Title

Report of the International Workshop on Interoperability for GIScience Education

Authors

Kemp, Karen K.
Reeve, Derek E.
Heywood, D. Ian

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Report of the International Workshop on Interoperability for GIScience Education

IGE '98

Soesterberg, The Netherlands
May 18-20, 1998

by Karen K. Kemp
National Center for Geographic Information and Analysis
University of California Santa Barbara CA

Derek E. Reeve
UNIGIS, Department of Geography
University of Huddersfield, UK

and D. Ian Heywood
Open and Distance Learning Centre
Robert Gordon University, Aberdeen, UK

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Report of the International Workshop on Interoperability for GIScience Education, IGE '98

by Karen K. Kemp, Derek E. Reeve and D. Ian Heywood

Introduction

In December 1997, the National Center for Geographic Information and Analysis (NCGIA) and the Open GIS Consortium convened an international conference and workshop on Interoperating Geographic Information Systems (Interop'97). Topics addressed at Interop'97 included the current state of research in related disciplines concerning the technical, semantic, and organizational issues of GIS interoperation; case studies of GIS interoperation; theoretical frameworks for interoperation; and evaluations of alternative approaches. Arising from these discussions about GISystems interoperation was an awareness that interoperation might also be applied to GIS education. These discussions led to a decision to organize IGE '98—Interoperability for GIScience Education. The workshop was held in Soesterberg, The Netherlands on May 18-20, 1998. Organization of the meeting was undertaken by The Free University of Amsterdam where Ian Heywood was a visiting scholar for the '97-'98 year.

The report from the Interop'97 meeting defines interoperability for GIS in the following manner:

> Interoperability means many things to people. It means openness in the software industry, because open publication of internal data structures allows GIS users to build applications that integrate software components from different developers, and it allows new vendors to enter the market with competing products that are interchangeable with existing components, just as the concept of interchangeable parts helps competition in the automobile industry. In the past few years the Open GIS Consortium (OGC) has emerged as a major force in the trend to openness, as a consortium of GIS vendors, agencies, and academic institutions (http://www.opengis.org). Interoperability also means the ability to exchange data freely between systems, because each system would have knowledge of other systems' formats. Exchange standards such as the Spatial Data Transfer Standard … have had a significant impact on the ease with which data can be transferred between systems. They allow a user of one vendor's products to make use of data prepared using another vendor's products, because data can be transferred in a standard format. Interoperability also means commonality in user interaction, as system designers build interfaces that can be customized to a 'look and feel' familiar to the user. (Goodchild, Egenhofer and Fegas, 1998, p. 2)

Interoperability in GIS is important because

> Geographic information systems have been adopted widely over the past two decades in support of planning, forestry, agriculture, infrastructure maintenance, and many other fields. Each software product developed essentially independently, with little in the way of overarching theory or common terminology. As a result, it is very difficult

> for different systems to share data, for users trained on one system to make use of another, or for users to share procedures developed on different systems. The term ‘ interoperability’ suggests an ideal world in which these problems would disappear, or at least diminish significantly, as a result of fundamental changes in design, approach, and philosophy. (Goodchild, Egenhofer and Fegas, 1998, p. 1)

The advent of interoperating GISs has many implications for education. Many of the measures of the success of interoperation identified at Interop '97 are specified as measurable changes in the content of GIS courses. This suggests that GIS education may become an unwitting accomplice in the move to interoperation. However, an alternate view may be that GIS education will become a fortunate beneficiary. The vision of interoperating GISs foresees ubiquitous GIS and the corresponding necessary pervasive spatial thinking and awareness. The same vision also acknowledges that success in interoperability means that there are many things which will no longer need to be learned. How will GIS education change with interoperability? There are two perspectives to consider in this context: 1) Interoperability and GIS education, and 2) Interoperability for GIS education.

While the first of these perspectives will be an important growing theme for GIS educators which will undoubtedly provide substance for other important meetings and other reports, the meeting recorded in this report focused on the second perspective—interoperability *for* GIS education. The basis for the discussions at this meeting are outlined in the White Paper provided in the section following the list of participants next. Subsequent sections summarize discussions at the workshop about the problems which interoperability for education might address, provide details of some solutions identified and describe the meeting's outcomes and plans for future work.

Reference

Michael F. Goodchild, Max J. Egenhofer, and Robin Fegeas, 1998. *Interoperating GISs, Report of a Specialist Meeting*. National Center for Geographic Information and Analysis, University of California Santa Barbara.

List of Participants

Workshop Co-Leaders

Ian Heywood, Manchester Metropolitan University, UK
Karen Kemp, NCGIA, University of California Santa Barbara, USA
Derek Reeve, UNIGIS, University of Huddersfield, UK

Steering Committee

Hans Bestebreurtje, HP Europe, The Netherlands
Antonio Camara, New Technical University of Lisbon, Portugal
Kenneth Foote, University of Texas, Austin TX USA
William Miller, ESRI, Redlands CA USA
Mark Resmer, Sonoma State University CA USA
Henk Scholten, The Free University of Amsterdam, The Netherlands
David Unwin, Birkbeck College, London UK

Local Organizing Committee

(all at Free University of Amsterdam)
Sarah Cornelius
Ian Heywood
Andrea Locashio
Arienne Mehieur
Henk Scholten

Meeting Participants

Marinus de Bakker, Van Hall Institute, Groningen, The Netherlands
Hans Bestebreurtje, Hewlett-Packard Netherlands
Karl Chang, Department of Geography, University of Idaho, USA
Sarah Cornelius, Free University of Amsterdam, The Netherlands
Ken Foote, Department of Geography, University of Texas, USA
Pip Forer, Department of Geography, University of Auckland, New Zealand
Ian Heywood, Manchester Metropolitan University, UK
Karen Kemp, NCGIA, University of California, Santa Barbara, USA
Werner Kuhn, University of Muenster, Germany (representing Open GIS Consortium)
Béla Markus, College of Surveying and Land Surveying, University of Sopron, Hungary
Arienne Mehieur, Free University of Amsterdam, The Netherlands
Bill Miller, ESRI, Redlands, CA, USA
Peter Nijkamp, Faculty of Economics, Free University Amsterdam, The Netherlands
Andrea Locashio, Free University of Amsterdam, The Netherlands
James Petch, UNIGIS and The Manchester Metropolitan University, UK
Derek Reeve, UNIGIS and University of Huddersfield, UK
Mark Resmer, Instructional Management Systems Project & Sonoma State University, CA, USA
Henk Scholten, Free University of Amsterdam, The Netherlands

Julia Seixas, New Technical University of Lisbon, Portugal
Michael Solem, Department of Geography, University of Colorado, Boulder, USA
Josef Strobl, Department of Geography, University of Salzbury, Austria
John Wilson, University of Southern California, USA
Stephen Wise, Department of Geography, University of Sheffield, UK
Martha Ullrich, Hewlett-Packard USA
Jorge Xavier da Silva, Laboratorio de Geoprocessamento, UFRJ, Rio de Janeiro, Brazil

Meeting Sponsors

National Center for Geographic Information and Analysis, University of California Santa Barbara, USA

UNIGIS International, Manchester Metropolitan University, UK

Institute for Spatial Informatics, The Free University of Amsterdam

Hewlett Packard Netherlands

White paper
Interoperability for GIScience Education: Building a flexible knowledge and resource base

by Ian Heywood and Karen Kemp
December 18, 1997

The motivation for this meeting comes from a recognition that GIS educators in the private and public sectors are faced with both an opportunity and a dilemma. As the GIS vendors move to open systems which can be integrated with many traditional operations, the use of spatial data and analysis will become widespread throughout business, government and education. Hence the need for GIScience education is expanding rapidly. However, at the same time, rapid changes are occurring in both GIS technology and the structure of higher education. These shifting foundations make it impossible for individual GIS educators to stay on the leading technological edge where their students need them to be. Collaboration in education is now essential.

The opportunity

GI and its associated technologies are migrating outward from the specialist niche markets in which they have been embedded over the last 20 years. This can be seen in

- Growth in off the shelf GI products packaged with data for specific applications
- The move by vendors towards an Open GIS environment
- Creation of on-line open access Web based GI products

This means that a greater number of individuals are going to need to work with the technology in their everyday lives. Eventually this interfacing will be seamless, as users are able to perform high tech spatial tasks via intuitive interfaces. However, that points lies some time in the future. In the meantime the education community will need to provide a broad based education strategy to deal with this growth in demand.

Many educators in both the public and private sector are already responding to this challenge in their own individual ways by providing

- Web resources such as the Virtual Geography Department and the NCGIA Core Curricula
- Flexible education programs such as those provided by distance learning (eg. UNIGIS)
- Virtual learning centers such as the Western Governors' University and ESRI's Virtual Campus.

The dilemma

However, all of this is being done against a background where:

- A significant percentage of GI knowledge, particularly as it relates to the technology, becomes outdated within less than 6 months.

- New GI products, services and ideas are appearing at a rate beyond any one individual's ability to keep track.
- It is impossible for an individual educator to stay at the technological leading edge in their field and to keep their learning materials up-to-date.
- The model of higher learning is changing from a traditional, one-time-through university education experience to a flexible lifelong learning environment.
- Mature, busy students are are demanding effective and efficient learning opportunities.
- Many students are no longer satisfied with the talk and chalk approach to university education.
- Professionally designed education products now compete against traditional one-off materials.
- Central support for traditional education institutions is shrinking while for-profit education institutions are beginning to compete for the growing number of mature students.
- An increase in demand for just-in-time education is apparent in both academic and industry settings.
- Concern is increasing over how the quality of educational GI programmes can be maintained in light of decreasing budgets and rising student demand.

Workshop aim

The aim of this workshop is to explore how the GI community can work together to develop an Interoperable or Open environment in which educators can exchange resources and add value to these resources for use in their own unique educational settings while at the same time retaining intellectual (and commercial) copyright. Can such an enterprise provide a framework for collaborative education which allows GIS educators to stay on the leading edge of both the technology and the changes happening in higher education? Both technical issues, such as metadata, data formats and technology, and educational/institutional issues related to collaborative education and sharing of resources will need to be considered.

Themes for workshop discussions include:

- Why is this a GIS question?
- Creating knowledge bases
- Finding knowledge in a distributed resource base
- Building and promoting learning resources
- Developing futureproof learning resources and systems
- Strategies for meta GI education infrastructures
- Challenges for curriculum development

- Lessons learnt from TLTP type projects
- Metadata for education resources
- Accreditation of distributed learning
- Assessing and controling quality of distributed resources
- Localization of global materials
- Developing value added products from global resources
- The role of publishers and other commercial enterprises
- The role of data providers/vendors
- Academic credit and financial return for contributions to an education resource base
- Foreign language issues

Related projects

Advanced Distributed Learning Network

The purpose of the ADL initiative is to ensure access to high quality education and training materials that can be tailored to individual learner needs and can be made available whenever and wherever they are required. The initiative is designed to accelerate large-scale development of dynamic and cost-effective learning software and to stimulate an efficient market for these products in order to meet the education and training needs of the US military and workforce in the 21st century. It will do this through the development of a common technical framework for computer and net-based learning that will foster the creation of re-usable learning content as "instructional objects." ADL is a collaborative effort with the public and private sectors launched in November 1997 by the US Department of Defense and the White House Office of Science and Technology Policy (OSTP)

Instructional Management System project

In November 1994, Educom launched a new initiative in the US called the National Learning Infrastructure Initiative (NLII). The NLII identified a common need among educational institutions for a non-proprietary, Internet-based Instructional Management System (IMS) to provide the means to customize and manage the instructional process and to integrate content from multiple publishers in distributed--or virtual--learning environments. The IMS project was formed as a catalyst for the development of a substantial body of instuctional software, the creation of an online infrastructure for managing access to learning materials and environments, the facilitation of collaborative and authentic learning activities, and the certification of acquired skills and knowledge. The IMS project will support an open architecture for learning by developing a technical specification and designing a reference implementation for enabling the creation of quality learning environments and materials. The nature of the IMS's open architecture was derived from two main assumptions: successful software is modularized and industry standards support software development.

Workshop Deliverables

The Workshop Leaders will prepare a meeting report immediately following the close of the workshop. This report will contain a record of the discussions and will outline the proposed research and development agenda as well as a suggested action plan. Based upon this report and the outcome of the meeting, presentations will be made at various GIS education meetings to be held during late 1998 in order to involve the entire GIS education community in discussions about the proposals outlined.

Possible Research Questions

- How to formalize GI knowledge for educational purposes?
- What kinds of resources are needed in a GIS education resource base?
- What are the fundamental components that can be served as resource objects?
- What are the metadata requirements?
- How can we categorize resources according to different learning modes?
- What kinds of functionality are needed to support access to, use of and knowledge discovery in such a distributed resource base?
- How to handle obsolescence of GI knowledge? Do we need a system of archiving and versioning?
- What are the copyright issues? Do we need to construct some new mechanisms for sharing private resources?
- What are the institutional and organizational issues related to collaborative education?
- How can we teach locally using global resources? What are the implications of using materials developed in other countries or different disciplines?
- How do we express quality in education products and what mechanisms can assist individual educators to assess it?
- What are the accreditation issues involved in collaborative education and flexible learning based on distributed education resources?
- What is the relationship between our vision and related projects for the development of systems for distributed student-oriented materials?

GIS education problems which interoperability may address

by Karen Kemp

Setting the context

At the beginning of the meeting, the participants introduced themselves and revealed their personal reasons for attending this meeting. It is interesting to see the range of higher level strategic education questions that continue to haunt educators. Some of these issues are:

- Is there a logical process which can be used to facilitate the development of good education materials?
- How do we create good spatial analysts?
- How can we improve pedagogy?
- How can we improve the level of research conducted about education?
- How can we facilitate collaboration in education?

During the early discussions, it soon became apparent that there were some important and somewhat contradictory perspectives on the topic of the meeting about which we needed to be clear:

- *Is the metaphor we are using for interoperable education here that of a publication made of interchangeable parts or a total structural change in education, or both?* The conclusion of the group was that both need to be considered and integrated during our deliberations.
- *Are we talking about full distance learning programs, materials for distance learning, or materials for on-campus instructor-led learning?* As the participants came from different contexts with respect to distance learning and on-campus instructor-led learning, it was necessary to keep this distinction in mind throughout our discussions. However, the focus of the meeting was on how to make on-line education materials interoperable and shareable, no matter what education context they were to be used in.

In the first breakout session, participants discussed the problems they felt motivate the need for interoperability in GIS education. Both problems of a general nature and problems specific to GIS education were recorded.

