GEOSPATIAL TECHNOLOGIES
Real Projects in **Real** Classrooms

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Imagine a high school class where students beg the teacher to open the classroom or lab on the weekend or over the spring holiday, or a class where students choose to come to school an hour early every day. Sounds like the stuff of a teacher-authored fantasy novel, but it's not. It's happening in Virginia and elsewhere, as students are engaged using technology to address real-world problems using real data—not in taking yet another high-stakes standardized test.

What is this technology, and what are these projects that evoke such unexpected drive and devotion from these high school students? They are the geospatial technologies of geographic information systems, global positioning systems, and remote sensing (satellite imagery). Their integration into different curricular areas lets students focus on understanding their community and the many issues that spatial problem solving lets them address. Other articles in this issue focus on the details of spatial thinking, problem solving, and the use of various software to make maps. In this article we'll focus on examples of what students are doing with these skills and technologies.

The project described above was done by students in the Geospatial Semester, a cooperative dual-enrollment program between James Madison University (JMU) and school districts in Virginia, in which students earn dual-enrollment credit as they complete high school and focus on projects of local interest. These Hopewell, Virginia students were presented with a challenge: the transportation director for their school district had died suddenly and unexpectedly and had taken all of her knowledge about bus routing to the grave. The district was faced with spending a lot of money to hire consultants to sort out the transportation network when they decided to offer the students a chance to take on the project. Under the direction of their teacher, Mr. Jay Ruffa, these students recreated (and recorded!) the entire network of bus stops and bus routes digitally using GIS software and shared their results with the local school board (see figure 1a). While completing the project, the students discovered a number of ways to make the system more efficient and simpler to manage. They also were engaged in a way most of them never had been in a school project—their desire to work nights and weekends to get the job done was refreshing. They remarked on the challenges of being able to come together in work teams to complete their tasks (another one of those twenty-first-century skills) and how that was more difficult than mastering any software. Perhaps most remarkable was the backstory of one of the presenters of the final project to the local school board. The last time this young man had come before the school board was to be suspended for bad behavior less than twelve months prior.

Hopewell city planners took note of the students' work, and last year the students were asked to help Hopewell create an evacuation plan and develop maps to support evacuation in case of a chemical spill or industrial accident. Last year's class approached the project with the same vigor as the initial class. Their work is shown in figure 1b (shown on the next page).

In Crozet, Virginia, at the foot of the Blue Ridge Mountains, students in the Geospatial Semester took on a very different project. Working with the Nature Conservancy, these students started to explore their

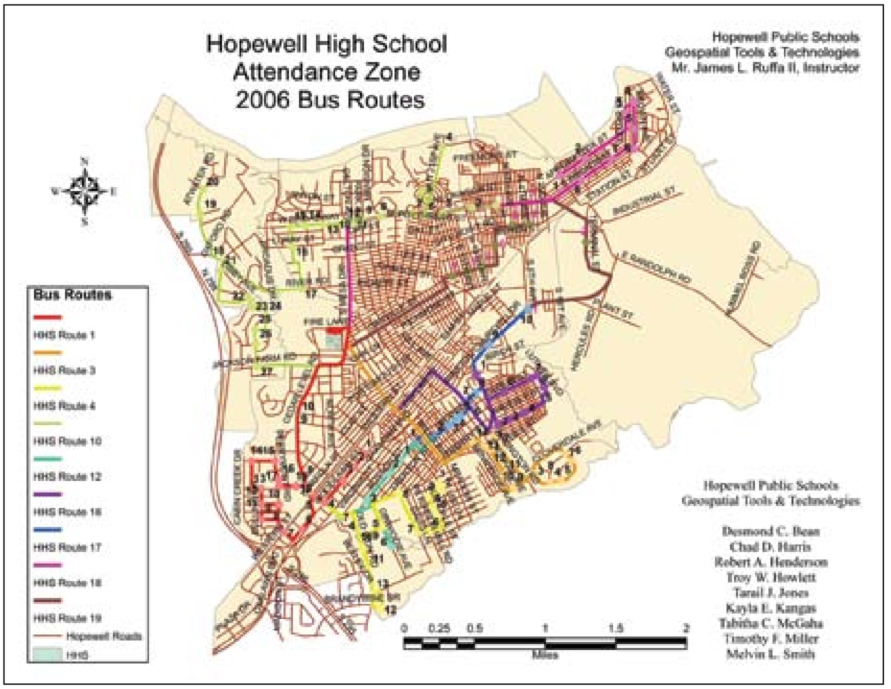

Figure 1a. *Hopewell School Transportation map*
Map courtesy of Mr. Jay Ruffa and his Hopewell High School Geospatial Semester class

