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GeoLearning



Thoughts on Geography and Education

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Defining Geography for Education

Odds are that if I ask you and the person in the next office to describe the field of geography, I will get pretty different answers. And if I were to ask other members of your family—your mother, your brother, your spouse—I would get an even broader range of answers. And if I were to ask the people next to you on your morning commute, the answers would be more diverse still.

This diversity is, of course, an inherent property of human psychology. We all carry around our own personal understanding of words and concepts that result from our own particular set of experiences.

In most cases, the fact that there is such a broad range of definitions for the field of geography isn't a problem, but there is one place where it is a serious issue—in conversations about geography education.

In more than a decade of talking to people about how to improve geography education, I have learned that it is important to be explicit about the definition of geography that I am using.

While there are, of course, as many definitions of geography as there are people, there are three clusters that are important for discussions about geography education. I call these clusters of

definitions "geographers' geography," "the popular perception of geography," and "school geography."

Before I go on, I should note that these definitions are all specific to the United States. From talking to geography educators from other parts of the world, I believe that these clusters exist elsewhere, but I have also learned that the specific definitions in each cluster and the similarities of the clusters to each other differ from place to place.

Geographers' Geography

While there can be no "correct" definition of a field, the cluster of definitions that I think of as geographers' geography has a status that sets it apart from the others. It reflects the way experts and practitioners in geography think of their field. Because geographers' definitions of geography are the product of academic study and discussion, they cluster around a set of conventional definitions, including geography as the study of place and space and geography as the study of spatial patterns and processes at the earth's surface. Geographers also commonly describe geography as encompassing human geography, physical geography, and human-environment interaction.

Unlike nongeographers, who often define maps, mapmaking, and map interpretation as the defining characteristics of geography, geographers tend to talk about maps as being instrumental to geography but not the defining feature. In my experience, geographers describe maps as tools that they use to understand and communicate about space and place.

The benefit of being able to refer to geographers' definitions of geography in discussions about education is that they make it easy to describe the specific advantages of geography in contrast to other subjects of study, and they highlight the societal goals that geographic understanding and practices support. It is easy to connect geographers' geography to the myriad activities of commerce, government, and community life.

The Popular Perception of Geography

Unfortunately, the popular perception of geography is very different. I find the understanding of geography that I encounter on a daily basis to fit the stereotype that geographers refer to as "place-name and location" geography frighteningly often. Most people I encounter, regardless of their level of educational attainment, view geography as a body of discrete knowledge about the world that includes names and locations of countries, cities, bodies of water, and major geological features and facts about those places.

Most people I talk to consider map reading and wayfinding to be the only skills that geography teaches, and if they are aware that one can study geography at an advanced level or practice geography professionally, they believe the focus of that geography is mapmaking.

From the perspective of geography education, the popular perception of geography is as pernicious as it is widespread. People are increasingly aware that factual knowledge is of limited value in the Internet age, so it is difficult to have a productive conversation about the value of geography education with someone who believes geography is about factual understanding and thinks its usefulness for careers is limited to the obscure profession of cartography. Unfortunately, it can be very difficult to change this perception of geography, especially in a single conversation, when the individual has had no personal exposure to systematic geographic reasoning or problem solving.

School Geography

The third cluster of definitions I encounter is what I call "school geography." This is what is taught in schools under the label of *geography*. School geography is typically a little broader than the popular perception of geography but dramatically narrower than geographers' geography.

In the United States, the overwhelming distinction between school geography and geographers' geography is that school

geography focuses almost exclusively on human geography. To the extent that physical geography is taught as geography in the United States, it is taught as background and context for human geography. This is not to say that physical geography is not taught in American schools. Some physical geography is taught, but it is taught under the labels of *earth science*, *environmental science*, and *geoscience* rather than *geography*. Anything that is taught with the label *geography* is taught as part of the social studies curriculum and focuses on the geography of people.

The second characteristic of school geography is that it focuses primarily on factual knowledge. It would not be fair to modern curriculum designers, textbook authors, or teachers to say that geography education today focuses exclusively on facts, but it is fair to say that school geography is so dominated by the teaching of facts that it has not done anything to change the popular perception of geography as being about knowledge of discrete facts.

Geographers and geography educators have worked hard to change the definition of school geography through the development and dissemination of standards that reflect the subset of geographers' geography they believe K–12 students should learn. However, the impact of these efforts on the geography that is taught in schools is still limited.

Like the popular definition of geography, the school definition of geography is a problem for conversations about geography

education. It leaves out the critical component of physical geography and makes it difficult to talk about the study of human-environment interaction. Likewise, the focus on factual knowledge makes it hard to make the case of the importance of geography education in our modern world.

The bottom line here is that the differences between these definitions represent both a challenge and an opportunity. The challenge is that it is very difficult to have productive discussions about improving geography education when the participants in these conversations have definitions that are limited to either the popular perception of geography or the school definition of geography.

On the other hand, it exposes an opportunity in the form of a specific issue to work on. If we could bring the geographers' definition of geography to a larger audience, it could make it much easier to bring about change in geography education. While it is difficult (I can't count the number of times when I have explained to people what I mean by *geography*, only to have them revert to their old understanding of geography a few minutes later), people can learn new definitions. It requires deliberate effort and clever communications strategies, but it can be done. In fact, I believe that it must be done if we ever are to make significant progress on the challenges of improving geography education and geographic literacy.

For more information about the efforts that the National Geographic Society, the Association of American Geographers, the National Council for Geographic Education, and Esri are making to increase popular understanding of geography, visit GeographyAwarenessWeek.org.

(This article originally appeared in the Winter 2013/2014 issue of *ArcNews*.)

Connecting Schoolchildren to the Real World? That's Extraordinary!

One of the perks of my job is that I get to visit extraordinary schools and classrooms. It is rare that I don't find a school visit to be inspiring, but over the years, I have seen a couple of places that really stand out. They are so inspiring that I have used each of them as an example in presentations and conversations hundreds of times, but I still want to share them more broadly.

Why do I find them so inspiring?

First, in a world where people have come to associate excellent teaching with heroic effort, these examples show what can be done through simple, commonsensical activities that any teacher can do with ordinary levels of training and resources.

Second, they involve establishing meaningful connections between students and the world outside of school. I often say that we have designed schools and schooling to be optimal for learning to read, write, and do math, but they couldn't be worse environments for studying the real world. Both of these examples overcome the limitations of modern schools to enable students to study the real world.

Finally, they do not seek to fill students' minds with as much knowledge as they can in a short period of time, which has

become the default practice in modern schools. Instead, they develop conceptual understanding through experience over an extended period of time. Given the choice between having young people acquire large quantities of knowledge in short periods of time or developing conceptual understanding over extended periods, which do you think will be most valuable to them and their communities in the long run? For me, there is no question.

The Goodwillie Environmental School

The first example is a school just outside Grand Rapids, Michigan, that I visited seven or eight years ago, but I remember like it was yesterday. Called the Goodwillie Environmental School, it is a magnet middle school on a 28-acre plot of mostly wooded land. Here are a few of the facts about the school that made such an impression on me:

Every day, the buses let the students off on the opposite side of the property from the school building, and the students walk a half-mile through the woods to the school building.

The students eat lunch outside every day all year, rain, snow, or shine, unless there is lightning or a dangerous storm.

At the beginning of the year, every student identifies his or her own spot in the woods. Every student spends at least 30 minutes, at least once a week, in that location, observing and recording in words and pictures what they see, hear, smell, and feel in a phenology ("seasonal change") journal.

Every aspect of the curriculum is tied to environmental themes, and the temperature in the school is kept at 65 degrees F during the colder months to make it easy to transition from inside to outside throughout the day.

Since many students wear fleece and hats throughout the day, one of the school's slogans is "hat hair is cool," and there are no mirrors in the bathrooms.

Bank Street School for Children

The second example is very different on the surface and nearly identical in concept. This one is found in the heart of New York City at Broadway and 112th Street. It is a program at the Bank Street School for Children, an independent school that is part of Bank Street College.

They have many wonderful programs at the School for Children, but the one that captured my imagination is a project focusing on the Hudson River that is conducted in second grade. In this project, the students in each class collaborate on a study of all aspects of the river through firsthand observation, interviews with adults, and consultation of primary and secondary sources.

The most important parts of their study are the firsthand observations and interviews of adults. Students travel the two blocks from their school to the river on multiple occasions throughout the year to observe what takes place in, on, and around it. They plan and conduct interviews of people who work on or near the river as well as experts in the history and science of the river.

This study is wonderful on its own, but what makes it such a fabulous example of excellent teaching is what the students do with what they learn. Over the course of the school year, they build a physical model of all the aspects of the river on a tabletop measuring approximately 15 feet long and 3 feet wide.

The students create their model out of everyday materials, adding to it bit by bit, as they learn new things. When I visited in March, the model was extensive. It included a papier-maché hill on one end, representing the headwaters of the river in the Adirondacks, and butcher paper painted blue at the other, representing the bay past the tip of Manhattan. In between was a 1.5- to 2-foot-wide, blue-painted river with boats on it; bridges across it; and all kinds of signs, buildings, people, and vehicles on either bank.