What is special about GIS education?

The technological basis

Since GIScience is based on a continually evolving technology, technical foundations and even some concepts change rapidly making it difficult to justify investing too many resources in the development of shareable education materials. How can we separate education about the technology from education about the concepts so that elements which do not change do not need to be constantly revised? Can we achieve this by breaking education materials into several smaller components? How small do thse components need to be (i.e. what level of granularity is needed)? Additionally, since technology is central, open concepts are relevant for both our education materials and our technology and data. Is there some overlap between open education systems and open GIS technology which we can take advantage of?

Problems of localization and generalization

In the GIS education context, both concepts and data need to be *localized* in order to address:

- Differences imposed by local and federal institutions and regulations.
- Differing national data models, formats and standards, including semantic variations in classification systems.
- Cultural differences between both different geographic regions and different disciplines.
- Language variations both within and between language groups (i.e. South American Spanish versus European Spanish).

This leads to questions about what can and should be localized and what not. As well, many concepts and general topics such as geocoding and street networks are not easily *generalized* across various geographic regions. Is there some way to separate the general from the specific when preparing education materials for general use? Can this be achieved by separating concepts from context? Can we identify a level of granularity which achieves this?

The multidisciplinary nature

The way in which GIS is used differs considerably across disciplines. Thus, what needs to be learned also varies. As well, although GIS is assumed to have almost universal application, there is a general lack of spatial literacy. Is it possible to determine the fundamental core needed and to teach it broadly and generically across all disciplines?

The international character

Given that there are only a handful of major GISystems used worldwide and that international standards for open systems and data exchange are currently being developed, the potential for materials developed by any instructor to be useful to colleagues around the world is quite high. As a result the sharing of education materials is already a well established state of affairs in the GIS education community. This has placed the community at a critical stage at which it has become essential to identify and address education interoperability problems and issues.

General problems for interoperable education

Technical issues

The group acknowledged the urgent need for collaborative efforts and mechanisms intended to assist in the discovery of diverse but relevant educational materials already available on the WWW. However, later presentations by several participants demonstrated that many of the important technical problems are currently being addressed (see the following section "Some Solutions").

Institutional issues

While we would like to be able to share materials internationally, different incentive models for contribution create barriers to the type of international collaborative projects needed to make interoperable education work. At a minimum, the need for intellectual property protection and for financial return on investment of time vary considerably between the US and Europe. These models need to be clearly specified so that these differences can be accounted for when planning and conducting collaborative projects. In addition, as education materials are developed by various kinds of institutions, both private and public, mechanisms for promoting collaboration while providing for financial transactions between them are needed.

A further institutional issue relates to shifting education paradigms. A large repository of on-line interoperable education materials provides an opportunity to move from "just-in-case" to "just-in-time" to "just-for-you" education, but not all educational institutions are prepared for these kinds of delivery mechanisms.

Finally, questions of granularity are not only technological, but they also need to be discussed at the institutional level. What is the appropriate level of interoperability from the institutional perspective? Should it be at the course level, the unit level, the exercise level or the component level? Are different interoperable mechanisms needed for each level?

International issues

Since GIS is international in character, it follows that any interoperable education activities need to account for international differences in education in general. These range from the obvious problem of language differences to more subtle issues of different education styles. Attention will need to be given to appropriate structures and components of educational materials so that they will suit eudcational needs worldwide. Can materials prepared in English simply be translated to other languages? Are there vocabularies and/or dictionaries for GIS technical terms in all languages? Are there differences in how educational experiences should be structured in other regions? How might these differences be accounted for in the definition of education components?

Some Solutions

As the meeting leaders prepared background papers and other materials for this meeting, it was soon apparent that the concept of interoperability for GIS education did not exist in a vacuum. A number of major and important projects are currently underway which provide significant foundations for GIS education interoperability. Presentations by active participants in these projects provided considerable insight into how we might solve some of the problems identified. This section provides brief descriptions of these projects within the context of Interoperability for GIS education.

Instructional Management Systems (IMS)

by Jim Petch

The Instructional Management Systems Project (IMS) represents a consortium of government, academic and commercial organizations who are developing a set of specifications and prototype software for facilitating the growth and viability of distributed learning on the Internet. It was acknowledged by the meeting participants that any development in interoperable education in the GIS field should probably work within the IMS model since it appears to be the dominant model in higher education and one with which major educational institutions in North America and Europe are already aligning themselves. The IMS project provided a focus to much of the discussion of the meeting and set out most of the issues which must be addressed.

There are two main areas of work in IMS: the provision of a set of standards which will be published under IEEE and the testing of the standards and the delivery mechanisms through a prototype. Both areas are under way and parts of the standards are published in draft.

There are five main areas in which the project team is developing specifications and building prototype code:

- *Metadata* - descriptive information about learning resources for the purposes of finding, managing, and using these learning resources more effectively. The IMS metadata dictionary, an expansion of a part of the metadata specification of the Dublin Core, is currently available and has defined an extensible number of fields and values for labeling learning materials. The IMS is also developing, with the National Institute of Standards and Technology (NIST), a process for managing the creation and evolution of metadata across different domains.
- *Content* - interfaces which define the actions and responses that IMS-compliant content may perform, including assessment, sequencing, reporting data, bookmarking, notification and metadata. This involves a consideration of system architecture and compliance with ActiveX/DCOM , JAVA/CORBA models and the use of HTML, XML and CGIs.
- *Management Systems* - functions such as access control, session management, tracking students' progress through learning processes, control over the virtual learning environment, and security.

- *Profiles* - of students and instructors that include personal, performance, and preference information.
- *External Interfaces* - to services external to the core management system such as electronic commerce, backoffice, full-text indexing systems, digital library services, and databases.

As well as briefly describing these basic components, Mark Resmer, IMS Project Director, also commented on how IMS addresses a number of the areas of concern earlier identified at the meeting:

- how IMS addresses the issue of intellectual property
- how lineage is recorded in the metadata descriptions
- authentication and how rights of access and use will be managed
- the commerce model being developed to handle financial transactions
- how IMS may provide assurance of quality through the use of review bodies (a la Michelan stars), usage records and assessment of educational outcomes by external bodies.

The group recognized that effective adoption of IMS standards and procedures within the GIS community requires an understanding of how these issues map on to experience and materials in the area of GIS education. Resmer identified several aspects of the GIS education community's concerns that may necessitate special attention:

- There is a need to separate content from infrastructure
- There is an acknowledged distinction between training and education. Can these share a common set of standards? Is all learning the same?
- There are several layers of interoperability needed: from technological (objects communicating) to semantics to institutional. Likewise, IMS is middleware in which technology is the foundation, policy and institutional matters are above this.
- Given the need for localization in geographic information science, how should learning profiles or educational settings be matched to metadata? Can we establish hierarchical schemas in metadata to address geographical or disciplinary foci?
- What is the appropriate level of granularity given the need for localization? Can we use nested hierarchies in metadata to address this? Can small objects be viable?
- IMS may provide the mechanisms needed to address the incentive problems.

Website

Instructional Management Systems: http://www.imsproject.org/

The ESRI Virtual Campus and Knowledge Base

by Sarah Cornelius and Bill Miller

The Virtual Campus

The ESRI Virtual Campus, an environment for Web-based training in GIS, was launched in July 1997. The on-line courses currently offered through the campus have been highly successful, attracting over 1200 students in the first nine months. The campus, which is also being adopted into the curriculum by universities around the world, is currently being remodelled to accommodate new features and expanded content.

The current campus offers a series of six interactive on-line training courses in ArcView GIS®. The first course in the series is free. Students may purchase the other courses individually, or as a complete series. Additional courses will be offered in an expanded version of the campus this summer. The expanded version of the campus (available in August 1998) will provide additional courses and a new student interface. The on-line materials will be presented in a separate window running alongside ArcView GIS on the user's PC (a time locked edition of ArcView GIS software is available for downloading to those who subscribe to an entire series.

The course template will include the following sections:

- **Introduction** - an overview of the course to follow, orientation advice, details of hardware and software requirements, and navigation instructions.
- **Content** - each course consists of multiple lessons, expected to take about 2-4 hours. A standard set of components is used to create content (although these may be grouped in different ways). For example, Lesson 2 in the new course titled *Basics of the ArcView 3D Analyst* uses the following components to structure the lesson content:
    - Goals
    - Topic 1: *Navigating in a 3D scene*
        - Concepts: *Rotating in a 3D scene; Zooming in a 3D scene; Panning in a 3D scene; Refreshing a theme.*
        - Examples: *Finding hawk's nest*
        - Exercise: *Navigate a 3D scene*
    - Topic 2: *Using the viewer control bar*
        - Concepts: *Identifying themes; Selecting features; Selecting graphics; Saving a scene as an image.*
        - Exercise: *Identify and select features*
    - Topic 3: *Managing data*
        - Concepts: *Copying and deleting files*
        - Exercise: *Manage grid and TIN data sets*
    - Summary
    - Self-test

  The structure and presentation of the material in each lesson allows students to follow a variety of learning strategies. A sequential path can be taken through the material, or the student may prefer to attempt the exercises first, visiting and re-visiting concepts and examples as they feel necessary. These options are facilitated by hyperlinks between material. In addition, the system will re-start at the point where a learner exits, preventing the need to repeat early steps in a lesson.

Other features designed to assist the learner include:

- clickable graphics leading to further details (to allow the delivery of multimedia materials and address problems faced with download speeds)
- links to illustrations and results at various stages of exercises to allow the learner to check progress
- challenges at the end of exercises to help reinforce learning.
- self-tests that re-direct learners to the part of the lesson where concepts were first explained when mistakes are made.

- **Exam** - a random set of questions drawn from the self tests in each lesson (based on a model proposed by the exam designer) is presented to the student at the end of each lesson. These lessons are graded on-line.

The Knowledge Base

The Knowledge Base is essentially a database of GIS concepts, examples, exercises, and test questions that can be retrieved and structured according to the wishes of a course author. Additionally, the Knowledge Base can be used to publish the content of a course as a Web-based training module, as self-study workbook, or as notes for a lecture-based course. The Knowledge Base was developed in response to the resource intensive nature of lesson building for the Virtual Campus, and has been proven to cut course development time substantially.

ESRI plans to use third party authors to assist with the creation of content for GIS concepts, examples, exercises and other materials. The authoring program uses a business model that will allow external authors to receive royalties when their materials are used in the Campus. With contributions from a wide range of individuals it may ultimately be possible to include course components that are videos, games or other resources beyond thos developed by ESRI. Thus, a tutor in Belfast might design a lesson incorporating concepts written by a Professor in California, a game written by a team in Manchester, and a 'real world' example from a telecommunications company in Hong Kong.

Applicability to interoperable education

The ESRI Virtual Campus is a proven success in GIS training. The alumni include individuals at all educational and professional levels, drawn from an international audience. Over 200 new students register for courses each month, and 95% of these take the full series of courses. At one level the Virtual Campus is a resource that can be used as an interoperable element of a larger educational programme. This has been demonstrated by its successful use in both traditional classroom environments (for example with undergraduates at the Vrije Universiteit, Amsterdam) and distance learning (on the UNIGIS postgraduate courses). In the future it will be possible to customise the courses offered - for example with an institutional logo - to make the use of externally produced materials almost seamless.

The Knowledge Base takes the opportunities for interoperability in GIS education to a new level. The database of GIS concepts, examples, and exercises, structured into 'bite-sized' components ready for re-combination to meet the needs of a particular tutor, seems to offer an attractive model for the management and use of interoperable course content. Where materials do not fit into the Knowledge Base database directly (for example a game or video), information about where these can be obtained could be included instead. In addition, the system is broadly IMS (Instructional Management System) compliant, thus the content in the Knowledge Base could be linked with other systems for the management of instructional materials.

There are a number of challenges that need to be addressed by the Knowledge Base:

- The system is still under development, and has not been fully tested by external authors.
- There is an urgent need to populate the Knowledge Base with appropriate material. Where will this material come from? One possibility is the revised NCGIA core curriculum - however, this is not complete. Another possibility is to allow individuals to contribute - in this case how can the quality of material be assured?
- For the structuring of interoperable materials, is the ESRI model of lesson components, particularly the granularity of this model, appropriate? Can alternative levels of granularity - e.g. at the lesson level - be supported? At present, the Knowledge Base does allow authors to develop their own components, so this may not be a problem.
- To achieve widespread use amongst educators the Knowledge Base will benefit from alternative explanations of concepts and examples to address different cultural and application contexts. As an example an alternative explanation could be used by learners seeking to improve deficiencies highlighted by self-tests (re-direction to the original concept that they did not understand the first time, may not be the best way to improve learning!).
- Motivating learners is always a challenge, and it remains to be seen whether the Knowledge Base and the Virtual Campus will deliver a product that can continue to delight learners throughout a course of lessons. While it is still too early to say, the use of the Virtual Campus by a wide variety of students from around the world might indicate that the answer to this question is 'yes'.
- The delivery of materials over the WWW may also be an impediment to widespread use of the resources in educational settings, although there are plans to release the new campus on CD-ROM to allow for off-line use.

The ESRI Virtual Campus and the Knowledge Base are innovative and exciting developments for those interested in interoperable GIS education. Whether they are incorporated directly into educational programmes, or used in whole or part as models for the testing and development of other interoperable delivery mechanisms, they will surely stand as examples from which we can learn more about the delivery of GIS education over the WWW.

Websites

ESRI:

- ESRI home page: http://www.esri.com
- Virtual Campus: http://campus.esri.com

Use of the Virtual Classroom in other educational programs:

- RIDE course, Vrije Universiteit, Amsterdam:
- UNIGIS course: http://www.unigis.org

The Virtual Geography Department Project

by Kenneth E. Foote

The Virtual Geography Department Project offers one possible model for building collaborations and interoperability in GIS education. It is a project begun at the University of Texas at Austin in 1995 under a grant from the US National Science Foundation. Its goal is to develop a discipline-wide clearinghouse for high-quality instructional materials in the Worldwide Web. Summer workshops funded by the grant have been used to bring together almost one hundred geography faculty to discuss, plan, and develop materials in many different subfields. So far, "working groups" have been formed, in Cartography; Introductory Human Geography; Cultural Geography; Physical Geography; Earth's Environment and Society; Urban and Economic Geography; Geographic Information Sciences, Remote Sensing, and Statistics; Virtual Fieldtrips; History and Philosophy of Geography; and World Regional Geography and Area Studies. Each working group is being sponsored by a different department with members sharing plans and materials under the guidance of volunteer leader. Stress is being be placed on curriculum integration through the creation of on-line syllabi, texts, laboratory exercises, field activities, and resource materials that will be of service to instructors in each working group areas. The project will link existing materials already available on the Internet but, more importantly, attempt to develop a plans at the subdisciplinary level for the creation of new Web-based materials. In some ways, the project mirrors the specialty group organization of the Association of American Geographers. Indeed, the grant has led to the creation of a new specialty group which will help to coordinate the development of such resources more widely within the discipline. This specialty group will help to sustain the momentum of the project once NSF funding ends in 1999.