local watershed to see how much of it had become impermeable (areas where water could not soak in, but would run off—for example, driveways, parking lots, and so on). The percentage of impermeable surface is a key factor in rating the health of the watershed and an important indicator for the Nature Conservancy in their preservation efforts. This project involved a nearly semester-long effort by these students to gather data, calculate impermeable areas in three different ways, and present their results. An example of student work is shown in figure 2. After regular visits to the classroom, it was interesting to note the degree to which the students were motivated and how they had to learn new techniques on the fly. But at the end of the project, after they had presented their work to the Nature Conservancy, the students didn't reflect on the technical challenges—rather, they were delighted to have adults take their work seriously and engage with them. Too often high school students never have opportunities like this to engage with their community and take up a problem of interest. As adults, we can forget how motivating this can be.

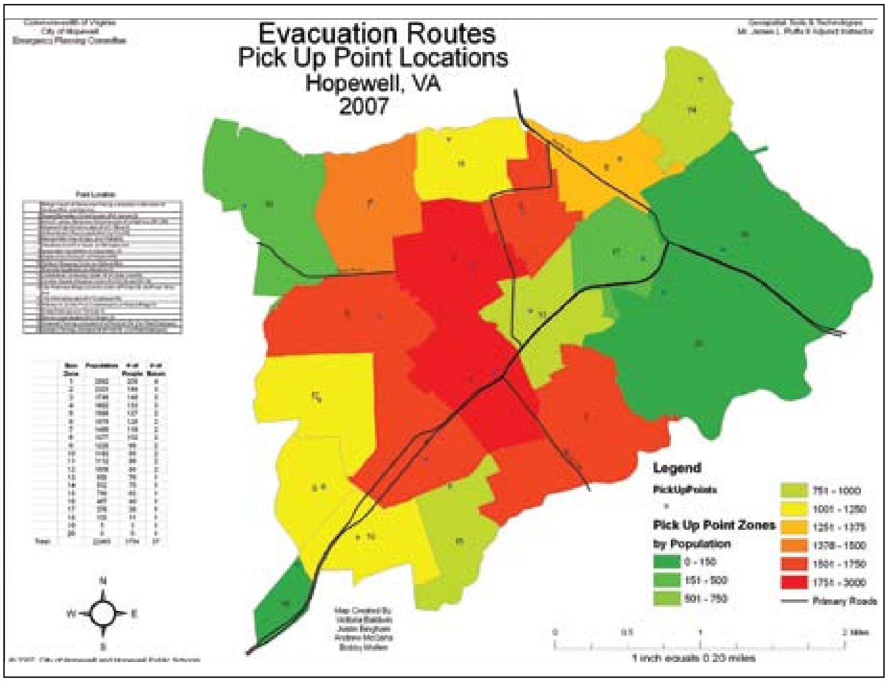

Figure 1b. *Hopewell Evacuation map*
Map courtesy of Mr. Jay Ruffa and his Hopewell High School Geospatial Semester class