Through serious discussion and debate, the students had determined what to build and how to build everything in their model. They had designed ferry landings and built ferry boats, which they could move from one side of the river to the other in a simulation of their daily schedule. Soon before my visit, they had

been learning about pollution in the river, and so there were also freshly made signs along the banks requesting that people not litter.

Since this is second grade, the students were allowed to play with the objects in their model during lunch and recess, but the rest of the time the model was reserved for serious building and simulation.

I was intrigued to learn that the students were just about to start studying the history of the river, which they were going to learn in reverse chronological order. The teacher explained that as they went backwards through history, they would start removing elements from their model in a step-by-step process that would leave the river and its surroundings in a pristine state, representing the time before humans settled in the watershed.

An Underlying Lesson for Education

As I said before, I find these inspirational because they are simple, connect students to the real world, and develop real understanding, but I also believe they have a deeper lesson for good geoeducation. Young people will do amazing things when we ignore our usual expectations about what is appropriate for them and what they are capable of. Second graders will conduct sophisticated interviews of adults and create functional models and simulations. Middle school students will suspend their concerns about physical appearance and will develop deep

connections to natural cycles. Making this happen doesn't require a heroic effort, just a change in priorities and approach.

(This article originally appeared in the Fall 2013 issue of ArcNews.)

Charting a Path for Precollege Geography Education in the United States

The problems of education can seem intractable, but four organizations have been working together to improve geography education in the United States for more than 30 years, and they continue to do so. These organizations—the Association of American Geographers (AAG), the National Council for Geographic Education (NCGE), the American Geographical Society (AGS), and the National Geographic Society—have recently recommitted themselves to this important work through the publication of several landmark documents.

The first of these is a major revision to *Geography for Life: National Geography Standards*. *Geography for Life* lays out learning goals for geography in three grade bands: K–4 (ages 5–10), 5–8 (ages 10–14), and 9–12 (ages 14–18). These goals represent a consensus among geographers and geography educators of what geographically informed individuals should know and be able to do with their knowledge.

First published in 1994, *Geography for Life* has been thoroughly revised to bring it up-to-date with the state of geography and of research on education. For example, when the first edition of *Geography for Life* was published, GIS only merited a mention in

an appendix. In the second edition, GIS figures very prominently in the section of standards called "The Earth in Spatial Terms."

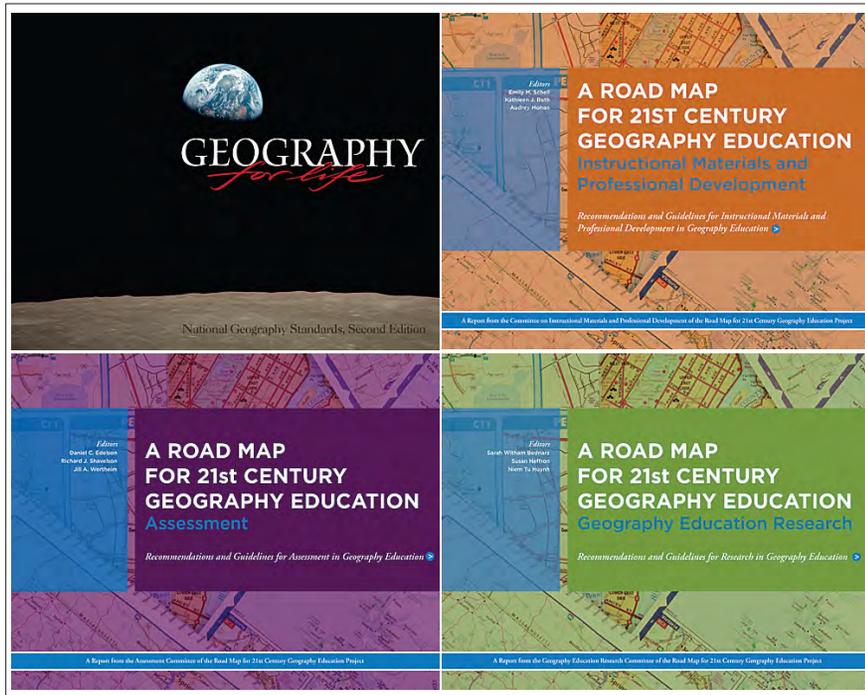
While the federal government in the United States does not adopt or endorse educational standards, *Geography for Life* carries the weight of the four national geography organizations. The organizations created the standards to provide guidance to state and local educational agencies in the creation of their educational standards and curriculum programs.

Around the time that the second edition of *Geography for Life* was going into final edits, the four geography organizations, which collaborate on education initiatives under the auspices of the Geography Education National Implementation Project (GENIP), began discussing how to ramp up the speed and increase the reach of their collective efforts.

The result of these discussions was a proposal to the National Science Foundation to create a set of strategic plans for the improvement of geography education over a 5- to 10-year timeline. The organizations declared that it was time to create "a road map for geography education in the 21st century" and, with the support of the National Science Foundation, launched into an intensive 24-month research and planning project. The resultant

road map, which lays out a path to the effective implementation of the learning objectives detailed in *Geography for Life*, was released this spring in the form of three topically focused reports.

The work of the Road Map Project was conducted by three committees composed of leading geographers, educators, and researchers in the science of learning who were selected by a leadership committee representing the four organizations. The committees were charged with creating recommendations



A road map, which lays out a path to the effective implementation of the learning objectives detailed in *Geography for Life*, was released in the form of three topically focused reports.

for how to improve the effectiveness of geography education in three areas that the geography organizations identified as being important levers for change: instructional materials and professional development for teachers, assessment of student progress, and research on learning and teaching.

The committees conducted a review of current practices and current research in their assigned area and then formulated recommendations for how to improve geography education over the next decade through focused work in their area.

The Instructional Materials and Professional Development Committee considered the current state of the instructional materials for teaching geography and the preservice and in-service education that teachers who are responsible for geography education receive. Based on this analysis and a review of the literature, the committee formulated recommendations and guidelines for both instructional materials and professional development that will lead to improvements in instruction and in learning outcomes.

The Assessment Committee studied the current state of assessment in geography and reviewed its history. Based on the analysis of existing practices and a review of the literature on assessment as a support for improving educational outcomes, the committee formulated guidelines for developing assessment instruments and for conducting assessment that will lead to improvements in instruction and outcomes.

The Geography Education Research Committee reviewed the existing education and cognitive science research literature to identify gaps in our ability to answer significant questions about geography education based on research. Drawing on this analysis, the committee formulated recommendations for research questions and approaches that will build a knowledge base to guide improvement efforts for geography education in the future.

The result is a set of specific recommendations to improve geography education over the next decade that is grounded in the most comprehensive study of geography education that has been conducted in the United States. It is, in fact, a road map for achieving the goals laid out in *Geography for Life* that the four members of GENIP are committed to implementing over the course of the coming decade.

Achieving the goals of *Geography for Life* will require a greater public commitment to geography education and the allocation of more funding than we have seen before in the United States. By creating the road map, the geography education community has provided a strong justification for making that commitment and described how those resources can be used most effectively.

The next step in this process is to bring these landmark documents to the attention of policy makers, funders, and educators who are in a position to act on their recommendations. To assist with this effort, contact any of the GENIP organizations.

For more information, *Geography for Life* can be [viewed online](#). The print edition can be purchased from the [National Council for Geographic Education online store](#). The reports of The Road Map for 21st Century Geography Education Project and executive summaries are [available at no charge](#).

(This article originally appeared in the Summer 2013 issue of *ArcNews*.)

