Report: Communicating & Defining Geospatial Industry Workforce Demand, http://www.aag.org/giwis/ accessed May 22, 2006.

DiBiase, D., DeMers, M., Johnson, A, Kemp, K., Luck, A., Plewe, B., Wentz, E., eds., 2006 (in press). Geographic Information Science and Technology Body of Knowledge 2006. Washington DC: Association of American Geographers.

Gaudet, C., H. Annulis, and J. Carr, 2003, Building the Geospatial Workforce, URISA Journal, Vol 15, no 1, pages 21-30. (access - http://www.aag.org/roundtable/Resources/gaudet-et-al-2003.pdf)

GITA, 2005, GITA Receives $700,000 Grant from U.S. Department of Labor, grant awarded under the President's High Growth Job Training Initiative, as implemented by the U.S. Department of Labor's Employment and Training administration**.** July 7, 2005: Colorado, press release http://www.gita.org/news/press_releases/7-2005-dol_grant.htm accessed May 1, 2006

Goodchild, M. F., and Kemp, K. K., eds., 1990, *NCGIA Core Curriculum in GIS*. Santa Barbara, CA: National Center for Geographic Information and Analysis, University of California.

Kalweit, Susan, 2006, Chair, USGIF Education Committee, Personal communication.

Marble, Duane F., and members of the Model Curricula Task Force, 2003, Strawman Report: Model Curricula. University Consortium for Geographic Information Science. http://www.ucgis.org/priorities/education/strawmanreport.htm Accessed May 30, 2005.

National Science Foundation, 2005, Integrating Geographic Information Systems and Remote Sensing for Technical Workforce Training at Two Year Colleges, accessed May 1, 2006, http://www.ncge.org/publications/gew/.

NCGIA. no date. NCGIA Core Curriculum in GIScience, www.ncgia.ucsb.edu/giscc/, accessed May 1, 2006.

Plewe, B, 2006, Personal communication.