Community GIS: University Collaboration and Outreach with K-12 Teachers

Edwin Joseph

Abstract

GIS is rapidly emerging as an essential tool for students to study local and global communities. With geography now included as a core subject in schools, training teachers to learn and apply geographic information systems techniques in their classroom will not only pave the way for a more environmentally conscious student population, but will provide their students with an improved geospatial sense of the world. In short, integrating GIS into the school curriculum answers the call for including critical thinking, integrated learning, and multiple intelligences in curriculum design. This paper describes how through training workshops and sharing of resources, schoolteachers from four elementary and middle schools partnered with Grand Valley State University to improve their curriculum by integrating GIS into their curriculum. It also provides a framework for sustainability or GIS in schools.

Introduction:

This paper documents an approach to integrating Geographic Information Systems (GIS) into the elementary and middle school curriculum, and provides examples of how area schools in Grand Rapids Michigan are collaborating with Grand Valley State University and GIS organizations to enhance existing lesson plans, research, and other educational activities. Many teachers are excited about using GIS, but Brownwell (1997) questions the effectiveness of current approaches. U.S. Department of Labor (1991) claims that the most effective way to teach skills is in the context of established subject matter. In the case of GIS, Hill (1995a, 1995b) points out that working with others to cooperatively acquire and use information is beneficial for understanding complex interrelationships and GIS without an interdisciplinary approach will not be an effective tool for teaching (Jacobs 1989).

This project therefore seeks to develop experiential and service learning practices among students taking introductory GIS at Grand Valley State University, and foster sustained and effective GIS capacities in the participating elementary and middle schools. The interaction is expected to enhance geography education for elementary and middle school teachers and help connect conceptual and applied geographical knowledge. In many ways education technology research has enabled schools to strengthen their teaching programs through computer technology and innovative teaching approaches.

Objectives

Grand Valley State University began offering introductory GIS in 1998. Over the last two years Grand Valley has developed working relationships with several schools and teachers in Ottawa and Kent County. In 2000 we began an outreach to Ottawa County Schools with a focus on awareness of GIS. Our model was to introduce elementary and middle school students to GIS in the presence of teachers with the premise that teachers are more likely to adopt GIS technology when they recognize that their students are

interested in subject matter (content) that would otherwise be difficult to capture their interest using another mode (process). Once teachers realized that GIS technology can improve the quality of learning in the classroom we believed it could widen the scope of teaching, and help transition children into the information rich society in which they live.

But to accomplish this we needed a way to develop a sustainable program and a reasonable context to ensure success. One way we did this was to show how GIS provided a bridge for linking information from various organizations and disciplines, such as biology and earth and space science, and. demonstrate how GIS could be used to model our complex world--global or local; and, understand the need to collectively through a network (figure 1).

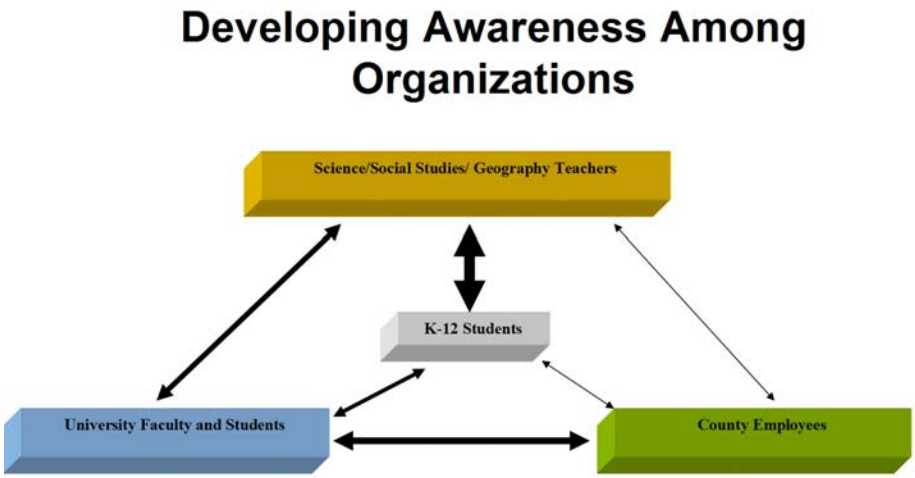

Figure 1

Organizations that use GIS in their daily planning activities are important resources for teachers, K-12 students, and college students. Grand Valley has ongoing relationships with, and provides opportunities for K-12 teachers to work closely with County GIS Organizations. We have been able to facilitate a collaborative network among these groups where local GIS datasets provided by county organizations are updated by Grand Valley students attached to service learning projects with schools. Grand Valley also conducts GIS training for groups of teachers in our partner K-12 schools. In this collaborative endeavor all stakeholders have access to information that will enhance their learning and skills. K-12 teachers in particular find this relationship extremely beneficial. The ultimate goal is to continue to develop shared resources that are integrated into curricula.