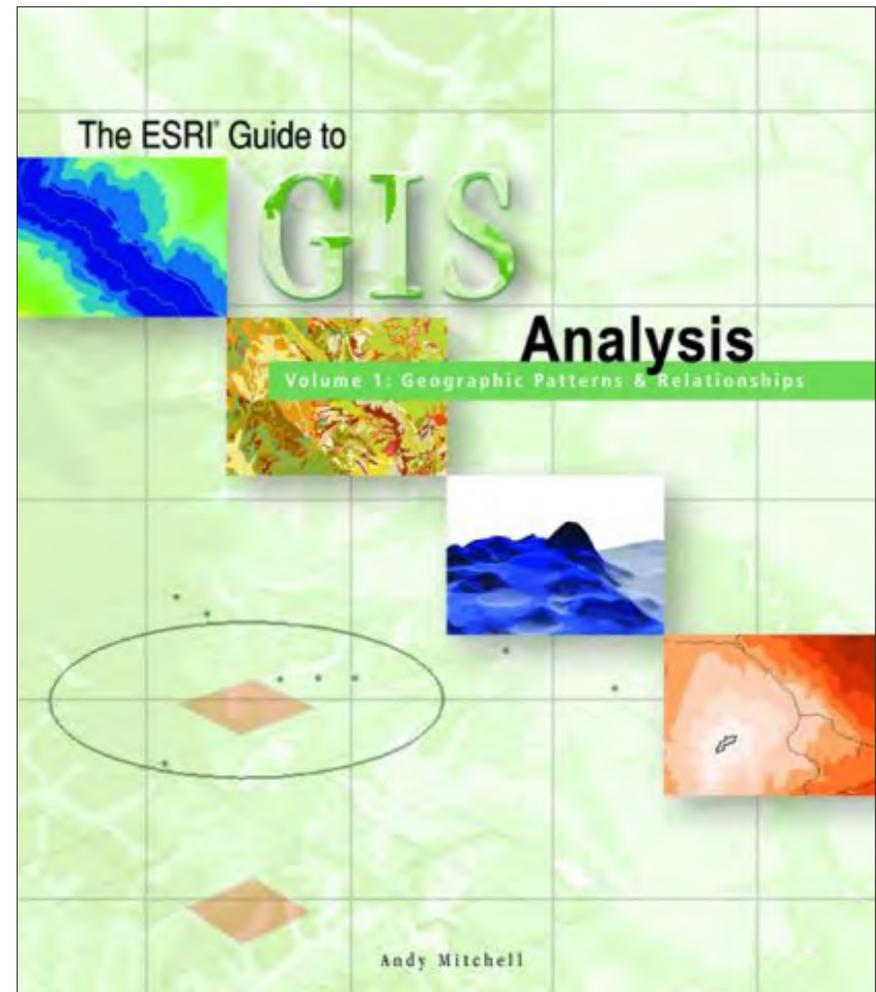
Using GIS to Explain Geographic Reasoning

I began the winding path that has become a career, as a researcher in artificial intelligence. I was drawn to artificial intelligence by one of its central tenets: you can understand how the human mind works by trying to reproduce its behaviors in the form of a computer program.

I was musing about that recently as I found myself using what GIS software does while trying to explain to someone what I mean by "geographic reasoning." As I've written before in this space, one of my biggest challenges as an advocate for improved geography education is explaining what geography is really about.

Since most people tend to associate geography with factual knowledge, I want to be able to broaden their understanding of geography by explaining geographic reasoning to them. However, I've struggled to find descriptions of geographic reasoning that are helpful when talking to people who haven't studied geography.

What I've found are two kinds of descriptions of geographic reasoning. One characterizes geographic reasoning using terms and examples that only other geographers can understand. The other is frustratingly circular: geographic reasoning is what geographers do to understand the world; geographic reasoning



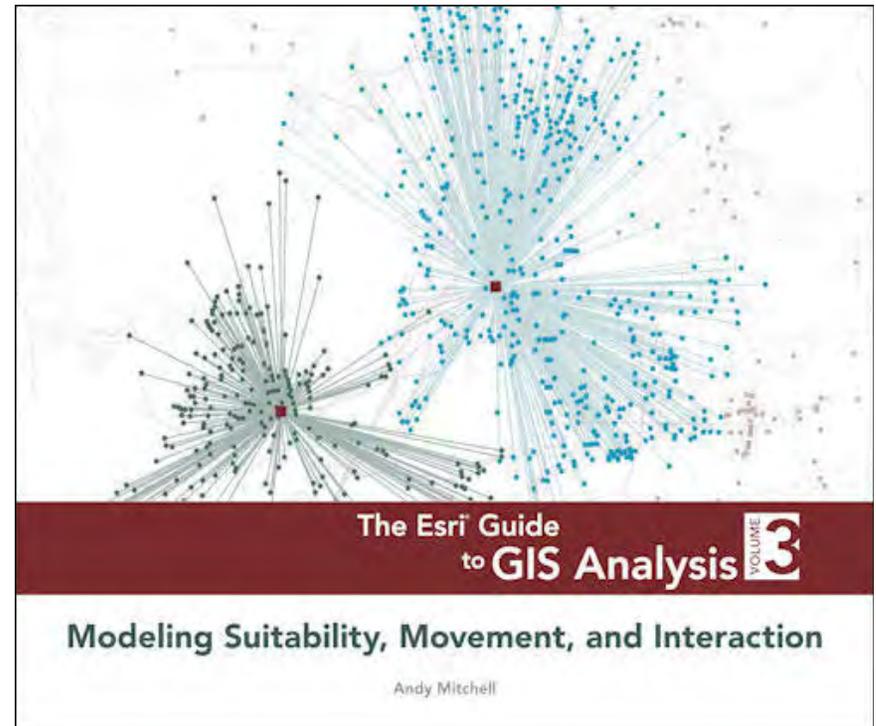
consists of asking geographic questions, gathering and analyzing geographic information, and constructing geographic explanations; geographic reasoning is the process of constructing explanations and predictions about place and location.

There is no shortage of examples of geographic reasoning. John Snow's discovery of the source of the 1854 cholera outbreak in London immediately comes to mind. However, it's hard to see what the underlying reasoning is in individual examples.

However, as I was leafing through Andy Mitchell's [Esri Guide to GIS Analysis](#) at the User Conference this summer, I had a flash of insight. The table of contents of that wonderful three-volume guide to GIS can be read as an overview of geographic reasoning. Consider the following:

- Measuring geographic distributions
- Identifying patterns
- Identifying clusters
- Analyzing geographic relationships

This list happens to be the main chapters in the second volume of Mitchell's series, but to me it reads like a clear list of the core components of geographic reasoning. I assume that Mitchell did not sit down to identify the conceptual categories of geographic reasoning. Presumably, he set out to create a well-organized overview of what you can do with sophisticated GIS software.



However, the outcome here is the same as the one that many researchers in artificial intelligence seek.

Over the course of the last 50 years, GIS software developers set out to create a set of productivity-enhancing tools to support geographic reasoning. Over time, they increasingly externalized geographic reasoning in the software, so that when a modern instructor sets out to teach someone how to use GIS, what they are essentially doing is providing an overview of geographic reasoning.

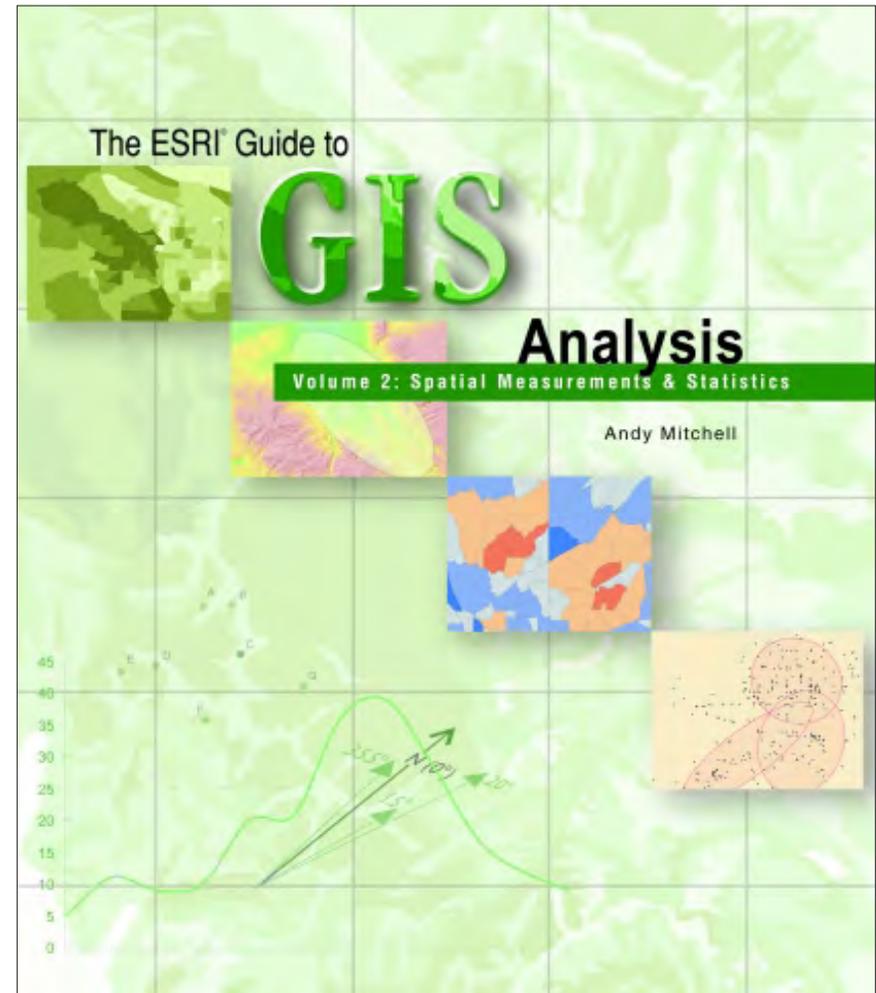
The hidden benefit of GIS, therefore, is that GIS software has come to embody geographic reasoning to the point where the best way to explain to someone what geographic reasoning consists of may be to demonstrate to them what you can do with GIS.

Want to introduce younger children to geographic reasoning? How about using the following as a progression?

