

The Fourth R? Rethinking GIS Education

By Michael F. Goodchild

When Ross Newkirk and I started a course in GIS at the University of Western Ontario in Canada in 1975, we hoped to introduce some of the students in the undergraduate geography program to a new kind of computer application, one that seemed to have enormous promise.

Thirty years later, that promise has been realized in spades. GIS courses are available at almost all universities and colleges and are enthusiastically received by students in majors ranging from geography to criminology, from environmental studies to civil engineering. It would be hard for anyone majoring in any of the sciences dealing with the earth's surface to avoid at least hearing about GIS, and courses are even available in some of the humanities—at the University of California, Santa Barbara (UCSB), for example, one can learn about GIS applications from a professor interested in the sacred meanings of space in Japanese culture. The number of students taking GIS courses each year in the United States alone is certainly in the tens of thousands and worldwide may exceed 100,000.



Who takes these courses? Students headed for careers in planning and the environmental sciences see GIS as a definite asset on a resumé, whether they eventually work in the private sector, in government, or in research. The military and intelligence communities are hiring students trained in GIS as fast as they can find them. But in other cases, the motivation is more abstract and altruistic and more in line with the traditions of liberal education: GIS is seen as something that every educated person should know about, a set of tools that allow us to see and interact with the world in new and stimulating ways, a contemporary way of satisfying a deeply felt love of maps and geography, and a way of expressing concern for the future of the planet.

It's that last set of motivations that I would like to address, because it seems to me that we are currently at a critical point in the evolution of GIS education. In the past year or so, there has been a dramatic increase in the availability of GIS in society, in its importance in the everyday lives of citizens, and in its value in a host of human activities. No one following the events of August and September 2005, in the days immediately before and

after Hurricane Katrina, could have missed the message that GIS and spatial data were of absolutely critical value. Anyone with Internet access could download a thin client and use the Google Earth service to see the situation in New Orleans, Louisiana, at submeter resolution wherever they were located on the planet. Since the advent of Google Earth in early 2005, along with many other equally compelling and accessible services, such as ESRI's ArcGIS Explorer (www.esri.com/arcgisexplorer), Microsoft's Windows Live Local (local.live.com), Amazon's A9 (A9.com), satellite navigation systems, and online maps and driving directions, the general public has become far more aware of the power of spatial data and the degree to which technology now allows easy sharing, visualization, and exploration of information about the planet's surface. When Nature ran a cover story on Google Earth earlier this year, I was quoted as saying that Google Earth represented the democratization of GIS, just as the PC had democratized computing 25 years previously.

While we recognize these services as the accessible and highly visible version of the technology we call GIS, to the general public they are simply useful services that may or may not be perceived as having anything in common—and very few will link them to the familiar acronym. But all of them represent spatial ways of viewing the world and solving day-to-day problems, and they demand certain abilities on the part of the user, for example, an ability to capture and communicate knowledge in the form of a map, understand and recognize the world as viewed from above, recognize and interpret patterns, know that geography is more than just a list of places on the earth's surface, see the value of geography as a basis for organizing and discovering information, and comprehend such basic concepts as scale and spatial resolution. Together, these amount to what one might term *spatial literacy*, a set of abilities related to working and reasoning in a spatial world and to making a picture truly worth a thousand words. Children grow up to function as adults in a world in which the three Rs—reading, writing, and arithmetic—are considered essential as much to basic functioning as to the realization of life's higher objectives. Today, we surely have to add spatial literacy to the list.

This theme seems to be striking a chord in many places around the world. In the United Kingdom, three universities are collaborating in SPLINT (www.spatial-literacy.org), and have had some success in reaching this new, much broader audience. In the United States, the National Research Council (NRC) recently released a long-awaited report *Learning to Think Spatially* (www.nap.edu/catalog/11019.html), which includes many useful ideas about how to promote spatial literacy in the K–12 world. Google Earth has stimulated a large and growing community of hackers and bloggers who are feverishly adding value to

the service through mashups, commentaries, and extensions—and many of this new community have no background in GIS whatsoever.