Sustainability

GIS in elementary and middle schools will be effective to a large extent by how much teachers are willing to learn and apply the technology. However the effective use of GIS involves more than just learning about a computer program to create maps, it can become a whole new and interesting educational experience. GIS can improve the nature of geographic inquiry through its dynamic visualization and mapping capabilities. Integrating GIS in elementary and middle school curriculum will therefore promote

understanding of spatial relationships and develop better understanding of spatial phenomena.

Defining GIS

While many people describe GIS as simply a map-making tool, Star and Estes (1990), defines GIS as an information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data. A working GIS therefore consists of hardware, software, data, people, and methods; and establishes a dynamic link between location and feature which can be retrieved, analyzed and stored.

Geographic Information Systems (GIS) Technology is an innovative tool that is useful for improving geographical skills in K-12 education. It gives students and teachers the ability to acquire, organize, and analyze spatial data. It also has the potential to change the way teachers organize their class and field activities, and the ability to create new learning experiences for their students. Indeed, some educators believe that GIS will bring about educational reform (Barstow 1994). For example, in 1994 TERC organized the First National Conference on the Educational Application of Geographic Systems (EdGIS), funded by the National Science Foundation. A number of GIS-related educational projects grew out of the recommendations of that conference (Rooney 1997). Rooney (1997) also noted that even though GIS is now available to K-12 education, modest budgets for technology and staff development, and limited emphasis on students developing spatial analytical skills, prevent schools from effectively integrating the technology into the classroom curriculum.

Defining Community and Community GIS:

For some people, the word community means neighborhoods, towns, and cities. Others define community as every collection of people who share a profession or characteristic, and are entwined in a web of relationships and interactions for the well-being of themselves and others. This second definition views community is a dynamic entity that emerges when a group of people participate in common practices and depend on each other for mutual benefit. Using both definitions of community however, it is quite easy to see how Geographic Information Systems (GIS) seems appropriate for exploring relationships among neighborhoods, towns, and cities and the actions of people as we explore this emerging technology. Community GIS therefore involves building local GIS capacity using existing community resources to implement experiential learning activities.

Justifying GIS in the School Curriculum

Beyond the sharing of geographical information, there are some clear reasons why GIS technology should be used in the classroom. The National Geography Standards states that successful geographic inquiry involves the ability and willingness to pose questions regarding what, why, and where about spatial phenomena, and identified GIS as the only technology that can assist students in meeting all of those standards (National Geography Standards Project, 1994). But GIS is more a method than a technology. It presents new

ways to understand the world around us, and will excite the curious learner. Children by nature are curious and will be attracted to its dynamic and visually attractive graphic user interface. This makes it easy to incorporate into lesson plans. But integration does pose several problems. First, when the standards were written it was not clear how GIS would fit into the curriculum and the National Geography Standards did not require the use of GIS in schools. Second, the cost of acquiring GIS technology is still prohibitive for many school districts. Third, reinvention becomes a significant part of implementing GIS.

The *Guidelines for Geographic Education: Elementary and Secondary Schools* however, outlines these five skills as:

1. Asking geographic questions
2. Acquiring geographic information
3. Organizing geographic information
4. Analyzing geographic information
5. Answering geographic questions

As students develop and complete projects using GIS they will *ask questions that help them learn about the world; design and conduct investigations using appropriate methodology and technology; learn from books and other sources of information; communicate findings of investigations using appropriate technology*-Michigan Stand 1; Construct New Scientific Knowledge. They will also *analyze claims for their scientific merit and explain how scientists decide what constitutes scientific knowledge; show how science is related to other ways of knowing; show how science and technology affect society; show how people of diverse cultures have contributed to and influenced developments in science*. –Michigan Stand II; Reflecting on Scientific Knowledge.