1. Mapping where things are
2. Mapping the most and least
3. Mapping density
4. Finding what's inside
5. Finding what's nearby
6. Mapping change

Ready to teach advanced students about sophisticated forms of geographic reasoning? What about these?

7. Finding suitable locations
8. Rating suitable locations
9. Modeling paths
10. Modeling flow
11. Modeling interaction



It will come as no surprise that I lifted the first list from the table of contents of volume 1 and the second from volume 3 of Mitchell's series.

So the next time someone asks me what's valuable about geography education, I won't turn to John Snow and the 19th century. I will tell them about identifying patterns and clusters or modeling paths and flow.

(This article originally appeared in the Spring 2013 issue of *ArcNews*.)

Break-the-Mold Approaches to Geography Learning

Before you read this column, I want you to pause for a moment to consider the following question: How could we make geography learning more enjoyable for young people?

My nonscientific research indicates that about 1 percent of the general public enjoy learning geography so much that they cannot imagine a way to make it more enjoyable (you know who you are). The rest of us tend to generate ideas like making geography learning into a game, making it more relevant, or adding rewards.

I don't think people's answers to the question are nearly as interesting as what flashes into their minds when asked to think about geography learning. My nonscientific research on this reveals that most of us picture very traditional classroom activities: memorizing place-names and locations, learning to interpret maps, reading about foreign cultures, analyzing population pyramids, and tracing migration paths. Two things tend to characterize that image: it doesn't feel relevant or useful to the learner, and it doesn't feel inherently enjoyable. So when we think about improving geography learning, we think about how we can change those experiences.

There are a small number of people out there, however, who summon up very different images when they think about geography learning. Maybe they never experienced traditional geography education, or maybe they experienced it and have completely rejected it as a model for learning. They envision activities that feel both relevant and enjoyable. These are the people we need to find and listen to, because they don't think about improving geography education by incrementally improving traditional approaches. They think about completely new approaches to geography teaching and learning.

One place where you can find people like that is in the Geography Collective, a group of innovative thinkers in the United Kingdom. They describe themselves in the following way: "We are a collective of geography activists, teachers, therapists, academics, artists, and guerrillas. We've come together to encourage [young] people to see our world in new ways."

The members of the Geography Collective characterize themselves as "guerrilla geographers," and their goal is to engage others in guerrilla geography. By their definition, guerrilla geography consists of "operations carried out by small,



The Geography Collective's Mission:Explore website.

independent geographers to cause thought [and] connected thinking, stimulate the public, and to wear down public resistance to geography, usually carried on by a number of small

groups behind public lines or in occupied spaces. . . . Guerrilla geography is irregular [direct action] educating."

Its approach to engaging people in guerrilla geography is through a set of miniadventures that are designed for young people to do by themselves or with adults. These adventures—or "missions," as the Geography Collective calls them—encourage exploration. They challenge participants to explore either new or familiar places with new perspectives.

These missions are always quirky and often have a sense of playful mischief about them. One mission asks explorers to locate places where one neighborhood ends and another begins and then explain how they know. Another asks them to "go outdoors in search of the most beautiful poo you can find [it's a kid thing]. When you discover it, take a picture of it." A third asks them to explore the world from a bug's-eye view by taking macrophotographs. And a fourth, called Avoid Seeing Red, instructs explorers, "If you see red, shield your eyes, look irritated, and walk in another direction."

The Geography Collective shares its missions with children, parents, and educators through a series of books and a website, Mission:Explore. The website offers points for completing missions and allows explorers to collect points toward "badges" as rewards.

Behind the playfulness and quirkiness of the Geography Collective's missions are carefully considered philosophical and educational stances. One is that young people should be

encouraged to explore their surroundings and express their own opinions about the positive and negative aspects of different spaces. Another is that they should recognize their own role in shaping the world. Underlying all of what the Geography Collective does is the goal of teaching geography as a method for observing the world and deciding how to act in it.

The Geography Collective does not position its approach to geography learning in opposition to traditional geography or even as an alternative. It presents its approach as providing an additional set of experiences that are disappearing from the modern world, where children are taught that all the interesting things in the world have already been discovered and adults believe it's more important to protect young people from the hazards of the world around them than to give them the chance to explore it.

The Geography Collective is one of the most creative groups in geography education today, and every time I learn more about its work, I get more excited about it. However, I do find myself wishing that creative approaches to geography teaching and learning were not so unusual. This is just one transformative approach to geography learning, and it is not going to resonate with everyone. Where the Geography Collective's approach is quirky and playful, others might be practical and serious—but equally effective and motivating to learners.

I can't help feeling that truly creative approaches to geography learning are discouragingly few and far between right now. Too few people are even thinking about geography education, and those who are still focus too much on incremental improvements rather than entirely new approaches. We should take the Geography Collective members and others like them as inspiration. We must challenge ourselves to think more creatively and seek out and promote the creative ideas of others.

(This article originally appeared in the Fall 2012 issue of *ArcNews*.)

Geo-Education: Preparation for 21st-Century Decisions

Geo-education is about preparing people to make the important decisions we will all face in the 21st century. At National Geographic, we call people who are prepared to make these decisions geo-literate.

Geo-literacy requires three kinds of understanding:

Interactions—A geo-literate individual understands that the world is composed of interacting systems that move and transform resources. These may be social systems, like political, economic, and cultural systems. They may be technological systems, like transportation, energy transmission, and communications systems. Or they may be environmental systems, like hydrological, atmospheric, and ecological systems.

Interconnections—A geo-literate individual understands that these systems connect people and places to each other. This means that events that happen in one location affect other people and places. It also means that our actions affect other people and places.

Implications—A geo-literate individual is able to use his or her understanding of interactions and interconnections to make well-reasoned decisions. This means being able to anticipate

the cascading consequences of actions that result from systems interactions and interconnections among people and places. It also means being able to weigh costs and benefits for oneself, for one's community, and for other people and places when making decisions.

More important than what it requires is what geo-literacy enables you to do. Here are six categories of critical decisions that geo-literacy prepares people to make:

Community life—A geo-literate individual understands the factors that improve or degrade the quality of life in a community. These factors include everything from walkability to cultural resources to housing stock. A geo-literate individual is able to use that understanding to (1) make good personal choices about where to live and spend time, and (2) make good civic choices about how to improve the quality of life in his or her community.

Location and transportation—A geo-literate individual is able to reason through problems involving site selection and transportation planning. These problems come up in personal, professional, and civic life, but they are particularly important in professional life in the modern world. Individuals with geospatial reasoning skills are in high demand in fields as diverse as military

logistics, intelligence, natural resources management, and supply-chain management.

Interactions across cultures—Our local communities are increasingly diverse, and our daily lives increasingly involve interactions with people in faraway places. Both of these trends make it important that members of our society be culturally literate, meaning able to communicate and collaborate effectively with individuals from different cultures.

Environmental and social impacts—Both the connections that knit together our world ever more tightly and the growth in our global population mean that the impacts of our actions on the environment and on other people are amplified. This makes it all the more important that we all be able to anticipate the potential environmental and social impacts of our actions and make decisions accordingly.

Global affairs—While most individuals' direct influence on global affairs is limited, people throughout the world have growing opportunities to shape global affairs through participation in political processes and public opinion. So geo-literacy is important to be able to participate in the public debate about trade, diplomacy, military action, and foreign aid.

Acts of caring—By "acts of caring," I mean actions to improve the lives of other people or care for the world that we share. This includes efforts to alleviate poverty, reduce hunger, or improve health care and education. It also includes wildlife conservation

and environmental restoration. Whether one is taking action oneself or providing financial support, it is important to be able to make informed decisions about what actions are most likely to have a meaningful and lasting impact. This requires geo-literacy.

The challenge of geo-education is weaving the knowledge and reasoning skills required to make these six categories of critical decisions into the written curriculum of schools and the unwritten curriculum of home and community life. This is a challenge that we have not yet taken on explicitly in our modern society, but we must all take it on if we are to prepare today's youth for the world they will inherit.

(This article originally appeared in the Summer 2012 issue of *ArcNews*.)

Unlocking the Educational Potential of Citizen Science

I have been a fan of citizen science for many years, but I do not think the citizen science movement has had the educational impact that it could. *Citizen science* is the name for scientific research projects that engage members of the public in some aspect of their research. There have been some high-profile citizen science projects recently in which members of the public have conducted image analysis and solved protein-folding problems, but the overwhelming majority of citizen science projects involve crowdsourced data collection.

For example, some of the largest and longest-running citizen science projects are in ornithology. In projects like the National Audubon Society's Christmas Bird Count and the British Trust for Ornithology's Garden Birdwatch, birders contribute their observations to databases that scientists use to track trends in bird populations and species distributions.

These two projects, like many others, fall into a category of citizen science project that I call *community geography*. In community geography projects, the data is georeferenced and used for spatial analysis.