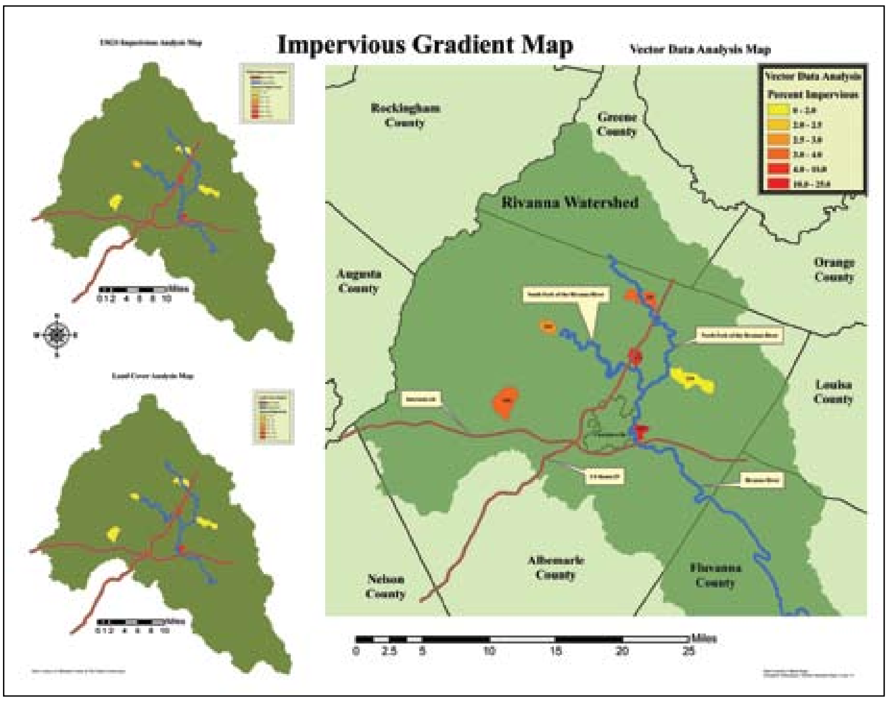

Figure 2. *Watershed impermeable surface map example*
Map courtesy of Mr. Paul Rittenhouse and his Western Albemarle High School Geospatial Semester class

Two schools, two special teachers, two particularly motivated classes—this is the stuff of legend (and magazine articles), but not of systemic change. We all know of that "special" teacher and the magic he or she can work, but we also know that often the magic is bounded by their classroom walls. In the Geospatial Semester and our other geospatial curriculum work at JMU, we're looking for ways to scale the experience from a single teacher and classroom to many teachers and many classrooms so more students can learn from access to these technologies and ways of thinking.

Geospatial Semester

The Geospatial Semester initiative (developed in concert with my colleague Kathryn Keranen) was created to both bring geospatial technologies to more students and to offer high school seniors project-based work to help them transition to either higher education or the workplace. Too often the final semester of high school is a wasteland, and students move to college with an emphasis on taking tests but too few other experiences. Currently in its third year, the Geospatial Semester offers students the opportunity to learn about GIS and GPS, pursue an in-depth project of local interest, and earn college credit at JMU (up to twelve hours at a substantial discount). Teachers in the high schools collaborate with university faculty to develop projects and support the student work. While I described two examples of projects above, there are many others from the twelve school districts currently participating in the project. From an exploration of impact of hospital closings on health care in Washington, D.C., to traffic and crime studies in other cities in Virginia, these students are using the geospatial tools to solve problems and answer questions—in other words, to support decision making. They are engaged, and they feel they are making a difference—a powerful combination. But this project has benefited from a much broader network of support than just JMU and the participating schools.

Building the Infrastructure

The Virginia Department of Education (VDOE) has played a key role in fostering the use of geospatial technologies in the Commonwealth of Virginia. VDOE has developed and supported the Geospatial Instructional Applications Initiative (GIAI), a joint effort offering these technologies to all teachers of students in grades 6–12. Supervisors at the VDOE realized that, for these technologies to take hold, it was going to require a cross-curricular effort, so along with a site license for the ESRI ArcGIS software for all middle and high schools in Virginia, the GIAI provided training for more than 160 teachers of science, social studies, and Career and Technical Education (CTE). This marks the first time (at least in recent memory) that these disciplines have collaborated on technology. VDOE supported this initiative because of the importance of the use of these tools and the opportunities they provide for Virginia's students, both in terms of developing spatial-thinking skills and creating career possibilities. The site license in particular has been of great benefit to the Geospatial Semester.

Other articles in this volume have made the case for the importance of spatial thinking and described some of the different technologies available to help students and teachers. A recent National Academy of Science report (National Research Council 2006) also made the case for both the importance of and the underemphasis on these tools and techniques. In Virginia, we've recognized that providing the software and some training is not enough. We need to do the hard work of thinking about how these map-based tools and the spatial-thinking techniques integrate into the curriculum in a way that will allow teachers across the technology–skill continuum to use them with their students.