Many of the requirements of teaching constructively are addressed by using GIS as a tool to teach ecology and social studies. For example, middle school students can investigate a local environmental problem, using fieldwork, GPS and GIS technology. The students can work collaboratively in a complex and authentic context. They can collect data at the site, create a database, and map the area. Using ArcView, a group of students can explore relationships among rainfall, run-off, and urban land use in the area. They can interview city officials, local residents, and concerned citizens to see the problem from a variety of perspectives. The class can manage the project on their own with input from their teachers. In the end they can produce a video or other media and present their findings to the county government. This type of project integrates social studies, language arts, mathematics, communication, and the natural sciences. GIS will allow the students to manage a complex case so they could see relationships; and help them develop and answer hypotheses. They can test these hypotheses, make tentative interpretations, and elaborate and test further interpretations.

Obstacles

Despite the emerging opportunities of GIS in the Ottawa and Kent County school districts, there are a number of impediments to its use in schools. Beyond the apparent ones of cost and curriculum development, there is a need to develop workplace competency among teachers. There is also a need for in-service training of teachers to

raise their level of computer literacy. Teachers also find it difficult to allocate time for attending conferences, workshops and in-service training to discuss curriculum ideas and techniques for embedding GIS within the various disciplines. Ultimately they need to recognize that in-service training does ensure that teachers do not attempt to teach GIS, but instead recognize that GIS is a tool that enhances spatial understanding and problem-solving skills. Teaching *with* GIS may give students and teachers alike the ideal environment to construct understandings about complex geographic relationships.

Overcoming Obstacles

Teachers therefore need time to develop GIS-based lesson plans that focus on inquiry-based learning. It is difficult to accomplish the task of generating new ideas for integrating GIS into the classroom without a motivated learning community, administrative support, and a significant budget to sustain its implementation. Bednarz and Audet (1999), claims that "exemplary models for integrating GIS into pre-service teacher preparation programs do not exist" (p. 65). Insurmountable pedagogical obstacles therefore confront teachers who were trained to use GIS but who are either unwilling or unable to develop meaningful related activities. It is not surprising that less than 20% of GIS software is effectively used for GIS teaching (Audet and Paris 1997). How GIS technology is introduced in K-12 education will influence its diffusion, and the extent to which it becomes institutionalized is dependent on social, political, cultural, and economic factors.

The Grand Valley Approach

First year activities

Grand Valley State University engaged in a long-term project with middle and elementary schools to develop thematic maps within school districts. When the project began none of these schools had GIS capability, nor were the teachers exposed to GIS. I began by conducting two half-day hands-on GIS workshop for teachers. Students then attended a one-day field trip to our primary GIS lab. Students were taught how to identify, collect, and classify GIS point, line, and area data, and how to represent real world data in a GIS. I then followed up with visits to the schools to plan subsequent activities.

Second year activities

The second year of workshops and field activities included treasure hunts, learning to display hardcopy aerial photos as stereo pairs and several other GIS-related activities developed by Grand Valley. Grand Valley students were also involved in developing some of the GIS activities, and provided support for all events. The activity worksheets were then given to teachers to critique, modify or improve. They also gave teachers the opportunity to see how to develop GIS activities for their students in the future.

Third year activities

The following year, Grand Valley students created sample data for area county parks and developed protocols for generating thematic maps of school neighborhoods. These protocols were simple enough for elementary and middle school children to understand and implement, yet the data were useful for the county offices to incorporate into their

existing GIS database. Elementary and middle school students were taught how to create, edit, and update maps of county parks from orthophotos. GIS mapping allowed elementary school teachers and students to gain a greater appreciation of their neighborhood parks, and they learned how GIS could be used as a methodology for analyzing spatial phenomena.

Teacher Training

This collaboration between Grand Valley and area middle and elementary schools now includes the provision of computers and regular GIS training for teachers. As part of a recently funded grant "GIS Outreach: Building Relationships between GVSU, K-12 schools, and the Community." I conducted three 2-Day ArcView GIS Authorized workshops for teachers between June 2003 and July 2003. The goal was to train at least 10 teachers from five schools who will form a core user group in the school district. These teachers will then become coordinators of a countywide program to recruit other teachers and collaborate with them to incorporate GIS into their lesson plans. They will be meeting at the end of every semester to review lesson plans and determine the best approach for incorporating GIS.