What might all this mean for GIS education? It seems to me that it demands a new approach in which spatial literacy is recognized along with other basic abilities—that maps, pictures, and spatial data need to rank with numbers, text, and logic as essential ways in which humans function, both on and off the job, as they reason, interact, and generally live their lives. In the tradition of U.S. liberal postsecondary education, this makes spatial literacy part of what is variously known as the core curriculum or general education—the set of courses available to everyone and from which every student is expected to choose a significant fraction of their course load.



Illustration by Jay Merryweather

What would a course in spatial literacy look like? I think it would cover a minimal set of the basic concepts of spatial thinking and reasoning: location and place, distance and direction, topological relationships, wayfinding, map reading, etc. The course should discuss fundamentals of geographic understanding, including concepts of neighborhood, spatial interaction, competition for space, territory, migration, and spatial context. Visualization, cartography, and the ways in which humans express themselves visually would also form a major part of the content. The course would be grounded firmly in technology and would introduce students to some of the basic concepts of GIS—rasters and vectors, layers and overlay, points, polylines, and polygons—as well as to the world of geospatial data and infrastructure. It would cover the fundamental ways in which humans describe and record the world using coordinate systems, datums, and map projections. Finally, it would be good to include coverage of the special properties of geographic data, particularly spatial dependence and spatial heterogeneity.

If this sounds familiar, it is because these are all topics covered in the education of today's GIS professionals. But the emphasis here is very different, focusing on what every member of tomorrow's society should know rather than on the very specialized skills that we teach in GIS courses today. The objectives are very different, also—this is spatial literacy for everyone, or at least everyone who has the opportunity to take undergraduate general education courses, rather than for the few.

It seems to me that the situation today with respect to the fourth R is similar to the situation in the late 1980s with respect to GIS: there is plenty of interest, but there are very few models of how such a course might be constructed and taught, and there are no textbooks. In 1988, a collaborative effort by the GIS community produced the National Center for Geographic Information and Analysis (NCGIA) Core Curriculum (www.ncgia.ucsb.edu/pubs/core.html), which filled a critical gap and allowed many universities to define the content of new courses. Something similar today might produce an equivalent set of materials for courses in spatial literacy, to fill the gap before suitable textbooks appear.

I have focused on undergraduate education because my experience is in the postsecondary world, but it is clear that the development of spatial literacy needs to begin much earlier. The NRC report has already laid much of the groundwork, and is full of practical ideas, but many issues remain. Not least among them is the question of where spatial literacy belongs in the curriculum. Should it be taught as part of geography, which is a comparatively minor part of the content of social studies courses in most schools? Perhaps it should be developed in mathematics, where it is invaluable in the teaching of geometry, set theory, and calculus. In fact it is easy to see how spatial literacy can be helpful in just about any area of the curriculum. But this is both good news and bad news—good in the sense that it provides an immensely strong argument for spatial literacy, but bad in the sense that no single discipline is clearly responsible for adopting and promoting it.

These and many other issues will be the subject of increasing debate in the next few years. What is clear, however, is that GIS education needs to think about its future and about scaling up to an entirely new concept of its role. One hundred thousand students taking GIS courses worldwide is impressive, but it represents no more than 0.1 percent of all of the students passing through the world's educational system in any one year. Postsecondary education is notoriously resistant to change, and yet pressures for change are overwhelming, particularly in rapidly developing countries, such as China. Moreover,

any educational system has its pressure points where change can be initiated effectively. Graduate students can be very effective at embarrassing their stuck-in-the-mud professors to accept new ways of thinking; funding agencies and foundations can provoke change by well-directed infusions of resources; and collaborative efforts across an interested community can work wonders. Together we can make this happen.

About the Author

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More Information

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