This sort of clearinghouse arrangement is suited to the sharing of instructional materials among individual instructors, particularly short, ephemeral exercises and tutorials that may not otherwise be published commercially or distributed outside of a single department. These are "packaged" using standardized cover pages that include an abstract, table of contents, facts of publication, and instructor's notes. This way, instructors wishing to use the materials can gain a ready overview of each exercise or tutorial. This packaging could be readily adapted to the IMS scheme.

This sort of clearinghouse arrangement is not without its weakness. Though contributors gain some limited credit and recognition for their work, as they do for publishing conventional research articles and instructional materials, they receive no direct monetary compensation for their efforts. At the same time, no single contributor needs to bear the burden of producing more than one or two exercises for the clearinghouse itself to succeed. In the long-run, a clearinghouse arrangement for sharing some instructional materials might be used in parallel with pay-for-use training services offered by vendors such as ESRI or on-line distance education programs like UNIGIS.

Website

- Virtual Geography Department Project:

UNIGIS

by Derek Reeve

UNIGIS is an international network of universities which together offer a post-graduate diploma and MSc in GIS by distance learning methods. Our students complete ten modules each of which covers a substantive GIS topic in order to gain their diploma. They may then choose to write a dissertation to qualify for an MSc award. There are no examinations, the students being assessed via the assignments that they return for each module. Contact is maintained with students primarily via Email, although telephone and fax support are also available to them. Students can elect to attend up to three workshops during their studies, but some students choose to complete their studies purely by distance methods. Further details of our programme are provided on our Web site.

The UNIGIS programme has been taught from the UK since 1991. We already have, therefore, considerable experience of delivering GIS education to distant students and in the context of the present meeting would offer the following observations :-

- *The Instability of the Web for teaching purposes :* There is already a large amount of GIS material on the Web which can be used for teaching and, indeed, within UNIGIS we are increasingly finding that we refer students to Web sites where previously we might have referred them to journal articles. There are, however, significant problems at present with using the Web for teaching. The quality of material is not guaranteed, there being no equivalent of peer review on the Web. The continuing availability of material is not guaranteed - it may be that the great site upon which you've based your lecture may be taken 'off the air' by the site owner tomorrow. The legality of linking materials from Web sites into ones own pages sometimes gives one pause for thought - do many academics actually understand the copyright implications of using Web material?

  If the present discussions can lead to a situation in which GIS web-based materials are classified according to their origins, contents, quality, longevity, etc and clarifies the conditions under which they can be used by teachers, this will represent a major advance for UNIGIS and all other similar programmes.

- *The Need for a sustainable business model :* Much of the material on the Web is freely available and there has so far been a laudable ethos that the Web is an arena for sharing knowledge. Visitors to the UNIGIS site, however, will find that most of our materials are behind a password which is available only to our students. The reason for this is, quite simply, that we have no choice - UNIGIS is our business. We have to generate income by selling our materials in order to support our operation.

  Once teaching via the Web becomes a mainstream activity of other institutions, they too will need to consider how to charge for their materials. Within the UNIGIS network we have evolved a system of royalty fees and concept payments which allows those sites which originate materials to receive a return for their effort whilst giving other sites access to materials which they could not themselves have generated. A similar pattern of fee payments will need to be generalised and incorporated into interoperable Web based teaching systems.

  If a secure business model can be developed for publishing web educational objects, then it will very probably be in the interests of UNIGIS to bring its materials 'in front of the password' and to offer them generally on the open Web market. Such a Web market would then also allow UNIGIS to buy-in from other providers modules which we cannot generate internally. We can see great potential benefits in the establishment of a proper mechanism for fair exchange of materials via the Web.

- *The importance of cultural differences :* As an international network we have learned at first hand the need to be sensitive to national differences. Although GIS is often regarded as a technical subject, it is of course embedded in national contexts. At present our UNIGIS materials have been authored primarily in the UK and so our non-UK sites have the task of customising these core materials to fit their local circumstances. We know that this local customisation process is not a trivial task. One wonders how the process of local customisation will be achieved within an interoperable online environment.

  The importance of national differences extends beyond concerns about content. National circumstances also affect the appropriateness of particular delivery mechanisms. In the UK, for example, our students retain a possibly exaggerated concern about the costs of online study if they have to pay their own telephone bills. In other countries in which we have students, web access is still extremely restricted. In Ethiopia, for example, there are only 60 modem connections available for the entire country. In some countries, the Web and Email remain forbidden.

  It is possibly inevitable that, at least initially, that interoperable GIS online education will actually be available to students if they speak English, understand about Tiger files and Ordnance Survey data, and can afford the necessary technologies and fees. We should hope, however, that quickly such education will become multi-lingual and multi-cultural.

- *Avoid 'hi-tech' (or 'the joy of paper') :* Discussions with our students reveals that many of them would find an educational experience which tied them continually to their computer unsatisfactory. Many of them actually study away from their computers - we had one student who completed his diploma in minimum time by studying our materials on the train during his daily commute into and out of London. Although we are increasingly using the Web as a mechanism to deliver our materials, we know that many students will subsequently print-off large portions to study off-line in the traditional manner. This will restrict the levels of interactivity which we can build into some of our materials.

Our experiences suggest that the authors of interoperable GIS educational objects will generally need to have a realistic model in their minds of the manner in which their materials will be used by students, and may have to temper their enthusiasms for the latest plug-ins and other hi-tech gismos by a knowledge of the level of equipment which is likely to be available to students. At the very least, a statement of the resources needed to use an educational object should form part of the metadata associated with it.

So, our experiences with UNIGIS convince us that it is certainly possible to deliver high quality GIS education by distance, and increasingly online, learning methods. We look forward to the emerging 'interoperable' education era as a welcome development and extension of our activities and will wish to contribute strongly. We are aware, however, that there will be difficulties to be resolved along the way.

Website

UNIGIS: - http://www.unigis.org

The UNIPHORM Project

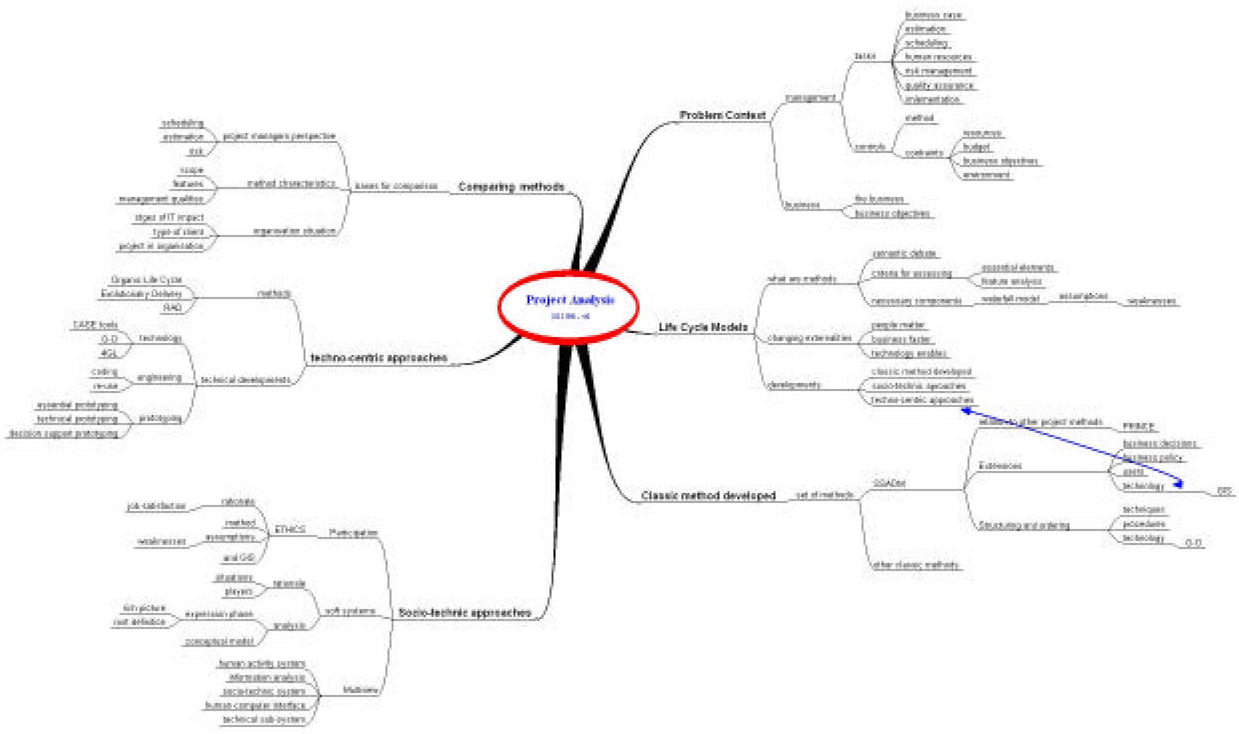
by Jim Petch

The UNIPHORM Project is funded under the EU PHARE Programme in Multi Country Distance Education and has as its objective the development of course materials and of a sevice to support distance education in Open GIS for professionals. The partner institutions are the UNIGIS sites at Manchester/Huddersfield, Salzburg, Sopron, Bucharest and Debrecen and the PHARE Study Centres at Miskolc and CDOECS, Bucharest. The remit of the project is for the development of course materials at the UNIGIS sites and the subsequent delivery through PHARE study centres.

The course materials are being prepared and will be held as reference copies in English. These materials are translated into Hungarian and Romanian by the respective UNIGIS centres and then used by the PHARE centres in their training networks. This complex arrangement is effective for the sharing of workloads and the eventual setting up of a course which reaches a large market but it provides many problems of control. This short section outlines the response of the development team to a number of problems of managing the design, creation and production of course materials and the subsequent course development and delivery.

The management of the set of processes from initial writing through to final delivery is achieved using a template based on two software products , Microsoft PowerPoint and Mindman from Michael Jetter (http://www.mindman.com). With MindMan, you organize and visualize your ideas by creating mindmaps (see Figure 1). The main topic is placed in the center of the mindmap while your ideas are placed on branches which radiate out from this focus. You can drag-and-drop branches to reorganize your ideas quickly, MindMan automatically reformatting your map as you work.

Figure 1 - A mindmap created using MindMan

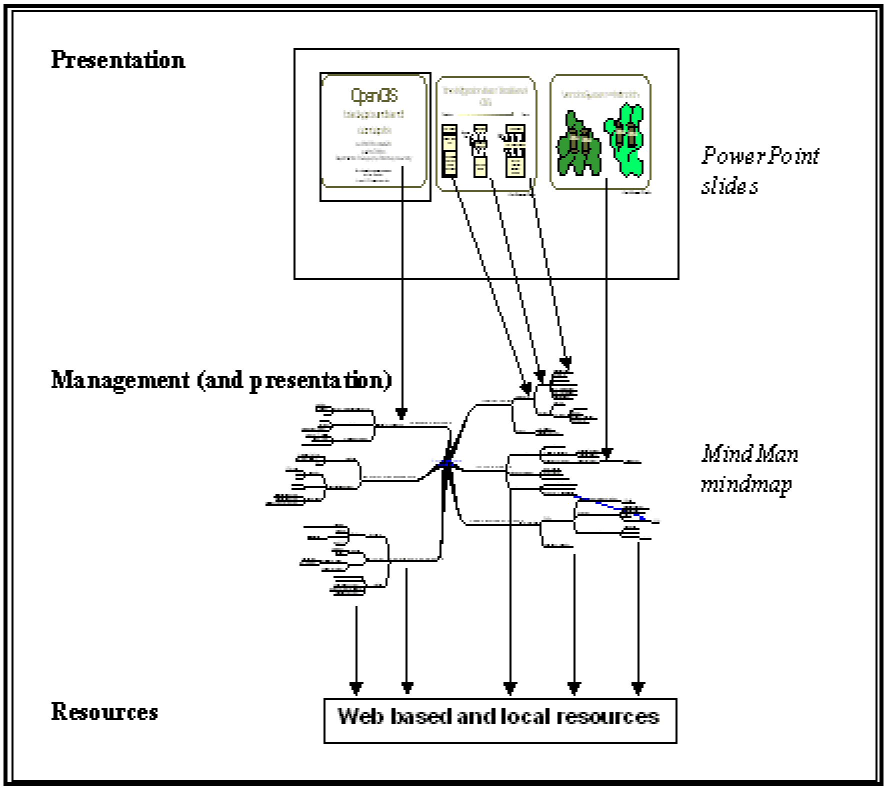


The design template is a three part structure, each element corresponding to one of three functions: resources, organisation and presentation (see Figure 2).

- *Resources:* these are files accessible through hyperlinks from the branches of the mindmap, held locally or on the web. These files are the resources for teaching and learning and can consist of text, graphics, exercises, case studies or URL lists for further work as resource discovery for students.
- *Organisation:* The principal tool for course design and organisation of the resources is a mindmap created using Mindman. The mindmap is also used as a presentation tool since students and staff can use it to see the course structure and logic as well as the links to and meaning of resources. This is an important pedagogic element which is difficult to achieve in other ways.

  Building the mindmap is actually the first stage in course design. The course author uses MindMan to lay out the structure of the lesson on which the PowerPoint show is based. Resources are then collected to satisfy the demands of the course. Resources held as local files or on the web are connected via hyperlinks on any of the mindmap branches. The branches are highly configurable in terms of their location as well as easily edited. This means that authors can easily engineer or modify the structure and the resource links according to particular needs or in response to new or changing resources. Mindmaps can be exported as active images for use on web sites or as java applets of pages which can substitute for PowerPoint shows.

Figure 2 - The three part template of the UNIPHORM project



- *Presentation:* PowerPoint is used to provide both lecture materials and class notes. The significance of PowerPoint is that it is structured as pages. Pages are thus the organisational unit both for presentation and for producing manuals. They are in other words the level of granularity for presenting materials to students. The level consists of a slide, typically with some text and a small mnumber of bullet points, together with notes of up to 500 words and the associated resources.