Community geography projects can be a boon for researchers. Volunteer data collectors provide investigators with the

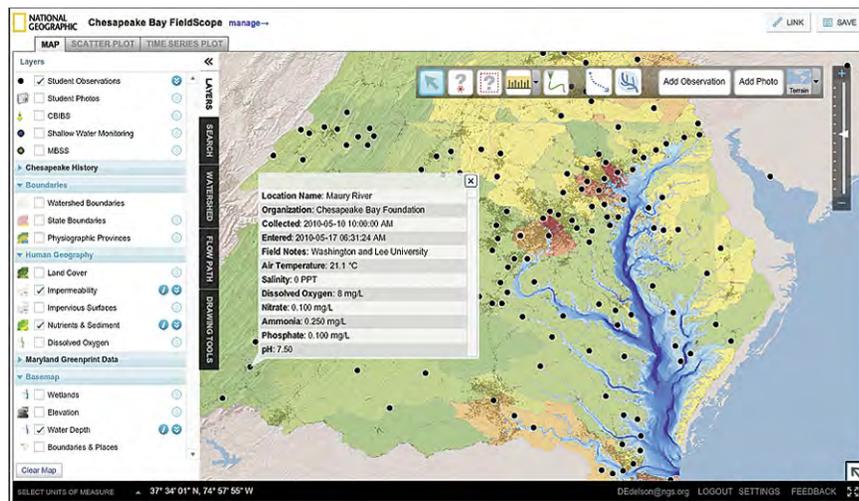
opportunity to obtain a quantity and geographic range of data that would not be practical through any other mechanism. They are also a boon to participants, who get to join a community; participate in something meaningful; and, in many cases, learn some new science.

For as long as I've known about them, I've been fascinated by the educational possibilities of community geography projects. I'm a big believer in both inquiry-based learning and breaking down the boundaries between school and the real world. Community geography does both—except for one thing. Collecting data is only one part of the scientific process, and most community geography projects only engage participants in data collection.

In the stereotypical community geography project, participants take measurements or record observations and submit them to a central database for scientists to analyze. In some cases, participants are able to see a map of the data that has been submitted or see results of previous analyses that have been conducted by scientists. However, it is very rare that participants have a chance to create and interpret visualizations or analyze data themselves.

After talking to organizers of community geography projects, I've learned that most of them would prefer to provide their participants with opportunities to work with the data, but they lack the resources or expertise to create tools that would enable their participants to do their own visualization or analysis.

So, a few years ago, National Geographic—with support from Esri and others—set out to create a web-based platform for community geography that would provide participants with the ability to visualize and analyze their own data using GIS. We call this platform [FieldScope](#). The idea behind FieldScope is that it is designed specifically to support citizen scientists—individuals who are interested and invested in researching a specific scientific question but who lack the training or technical skills of a scientist.



A FieldScope map from the Chesapeake Water Quality Project showing a student's water quality measurement.

This has required that we create easy-to-use interfaces and offer users a set of analytic tools that are either familiar or easy for a novice to grasp.

One of the first FieldScope projects that we deployed is dedicated to studying water quality in the tributaries to the Chesapeake Bay. Working together with environmental educators throughout the Chesapeake Bay watershed, we identified a set of water quality measurements that could be done by students and teachers across a wide range of grades, and we created a FieldScope application that displays not just student-collected water quality data but also a wide variety of data layers describing the land in the watershed, including land use, impermeability, and nitrogen yield.

We also provided users with analysis tools that enable them to create time plots and scatterplots for the data that they have collected, and we implemented a set of hydrologic analysis tools that will help them understand the underlying dynamics of the watershed. For example, we have provided users with a flow path tool that allows them to click anywhere in the watershed and see the path that water will flow from that point to the bay. Users might employ this tool to see the portion of the river system that would be affected by a point source of pollution.

This Chesapeake water quality project has proved very popular in public schools; in the two years that it has been active, more than 600 teachers have received training on the software, and we have

recorded more than 40,000 visits to the site. It is also succeeding in engaging users in analysis. In the first three quarters of 2011, we recorded more than 75,000 geoprocessing events and more than 45,000 uses of the query tools.

In the 2011–12 school year, both Fairfax County, Virginia, and Anne Arundel County, Maryland, have incorporated the project into their science curricula for all middle school students.

With support from the National Science Foundation, we are currently in the process of expanding FieldScope's functionality and creating authoring tools that will enable the broadest possible community of citizen science projects to build FieldScope applications for their own users. This spring, we will be launching FieldScope applications for two national community geography projects: Project BudBurst, which is studying plant phenology, and Frogwatch, USA, which is studying the distribution of amphibian species.

FieldScope, with its carefully designed user interface and specially selected GIS tools, is beginning to unlock the potential of citizen science as a learning experience. Teachers and students have responded enthusiastically to the opportunity to participate in geospatial analysis of data. In part, their enthusiasm stems from the fact that it's data about their own community that they helped collect. Administrators, in turn, are seeing that the entire experience of community geography is enabling them to achieve

important learning outcomes for both science understanding and science skills.

Our goal over the next few years is to bring this powerful educational experience to as broad an audience as possible, young and old, in school and out.

For more information about National Geographic FieldScope and the Community Geography Initiative, visit natgeoed.org/fieldscope.

Read other articles in the [GeoLearning series](#).

(This article originally appeared in the Spring 2012 issue of *ArcNews*.)

A Role for Old-Fashioned Geographia in Education

The word *geography* comes from the Greek *geographia*, which means "writing or describing the world." I frequently hear people say that the word *geography* is outdated because modern geography is about much more than just describing the world.

I tend to be sympathetic to that view because I believe that the power of modern geography is in its approaches to solving problems and answering questions. However, I think that describing the world is an essential component of geography, and it should have a central part in geography education.

I have been thinking about this a lot lately because I have been thinking about the challenges of teaching young people about human impacts on the environment. I have become convinced that the biggest challenge in teaching about the environment is students' lack of familiarity with their environment. How do you teach children about changes to the environment if they do not know what the environment is currently like?

But how, you might ask, is it possible to not be familiar with one's environment? In the modern world, there are two ways in which children are unfamiliar with their environment.

First, the environment they live in is increasingly circumscribed. Middle-class youth in our society live largely in enclosed, interior spaces. When they need to travel through external spaces, they tend to do so in enclosed vehicles that are piloted by an adult. Today's typical K–12 students go to school in a car or bus that picks them up very close to their homes and delivers them to the front door of their schools. They typically spend their afternoons in their school or another building, which they are transported to, again, in a bus or a car, until they return home by the same modes of transportation.

Second, they have little opportunity or motivation to notice their environments. They are isolated from the external environment by various forms of cocoon, and they are not responsible for navigating by themselves, protecting themselves, or caring for any aspect of the environment.

I do not want to romanticize the past, but I do want to point out that only two generations ago, most Americans still depended directly on their environment for their livelihood and were not isolated from the external world by fully climate-controlled, protective buildings and vehicles. I also cannot ignore the fact that most people on earth still live that way.



Young people learning to notice patterns in nature.

Middle-class American children no longer have much need to be aware of their environment. They are isolated and protected from it, particularly during the part of the day set aside for education.

The result is that we have created an excellent environment for young people to learn math, language arts, and abstract science and social studies, but we have created a terrible environment for young people to learn about their world. I worry about my own middle school daughter, who is studying earth science right now

in a classroom that seals her off from any direct interaction with the natural processes that she is studying.

Worrying about how to teach children about a world from which they are so isolated eventually led me back to the original concept of *geographia*. Before students can understand the world, they need to observe it. To observe it, they need to experience it, of course, but they also need to notice it. It's not just about looking; it's about seeing. And teachers have known forever that the best way to get students to be good observers is to engage them in documentation and description.

At National Geographic, we have begun exploring ways to turn students into old-fashioned geographers—in other words, describers of their world. One of the strategies we have been using is engaging students in what different people call *citizen science*, *public participation in research*, and *volunteered geographic information* initiatives. In these projects, participants collect and share geographic information with each other and, in some cases, conduct investigations or solve problems with the information. At National Geographic, we've adopted our own term for these projects. We call them *community geography* projects, and with support from the National Science Foundation and Esri, we're developing a web-based GIS and social networking platform to support community geography initiatives.

I like to use Project BudBurst as an example of how these projects foster noticing. Project BudBurst is an educational

outreach initiative of the National Ecological Observatory Network that focuses on phenology (seasonal changes) in plants. The concept behind BudBurst is very simple. You pick a specific tree or shrub and monitor it throughout the year, recording your observations in a database that is shared among thousands of people monitoring other trees and shrubs throughout the United States. You note when flower and leaf buds appear and open. You also note when they fade, turn color, and fall off.

It's safe to say that virtually every student in every classroom in America knows that plants have seasonal cycles. But how many of them know the specific cycle of any specific types of plants? And how many know how these cycles change from place to place and year to year? And how many know what the natural variability of those cycles is in a specific location or a specific year?

It is only when people are familiar with these kinds of patterns and cycles that they can begin to understand what it might mean for human activities to change the environment.