Program Cost and Sustainability

Grand Valley provides Authorized GIS training as a service to teachers. This eliminates major training cost ($400.00/day/teacher or $8,000). Schools are also given a stipend of $100.00/day per teacher through a grant to pay for substitutes when regular faculty members are participating in training workshops or other GIS-related meetings. This approach to training saves the school district $10,000.00. The cost of the software is $450.00 per school. The license allows for installation on all computers in the school. Acquiring five copies of ArcView costs the school district $2,250.00. Also, if schools had to purchase computers for the project, the cost would be approximately $75,000.00 for 50 computers. Even though Grand Valley provides slower computers for the project, they are adequate enough to run the software. In addition, the university has allocated computer facilities on campus dedicated to K-12 GIS education. A Website and FTP service will become available for exchanging data among schools in late September 2004, and an Internet map server for the project is already operating at the university.

Dissemination of Computer Hardware

Grand Valley has started donating used computers (with Pentium II and III processors) to middle and elementary schools whose teachers have participated in GIS training. The computers are first loaded with limited license GIS software (ArcView 3.3), which are then upgraded to full versions after its purchase. Teachers are encouraged to write grants to cover the cost of GIS software. The computers are delivered with generic GIS training data that comes with the software, and local GIS data provided by the county offices. These include orthophotos and digital elevation models (DEMs) and shapefiles of the school district, neighborhood parks, and school neighborhoods. Schools are encouraged to purchase the full version of the software since the cost for software is minimal compared to training.

Impact of GIS Day

GIS Day is a day set-aside during National Geography Awareness Week for Geo-Spatial science professionals to educate the public about the important contributions that Geo-Spatial Science related technologies make in all of our lives. For GIS Day 2003 we invited 350 students from area middle, and high schools for GIS learning activities. Students participated in a "scavenger hunt" to test their skills with Global Positioning Systems Units and had access to GIS lab facilities to view numerous poster exhibits, and a mini career fair. We coordinated with NASA's education offices to obtain maps, CDs, bookmarks, and other literature to distribute to the students. Students were also given GIS day specific souvenirs purchased from ESRI and had a chance to compete for prizes. All students received a certificate of participation. Grand Valley's Offices of Multicultural Affairs and Admissions coordinated minority students' college visits to coincide with GIS day. We introduced approximately 120 minority students from the Greater Grand Rapids area to GIS.

We held a GIS workshop that included presentations by professionals representing various community organizations, urban planning, resource management, emergency management, education, science, government, and industry. We are encouraging presentations that highlight collaborative work between Grand Valley students, faculty, area schools, and community organizations for GIS Day 2004. Below is a list of activities we plan for 2004.

June 2004	1st workshop for teachers. This 2-day workshop introduces teachers to GIS.
July 2004	Meet with community organizations to discuss fall projects for K-12 and GVSU students.
August 2004	2nd workshop for teachers. The focus here will be on using GIS as a teaching tool. Teachers will model various projects that their students can do in the fall and spring semesters.
September 2004	Teachers, county employees and GVSU faculty and students meet as teams to begin planning projects.
Sept.-Dec. 2004	Implementation of activities in classrooms.
Sept.-Nov. 2004	Preparation and planning for GIS Day.
October 2004	Michigan Space Grant Conference
Nov. 2004	GIS Day.
Jan.-April 2005	Projects continue in schools.
April 15, 2005	Student Scholarship Day Presentations on GVSU campus.

DISCUSSION

Research has shown that GIS has been adopted by less than 2 percent of American high schools (Kerski 2003). This is not because the technology is overwhelming or too intense for use in schools, but a number of factors prevent its adoption. Those include high cost of implementation, and the lack of a combined on going and systematic approach to training that addresses the needs of teachers. However, GIS applications range from introductory to complex, making it possible for teachers to explore selective capacities within the software, and over time develop their innovation capacity. The

potential for implementing GIS in the elementary and middle school curriculum is therefore tremendous if the above-mentioned constraints are minimized.

As teachers and students are given unrestricted access to computer technology and GIS they will ultimately develop better computer literacy skills and become more comfortable with the technology. GIS is an important tool for the 21st century and will provide training for future careers. However, the key factors limiting its use in schools include teachers' limited access to learning resources, time commitment to learn GIS, and availability of local GIS data sets. The model I described provides continuous collaboration, in-service training, hardware, software, and funding to promote GIS activities in schools. These factors should no longer pose impediments to successful GIS integration.

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Author Information:

Edwin Joseph PhD.
Assistant Professor
Department of Geography & Planning
Grand Valley State University

1Campus Drive
Allendale MI 49401
Telephone: (616)331-2990
Fax: (616)331-2328
Email: josephe@gvsu.edu