Strategic Change in GIScience Education

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Abstract
Major changes are about to engulf higher education. GIScience education is particularly exposed to these changes due to its dependence on technology and rootlessness with regards to traditional disciplines. Many important strategic activities and major projects involving the future of GIScience education have recently been conducted or initiated. Considering these activities and projects within this context of change in higher education helps ensure that they produce the most impact, address important existing and near-future demands, and satisfy the customers, our students.

I. A NEW ECONOMY BASED ON INFORMATION

"We are right now in the very early stages of a new economy, one whose core is as fundamentally different from its predecessor as, say, the automobile age was from the agricultural era. If you grasp this premise it's much easier to understand a lot of what's going on around you, including why a seemingly unrelenting tsunami of change keeps washing over you and your business" (Huey 1994).

Like so many aspects of our society today, education in all its forms is undergoing rapid evolution. As we move away from an industrial based economy to one based on information, knowledge rather than labor is the basic commodity. "The knowledge and creative genius of the product strategists, developers, and marketers are the key" (Tapscott 1996, p. 47). Information economies demand workers who can learn quickly as business and technology evolve. Companies in which workers are unable to adapt to changing conditions will be unable to keep up. This implies that we must shift from education systems oriented to learning competencies and knowledge only at the start of careers to one which leads to acquiring skills for lifelong learning and adaptation to change.

These fundamental changes in the economy have produced many new pressures on the traditional education system. While elementary and secondary education continue to adapt as education theories change, school budgets are adjusted, and technology appears in the schools, the rate of change in higher education will soon become much more significant and far reaching. These changes are occurring throughout higher education but many are particularly acute in the field of Geographic Information Science (GIScience). Recently three separate activities to identify areas of strategic need in GIScience education have attempted or will soon attempt, either directly or indirectly, to address these pressures. These activities are:

- a set of education priorities developed by the University Consortium for Geographic Information Science (UCGIS)
- summary reports from discussions at the Second and Third International Symposia on GIS in Higher Education (GISHE)
- a workshop to discuss the need for and feasibility of a framework for interoperability in GIS higher education.

This paper considers the outcomes of these and related activities with respect to trends in higher education brought about by the tsunami of change occurring in our global economy and digital technologies.

II. PRESSURE FOR CHANGE IN HIGHER EDUCATION

The changing context for higher education is already a great concern for many university administrators who must be prepared to respond to them fiscally. It is equally important for faculty to consider these changing conditions so they can anticipate the new kinds of demand for education and prepare to address them. As in all futurist discussions, there are many analysts (see for example, Denning 1996, Tapscott 1996, Twigg and Oblinger 1996). However, the general themes are consistent. The following sections summarize the most immediate trends pressuring higher education in general and GIScience education in particular.

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Workplace trends

- Lifelong learning – Rapid knowledge development in an information based economy now requires education upgrading throughout our lifetimes. Life can no longer be divided into the period when you learn and the period when you work.
- The convergence of work and learning – As the economy moves towards one based on information and supported by technology, learning and rapid adaptation to change must become a fundamental part of work.
- New competencies – New technologies in the workplace, such as GIS, require new competencies. Since these technologies arise and evolve quickly, new skills must often be learned outside traditional education systems.

Technology trends

- Digital communication – Increased computer power and bandwidth produce new learning opportunities through the rapid distribution of information and new mechanisms for non-traditional education.
- Disintermediation – This is perhaps one of the most important of the trends. Information technology has made it easier for producers to reach their customers directly. For example, consider the ease of making your own airline reservations via the WWW or the convenience of downloading government tax forms without having to go through a central information office. Disintermediation will affect many institutional structures in education.
- Mass customization – Given powerful digital production and communication systems, it is now as inexpensive for many companies to produce individually customized products as it was once to produce hundreds of identical products (Tapscott 1996). Consider the possibilities for mass customization in education.