So, ironically, the key to achieving the understanding and problem solving that we associate with modern geography is to start with the observation, documentation, and description that are characteristics of traditional geography.

Information about National Geographic Education's Community Geography initiative is available at natgeoed.org/community-geography.

(This article originally appeared in the Winter 2011/2012 issue of *ArcNews*.)

The Challenge of Defining Geo-Literacy

For quite some time, I've been struggling with the challenge of how to explain to the general public what geo-literacy is and why it is important. Over more than a year, with a lot of help from others, I've developed a definition that captures the essence of geo-literacy and resonates with both academic and applied geographers.

As I've written in this space before, geo-literacy is preparation for making geographic and far-reaching decisions. Geographic decisions are decisions about location or transportation; far-reaching decisions are decisions that have remote consequences. Geo-literacy requires three abilities:

- The ability to reason about human systems, environmental systems, and human-environment interactions
- The ability to reason about geography
- The ability to reason through decisions systematically

If you are an *ArcNews* reader, then the odds are good that these three bullets mean something pretty specific to you and that your interpretation of these bullets is pretty close to mine.

My challenge is that these bullets do not mean much to most Americans. Not only do most Americans lack these abilities, I believe that most of them have never even heard anyone talk about them. Phrases like reasoning about systems, geographic reasoning, and systematic decision making do not convey much meaning to people who have never been taught those skills. Worse, they do not have the power of name recognition the way algebra and calculus do.

The challenge here is how to convey a message about the importance of knowing something to people who don't know it themselves and to do it without (a) making them feel bad for something that is not their fault or (b) putting them off with a tone of superiority.

I am writing this column because I don't know how to solve this challenge, and I am looking for help. I am pretty sure, however, that the path to the solution lies through compelling examples. I argue that the reason modern societies need to provide their citizens with geo-education is the big cost that people pay individually and collectively for geo-illiteracy. My hunch is that the right examples of these costs will convince people.

Here are a few examples drawn from modern American life, some of them from my own experiences:

A geo-literate individual should be able to take constraints and considerations into account to optimize choices about locations. This is a case of geographic reasoning. For example, when people are not able to identify and weigh their commuting options successfully, they pay costs in the forms of wasted money, lost time, and frustration that only grow over time. When owners of small retail businesses or decision makers in large retail businesses make poor decisions about location, they pay for their failures in geographic reasoning in lost business, which translates directly into lower revenues for the company and reduced economic opportunity for the workforce.

The cost of a store or restaurant closing because of a poorly chosen location goes far beyond the business owner. It is an economic loss for the community. We currently consider the frequent failure of retail establishments to just be a part of life. However, a substantial percentage of these failures is a direct result of poor geographic reasoning that could be prevented, leading to substantial economic benefits.

Another important kind of geographic reasoning is not about where to do something but about whether to do something in a particular location. For example, in the last decade, citizens of America and many other nations have faced decisions about whether they should send troops to fight wars in foreign lands,

such as Iraq and Afghanistan. A geo-literate individual should be able to analyze information about locations to form an independent assessment of the appropriateness of a proposed action in those locations.

I would have more confidence in the democratic decision-making process about military deployments in America if more Americans were able to interpret thematic maps showing topography, ethnic and religious populations, and distribution of natural resources. I believe there are many valid arguments on both sides for whether the United States should have gone to war in Iraq and Afghanistan, some of which may outweigh geographic considerations. However, I worry about the role of the public in making decisions like these in a society where many are not able to reason systematically about geographic factors.

Even though there is no way to determine, even in retrospect, whether we have made the right decision about military deployments, we can still assess the costs associated with those decisions. In the case of these large-scale military deployments, the costs are measured in billions of dollars, thousands of lost lives, and hundreds of thousands of lives permanently changed.

A geo-literate individual should be able to anticipate remote impacts of local decisions. This is a case of reasoning about systems. For example, in the Chesapeake Bay watershed where I live, state governments advise residents to only wash their cars at car washes because the runoff affects water quality in the

bay. If most people who receive this advice do not understand the impact of detergent and other runoff from roads on aquatic ecosystems—which most don't—and do not understand where the water that leaves the bottom of their driveway goes—which most also don't—then the odds that they will follow that advice are very low.

The same goes for farmers and fertilizer, though farmers in the Chesapeake watershed are subject to laws restricting runoff, not just advisories. If farmers do not understand the effects of fertilizer runoff and they know that their state government cannot afford to enforce runoff laws, they are unlikely to expend much effort to obey them.

The result of uninformed decision making about runoff is an enormous environmental and financial cost resulting from millions of individual decisions with far-reaching consequences. The fisheries in the Chesapeake Bay, the Gulf of Mexico, the San Francisco Bay, Puget Sound, and many others, are all threatened by runoff. The livelihoods of hundreds of thousands of individuals who depend directly or indirectly on fishing in those locations are threatened.

Those are three examples of how the widespread lack of geo-literacy can add up to huge societal costs. What do you think? Are these compelling?

(This article originally appeared in the Summer 2011 issue of *ArcNews*.)

Scaling Up Classroom Maps

Usually, when you talk about the scale of a map, you're talking about the ratio of distances on the map to distances in the real world. These days, however, when educators working with National Geographic maps talk about scale, they may be talking about how big the map is. For example, a teacher may have her students working on a map at the "scale" of a tabletop, a large wall, or even a basketball court.

So what's going on with all these big maps? Well, we've learned that kids find large maps to be magnetic. And not just young kids. Teens and adults find large maps irresistible as well.

Imagine walking into your school gym and finding half of the floor covered in a glorious, full-color, National Geographic map of Asia. If your school is one of those that has signed up for a visit from one of National Geographic's Giant Traveling Maps, you could.

Most people find they can't just look at these maps. They *must* walk on them. They count how many steps it takes to get from Beijing to Moscow. They lie down to see if they can reach from the southern tip of India to the northern tip. They find the maps amusing, just like the oversized cereal boxes at Costco.



Two Middlebury, Vermont, third graders explore the Atlantic coast of South America (photo: Dan Beaupre).

Frankly, people find the scale of these maps fascinating. And educational. Unlike regular-sized maps, you can see lots of detail and a large portion of the earth's surface at the same time. Similarly, you don't shift your eyes or turn the page if you want to look at a different location. You move your whole body, like you



Students at Alta Vista Elementary School in Los Altos, California, take a well-earned break after traveling from Florida to Alaska on the Giant Traveling Map of North America (photo: Scott Schilling).

do in the real world. These maps allow people to interact with a map kinesthetically, experiencing scale and direction as physical sensation.

Now imagine taking 136 sheets of 8.5" x 11" paper and putting them together to form a mosaic map of the world that is 17 sheets wide and 8 sheets tall. If you download one of the free NatGeo MapMaker Kits, you could. These "megamaps" are only 10 feet wide and 7 feet tall, but they still take several strides to walk across. And, since they are made of regular printer paper, you can draw or paste things on them. You can even cut them up.



Students use markers to illustrate data on National Geographic Education's NatGeo MapMaker Kits (photo: Mark Thiessen, NGS).



Students record data about tourist impact on different countries in Europe using National Geographic Education's NatGeo MapMaker Kits (photo: Mark Thiessen, NGS).

These "scaled-up" maps have great educational potential. They break down the usual barriers between people and maps. They draw people in, and they encourage them to interact.

Both the Giant Traveling Maps and the MapMaker Kits are packaged with a variety of hands-on (literally) activities. When a Giant Traveling Map arrives at your school, it comes with a trunk full of materials that transform it into a giant game board, including giant dice, traffic cones, plastic building blocks, and

beanbags. The MapMaker Kits are designed as basemaps for students to draw, glue, or overlay information on.

In fact, some of the most engaging activities for these oversized maps are essentially low-tech versions of geospatial analyses. Have you ever represented a buffer with a hula hoop? Measured a linear distance in units of arm spans? In a classroom down the street, students may be symbolizing data by pasting construction paper circles of differing sizes and colors on a map. Or they may be creating contour maps with yarn and delineating watershed boundaries with a crayon.

Some of the best educational ideas are just slight twists on conventional practice. What we've discovered is that blowing up maps to unusual sizes is one of those ideas.

For more information about the Giant Traveling Maps, visit www.nationalgeographic.com/giantmaps. For more information on the NatGeo MapMaker Kits, visit www.natgeoed.org/mapping.

(This article originally appeared in the Spring 2011 issue of *ArcNews*.)

Tricorders—The Next Tool for Geographic Learning?