At JMU and elsewhere, we've been working to develop sets of materials that are aligned with current curricula that use geospatial technologies effectively. We've also been working to develop a scope and sequence of skills that would lead from an introduction in the upper elementary grades to the sophisticated use described above by high school students. Contact the author for more information. Others across the United States are also busy trying to develop materials. The list below provides some links for some of these materials.

Curriculum and Project Resources

1. <www.esri.com/arclessons> (Online database from ESRI with freeware lessons for different GIS software—ArcLessons)
2. <www.isat.jmu.edu/stem> (Collection of middle school lessons from the National Center for Rural STEM Education—Rural STEM)
3. <www.worldwatcher.northwestern.edu> (Software and curriculum lessons from the GEODE initiative at Northwestern University)
4. <http://edcommunity.esri.com> (GIS in Education portal from ESRI)
5. <www.eastproject.org> (EAST project—a technology-focused middle and high school project that includes GIS and GPS in their repertoire of technologies)

These curriculum materials provide the connection to key content and build students' skills in using the geospatial technologies to solve problems. Many of the activities start with either online or simplified versions of the GIS software (such as ESRI's Arc Explorer—Java Edition for Education) to provide a successful entrée for teachers and students.

Here are some examples of middle school activities and their curricular ties:

- Imaginary Lines (social studies, available at ArcLessons)—Students explore the concepts of latitude and longitude and learn about the different ways to split the Earth into hemispheres.
- Current Quakes (science, available at ArcLessons)—Students download up-to-the-minute earthquake data from the Internet and display it to look for patterns in the position of earthquakes and volcanoes. This activity can be extended into plate tectonics for older students.
- Energy (science and social studies, available at Rural STEM)—Students map production and consumption patterns for different kinds of energy (including fossil fuel–based) over three decades. They analyze which countries are net consumers and net producers of energy and consider future trends.
- Watersheds (science, available at Rural STEM)—Students discover the watershed in which they reside and the connection of that watershed to other ones nearby. They also assess the health of their watershed.
- World Demographics (social studies, available at Rural STEM)—Students explore the different indicators of the health and economic wellbeing of different countries and compare developed and developing nations.
- Carbon Footprint (science and social studies, available at Rural STEM)—Students learn about the concept of a national carbon footprint and compare the carbon footprint of different countries. They also devise strategies to lower their own carbon footprint.

Each of these activities has a strong math strand because most of the data is numerical, and basic descriptive statistics are a key part of geospatial analysis. This is also just a small cross-section of the activities available on the Web or via commercial publishers. The activities cover a wide range of content and easily tie in with science and social studies standards taught in middle grades.

Implications and the Future

As you can see from our efforts in Virginia, these tools are gaining traction in schools. What are the implications for librarians and media specialists in this geospatially enhanced world? There is an initial and immediate need to develop some knowledge of the range of tools available and what they can afford teachers and students in your