Education trends

- Increasing demand – Lifelong learning and changing technologies lead to vastly increased demand for education. However, this demand is largely for non-traditional opportunities.
- Changing demographics – Given the workplace trends noted above, older adults are returning to traditional educational institutions in large numbers, as well as seeking other educational opportunities. These students have different goals and constraints than their younger colleagues. Accessibility, flexibility and cost are important factors.
- Demand for results – Rather than being oriented towards achieving course credits, degrees and certificates, older students often have education goals that emphasize skill development and competency. As well, older students have less patience with non-productive learning situations, so as they increase in number, demands for accountability and quality are likely to increase.
- Knowledge explosion – Given the rapid increase in the amount of information and knowledge being created, new approaches to learning are needed. It is no longer possible to memorize all the information one needs to know in a career during an undergraduate degree program. New skills are required, particularly those which lead to a facility for lifelong learning.
- Globalization – Although recognition of our global responsibilities grows slowly in the US, there is no escaping that our economies are now globally structured and that employment may often reach across international boundaries. International curricula and certification will become important marketable commodities for both education institutions and graduates.
- Competition – Given increased demand, new educational goals and demands for accountability, there is now great opportunity for private sector educational institutions to enter the market. These private sector institutions will compete directly with traditional universities while being more capable of responding quickly to new demands.
- Teaching as mentors – As faculty become more sophisticated in their use of computers to supplement or replace traditional teaching activities (transmitting information, presenting exercises and assessing student progress), teaching can shift to a focus on helping students learn. Thus, teaching changes from simple transmission to mentoring, coaching and mutual discovery by involving students in current research (Denning 1996).
- Collaboration and differentiation – Significant funding by federal agencies plus easy access to the WWW have encouraged rapid growth in online and digital teaching resources for higher education. Faculty no longer need to create all their course materials themselves. As the mechanisms for sharing resources mature through formalized collaboration, intercampus teaching and the development of information systems for teaching, faculty roles will differentiate according to interests and strengths. For example, some may focus on content organization, others on designing learning systems and others on mentoring activities.

III. GIS EDUCATION COMMUNITY RESPONSES

Once enumerated, these trends seem self-evident. However, many in higher education have yet to acknowledge these substantial tensions which will surely change the character of the universities in a very few years. GIS education is particularly exposed to these pressures for two reasons. Since GIScience has yet to find a disciplinary home, as it is unlikely to do, there is no existing academic infrastructure to provide inertia and resist change. Adding force to these pressures, in GIS, being technologically-based, change is a fundamental characteristic of the field. Such rapid change makes it very difficult for individual GIS instructors to stay at the leading edge of everything they need to teach. General dissatisfaction with the existing context for GIS education is clear in the number of recent attempts to identify directions for strategic change and to lay out action items for moving in those new directions. The following sections summarize two recent community-wide efforts addressing this need for change.

UCGIS GIScience education priorities

In June 1997, the University Consortium for Geographic Information Science (UCGIS) devoted its second annual assembly to the identification of several priority areas in which action should be taken in order to advance Geographic Information Science education (Kemp and Wright 1997). The areas identified are:

- Emerging technologies for education – Due to the technological foundations of GIScience, UCGIS members feel it is important to acknowledge responsibility for assuming an active role in testing and advancing new educational technologies.
- Supporting infrastructure – There are a number of issues related to maintaining computer-based lab facilities which have direct impact on GIS education. In addition to obvious issues such as funding sources and management plans, supporting infrastructure also addresses the question of the relationship between tenure review and the excessive laboratory supervision commitments required of junior faculty.
- Access and equity – As GIS becomes ubiquitous, the need arises to formalize coverage of access and equity issues in our courses. These issues are double-sided. From one perspective, there is a concern to ensure that our systems and education programs are equally accessible to disadvantaged students. From the other perspective, it is important to ensure that students are taught to consider the role and impact of GIS in society.
- Curriculum content – A need for reexamining the "one-size fits all" paradigm in GIS education is clear. There are many constituencies and needs which must be met uniquely. Two of the most important constituencies to UCGIS member institutions are:
  - Professional GIS education – For various reasons cited above, working professionals are one of the most important emerging GIS education markets.
  - Research based-GIS education – As GIScience emerges as a major new field, it is necessary to identify the necessary competencies for the next generation of GIScience academics.
- Learning with GIS – This theme recognizes that education is a relatively overlooked application area for GISystems.
- Accreditation and certification – As mature students turn to public and private educational institutions for opportunities to learn about this new technology and science, they are demanding accountability and recognition of competence. These demands require that the GIS education community acknowledge and address these thorny issues.