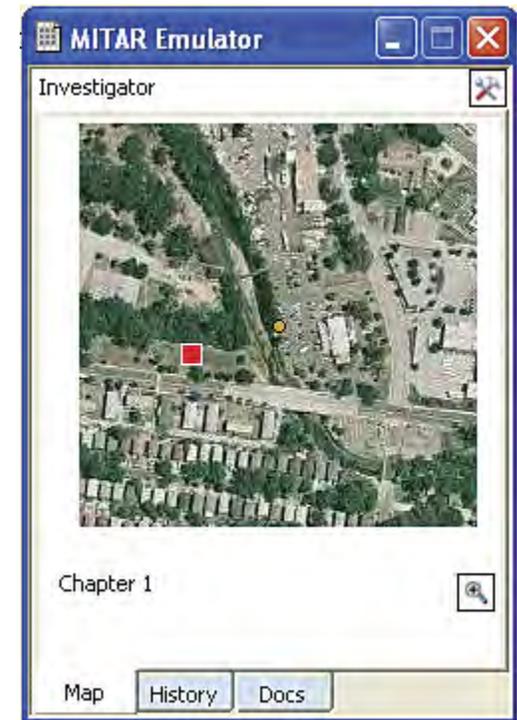
If you're of a certain age, you probably find yourself looking around and remarking on how much today's world looks like the world that Gene Roddenberry imagined in the original *Star Trek* series. OK, we don't have transporters or warp drives. But we do have computers you can talk to, two-way video communications, and devices that work like communicators and tricorders.

There is a lot of discussion these days about what impact these *Star Trek* technologies might have on education. In just the last two weeks, I attended a one-day summit on the promise of wireless technologies for education and a two-day workshop on the use of mobile devices for citizen science.

For geoliteracy, I think these devices offer amazing opportunities to move learning outside the school building, and we've been designing software at National Geographic that students will be able to take into the world on handhelds that will enable them to record observations, combine them with observations of others, and analyze them for geospatial patterns. However, an inescapable challenge of learning in the real world is that the real world is complex and unpredictable. Sometimes it is too complex and unpredictable to enable you to be sure that you can teach specific relationships or skills through real-world experiences.

One solution to this problem is to create virtual worlds that eliminate the messiness of the real world. For example, you can create a simulated world that students interact with on a computer screen where all the water quality probes are properly calibrated and the relationship between water quality and ecosystem health follows predictable patterns. Unfortunately, these simulations sacrifice the experience of moving around and using actual devices for the benefits of predictability.

However, in recent years, I've been hearing about some very clever people who have been designing what they call



Tricorder or augmented reality?

"augmented reality" environments to get the best of both worlds. Here's an example:

Researchers from the Missouri Botanical Garden and Massachusetts Institute of Technology (MIT) are working with upper elementary and middle school teachers to design games in which students move around in the real world but interact with simulated characters on the screen of a handheld and use the handheld to make observations and measurements that are generated by a simulation. Some of the scenarios that they have explored in their games include watershed studies, food web investigations, and a cemetery-based scavenger hunt where students "meet" people who had lived in their community through minibiographies crafted from historic census records.

I asked Bob Coulter, the director of the project at the Missouri Botanical Garden, what playing one of these games feels like, and he described it like this:

Imagine you have already learned a bit about watersheds, point and non-point source pollution, and some basic measures of water quality. As part of your study, you now have the opportunity to investigate a water pollution problem in the park down the street. To start, you watch a short video of a local water quality expert on your GPS-enabled handheld. After the expert introduces your challenge, the handheld guides you to relevant sites

where you can "sample" the water and make other observations.

The handheld screen displays your position on an aerial photograph as you move toward your next stop, indicated by an icon on the screen. At each location, a simulated expert poses provocative questions and encourages student investigators to observe salient features. With limited time to complete your investigation, you have to draw on what you already know and what you learn from the simulation to make wise choices.

The advantage of this kind of augmented reality experience over "ordinary" reality is that students' experiences can be designed to provide the optimum amount of complexity and challenge for their stage in the learning process. Middle school students can operate in a world where everything follows predictable patterns. College students can operate in a world with sensor error and statistical anomalies. They can also carry learning resources, like field guides, with them in the field, and they can communicate with each other in real time.

The advantage over virtual reality is that students are able to move around on real terrain and develop real-world skills, like coordinating between an overhead map and their on-the-ground view. For designers, augmented reality enables them to take advantage of all the attributes of the local setting

without being limited by them at all. The project at the Missouri Botanical Gardens is taking advantage of the MIT Augmented Reality (MITAR) authoring tools, created by Eric Klopfer and his colleagues, which allow teachers to create their own learning games for their own students and their own locale.

Right now, this is all still in the experimental stage. The researchers are working out how to blend real and simulated worlds and help teachers design effective learning activities. Once they have figured all these things out, though, these *Star Trek* technologies are going to take real-world geographic learning to a whole new level.

(This article originally appeared in the Winter 2010/2011 issue of *ArcNews*.)

Back to School with Geo-Literacy

It is back-to-school season as I write this, and I'm thinking about goals for the next year. In education, as in many other domains, goals are everything. If you don't have clear goals that you can communicate effectively, then you're never going to make any progress.

When I started working at the National Geographic Society, I was immediately confronted with the challenge of clarifying and articulating the goals of our K-12 educational efforts. This process has taken some time. I've been here more than two years, and we're still working on it, but it's probably the most important work we'll do.

National Geographic has been committed to improving K–12 geography education in the United States and Canada for decades. However, *improving geography education* is, at the same time, too broad and too narrow. Geography is boundless, so our first goal-setting challenge was to find a focus that is narrower than geography as a whole.

Using the broader National Geographic mission to inspire people to care about the planet as a guide, we are focusing our efforts on those aspects of geography that will prepare students to *care for the planet*. Specifically, we have chosen to focus on the

geographic knowledge and skills that young people will need to make the decisions they will face throughout their lives that have consequences for the well-being of the planet and its inhabitants. We call these *far-reaching* decisions because—even though the decision makers may not realize it—the consequences of the decisions extend far beyond the individual and his or her location. Far-reaching decisions may be personal, professional, or civic. They may be routine or come once in a lifetime. They range from decisions about how to commute to work to whether to outsource your company's manufacturing overseas to how to vote on a public referendum on immigration.

As we have investigated what people need to know to make far-reaching decisions, we have found that the knowledge and skills that they need go beyond geography. So we've found ourselves adjusting our scope to be more focused within geography and to extend beyond geography. In our current conception, our goals include three primary components: systems thinking, geographic reasoning, and evidence-based decision making.

- **Systems thinking:** Scientists today view the world as a set of interconnected natural and human systems. These systems create, transform, and move resources. Natural systems

include atmospheric, hydrologic, and ecological systems. Human systems include economic, political, and cultural systems. To be geo-literate, a person must be able to reason about how he or she depends on these different systems and how his or her actions can affect them.

- **Geographic reasoning:** Most of geography is based on two key principles: (1) the characteristics of a particular location influence what can and does happen in that location and (2) every place on earth is connected to every other. To be geo-literate, a person must be able to reason about the characteristics of and about the connections between places to understand the implications of decisions.
- **Evidence-based decision making:** Well-reasoned decisions involve a multistep reasoning process that includes both objective analysis of consequences and subjective weighing of trade-offs based on values. A person must be able to systematically analyze consequences of decisions and evaluate their pros and cons based on his or her values.

When combined, these three components provide an individual with the knowledge and skills to recognize decisions as being far reaching and make them systematically. Of course, this does not mean that everyone will make the same decisions. There will always be differences of opinion about the likelihood of various consequences and how to value different outcomes.

Because these goals no longer fit neatly within the traditional conception of geography, we have coined a new term for them, which I've used in this column before. We call this combination of systems thinking, geographic reasoning, and evidence-based decision making geo-literacy.

Clearly, having a geo-literate populace is valuable for more than just caring for the planet. It is valuable for economic competitiveness, national security, and personal well-being, to name a few, and we have allies in our educational reform initiatives who are motivated by these concerns more than concern for the well-being of the planet. However, geo-literacy is a priority for National Geographic's education programs because of our particular concern for environmental and cultural conservation.

So as I enter this back-to-school season, I am pleased to have a set of clear, coherent, and focused goals to guide our efforts. On the other hand, I am acutely aware that the components of geo-literacy cross traditional curricular boundaries and call for knowledge and skills that have not been part of any curriculum before. That gives the idea of *back-to-school* a new meaning. As I enter the school year with more clearly defined and articulated goals, I am also aware that over the next few years, we will have to go back to school in the design of the K–12 curriculum.

More Information

To find out how you can support National Geographic's geoliteracy initiatives, visit www.nationalgeographic.com/foundation/geographic_literacy.html.

(This article originally appeared in the Fall 2010 issue of *ArcNews*.)

GeoMentors Make a Difference

At the 2009 Esri International User Conference, Jack Dangermond, president of Esri, announced the GeoMentor Program during the plenary. This exciting collaboration between Esri and the National Geographic Society is designed to get more GIS professionals involved in education. The program helps GIS professionals find schools and other settings where they can serve as GeoMentors to the students.

There are lots of ways that GeoMentors can help educators, and the GeoMentor Web site provides a matchmaking service to help educators find GeoMentors that are well-suited to their needs and setting. The Web site allows GeoMentors and educators to seek out an appropriate partner and provides a safe channel through which to initiate contact. The site offers many ideas for projects that teachers and GeoMentors can work on together and tips for how to collaborate successfully.