  In UNIPHORM, students will receive manuals in which each page is made up of five or six PowerPoint slides and their attendant notes covering in all about 200 slides. Lecturers can use the PowerPoint slides as live lectures or make them available on the web. Slides and notes on each page are also the units for translation. Pages are structured to be independent. Though they can link to other pages and indeed should form part of a coherent whole, the materials they contain in the slide and notes should stand alone. This allows the insertion, deletion, editing and splitting of pages with minimal disruption. PowerPoint slides have hyperlinks to the second level of the template, the mindmap.

This template is designed to allow a high level of control amongst several institutions and authors and yet retain a high level of flexibility for course engineering. It imposes some restrictions in the way material has to be structured and presented but the payoff is substantial in terms of managing complex and shifting resources and in providing cheap and effective creation and delivery of courses.

Websites

- Mindman: http://www.mindman.com

The NCGIA Core Curricula

by Karen Kemp

The NCGIA Core Curriculum in GIScience

Like the original *NCGIA Core Curriculum in GIS* (Goodchild and Kemp, 1990), the new on-line Core Curriculum in GIScience (GISCC - http://www.ncgia.ucsb.edu/giscc) currently under development will be composed of over 150 units of materials organized as lecture notes and supporting materials. All materials are freely available on the WWW with development supported by base funding of the NCGIA. In keeping with the spirit and success of the original Core Curriculum and to meet the same specific need in the GIS education materials market, the new Core Curriculum concentrates solely on providing fundamental *course content assistance for educators* -- formally as lecture materials, but adaptable for whatever instructional mode each course instructor wishes to use. Thus, as before, we are not compiling a comprehensive textbook for students, nor are the materials designed to be used as distance learning materials. As well, as a "core" curriculum it is to be seen simply as a well structured resource. It is not intended to impose any specific structure or educational objectives, nor imply required content for GIS courses. Instructors are encouraged to pick and choose amongst the materials on offer in order to develop courses suited specifically for their own students. Course design remains the responsibility of individual instructors.

Each unit includes the quantity of information appropriate for a 50 minute lecture. Thus a unit consists of about 7 pages of point-form text, with inline sketches and graphics. These notes provide a structure within which the instructor can add anecdotes, examples and additional material to flesh out the framework, make it more interesting and add to its pedagogic value.

For development purposes, the units are organized as a tree, with geographic concepts at the bottom or root node. Above this are four major branches:

- *Fundamental Geographic Concepts for GIS*—these units deal with the concepts themselves, enumerates them, and describes their role in human cognition;
- *Implementing Geographic Concepts in GIS*—these units discuss the implementation and handling of geographic concepts in digital computers;

- *Geographic Information Technology in Society*—these units examine the management of these technologies, their implications for society, and the social context in which they are being used;
- *Application Areas and Case Studies*—these units critically examines how GIS is used in various applications.

Above each of these branch nodes are further subtrees terminating in individual instructional units or leaf nodes. The number of levels of the tree is not defined; new units can be added above existing ones to add greater detail, but each must be appropriately linked to the content of its parent. At best, the community as a whole will likely agree only on the lower levels of the tree.

By using a tree structure, the curriculum avoids linearity, and allows complexity to be added. If an instructor opts to traverse the entire curriculum, it could be done in any combination of height and breadth - height-first traversal would produce a linear and highly specialized course structure, while breadth-first traversal would place all of the introductory material first. The tree structure also provides a framework for the organization of related instructional materials since each unit contains a "References" section which lists not only print references, but relevant websites.

Editorial procedure and incentive structure

The editorial procedure for the new Core Curriculum is based on the journal metaphor. Each unit is overseen by a section editor, reviewed by 2 peers and revised accordingly before being posted to the website. This procedure was put in place specifically to provide an incentive for contribution. Authorship is clearly indicated and the format for citations given at the end of each unit.

Unfortunately, the incentives of citations and refereed publications has not proven strong enough to move commitments to prepare units to the top of most author's to-do lists. It was hoped that the GISCC would be fully populated within a year of its formal initiation, but as of June 1998, 2 years later, only 25 of the proposed 187 units have been publicly posted. However, since there continues to be considerable general support for the project, it will be continued, though at a much slower pace than originally planned.

The Core Curriculum for Technical Programs

The NCGIA has a second CC currently under development - the Core Curriculum for Technical Programs (CCTP - http://www.ncgia.ucsb.edu/cctp). While using the GISCC as a conceptual foundation, this curriculum is task-oriented, focusing on how to use the technology effectively. Therefore, rather than addressing topics such as error from an abstract perspective, the CCTP, for example, provides materials for the instruction of digitizing which includes a tangible demonstration of the relevance of those aspects of database error which arise during the digitizing process. The CCTP contains 51 units, each of which is quite extensive, including materials for instruction to the awareness, competency and mastery levels. Detailed outlines for hands-on exercises, with specific implementations for various GIS products, and a large quantity of supporting materials such as sample course syllabi and other education resources, are additions planned for future development. This project has had similar problems getting completed materials from assigned authors, though these authors do receive a small monetary stipend for their efforts.

The On-line CCs and Interoperable Education

At a minimum, the materials in the NCGIA's Core Curricula will be significant contributions to the global GIS education materials database. Each unit can be easily tagged with appropriate metadata once specifications are complete. At an organizing level, the branched structure of the GISCC along with the reference links included in each unit may provide one means of conceptually organizing the spectrum of materials available. In terms of granularity, having units based on a single classroom session allows considerable flexibility in the organization of topics for a course.

Reference

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

Websites

- GISCC - http://www.ncgia.ucsb.edu/giscc
- CCTP - http://www.ncgia.ucsb.edu/cctp

The Open GIS Consortium (OGC)

> The Open GIS Consortium, Inc. (OGC) is a membership organization dedicated to the development of open system approaches to geoprocessing. By means of its consensus building and technology development activities, OGC has had a significant impact on the global geodata and geoprocessing standards community, and has successfully promoted a vision of OpenGIS™ technologies that integrate geoprocessing with the distributed architectures of enterprise and Internet computing.
>
> OGC recognizes that new technologies drive the evolution of new business models. By means of an open and formal consensus process, OGC is creating the OpenGIS™ Specification, an unprecedented software specification which is a necessary prerequisite for geoprocessing interoperability. Through meetings, promotional activities, publications, and the network it nurtures, OGC also educates the industry and promotes development partnerships, business alliances, and market demand for new geotechnology-based products and services. OGC' s diverse membership reflects its significance to key application markets such as telecommunications, transportation, environmental management, defense, and urban information systems. (from the OGC web site, Corporate Brochure, page 1)

Although OpenGIS specifications are not designed to meet instructional needs in particular, the inclusion of functional geoprocessing components in instructional materials points at the need to ensure that GIS educators who are developing interoperable education materials consider these new geoprocessing specifications during their materials development.

Like IMS, OGC provides a proven model for the development of community-wide specifications. Certainly an Education SIG in OGC would provide a vehicle for discussions of geoprocessing interoperability as it applies to education, however, the need for such domain specific geoprocessing specifications is not clear. On the other hand, there are some education needs which relate to OpenGIS. Merging interoperable educational services (from IMS) with interoperable GI services (from OGC) seems doable NOW. Interoperability in education is pretty much the same across domains, and GIS interoperability is not different for educational purposes. But in order to make products appear, both sides need to be aware of each other, provide input to IMS metadata definitions or OGC topics, and explore/define business models.

Website:

- Open GIS Consortium: http://www.opengis.org

What's missing? What do we need?

by Karen Kemp

After considering the range of existing projects which are addressing various aspects of the GIS education problems identified initially, the group again returned to breakout groups to discuss what still needs to be solved. The following items were highlighted by all groups. Still needed are:

- A clear picture of the various incentive models which can be used to encourage participation in collaborative projects supporting interoperability for education and which will lead to long-term sustainability of such activities.
- Identification of the appropriate granularity and specification of the range of educational component types (e.g. exams, units, concept modules, exercises, applets)
- Models for the development of shareable GIS educational materials which address the issues of generalization, localization and technological change.
- A fully functioning prototype of a database of education components which can be combined into various types of educational "events".
- Mechanisms for structuring shareable education components.
- The creation of a huge volume of relevant metadata associated with education materials already on-line.
- Attention to the critical but still unexplored issue of language differences in the context of shareable GIS education materials.
- Mechanisms for quality control.
- Digital "wizards" which would assist in the creation of metadata and the construction of education "events".
- Efforts to learn XML
- A change in the education system which will support new education paradigms involving collaborative activities by educators.
- Dissemination of information about active projects and mechanisms which support collaborative and interoperable education.
- Information included in metadata which describe the context of shareable education objects, i.e. how is it to be used, what is the audience, what do people think who have used it?

Meeting outcomes

Overview of tasks

by Derek Reeve

Participants at the meeting were of the opinion that the technology to allow the delivery of interoperable educational objects via the Web will become available very soon. Furthermore the support for online learning programmes from governments and significant higher education bodies is such that it is inevitable that such programmes will expand dramatically in the short-term. The view of the meeting, therefore, was that we should work to ensure that GIScience educators are as well placed as possible to take advantage of the opportunities, and avoid the pitfalls, which the shift towards online teaching will generate.

From a range of possibilities, the participants decided that three major tasks should be given initial priority.

Task 1 - Metadata for GIScience Education Materials

A major concern must be to ensure that the interests of GIScience are strongly represented in the super-disciplinary projects which are presently laying down the ground-rules for online, educational interoperability. Just as the OGC are presently acting as a lobbying and technical development group to ensure that 'geography' is properly accommodated within emerging Distributed Computer Environments, so too GIScience educators need to lobby to ensure that GIScience' is properly represented in emerging online educational initiatives. It was decided, therefore that an immediate task for the group will be to work with educational metadatabase projects such as IMS, the WWW consortium, the Alexandria project and similar initiatives within the library community to explore how readily GIScience-relevant metadata can be embedded within their structures.

Task 2 - Prototype Knowledge Base for GIScience Education Materials

The participants believed that it would be desirable to generate as quickly as possible a prototype GIScience knowledge base, in order to learn what workloads are involved in creating such a structure and to create an exemplar which can be used at conferences and workshops to generate wider awareness. The meeting was impressed by the potential of the work already done by the ESRI knowledge base project. Rather than create an entirely new structure, it seemed appropriate to take advantage of the existing ESRI software. The second major task for the group, will be to generate an exemplar GIScience online knowledge base using the ESRI model.

Task 3 - Incentives for interoperable GIS education.

There was a consensus within the meeting that the move towards online GIScience education should not be viewed purely, or even primarily, as a technical issue. For online GIScience education to be successful, academics will need to feel that it is worthwhile to spend their time writing educational objects. Higher Education institutions will need to be able to see how revenue might be generated from online teaching. Students will need to feel that online teaching represents an advance in their learning programmes. There was a feeling within the group that the *incentives* which might make online GIScience teaching take-off need to be explored. The third task the group set itself, therefore, is to research the motivations which lie behind current online teaching initiatives and to try to anticipate what incentives might be necessary in future to encourage GIScience interoperable education to develop strongly.

The intention is that these three tasks will each be completed within an eighteen month period after which the technical and institutional requirements which need to be fulfilled to make interoperable GIScience education successful will be much better understood. The meeting participants agreed that within each of these tasks an emphasis should be placed upon disseminating as widely as possible the outcomes of our activities.

Task 1 - Metadata for GIScience Education Materials

by Karen Kemp

Given that significant international support has already been demonstrated for the Instructional Management System (IMS) and that considerable intellectual capital has already been invested, it is appropriate for this community to immediately begin active participation in IMS development. This task will review and refine the IMS standards to meet the specific needs of the GIScience education community.

Project stages

1. *Review available relevant metadata specifications*: Identify and review relevant metadata standards for education outside the Instructional Management System, including those in the library community, the WWW consortium and Alexandria Digital Library, in order to confirm that the IMS standards are appropriate for our further efforts and to identify elements of other standards (particularly GIS specific ones) which should be incorporated in to IMS.
   - Personnel needed: one graduate researcher
   - *Time frame*: begin as soon as possible, 2 months duration
   - *Expected result*: short paper summarizing results, including URLs for all relevant sites. Must be posted on IGE website, might be published as an NCGIA technical report.
   - *Funding required*: 2 months @ 100% for a graduate researcher, plus benefits
2. *Refine metadata specifications*: Assuming task 1 indicates that continued support for IMS is appropriate, form an information community group for IMS which will identify additional fields and field domains needed for GIScience education. Otherwise, it will be necessary to redefine this task for the appropriate alternative.
   - *Personnel needed*: small international task force working under the direction of IMS personnel, 6-8 GIS education materials developers from US, Europe and possibly Australia/NZ. May involve the establishment of a parallel domain SIG dealing with this information community in OGC.

- *Time frame*: begin as soon as possible, 6-9 months duration depending on availability of task force members, to incorporate results of Stage 1 as soon as they are available.
- *Expected result*: GIS extensions for IMS, distributed through IMS and OGC channels as well as .through various GIS channels (conference sessions, newsletter and journal articles). Possible NCGIA technical report/OGC white paper.
- *Funding required*: Travel expenses for two 3-4 day meetings (one US, one Europe) plus stipends for participation and contribution throughout the task period. Infrastructure support for metadata development process provided by IMS project.

3. *Build metadata for selected existing materials as a proof of concept*: Using materials in various on-line GIScience education materials under our control, build appropriate metadata additions or supplementary files as appropriate and put this information on-line. At the same time, colleagues with similar projects will be encouraged to participate by tagging their own files. Assuming the IMS project continues as expected, easy facilities for building metadata should exist soon. These activities will provide immediate feedback into the IMS metadata development process to identify and provoke necessary modifications and additions.
    - *Personnel needed*: Task force members from previous stage will gradually append metadata to their own on-line materials. Possibly, one student research assistant at 50% time for 3 months to create and post on the WWW independent metadata files for materials which are not HTML or directly accessible on-line.
    - *Time frame*: approximately 6 months from the completion of Stage 2 above.
    - *Expected result*: A large body of tagged and searchable metadata on-line, plus information regarding needed revisions or modifications to the standard established in Stage 2.
    - *Funding required*: Will vary on a site by site basis. For active, funded projects appending metadata should incur little additional cost or effort, however, being able to provide a supplement to significant relevant projects would help ensure adoption (perhaps 1 additional month of a graduate assistant at 50% for 4-6 major projects worldwide). If we decide to create additional independent metadata files, one student researcher for 3 months at 50% time.
4. *Test and demonstrate metadata searching*: Using the "soon-to-be-available" metadata search engines, perform controlled experiments to search for tagged educational materials, evaluating the success of the metadata in finding what is available and appropriate. Revise IMS GIS specifications as appropriate.
    - *Personnel needed*: one graduate researcher for 3 months 50% time
    - *Time frame*: 3 months beginning as soon as a sufficiently large body of tagged material is on-line and IMS metadata search engines exist.
    - *Expected result*: Demonstration of the value of IMS metadata for GIS education and further revision of relevant metadata standards. Progress reported via IGE, IMS and OGC channels. Full results reported in next Stage.