White papers describing each of these priorities can be found on the WWW at http://www.ucgis.org. From these priority areas was drawn a comprehensive list of specific action items. This list is also available on the UCGIS website. Action items are grouped into a number of categories including: case studies and surveys; research and development about and for GIS education; course content and teaching materials; clearinghouses and networking; policy; and, UCGIS workshops and seminars. While specific and doable, few of these action items are visionary and they do not speak directly to the pressures for change identified above. However, the exercise of identifying these priorities and their action items has been positive. The need for action in most of these areas is now acknowledged and many individuals are taking small steps in the directions suggested. While not comprehensive in scope, slow but positive change is beginning to occur.

Table 1 compares the UCGIS priorities with the changing context for higher education. Many of the trends are addressed, but little of this is in direct response to the pressures being felt in higher education.

GISHE

In 1996 and 1997, International Symposia for GIS in Higher Education were held in Columbia MD and Chantilly VA. Unlike the 1997 UCGIS assembly that

Table 1. General trends against UCGIS priorities

Trends	Workplace			Technology			Education							
'x' *indicates the priority may be a direct response to trends* 'o' *indicates an indirect response to trends* *UCGIS Priorities*	Work as learning	Lifelong learning	New competencies	Digital Communications	Disintermediation	Mass customization	Increasing demand	Changing demographics	Demand for results	Knowledge explosion	Globalization	Competition	Teaching as mentoring	Collab. & differentiation
Emerging technologies		o		x	o		o		o	o	o	o	o	o
Supporting infrastructure							x							o
Access and equity			o	o	o	o	o	o	o		o			
Curriculum content		o	o			o	x	o		o	o	o		
Professional education	o	o	x				x	o	o	o	o	o		
Research education			x				x			o				
Learning with GIS			o	x						o			o	o
Accreditation & certification	o	o	x				o	o	x	o	o	o		

was attended by faculty and graduate students from the country's leading research institutions, these symposia attracted a large number of participants from teaching universities, colleges and schools. Thus, in contrast to the higher-level research education issues addressed by the UCGIS, more practical issues arose at the GISHE meetings. At final plenary sessions held at each of the GISHE meetings, participants drafted action statements suggested by discussions held during the earlier paper sessions. Themes from these discussions were:

GISHE '96

- Networking
- Building private and agency partnerships
- Capacity building
- Identifying GIS employment needs
- GIS laboratory facilities
- GIS training for educators
- Professional development
- Distance education and the WWW
- Key spatial concepts
- Learning models for GIS
- Vertical articulation

GISHE '97

- Support for curriculum, classrooms, labs
- Industry, vendors, and jobs
- Future conferences and GISHE-like meetings
- GIS, technology, and geographical concepts in education (for K-12 and college)
- International contacts and issues

Outlines of these themes can be found on the GISHE website at http://www.ncgia.org/gishe. Some of these themes clearly overlap with the UCGIS priority areas and action items, but there are several new themes reflecting the more general education focus of these symposia groups. Once again, these themes are somewhat blind responses to the pressures for change. Table 2 continues the comparison between issues identified by the GIS education community and the general trends in higher education. Note that only new themes not covered by the UCGIS priorities are included in the table.