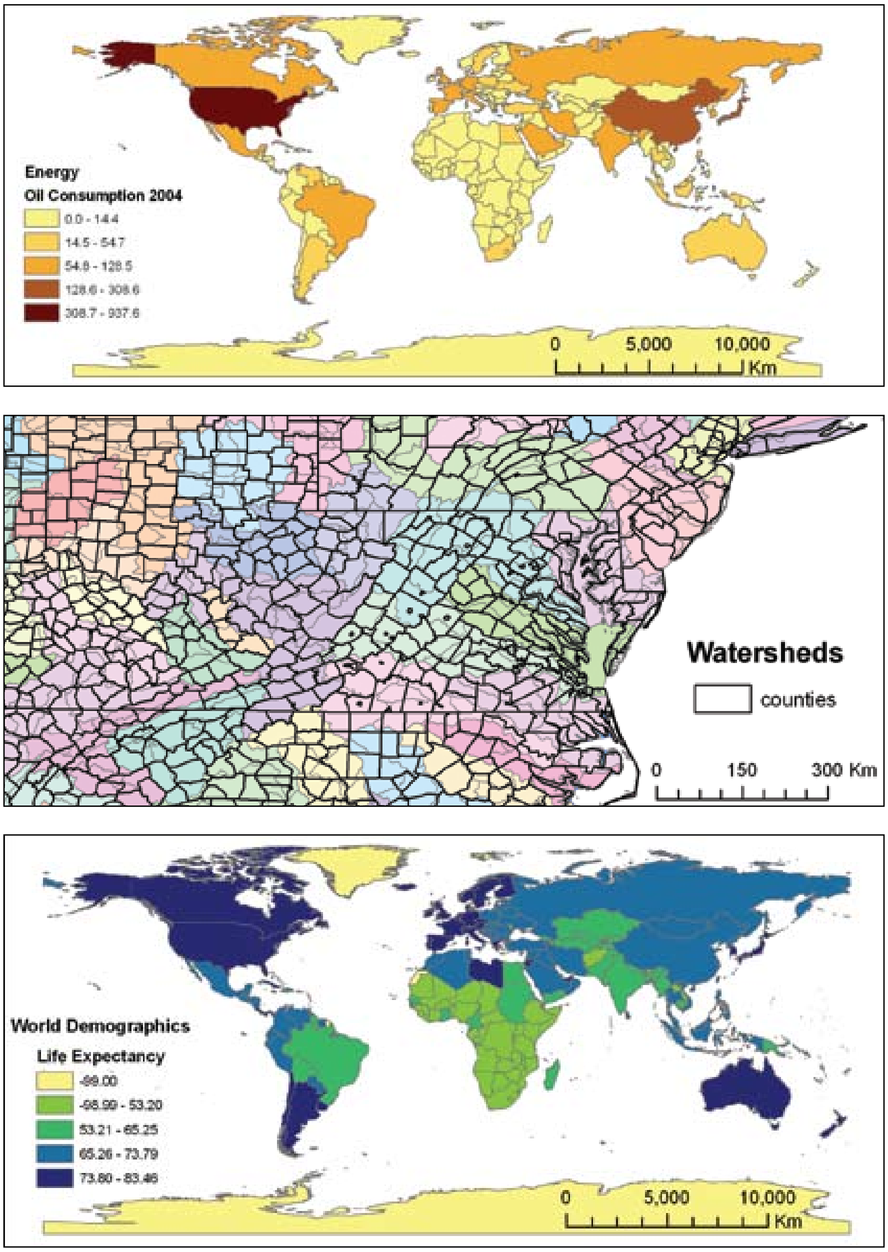

Figure 3. *Example screen shots from the Energy, Watersheds, and World Demographic activity*
Image courtesy of the author

building. Remember that these tools range from fairly simple applications such as Web-based maps and Google Earth to the very sophisticated professional-grade tools such as ArcGIS. At the very least, school librarians should have some knowledge of the basic tools and be able to point teachers and students to resources for the more sophisticated tools.

But there is another role for librarians and information specialists to play—one that is both old and yet new again. These geospatial tools all rely on data that must be stored and cataloged to make access simple and updating easy. Data is often stored centrally and maintained by data providers such as Google, the USGS, and others, but as teachers and students in your schools start to do their own projects, like the ones mentioned above, they will create data that needs to be archived and managed. The data also needs metadata, and who better to interact with students as they do this task than librarians and information specialists. This is an aspect of the rush to these tools that has been almost totally ignored, and students' data and projects are not having the impact they might because they don't know how to do the archiving. This is a huge opportunity waiting for some champions within the community.

This growing emphasis on maps and geospatial decision making has one final implication that is worth pondering. What if, rather than organizing the Internet by text, the central organizing theme was geographic—instead of using a browser to search, we used a globe. Information on the Internet could have geographic connections as well as keywords, allowing students and teachers to browse for information based on place. This is a very different organizing paradigm for information, but Google Earth and other tools are starting to make this a reality, not just a dream. Explorers of old relied on maps to find their way to new discoveries—perhaps the explorers of today will soon be able to do the same thing, only in cyberspace.

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Works Cited

National Research Council. 2006. *Learning to Think Spatially: GIS as a Support System in the K–12 Curriculum.* Committee on Geography. Washington, D.C.: National Academic Pr.