- *Funding required*: graduate researcher for 3 months at 50% time plus benefits

5. *Disseminate results*: If all previous stages have been completed to our satisfaction, it will be necessary to inform the GIS education community of available metadata specifications, facilities and services. Conference presentations and articles in relevant magazines and newsletters are efficient outlets for this information. Efforts should be made to encourage on-going support for these activities.
   - Personnel needed: IMS task force members and anyone else who has participated
   - *Time frame*: can begin to report as soon as Stage 2 is well underway and should continue 6 months after completion of Stage 4.
   - *Expected result*: widespread support for metadata tags throughout the GIS education community, widespread addition of metadata to available education materials, motivation for improved metadata search engines.
   - *Funding required*: none essential, though support for conference attendance and workshops at meetings worldwide throughout one year would ensure widespread adoption of the standards.

Totals

Total time required: 18 months to end of testing phase (Stage 4), plus 6 months for further dissemination and workshops.

Total personnel required:
RA: 100%, for 2 month in months 1-2 (Stage 1)
RA: 50% for 3 months in months 10-15 (Stage 3)
RA: 4 times 50% for 1 month in months 10-15 (Stage 3)
RA: 50% for 3 months in months 16-18 (Stage 4)
Task force members - 6 to 8 participants for 1 year

Total funding required:
RA: 100%, for 2 month in months 1-2 (Stage 1)
RA: 50% for 3 months in months 10-15 (Stage 3)
RA: 4 times 50% for 1 month in months 10-15 (Stage 3)
RA: 50% for 3 months in months 16-18 (Stage 4)
Travel: 12 domestic, 12 international (Stages 2 and 5)
Stipends/Summer month: 8 people $4-5000 each

Task 2 - Prototype Knowledge Base for GIScience Education Materials

by Ian Heywood

Adoption of the Instructional Management System (IMS) to produce a Metadatabase for GIScience will address the specific problems of cataloguing what educational GI resources exist, identifying where they are located and providing contextual information about their suitability of use at a given educational level. However, what adoption of an IMS will not do is provide a framework and toolbox that will allow GISience educators to construct a ‘unique’ set of course materials or learning experience from a distributed set of educational resources. To do this, a more structured GIScience knowledge base will be required. As ESRI have already started work on the development of their own knowledge base software to facilitate the production of training and instructional resources for the ESRI product range it is proposed that this group work with ESRI to explore the transferability of this concept to generic GIScience education. The aim will be to use the existing ESRI knowledge base as a rapid prototyping environment from which to review, evaluate and establish if a knowledge base approach will meet the specific needs of the wider GIScience education community.

Project stages

1. *Review available knowledge base initiatives*: Identify and review relevant knowledge base products for education and GIS external to the ESRI initiative, in order to confirm that the ESRI knowledge base is an appropriate tool for prototyping and proof of concept. In addition, such a survey will identify if there are any emerging standards (particularly GIS specific ones) which should be tested at the prototyping stage.
    - *Personnel needed*: one graduate researcher.
    - *Time frame*: begin as soon as possible, 2 months duration.
    - *Expected result*: short paper summarizing results, including URLs for all relevant sites. Must be posted on IGE website, might be published as an NCGIA technical report.
    - *Funding required*: 2 months 100% for a graduate researcher, plus benefits
2. *Evaluate, define or refine knowledge base structure*: Assuming task 1 indicates that continued support for ESRI's knowledge base is appropriate, form a knowledge base development group to critique the existing ESRI product and identify additional elements required for the knowledge base to allow it to support generic GIScience education.
    - *Personnel needed*: small international task force working with ESRI agreement.
    - *Time frame*: begin after stage 1 is complete, 4 months duration depending on availability of task force members. Most of the work will be completed during an intensive 5-day focus meeting – where the existing knowledge base shell is evaluated.
    - *Expected result*: A revised blueprint for a GIScience knowledge base which will allow educators to:
        1. Provide materials with minimum reformatting.
        2. Author new materials for different educational purposes at different levels.
        3. Construct a prototype system for testing by the wider GIScience educational community.

      The task force will seek comment on its blue print via conference sessions, newsletters, journal articles and the Web. Possible NCGIA technical report/OGC white paper.
    - *Funding required*: Travel expenses for one 5 day workshop (to be held either in the US, or Europe) plus stipends for participation and contribution throughout the task period.

Infrastructure support and access to knowledge base software will be by the provider of the knowledge base shell (ESRI?). 1 month funding for a graduate researcher 100%, plus benefits to write up the findings of the task force.

3. *Build prototype GIScience knowledge base for a single specific theme*: Choosing a specific theme (data capture was proposed at the meeting) use existing materials in various forms and under our control, to populate the prototype GIScience knowledge base. Use appropriate metadata from the IMS/GIS project to tag information in the knowledge base. Put the knowledge base on-line and request further contributions. At the same identify individuals and organizations that would be prepared to provide additional material for the knowledge base.

   - *Personnel needed*: Task force members from the previous stage will be requested to deposit examples of instructional material in the knowledge base. Please note that the term deposit is used metaphorically and the knowledge base will most likely be implemented in a distributed form. These same task force members will be required to append metadata to their materials. Other developers, external to the task force will be encouraged to contribute. A least one-graduate researcher full time for 6 months will be required to make changes to the existing knowledge base software to meet the requirements of the taskforce and assist with any technical issues associated with the population of the knowledge base. It is suggested that one individual researcher is employed and moved to appropriate task force sites as and when required.
   - *Time frame*: approximately 6 months from the completion of Stage 2 above.
   - *Expected result*: A body of structured GIScience knowledge, on a specific theme, on-line, and available to the wider GI community for evaluation and testing.
   - *Funding required*: One full time programmer for 6 months. Continued local support for taskforce members to allow them time to put material in a format appropriate for the knowledge base. Development of a mechanism to finance the involvement of other interested academics.

4. *Test and demonstrate the usability of the knowledge base*: Identify appropriate test bed sites. These sites must be able to evaluate the knowledge base from two perspectives (1) contributing educational resources (2) using the knowledge base to author new resources. Test bed sites should also be chosen across a range of disciplines and educational levels from schools through to professional development.

   - *Personnel needed*: one graduate researcher for 4 months, plus test bed sites.
   - *Time frame*: 5 months beginning as soon as the knowledge base is populated and on-line.
   - *Expected result*: Demonstration of the value of the knowledge base concept for GIS education. Progress reported via IGE, IMS and OGC channels. Full results reported in next Stage.
   - *Funding required*: graduate researcher for 5 months plus benefits, small bursary to test bed sites to encourage participation and evaluation.

5. *Disseminate results*: If all previous stages have been completed to our satisfaction, it will be necessary to seek a model for making the knowledge base concept ‘ live’ . This will require the development of an appropriate funding model. The success of the project will depend on its usability and perceived value. Therefore, either as a part of this research or as a separate initiative an appropriate business model has to be developed which will allow the knowledge base to be developed in a sustainable manner.
   - *Personnel needed*: knowledge base task force members and anyone else who has participated.
   - *Time frame*: can begin to report as soon as Stage 2 is well underway and should continue 6 months after completion of Stage 4.
   - *Expected result*: widespread enthusiasm for an online resource base of GIS material, which is regularly updated and can be customized for local use in a range of different instructional scenarios. This will be particularly true if an appropriate framework can be developed which rewards individuals for contributing materials, provides an easy mechanism for making material available without lost of IPR and provides a mechanism by which materials can be easily customized for local use.
   - *Funding required*: none essential though support for conference attendance and workshops at meetings worldwide throughout one year would ensure widespread promotion of the concept.

Totals

Total time required: 18 months to end of testing phase (Stage 4), plus 6 months for further dissemination and workshops.

Total personnel required:
RA: 100%, for 2 months in months 1-2 (Stage 1)
RA: 100% for 1 month in months 3-6 (Stage 2)
RA: (programmer) 100% months 7-12 (stage 3)
RA: 100% for 5 months 13-18 (stage 4)

Task force members - 6 to 8 participants for 1 year

Total funding required:

RA: 100%, for 2 months in months 1-2 (Stage 1)
RA: 100% for 1 month in months 3-6 (Stage 2)
RA: (programmer) 100% months 7-12 (stage 3)
RA: 100% for 5 months 13-18 (stage 4)

Travel: 12 domestic, 12 international (Stages 2, 3 and 5)
Stipends/Summer month: 8 people $4-5000 each

Task 3 - Incentives for interoperable GIS education

by Derek Reeve

The IMS and ESRI virtual campus projects described at the meeting make it evident that the technological platforms necessary to facilitate web-based, interoperable education are presently being developed and that very shortly interoperable education will be technically feasible.

Participants at the meeting, however, were clear in their view that interoperable education is not simply, or perhaps even primarily, a technology issue. For interoperable GIS education to succeed, *incentive models* need to be developed that will encourage stakeholders in GIS education - academics, universities, vendors, employers and students - to see benefit in participating. What will motivate academics to author GIS educational objects? Why might students look upon GIS educational objects as enhancing their learning experiences? Why should university authorities conclude that they can see advantage in encouraging faculty to become involved?

Early, anecdotal, evidence suggests that developing appropriate incentive models will be controversial. Indeed, within the meeting there appeared to be differences among participants in their views about what might motivate individual academics to contribute and about how their university authorities would view this new area of academic endeavour. Stepping back from our immediate focus upon GIS teaching, it is clear that there is already widespread apprehension about Web-based learning: There have been strikes at North American universities recently by faculty concerned at the implications for themselves and their students of Web based teaching. (Noble 1997, Todd 1998,Weiss 1998). Should web-based teaching ever become a dominant mode of delivery, it will change the working lives of academics, redefining their relationships with their students and their university employers. Universities might find it difficult in future to enrol students for conventional three or four year courses as students become accustomed to creating their own, bespoke study programmes from the 'best value' educational objects available online. Universities may well find that they begin to lose their conventional pre-eminence as providers of higher education as vendor companies and industry practitioners begin to contribute high quality educational objects. (In the meeting, it was noticeable that the GIS project which seemed the most quickly advancing towards providing online GIS educational objects was vendor based, the ESRI 'virtual campus'). Moving towards interoperable, web-based delivery obviously raises big issues about the future of higher education.

Clearly, there needs to be an urgent consideration of the *institutional frameworks* which will emerge around interoperable educational. On what basis will educational objects be published on the Web? Which institutions will gain and which lose? What impact will Web based teaching have on the lives of academics? Will 'courses' and degree programmes they are conventionally conceived begin to erode? Will students actually benefit?

Beyond GIS these issues have begun to be addressed, and indeed, there is already a neat phrase, the 'Educational Object Economy (EOE)', available to describe the economic aspects of this new area of activity (Apple,1997). We need to understand more clearly what the mechanisms within the EOE generally will be and, more particularly, how these mechanisms will work in GIS education. Possibly the EOE will be a mixed market structure. Within the software market, freeware and shareware co-exist with commercial products. Similarly, bookshops do not drive libraries out of existence. Perhaps the GIS EOE will similarly accommodate a range of incentive models. At the meeting, however, the directors of two of the foremost GIS web-based educational programmes hinted at the limitations of relying upon purely voluntary contribution. Kemp reports that the progress of the NCGIA Core Curriculum has been slower than anticipated, and Foote refers to the lack of monetary rewards in the Virtual Geography Department project. Altruism and enthusiasm it seems might take projects only so far. Although there will probably always be a role for voluntary contributions to the GIS EOE, it seems clear that as the GIS EOE develops beyond its present experimental stage, a majority of academics will expect explicit incentives, in terms of citation, career progression and/or direct monetary return, to be available. At the institutional level, university authorities may need to consider how they might generate income from the GIS EOE.

Researching something which has not yet happened and about the shape of which even enthusiasts are still unsure, presents particular challenges. The Delphi method of futures research, however, offers a methodology for investigating opinions about future events in a controlled manner. The participants at the meeting agreed to pursue a Delphi based approach to research opinions about the likely shape of the future GIS EOE, with particular reference to the incentive models which will emerge.

Project stages

1. *Research and synthesise present opinions about the benefits and dis-benefits about the emerging Educational Objects Economy* : Identify and review existing literature without regard for disciplinary boundaries to obtain the widest spectrum of experience and opinion. Within geography, canvass the views of academics who have already participated in online/CBL projects, including NCGIA Core Curriculum, Virtual Geography Department, the UK CTI GeographyCAL project etc. in order to determine whether participation in such initiatives has so far been regarded as being worthwhile, both personally and in terms of the pedagogic value of the materials produced. This will be done via an email questionnaire survey and interviews with key academics.
   - *Personnel needed*: one graduate researcher.
   - *Time frame*: begin as soon as possible, six months duration.
   - *Expected result*: a paper summarizing present opinions with regard to the likely shape of the future EOE, informed particularly by the views of those geographers who have already participated in GIS, and similar, online/CBL educational programmes. The results would be posted initially on the IGE website but would also warrant broader dissemination as an NCGIA technical report and through GIS and educational conferences and journals.
   - *Funding required:* six months @ 100% for a graduate researcher plus benefits. Travel expenses to interview relevant academics
2. *Research and execute a Delphi analysis into expectations about the future GIS EOE* : Conventionally Delphi analyses have required the following sequence a) prepare an initial position statement and set of propositions, b) invite a panel of experts to comment, c) revise the statement and propositions in the light of expert comment, d) iterate until stability of

opinion is reached. Previous examples of Delphi analysis will be researched. A panel of relevant experts will be assembled. An initial position statement and propositions will be prepared, based on material from stage1. Email will be used to quicken the iteration process.

- *Personnel needed*: One graduate researcher. Panel of 'experts'
- *Time frame*: Six months beginning immediately after the conclusion of the first phase
- *Expected result*: A report describing the scenarios embedded within the opinions discovered and making recommendations about how best to achieve a GIS EOE which maximises potential benefits.
- *Funding Required* : Six months @100% for graduate researcher plus benefits

3. *Disseminate results*: It will be necessary to disseminate the results of the research both within GIS and to the broader educational community. Conference presentations and papers in GIS and pedagogic journals will be appropriate outlets for the research.