IV. EVIDENCE OF CHANGE IN GIS EDUCATION

In response to, in spite of, or independent of these strategic efforts, change is coming in GIS education, as in education in general. Several projects are underway in the US and elsewhere which are clearly in response to these trends. Support for lifelong learning can be seen in the rise of university-based profes-

Table 2 . General trends against GISHE themes

Trends	Workplace			Technology			Education							
'x' *indicates the priority may be a direct response to trends* 'o' *indicates an indirect response to trends* *New GISHE themes*	Work as learning	Lifelong learning	New competencies	Digital Communication	Disintermediation	Mass customization	Increasing demand	Changing demographics	Demand for results	Knowledge explosion	Globalization	Competition	Teaching as mentoring	Collab. & differentiation
Building private and agency partnerships	o	o	o				x		o			o	o	
Capacity building		o	o				x			o				
GIS training for educators		o	o				x			o				
Vertical articulation							o							o
International contacts & issues							o				x	o		o

sional masters and certificate programs (such as those at the University of Minnesota and Rutgers University) and distance learning consortia (such as UNIGIS, see http://www.unigis.org). Teaching materials created by individual members of the education community and distributed on-line (such as the NCGIA Core Curricula, see http://www.ncgia.ucsb.edu/pubs/core.html) and web-based clearinghouses (such as the Virtual Geography Department, see http://www.utexas.edu/depts/grg/virtdept/contents.html) recognize the importance of collaborative efforts in education. As might be expected, education offered on-line by the private sector (such as the ESRI Virtual Campus, see http://www.esri.com) have emerged in direct response to several of these apparent trends. The rapid increase in on-line teaching materials has spawned yet another strategic community-wide effort in GIS education – a consideration of the potential of interoperability for GIS education. Might this be the cure all for our problems?

Interoperability for GIS education

In May 1998, a meeting was held near Amsterdam to consider whether there is a need for "interoperability" for GIS education. The motivation for this meeting came 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 occurring in both GIS technology and the structure of higher education make it impossible for individual GIS educators to stay on the leading technological edge where their students need them to be. Interoperability acknowledges that collaboration in education is now essential. The aim of this workshop was to explore how the GI community might 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 (=mass-customization) while at the same time retaining intellectual (and commercial) copyright. Several of the projects mentioned earlier were recognized as partial solutions though additional work on several fronts is needed before education interoperability is feasible. A summary of this meeting's discussions can be found on the web and projects resulting from this meeting will be discussed in detail elsewhere.

Table 3 considers these various individual programs and projects in the context of change in higher education. As can be expected, many of these activities more directly address the trends than the larger strategic issues identified by the community.

V. THE FUTURE?

So what does the future hold for GIS education? All

Table 3. General trends against individual projects and activities

Trends	Workplace			Technology			Education							
'x' *indicates the priority may be a direct response to trends* 'o' *indicates an indirect response to trends* *Major current projects*	Work as learning	Lifelong learning	New competencies	Digital communications	Disintermediation	Mass customization	Increasing demand	Changing demographics	Demand for results	Knowledge explosion	Globalization	Competition	Teaching as mentoring	Collab. & differentiation
Professional certificate programs		o	x				x	x		o		x		
Professional degree programs		o	x				x	x		o		x		
Distance education	o	x	x		o		x	x		o	o	x	o	o
Core Curricula			x	x		x				x				x
Clearinghouses			o	x		x				x				x
Vendor education on-line	o	o	x	x	x	o	x	x	x			x		
Interoperability for GIS education			o	x	o	x				o	o		x	x

of these trends will continue to push for various changes in the way higher education is structured and they will push even harder on GIScience education. Collaboration and sharing of resources will become essential in order to stay at the forefront of the science and technology. The need for campus-based physical computer laboratories will begin to disappear as hands-on training is offered on-line by the vendors, a situation that should help ensure that education materials reflect the most current software. The private sector will become major partners in education. Being aware of those factors that are pushing for change in higher education and accounting for them as we develop major projects will ensure that our customers remain satisfied and their demands can be met.

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