- *Personnel needed:* IGE authors and participating experts.
- *Time Frame:* Dissemination can begin immediately after the completion of stage 1 and should continue for six months after the completion of stage 2
- *Expected result:* To simulate discussion about the incentives which will be necessary to ensure that the GIS EOE develops appropriately
- *Funding required:* Not essential, but support for conference and workshop attendance throughout one year will help to stimulate debate.

Totals

Total time required: One year, plus six months for further dissemination and workshops
Total personnel required :
RA : 100% for six months (Stage 1)
RA : 100% for six months (Stage 2)
Participating panel of experts and respondents

Total funding required :
RA : 100% for six months (Stage 1)
RA : 100% for six months (Stage 2)
Travel : Interviews with relevant experts $4-5000 (Stage 2).
Dissemination at conferences $4-5000 (Stage 3).

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Appendix
Participant position papers

Marinus de Bakker

Van Hall institute
Dept. of Environmental Sciences
P.O. BOX 17
9700 AA Groningen, the Netherlands

A preliminary cost/benefit evaluation of interoperability of GIScience education

Development of good educational material requires a lot of time, lots of money, clear aims and especially skilled educators. Particularly educational material like for G.I. education in the rapidly changing world of information technology is difficult to develop and even more difficult to maintain. For a small group of educators (or even a person alone) it is almost impossible to keep ahead of the developments.

To extend the idea of interoperability ("to remove current constraints on using specific hardware and software", see Burrough and McDonell, 1998), towards education looks very promising. But the constraints between hardware, software and data are completely different in comparison with diverse educational systems like e.g. the dutch or the french.

The author uses the experiences of ten years work as an educator for many different students and course participants with a wide variety of background. In such a way these experiences will lead to a thorough discussion of educational interoperability .

The main question arise: "What are the benefits of interoperability and what are the costs or problems"? What do we need, and how can we organize these requirements?

Some of these aspects are discussed below.

Benefits

- Easy access to new or updated educational materials
- links in development → higher amount of change
- peer review
- students/course participants can find what they need (no dependency on lecturer)

Costs/problems

- cultural differences, so difficulties to use educational materials in different settings
- management would like to recover initial development costs
- most "normal" educational materials can be change over a period of five years
- datasets are best used, if they are located nearby (recognize your own surroundings)

- access to Internet (technology gap can increase the distance between the "haves" and "have nots")
- language differences

Needs

- a good method to indicate the level of the educational materials (meta-information)
- structure between materials (if you have done this, you can go there)
- exchange of credits for development (authors) and by students
- check on credentials of educators (experiences show, that people not involved in development have difficulties to use the materials)
- open educational materials (If you can not adapt the material to your own situation, you will not use it)

Proposal

More emphasis should be placed on knowledge transfer from lecturer to lecturer. The lecturer is changing from a formal teacher to a electronic assistant. GIScience education will expand, but most of the time people with a non-spatial background will use the "systems".

If the use of GIS is not any more recognizable as GIS, more emphasis should be placed on possibilities but also pitfalls in the use. Similar like the misuse of models, the general public should be made aware of these two aspects.

Literature

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Karl Chang

Department of Geography
University of Idaho
Moscow, ID 83843

Modular GIS Courses

I support modular GIS courses as the basis for collaboration in GIS education. The materials for each course are organized around a specific GIS topic, which offers something new, either conceptually or technologically, to potential students. I will illustrate my position with two courses that I plan to offer through the proposed UI GIS center.

Example 1: Data Conversion

This modular course emphasizes scanning as a preferred method for spatial data entry. The student will learn tracing algorithms, use of ArcScan for tracing, and other background information related to data conversion. Specifically, this modular course includes the following materials:

- Scanning vs. manual digitizing
- Conversion of scanned files to vector data
- Converter vs. tracing
- Algorithms for tracing
- Tracing using ArcScan
- Other available tracing packages, such as Autodesk CAD Overlay or Hitachi Tracer Trio + Recognizer
- Evaluation of data conversion

Example 2: Integration of GIS and Image Data

This modular course emphasizes the integration of GIS and image data for such tasks as hotlinks and data editing. Use of image data in GIS has increased remarkably in recent years, mainly due to technological changes and the increased availability of image data, such as satellite images, digital orthophotos, digital raster graphics, scanned files, and graphic files. Specifically, the modular course includes the following materials:

- Types of image data
- Image data compression
- Geo-referencing of images with GIS map layers
- Linking GIS and image data using ArcView's hot link feature
- Use of digital orthophotos and digital raster graphs for preparing and updating GIS map layers
- Applications of data integration in environmental monitoring and disaster management

Advantages of Modular Format

Modular courses have several advantages. The student knows exactly what he will get from the course and how the course can help him. Students on the UI campus regularly inquire what I intend to cover before they sign up for my GIS classes. Often this is because students need to learn specific aspects of GIS for their work or research projects. The need to learn specific GIS topics is even greater for GIS professionals who have to take refresher courses to keep up with constant changes in GIS knowledge and technology.

From the educator's point of view, modular GIS courses can be developed from his or her teaching and research activities. In my case, I delved into the data conversion topic because of soil mapping projects that I have contracted with the Natural Resources Conservation Service for the past two years. Modular courses can be easily maintained and shared between educators. After a mechanism for exchanging resources is established, it would not take many educators to work together to keep their learning materials up-to-date.

Issues in Course Preparation

Care must be paid to data sets, lecture notes, exercises, and course credit while designing a GIS course for distance learning. It is sometimes difficult to gather data that make sense to everybody taking the course. Another question is to use either real-world data or fictitious data. I prefer to use real-world data whenever possible, not because they are real but because they often present additional challenges to students.

Lecture notes and exercises for distance learning should be detailed and self-explanatory. A small mistake in instructions can be disastrous as far as the student is concerned. Publishers such as OnWord Press are experienced in producing professionally designed tutorials. These tutorials offer good examples for modular course preparation.

Because it takes a lot of time and effort to put together data sets, lecture notes, and exercises, the course materials represent intellectual properties. How to protect these intellectual properties is important to GIS educators. I do not have to worry about the copyright protection for my two proposed courses because most materials have already been published in my book.

A typical semester course at UI carries three credits. The above two GIS courses are designed for one-credit each. The courses can, however, be supplemented with independent studies, meaning that students can use what they have learned and apply the knowledge to a case study to earn additional one or two credits.

Delivery of GIS Courses

Delivery of modular GIS courses will be via a combination of Web resources, handouts or books, CDs, e-mail, and video conferences. A Web site will be set up for each course and used for announcements and general communication. The format is similar to the Web sites we have set up for the GIS classes that I team-teach (http://geogstu2.mines.uidaho.edu/geog475, and http://geogstu2.mines.uidaho.edu/geog385). Handouts or books cover lecture notes and exercises. CDs contain data sets to be used for exercises. E-mail is an effective mechanism for questions and answers. UI has video outreach linkups with other state universities in Boise, Coeur d'Alene, and Pocatello. Video conferences are useful for "face-to-face" discussions. Students will use computer facilities in near-by universities for GIS exercises. State universities in Idaho all use ESRI products and are in the process of establishing a statewide license agreement with ESRI.

Sarah Cornelius, Henk Scholten and Peter Nijkamp

Free University of Amsterdam
Department of Regional Economics
De Boelelaan 1105

Educating for interoperability: the user perspective

The fire, police and medical agencies are attempting to clear up after a major disaster. The fire service is being routed to their destinations by their on-board computers. The directions to the driver are spoken, and changes in routes due to new obstructions immediately relayed to the cab. Meanwhile, the computer provides floor plans of the buildings the fire team head for, and details of dangerous substances and the measures needed to tackle them. The team leader radios a request for a pollution dispersion model for one of the deadly chemicals contained in the building. Back at emergency planning headquarters, real time GI handling products provide instant updates on the situation, produce new maps, and predict the impact of the disaster. Maps and data are fed to the press in real time for distribution to the general population via TV and the Internet (Synergy, Hewlett Packard, 1994).

This is a vision of the not-too-distant future. GI will soon be ubiquitous and available at the touch of a button. The technical issues and even some of the organisational issues of geographic data exchange will be overcome. Spatial analysis tools will be available embedded in a wide range of computer software and the results will be instantly disseminated to all the users who need them. This is, perhaps, the goal of interoperability for GIS. But the education of future users also needs to be 'interoperable'. In a single day the fire fighter may need to use the on-board computer in the fire fighting vehicle, assess the results of analysis predicting the spread of major pollutants if the fire is not tamed quickly enough, and add new data to the corporate spatial database using GPS and hand held technology. To meet this challenge, skills in map interpretation, data collection and communicating spatial thinking are necessary. The fire fighter will need to be continually updating his skills and knowledge to keep up with changes in technology. The same will be true in many other professions.

There are a whole string of issues that need to be addressed if users such as the fire fighter can be educated to effectively apply and develop these new widely available tools. Clearly, whole new sectors of everyday GI users need to be made spatially literate to use spatial data effectively. At the same time, more sophisticated users need to know which analysis tools to apply to a particular problem solving situation. And there will still be the need to educate the next generation of GI software engineers and developers. To meet the differing educational needs of these users some of the training and education needs that can be anticipated are:

- just in time training
- basic spatial awareness
- intelligent guides to appropriate analysis tools
- advanced technical training for system development
- immediately available support for users
- continuous and intelligent professional updating tools

To deliver many of these training needs, virtual learning tools will have to be developed. No University or training agency will be able to meet the demands for lifelong learning and continuous professional updating by employing their current methods of education alone. Some of the tools they will use are already visible in embryonic form in the GI community. Examples include the Geographer's Craft (Foote, 1997) project, web sites that support individual courses (for examples), virtual training for commercial software (ESRI virtual campus), and commercially produced virtual classrooms and intranet training resources (Cap Gemini, HP, Arthur Anderson).

Most, or even all of these tools have limitations from an educational perspective. Few offer opportunities for users to assess their prior knowledge, or to evaluate the preferred learning style of the user. Few have suggested learning paths for learners with different needs or expectations. Few offer the support of a 'learning community' of educators and fellow learners, to guide, motivate and assess.

Figure one

		User Needs		
Pedagogic Framework • Information provider • Key to resource base • Facilitator of personal learning styles • Promoter of a sense of community		Learning Environment		Technical operationalisation of system • Client server • Open standards • Internet/ intranet
	Learning Community			
	Testing			
	UNIGIS	IMCOME	Professional Environment	
		Issues for development: Research Agenda		

Recognition of these issues has led to the development of a model for the development of virtual learning environments to help in a range of scenarios. The model is summarised in Figure 1. The pedagogic framework for development is a goal-oriented model of the functions that such a system should perform.

The goal-oriented model for the virtual learning environment has been, or is being evaluated, in three different contexts.

1. UNIGIS 'learning station'.

The UNIGIS distance learning programme offers a Postgraduate Diploma and MSc in GIS to professionals in GI and those wishing to enter the profession. The goal-oriented ideas of the virtual learning environment were implemented first in an off-line learning environment. This lacked the community element shown in Figure 1. Evaluation of the system highlighted the need to maintain motivation and continually 'delight' the student, as use of the environment decrease with progression through the course. Technical issues were also important for home based learners (Cornelius and Heywood, 1998).

2. The IMCOME project and the RIDE course.

With funding from the Dutch ministry of science the GIS group in the Department of Regional Economics at the Free University are developing a web support environment for a course in Spatial Economics. Implementing the system architecture in Figure 1 for a regular course has led to evaluation of the model above with students in a 'controlled' situation. The lessons so far include the importance of re-evaluation of course content to avoid an overly structured learning path, pointers to effective interfaces for the presentation of information to students, and the importance of motivation and encouragement for the development of a learning community.

3. Evaluation in the commercial environment

The application of the model in a commercial training environment presents additional challenges. Issues of support, group working and learning within the work context will be addressed in trials with several large GIS user organisations in the Netherlands (like RIVM, RABO Bank and Ahold).

The main lessons from these studies to date have been

- The importance of orientation for new users. It is hoped that this can, in time, include an assessment of learning style and prior learning to help students choose and appropriate learning paths through the materials.
- The importance of an active and supportive learning community. For motivation of learners, and self-help and self-direction in learning activities, a virtual learning community is essential. Tools such as discussion lists, pre-arranged virtual tutorials, chat rooms and video-conferences can help to develop this, but human input is an important element of the learning process
- How to overcome the rapid changes in technology - from mosaic to Netscape, from C to Java, from a professional editor to complete webpage builders.

- The changing role of the tutor. The tutor in a virtual setting becomes facilitator, motivator and coach. Their role is to keep materials alive and up to date, and support the learner.

These lessons have clear applicability to a wide range of other situations, from basic training in spatial awareness with virtual tools, to professional updating. For GIScience, the development of effective virtual learning environments would help to address many of the predicted training and education needs of users in the 21st Century, and play an important role for other applied sciences.

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Pip Forer

Department of Geography
University of Auckland
10, Symonds St. P.B. 92-019
Auckland, New Zealand

Position Statement and Abstract

This section outlines a personal perspective on the practical issues of GISc as they relate to this workshop It then elaborates on a particular area of interest.

I work on the assumption that interoperable education, in GISc or elsewhere, will be a significant strategy and one worth working to advance. It will be significant to Universities seeking to preserve autonomy but to provide cost-effective excellence in their learning resources, breadth of study and community accountability. It may well be an important tool against extreme corporatist forms of commodification and globalisation in education. In practice its promise of mixing external and local course ingredients offers an opportunity to preserve an education based on substantive, local direct human and institutional links.

In the area of GISc there are also, at least currently, substantial localised components of practice and legislation which need to be combined with generic components for successful local delivery. Such a demand mix favours a modular interoperable structure.

I also work on the assumption that for many national and curricular contexts the current scheduling constraints of tertiary education are not beneficial to student lifestyles. The advent of student loans and the fragmentation of student job opportunities is a critical factor in this, certainly in New Zealand and Australia. Interoperable arrangements would need to favour flexible delivery, and thus offer ways of enhancing lifestyle choices.

My general educational agenda is thus both conservative and radical. I am keen to utilise collaborative developments to enhance local learning opportunities. I am also keen to deconstruct the rigidity of present delivery systems and to spread learning opportunities, but to retain and enhance the human focus of learning. Interoperability seems a natural vehicle for testing solutions and meeting these various goals, and GISc a natural domain to work in initially.

For interoperative GISc education the barriers are considerable in four areas :

- Creating learning resources of excellence
- Allocating the recognition for contributions to these
- Developing optimal learning delivery structures
- Implementing portable and flexible accreditation structures

The first of these is the least problematic, although challenge enough. The dynamics of interoperability depend on the reasonable assumption that Specialisation frees time and allows enhanced development in depth. If that enhances the resource, then it can be further leveraged by technical support and overall management within the project. The key issue is defining the breadth of the desirable curriculum.

Consistent quality and sustainable achievement depend on the second set of problems being solved. The kind of activity involved fits no existing model completely : it isn't publishing, nor is it narrow institutional delivery. It involves a large virtual team with members functioning within a number of independent organisations with which specific working arrangements will need to be negotiated. There is a need for a relatively robust structure capable of functioning for up to a decade. Such a structure is at present relatively unproven and needs debate. It is this area that I perceive to be the most difficult barrier. Clarity in this area may be a prerequisite for any hope of substantial development occurring.

Optimal learning delivery structures are focal to generic student issues, and define the goal of the exercise. The issues here relate closely to section 1, but also include questions of what learning components get delivered and how (see Abstract below).

Flexible accreditation structures are vital if the enterprise is to be internationally successful. I suspect that there are very differentiated attitudes in this area.

I am keen to contribute a New Zealand perspective to any of these issues, but the Abstract below focuses on questions of delivery structures, in the broadest sense. This reflects a view that interoperability in GISc needs to be seen in the context of wider pressures on University education.

Abstract of Intent

The scope of what can be accomplished by interoperability in education continues to expand enormously due to a range of new technologies that allow effective communication and resourceing at a distance. These are now well established as tools for virtual teams working on research projects and collaborative developments. It is rapidly becoming possible to implement delivery of aspects of learning on a large scale using the same tools. For technological and many other reasons there is in parallel a growing pressure to re-think how mainstream learning might be best organised and delivered. This trend intersects with the problems faced in rapidly evolving

academic domains which need to maintain currency and share expertise. GI Science is clearly one of these.

Interoperability is largely about sharing resources and experience so as to augment traditional delivery. In general it involves a mix of internalised resources and external resources. Such a mix has always existed in the form of guest lecturers or course texts, but the opportunity exists to evolve more responsive and more integrated functions through so called virtual technologies. These technologies can function locally and internationally. It is argued here that their effective deployment now depends more on human issues (educational design and institutional organisation) than on technological implementation.

This contribution would focus on how different components of interoperability might be managed within a mainstream educational environment, as well as for return and distance learners. It will consider the interaction between GISc curricula, components of interoperability, virtual delivery options and student needs. It will seek to identify a range of GISc learning contexts (by stage of student or student goals) and discuss the requirements of interoperability (from course and student perspectives) and the constraints placed on it for those specific contexts. Significant attention will be placed on questions of areas of local content versus global validity, as well as virtual support versus local congregation for learning. The fundamental question will be what sort(s) of learning a framework for interoperable GISc should be seeking to support.

Béla MÁRKUS

College of Surveying and Land Surveying
University of Sopron
P.O.Box 52, Pirosalma u. 1-3.
H-8002 Székesfehérvár Hungary

Position statement

Open Learning in Land Offices - TEMPUS project JEP

The main objective of the OLLO TEMPUS project was the development of open learning materials and course infrastructure in Land Information Management within Székesfehérvár, College of Surveying and Land Management (CSLM) at professional and postgraduate level. The short term development of short cycle professional and practically oriented courses in Land Information Management using the existing Distance Learning network and the further development of CSLM facilities.

Distance Learning in GIS - PHARE project

Aims: The development of a distance learning professional degree in Geoinformatics at CSLM with a potential for further development to MSc level and focused on a wide target group. The target group consists of professionals in the Geoinformation and related industries (national mapping organisations, application oriented organisations - cadastre, local authorities, utilities companies or private Geoinformation production companies). Developing and refining distance learning modules in order to facilitate future conversion into multimedia computer based on-line training packages. Building up a long term collaboration with the International Institute for Aerospace Survey and Earth Sciences (ITC) by working on the co-authorship of the curricula and delivery of courses.

PRONET CCE - EU funded project (lead by ITC)

In the frame of the project CSLM will arrange and supervise the production and delivery of a 4 hour MCBT session on Geoinformatics both in Hungarian and English. The PRONET project will directly contribute to the "National Cadastre Program" of Ministry of Agriculture and the "National Topographic Program" for the benefit of the urban, rural and regional development. Target group: middle level managers at organisations (e.g. local authorities, utility companies, regional councils, ministries etc) potentially using land related, geographic data, responsible for capturing digital data, building databases for GIS, working on spatial query, analysis or modelling, monitoring of natural processes. Strategic direction: The MCBT session focus on problems how to start and manage a GIS project (quality of data, integration problems of data acquisition, financial aspects, typical errors using GIS functions and living with these errors in decision making).

UNIPHORM - PHARE project

Aims: Improving skills levels amongst professionals in PHARE countries comes up against the universal problem of educating and training people in work. This project aims to develop a distance education programme for engineers/technicians in PHARE countries on use of OpenGIS concepts. Independent market analysis by UNIGIS shows a considerable demand for distance education at this level in the GIS area across Europe. The educational needs shown by independent market research by UNIGIS are for focused technical training and support. Research also shows that delivery should be in brief intense packages which require minimum time away from work. There should be small incremental costs. Training should be directly applicable at work.

James Petch and Joseph Stobl

James Petch
Department of Environmental and Geographical Sciences
The Manchester Metropolitan University
John Dalton Building, Chester Street
Manchester M1 5GD

Josef Strobl
Department of Geography
University of Salzburg, Austria

Towards OCX controls for GI education ...

There are different aspects under which this topic can be discussed; I would like to focus on the interoperability among educational components (instead of e.g. education about interoperability in GIS).

Why this aspect is important: To facilitate worker mobility, choice between educational products, use 'market forces' for educational QA, flexible and efficient use of educational resources to cater to different needs, ...

Prerequisites for interoperability between edu components: Defined curricula and entities for delivery (what goes into which course?); entry and transition requirements between these courses; certification levels & standards (cf. ISO TC211 N502); overall, interop in GI edu is closely linked to the certification debate, although approaching it from a different angle.

Assumptions for further discussion: 1. there are accepted standard curricula; 2. a choice of learning units / presentation media is available; 3. multiple, readily available 'access points' (=educational institutions ?)

Facilitating factors: Firstly, since learners' mobility is limited, a flexible distance learning environment is instrumental in enabling the mentioned aspects of 'distributed teaching' (=learners collect instruction from multiple points!). Internet services currently are the (only?) major option for more or less ubiquitous access to interactive multimedia 'experiential' learning environments. A second factor is the globalization of software technology and the knowledge structures 'hardwired' into software products. Otherwise syllabi would be less well defined.

Key question: How can we build adequate, effective and motivating ("fun") learning environments based on distributed media? In other words, what is the "glue" between independent components for distributed teaching? How can we interface components and integrate them under different instructional metaphors, paradigms and styles?

Factors to consider for interop of edu components: * Familiarity: common style etc to provide 'homeroom feeling'

- Navigation: easy 'wayfinding'; sense of current location; intuitive, common structure for learning environment; build right expectations
- Completeness: 'one stop shopping' for knowledge acquisition
- Guidance: availability of a virtual and/or real instructor personality ('coach', 'mentor', 'tour guide')
- Social learning environment: arranging for peer contact to facilitate group learning
- Plug-and-learn: software / platform independence
- Scaleability: move between levels of qualification / ambition / understanding
- Multiple views: support different application / domain / role perspectives for flexible use
- Localization: how do we handle and overcome rifts between languages, cultural and technical contexts?

Some lessons learned within UNIGIS:

- The versioning lesson: a common curriculum is more than a collection of content entities; but requires defined structuring, perspectives, context and ...
- The Toolbook lesson: try to maintain software independence, or at least platform independence for interactive teachware components.
- The Spans lesson: try to achieve plug-and-play exchangeability for exercises (everything's done in quadtrees, right?). This requires stated objectives and defined interfacing.
- The reusability lesson: authoring educational components for multiple uses IS difficult! Horizontal (grouping of concepts) and vertical (levels of detail) modularization is key to flexible use of media, but may lead to unmanageable collections of bits and pieces.
- The localization lesson: we can teach students global content - but need to do so within the local culture.
- The K-99 lesson: learning (e.g. about GIS) doesn't happen only once in a lifetime: educational products need positioning along an educational timeline; covering more than one 'era' is definitely an advantage!
- The MD/SDO/SC lesson: how do we keep up with technological evolution? Remain in sync with the 'real world'? Keep in touch with industry?
- The Collabra lesson: groupware technology is a key instrument for Internet-based learning environments. Strategic choices in this area determine the success in bringing components together.
- The EC-US lesson: if you want to put supposedly interoperable components to the test, combine them under different learning style paradigms (the jury is still out on this one!)
- The domino lesson: (aka The 404 lesson aka The dangling node lesson) is there a thing like an educational object? Where semantics, properties, class relationships and methods are so clearly defined that interaction with other objects happens properly over through generations of changes?
- The maze lesson: multiple pathways through collections of educational resources are a striking idea - does a maze need to be a fully connected graph?
- The Watcom lesson: some existing great stuff will never make the educational interoperability grade; too bad we need to start development from scratch ...

What does all this tell us? Just like OpenGIS went a long way building foundations until first 'simple feature' results were achieved, we probably need to go a long way until interoperability for individually sustainable educational products in GI can be achieved. Just like in software development, competing players need to realize that they stand to benefit as a group (not necessarily individually in every instance) by cooperating building strong foundations. Education and industry is a two-way relationship: academics have shown industry the way in many cases, now industry demonstrates the benefits of OpenXXX approaches!

Júlia Seixas, Pedro Gonçalves, António Câmara

Grupo de Análise de Sistemas Ambientais
Universidade Nova de Lisboa
Quinta da Torre
2825 Monte de Caparica, Portugal

Interoperable components for GIS Education

1. Motivations

The extended use of GIS varies from simple map making to visualization and analysis for different disciplines. In each, different users have a specific data needs, formats and most important of all she/he possess a unique problem. As a response to this, the majority of GIS vendors supply a normalized *GIS-in-a-box* package, containing the data structure, formats, geographic functions that will ultimately impose the vendor flavor in the design and operability of the problem. The user becomes limited in the design of her/his own problem to the functions supported by the vendors. On the other end, the constant effort to achieve more market shares imposes the constant need to the upgrade of the spatial functions and data structures available. This creates an exponential growth in software complexity. In the long term the user ends with dependence to data and software standards and the need to a constant training upgrade.

Environmental modeling, statistical data analysis and GIS are three examples of computational activities that are usually relegated to separate, large and sophisticated computer systems. Usually each one of them has more functionality than is required by the user, whose needs exceed the range of a single one (e.g. both GIS and statistical data analysis). In the first two, the data organisation benefits from a GIS perspective and some very simple issues, like the quality of spatial coverage of the data, can be resolved by a simple geographical display. Likewise, the quality of the time coverage over a geographical region can be combined with a geographical display by enhanced visualisation. For these two examples (spatial and temporal coverage of data), for interfacing models over a large range of possible input parameters, and for many other circumstances, it is beneficial to have a level of integration which is much greater than a simple file transfer mode. These examples illustrate the difficulties arising when teaching GIS to environmental engineering undergraduate courses, where the focus should be more on the GIS related analysis of environmental problems than on the GIS itself. More widely, that constraint appears stronger when the students come from communities for which GIS is a completely new concept, like journalists or NGOs analysts.

It is not possible to design an all-in-one solution that integrates the user-oriented functions and GIS. To achieve interoperability, with the sharing of data and functionality between the systems, one must proceed with the decomposition of the GIS into small components available to other applications. If the user just needs to visualize the data, or query the database, or even a map overlay, it is necessary to make available those procedures and not the overall application. It is necessary to provide the building blocks, that combined with the use of macro-languages (similar to the BASIC) or Internet-based languages (like JAVA or VBSCRIPT) will further increase the power available to the end-user. But, even the classic GIS graphic interface must be reconsidered. Does it regard the map as a tool for communication or as simple store of information? Does the interface adapt itself to the user or the inverse? It should be possible to adapt the GIS interface to different uses, working in different places with the same data.

Transforming the GIS into components will also enable the design of end-user specific interfaces, adapted to its knowledge. If the user works with Internet browsers, or word processors, or spreadsheets, that should be the main application where the GIS will work. From fields like simulation, multimedia, or Internet, the GIS should take advantages of the possibilities already available in established applications. To achieve this, a work of deconstructing the GIS has to be done. In the end, the GIS application should be invisible to the end users, using just the geographic concepts to work the data within their own applications. Because our main concern on GIS education refers to non-geography courses (environmental and sanitary engineers) and GI-outside communities (e.g. journalists and NGOs members), that approach is the ideal working support.

2. The iNovaGIS *interoperable approach*

The goals to develop a Geographic Information interoperable technology state that it must be implemented as components, enabling the exchange and share of information and functions between applications for the design of user-oriented analysis. A component-based structure to the GIS, called *inovaGIS*, is proposed and implemented as ActiveX objects. These objects allow the separately use of visualization and query or map algebra procedures within other Windows based applications trough the use of Microsoft macro-languages (VISUALBASIC) or Internet based languages (JAVA and VBSCRIPT).

The *inovaGIS* is an ActiveX server that creates an interface to geographic data and information. It allows the use of GIS-like variables and functions in programs like *ExcelÔ* , *Visual BasicÔ* , *DelphiÔ* or any other WINDOWS™ software. All these software products have the capability to run macros or even to compile the source code. The system functions are well separated, but to the end-user the system works as one. This interconnection is achieved by means of the ActiveX technology.

One of the main advantages of *inovaGIS* components is the transformation of GIS as simple variables in common macro language, where traditional geo-processing services can be added to our software. For example, a set of interoperable functions already implemented include the visualization and queries to a raster map in IDRISI format (Clark University, 1998) from a *Microsoft ExcelÔ* spreadsheet.

Functions like defining our map attributes, the study area or set of data become simpler due to the potential of many macro languages present in common office applications. There is no need to invent or rebuild new script or macro to work with these geographic information structures. The full potential of software dedicated to environmental modeling, statistical data analysis simulation, or even data visualization can enhanced by the add-on of GIS concepts and functions. At the same time, the GIS application remains invisible to the user. When the variable is defined the user works directly in the data structure and functions.

The components created can be used in different applications from word processors, spreadsheets, to programming tools (like *Visual Basic*, *Delphi* or *C++*). At the same time there is no need to invent or rebuild new script or macro languages to work with. The interoperability of the system allows the design of different user interfaces according to the different needs as well as a more integrated analysis of the results.

Concerning GIS education, the *inovaGIS* allow the use and exploration of GIS related concepts and analysis without the need of learning GIS software specific systems, being possible the focus on the spatial dimension of the user issue. The *inovaGIS* includes a library of common GIS functions. However, if specific functions are necessary, its development is only restricted by the macro languages used. Its use in education is encouraged, being the software available as freeware from http://gasa.dcea.fct.unl.pt/inovaGIS/.

Related publication:

Gonçalves, P.P., Neves, N., Silva, J.P., Muchaxo, J. and Câmara, A., 1998. Interoperability of Geographic Information: from the spreadsheet to Virtual Environments in *Interoperating Geographic Information Systems*, Editors Michael F. Goodchild, Max Egenhofer, Robin Fegeas, and Cliff Kottman, Kluwer. (*in press*)

Michael N. Solem

University of Colorado - Boulder
Department of Geography
Campus Box 260
Boulder, CO 80309-0260

Position statement on Interoperability for GIScience Education

1. Enhancing GIScience education through research

Overall, the literature in GIS education is preoccupied with course content. Sui (1995) argued that a new pedagogical framework is needed to improve the quality of GIS education. Problems associated with the implementation of past instructional materials in GIS (Goodchild and Kemp 1992) should alert the GI community of the need for substantive research in GIScience education. Specifically, research is needed in the following areas of curriculum: teaching methods, materials development, and assessment.

Research on the teaching and learning of GIScience is necessary to further an understanding of the relationships between theories of knowledge and teaching practice. This understanding will help geographers create high-quality instructional materials in GIScience. Importantly, the GI community must work with educational researchers in geography to ensure that valid educational principles guide the creation and use of future instructional materials. This effort will require careful study of the literature on teaching and learning with technology. Specifically, future research should address differences in teaching, learning, and assessment in relation to behaviorism and constructivism.

Behaviorism is linked to an objectivist view of reality in which knowledge and skills are assumed to have existence and meaning independent of context and culture (Atkins 1992).

Behaviorist approaches to education place an emphasis on the acquisition of subject-matter through rote memorization and repetition of tasks. Furthermore, it is assumed that learning can be assessed in terms of how student performance (e.g., exam answers) compares to pre-defined criteria for correctness. Pedagogically, the lecture is seen to be the most efficient format for transmitting a body of knowledge to students. Moreover, behaviorist instructional materials tend to have certain identifiable characteristics, including (Atkins 1992: p. 254):

- prior definition of objectives with explicit and measurable criteria for assessment of performance
- material broken down into small, logically discrete instructional steps
- material often presented in the form of a rule, category, principle, formula, or definition followed by examples and implications of the rule etcetera applied
- learning activities sequenced for increasing difficulty or complexity
- opportunity provided to observe, review, and copy the desired behavior
- the sequence and pacing through the material is usually outside the control of the learner
- frequent review/revision with check tests at strategic points

Judging from this list of traits, the National Center for Geographic Information Analysis (NCGIA) Core Curriculum in GIS represents a behaviorist approach to teaching. The Core Curriculum, which was proposed in 1988 and later developed by the NCGIA, was made up of 75 units evenly divided between three broad topics: introduction to GIS, technical issues in GIS, and application issues in GIS (Kemp and Goodchild 1991). Instructional materials consisted chiefly of lecture outlines and tutorial exercises. The Core Curriculum enjoyed widespread adoption, although its subsequent evaluations were mixed (Coulson and Waters 1991; Kemp and Goodchild 1992b). On the positive side, most instructors lauded the content standards set by the Core Curriculum. But, many instructors faulted the "cookbookish" laboratory exercises as being too rote for the purpose of enhancing students' proficiency with GIS. Furthermore, Sui (1995) claimed that the vague pedagogic framework of the Core Curriculum led to problems of classroom implementation.

Behaviorism continues to dominate teaching and learning in higher education due to the lecture model's high visibility and familiarity (Katz 1993). Its primary strengths lie in a structured, deductive approach for efficient transfer of facts, skills, and basic concepts. Whether or not students actually retain information and skills delivered via behaviorist techniques is open to question (Oblinger and Maruyama 1996). Moreover, behaviorism has been widely criticized by educators for maintaining false cleavages between subject matter and learners. These critics prefer alternative teaching and learning strategies that, in theory, are more sensitive to cognitive processes (Scheurman 1998). These alternative approaches may be classified under the heading of constructivism.

Constructivism is premised on the assumption that knowledge is contextual; in other words, meanings subjectively exist and vary across individuals, time, and cultural groups (Guba and Lincoln 1994). Constructivists value the dialectics of learning over the transmission of received knowledge (Fosnot 1996). These principles have roots in the progressive education movement, which was launched in the late 1890s with the opening of John Dewey's Laboratory School in Chicago. Dewey (1938, 1956) believed that effective learning in schools occurred only when students were able to "psychologize" the curriculum, i.e., to reconnect subject matter to the experience from which it was abstracted.

Constructivists design lessons in which students learn from their experience as they actively inquire into meaningful problems (Hill 1990; Slater 1993). Learning objectives may be expanded to include the formation of higher-order skills (e.g., critical thinking), values (Fien and Slater 1985), and attitudes (Klein 1995) towards a subject. Characteristics of constructivist instructional materials include (Atkins 1992: pp. 259-260):

- learner required to engage with the material.
- learner expected to analyse, synthesize, summarize, describe, and solve problems.
- interaction with 'expert'.
- learner invited to explore and discover an environment for themselves, sometimes with guidance.
- learner expected to build up own hypotheses, explanations, definitions, categories, rules, etcetera, through study of examples and reflection on own experiences.
- learner moved back and forth between symbolic representation of phenomena and the real-life referent.

Two recent projects in GIS education, the Geographer's Craft and UCGIS Virtual Seminar, illustrate the principles of constructivism in practice. The former is a two-semester Web-based course that introduces students to research methods in geography (Foote 1997). In this course, students use the Internet to synthesize a variety of geographical techniques (including GIS, remote sensing, and spatial statistics) in order to solve authentic problems. The latter example refers to a UCGIS initiative in 1997 to involve several universities in an on-line "virtual course" on the theoretical foundations of geographic information science (Buttenfield 1997). Students enrolled in the semester-long course used the Internet to collaborate on course assignments, discuss theoretical problems, and publish term papers on-line. This approach defies conventional wisdom that the lecture is the ideal method for teaching about theoretical issues in geographic information science.

In summary, research on the teaching and learning of GIScience will result in a better understanding of students' curricular experiences with GIS and will support the creation of high-quality educational resources.

2. Achieving interoperability for GIScience education

The potential success of an interoperable environment for GIScience education can be enhanced with an understanding of the organizational issues involved in the development, implementation, and use of Internet-based instructional materials. My dissertation research will address three problems associated with Internet-based teaching in college-level geography. First, campus-based initiatives to promote teaching with technology are often haphazardly planned and implemented (Katz 1993; Meyer and Berger 1996). Indeed, such efforts often fail to involve faculty in the planning process and will, as a result, meet with slow acceptance or rejection

(Surry and Gustafson 1994). This situation threatens to undermine the success of geographical projects (e.g., the Virtual Geography Department) that are producing Internet-based instructional materials (Foote 1997). Burkman (1987) argued that more faculty would be willing to adopt instructional innovations if their perceptions were understood and considered by planners. Unfortunately, the relationship between adopter perceptions and innovation diffusion has received little attention from researchers (Morrill et al. 1988; Rogers 1995). Therefore, this research will measure geographers' perceptions of the Internet and explain how their perceptions affect its utilization.

The second problem requiring attention concerns the role of place in the diffusion of Internet-based teaching in geography. In higher education, faculty must consider many technological, economic, and personal issues before they decide to adopt or reject an instructional innovation (Heterick 1993; Surry and Gustafson 1994). The degree to which these issues form constraints to diffusion will be a function of general differences between research universities, comprehensive colleges, and liberal arts colleges. But, it is unclear what specific factors facilitate or impede teaching with the Internet across U.S. college geography. Therefore, this research will determine how factors affecting adoption decisions vary under different institutional contexts.

Finally, geographers, in general, do not understand the curricular implications of the Internet. Faculty can now create, use, and distribute instructional materials that transcend the spatial and temporal confines of physical classrooms (Dyrli and Kinnaman 1995; Howard-Vital 1995; Oblinger and Maruyama 1996). In practice, this can take a variety of forms, from on-line lecture notes to full-fledged distance education courses on the Web. In the past, technological innovations (e.g., GIS) have had dramatic effects on how geography is taught (Nellis 1994). Nevertheless, it remains unknown how the Internet will change educational practice in geography because no comprehensive data on its instructional uses exist. Seeking to aid that understanding, this research will assess how geographers are using the Internet for geographical instruction.

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Jorge Xavier da Silva

Professor Titular
Chefe do Laboratorio de Geoprocessamento
UFRJ, Rio de Janeiro, Brazil

A perspective

It is a fact, and not only an opinion, that the usage of a technology has serious consequences. It is, certainly, a direct way to the creation of social ties of many types, the most immediate of which are economical and political in nature. In science, where exchange of knowledge forcefully occurs, many dependent relations can be generated, and they need to be explicit and clearly perceived by the involved parties, at least for the sake of human mutual respect. If this entirely defendable ethical positioning (which has obvious pragmatic aspects) is adopted, it is consequential to realize that we are faced, as noticed by the organizers of the meeting, with the basic dilemma of conveying an ocean of information to navigators using many types of vessels, from nuclear and steam ships to dugout canoes. The conversation is difficult, and the possibilities of misunderstanding immense.

Many terminologies intercross at the field of environmental research. They are generated in specific branches of "pure" science, such as Biology, Geography, Physics, and also in applied research, such as Remote Sensing and Geoprocessing. One perverse and important consequence of this intercrossing of terms is the excessive value given to the strictly technical knowledge, i.

e., the direct command of procedures already tested and aimed to obtain efficient results from the usage of a technology. Unfortunately, this over-evaluation tends to cast a relevant penumbra upon the mastering of concepts and methods associated to environmental research (it is possible that the above statement applies only to countries like Brazil, but eventually the contention remains to be tested elsewhere). Under this penumbra, a researcher may become extremely apt to maneuver hardware and software, but may have serious difficulties to propose innovative solutions to environmental problems. The proposition of solutions that really respect peculiarities of the physical and social environment where they should apply may become scarce. The chances of failure may increase dramatically. This is not a desirable situation, either ethically or pragmatically.

Another contributing factor leading to this almost irrational situation of absence of favorable conditions to the generation of new solutions is, paradoxically, the high quality of the presentation of the commercial products associated to Remote Sensing and GIS. As a consequence of masterful presentations of these products, usually performed for an audience of administrative personnel (decision makers), the potentialities of the software and equipment are brought into light, often using carefully selected examples. The problems related to the generation of adequate databases of difficult and expensive data capture, the changes in procedures of data acquisition and storage, which clearly relates to the administrative functioning of the institutions where the GIS and SR technologies are to be implanted, among many other operational problems, quite often are conveniently placed in a hazy background, or, in some cases, are completely ignored. In Brazil, the decision makers tend, as a consequence, to consider that the problem of using the mentioned technologies is only one of having skilled technicians in their staff. Asking allowance for the colloquial expression: "when the chips are down", when are requested meaningful and useful results from the investment - and frequently only then - do appear the harmful effects of this preference for the hiring of technicians at the expenses of the acquisition of real environmental researchers.

We are aware that the sentences above may be considered, somehow cynically, a call for past methods, or one more attempt to expand and preserve the job market solely to our professional environmentalists. Actually, we are trying to visualize a compromising solution able to bring to the daily research reality, without loss of quality, the benefits of recent technological advances. This goal has to be pursued on the basis of the interpretation of alleged facts, and the overselling of Remote Sensing and GIS technologies, without the due attention to the adequate insertion of these advances in the social picture it is destined to portray, certainly is not beneficial. If the environmental researchers have impoverished their ability to propose idiosyncratic solutions, they tend to become mere denouncers of critical environmental situations. The excessive repetition of these denounces rapidly brings tiredness to the listeners and also to the denouncers themselves. A social deafening effect easily crops in from this unfortunate situation. The discredit shows up, both in regard to environmental research and to the administration. Obviously this discredit is extended, frequently by the frustrated administrators, to the technology itself. In the long run, every interested party looses: the applied researchers with the impoverishment of their creative power; the researchers involved with technological development witnessing somewhat meager results; the administrators with their failure to cope with their problems; the vendors seeing their product under discredit; and the social body having to continue suffering from the effects of avoidable problems.

An approach to reduce the undesired effects of the somewhat apocalyptic picture above delineated would be to promote directly the intervention of the University in the relations between the GIS and Remote Sensing advances turned available and the institutions where these technological resources would be used. In Brazil, this can be done through the participation of the University in the elaboration of public bids, specifically in the writing of the so-called "bid calls" or "edits for buying with public funds" ("Editais de licitação ou concorrência pública", in Portuguese). More adequate specifications of equipment and software may be expected from a cooperative effort carried by the University and the buying institutions, specially if the specifications of equipment, software, data, etc., are aimed at the peculiarities of the social environment, of which both the University and the buying institutions do participate.

Another cooperation of the University can be obtained through its contracting as a quality control agent. In regard to the generation of expensive (extensive in area and taxonomically) databases, the knowledge of the University personnel can be of extreme value, allowing the University to act as an independent analyzer of the adequacy of initial products such as Remote Sensing imagery and geocodifiable environmental data, as well as to perform quality investigation of the final products of environmental analyses.

The above delineated interventions of the University would turn easier the selection and integration of qualified environmental researchers by public and private institutions, thus allowing the minimization of the previously indicated problem of misuse of the technologies of Remote Sensing and GIS. More contact between the researchers and technicians would be expected from this closer relationship between the University and public and private institutions. Exchange of experiences are bound to occur, with mutual benefits. The grasping of new concepts, together with the direct contact with real problems, are examples of those benefits. In more than one sense, this can be seen as a reasonable contribution to overcome the gap between knowledge and action, so common in many countries. From these amplified relations, in synthesis, may eventually appear a better understanding of the capabilities, specific requirements and social needs related to the correct use of new technologies.