In the past year, many lives have been changed by GeoMentors, so I asked Charlie Fitzpatrick, Esri K-12 education manager and leader of the GeoMentor initiative for Esri, to share some stories from these volunteers and the educators they've worked with. At a time when so much of the media coverage about education



focuses on the challenges and failures, these stories show us what is possible and offer us hope.

Charlie reports that some educators have needed on-site assistance with getting software installed, convincing the guardians of computer labs that GIS activities are a legitimate

use of computers, or simply showing how to work through basic activities.

One elementary school teacher told Charlie, "It's just priceless having [the mentor] here. She was really persistent in helping us overcome the technical hurdles from our system, just installing through the permissions we have. Then, once it was installed, the kids are so fast with computers, they go beyond me quickly and I can't always help them. She came in and wrote down some procedures to help us do our work. The kids know how to do things, but when they get stuck, they go back to the sheets and figure out how to move forward. I couldn't have done this project without her."

While some educators keep a mentor all to themselves, others encourage them to work directly with students. One longtime mentor who worked with an individual student wrote, "I don't do stuff like that for the publicity but for the individuals involved. I'm happy to report that the student I e-mentored made it to college, where he's pursuing his dream of becoming an architect! That's satisfaction enough for me."

The most surprising thing Charlie told me is how much impact a mentor can have with a relatively small commitment of time. One mentor told Charlie, "I go visit the school once a month, and now when I arrive, the teacher has a couple questions and the kids have some specific questions—they write these down on a page ahead of time—and we spend the whole time just running

through their questions. Sometimes it's 'Where do I find data about my subject?' Other times, they ask something where all I say is, 'Look in the help file about the word X,' and they're off and running, just because they couldn't figure out the specific word to search under, like 'mosaic.' Sometimes, they can't wait and will ask me that by e-mail, and I just need to send back a single sentence to get them on track."

These stories have us convinced that we're on the right track with the GeoMentor Program. We were delighted with the outpouring of interest we received at last year's Esri User Conference, and we've continued to build up the numbers of registered mentors and educators throughout the year. We are still learning lessons about how to help educators and mentors find the right match and what resources we can offer to help them get their collaborations under way. We expect to continue to expand and improve the GeoMentor Web site for some time to come.

In the face of all the challenges of creating a new program, though, we continue to be driven by the clear need for programs like this one. As one club leader recently told Charlie, "Yes, there are lots of clubs, and they are doing some cool things, but if we had more adult volunteers, we could easily engage three times as many kids. That's the same everywhere. What we need most is helpers."

The goal of the GeoMentor Program is to recruit more of these helpers and connect them to educators who can use their help. If

this appeals to you, then please visit the GeoMentor Web site for ideas and inspiration and to seek out an educator who would like your assistance. It's easy to make a difference, and the rewards are unparalleled.

More Information

The GeoMentor Program is a joint initiative of Esri and the National Geographic Society, being implemented under the direction of Charlie Fitzpatrick from Esri and Anne Haywood from National Geographic. For more information or to sign up, visit www.geomentor.org.

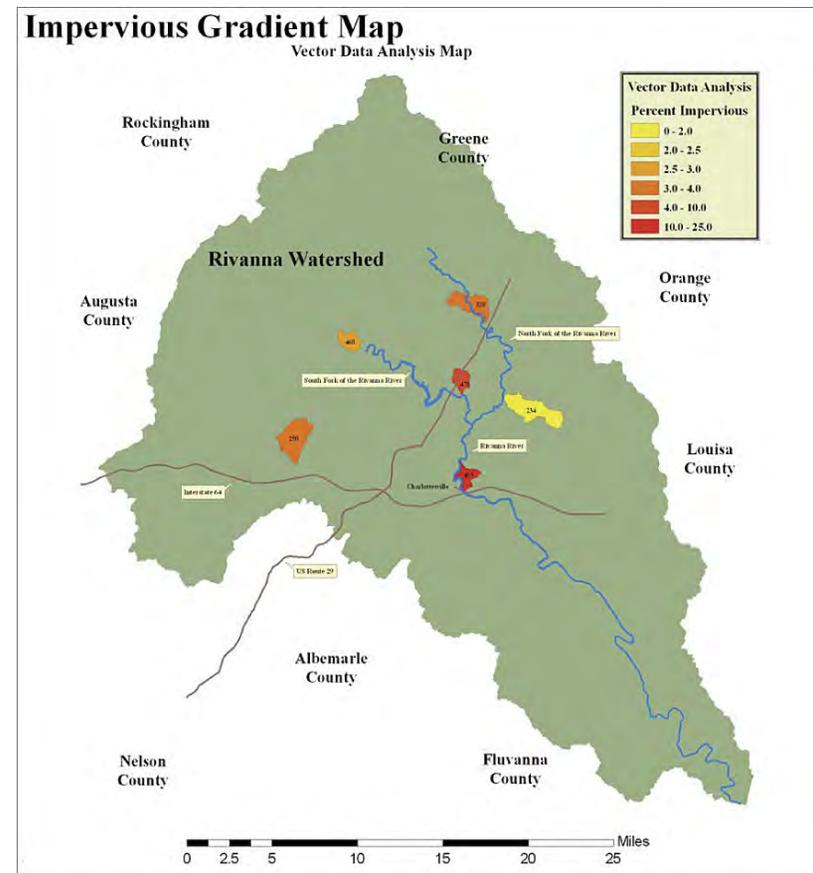
(This article originally appeared in the Summer 2010 issue of *ArcNews*.)

A Revolution in Geographic Education: Virginia's Geospatial Semester

A high school class in which students learn to use ArcGIS Desktop tools, work on real projects in their community, and get college credits . . . sound too good to be true? Well, it's not.

Professor Bob Kolvoord of James Madison University in Harrisonburg, Virginia, has created the Geospatial Semester, a course that is currently being taken by more than 300 students in 12 different school districts across the state of Virginia. Students who enroll in the course have the option of receiving course credit from James Madison, a four-year public university, if their work meets Kolvoord's standards. Because he and a colleague work directly with the participating teachers and students, their work almost always does.

The most exciting thing about the Geospatial Semester to me is the way it engages students in inquiry-based learning throughout. In my experience, too many introductory GIS courses are taught in the style that I call "peas and carrots," as in, "If you eat your peas and carrots now, you'll get to have dessert later." In the peas and carrots approach to learning GIS, students struggle through days and weeks of learning the mechanics of GIS in the hopes of one day actually getting to work on an interesting problem. How many classes in GIS consist of going through menu options one



Map showing the percentage of impervious surfaces in the Rivanna Watershed. (Courtesy of Paul Rittenhouse and his Geospatial Semester students at Western Albemarle High School in Crozet, Virginia.)

after another or learning how to do operations without knowing why you would use them?

In Kolvoord's approach, students spend the bare minimum amount of time learning the mechanics of GIS and begin working on interesting, real-world problems from the start. They add to their repertoire of GIS skills by working on increasingly challenging projects, some of which are taken from the book *Making Spatial Decisions Using GIS* (Esri Press, 2008), written by Kolvoord and collaborator Kathryn Keranen, a pioneering high school GIS educator. *Making Spatial Decisions* is the fourth volume in Esri's award-winning Our World GIS Education book series designed for classroom use.

While learning GIS skills is important, the primary focus of the class is the real-world project that every student does. Each student completes a community-based research project involving spatial reasoning and decision making. Student projects have included work with The Nature Conservancy, various city and local governmental agencies, and private businesses.

Their projects have included exploring the water quality in the creeks, streams, and rivers that make up a local watershed; identifying appropriate sites for cellular towers or wind turbines; and creating community evacuation plans. In the process, students develop their critical thinking, spatial reasoning, communication, and teamwork skills, while addressing a problem that's important to them and their community.

The projects require students to work cooperatively in teams and connect them to their local community as they pursue a solution to their particular problem. The solutions to these community challenges are not simple and require the students to assess the impact of their solution on different constituencies or stakeholders. As Kolvoord describes it, "[The students] get a good look at a rich tapestry of complications that challenge workers every day as they struggle with these types of problems."

Since its beginning in 2005 in four schools, more than 1,000 students have already passed through the Geospatial Semester. Kolvoord is quick to credit the teachers for the success of the program. Not only do the teachers need to develop GIS skills themselves, they also need to be expert at guiding students in doing independent projects.

Kolvoord is now starting to think about how to scale the program up. He envisions it being a nationwide program one day but recognizes that the biggest challenges are limited GIS expertise in schools and the difficulty of finding organizations that will work with students on projects. However, he sees great promise in the GeoMentor program as a way to overcome these challenges.

I can see it now . . . a high school class in thousands of communities across the United States, in which students learn to use ArcGIS Desktop tools, work on real projects in their community, get college credit, *and* work with a GIS professional as a mentor.

More Information

Visit the GeoMentor program at geomentor.org and National Geographic Fund for Geo-Literacy at www.nationalgeographic.com/foundation/geographic_literacy.html.

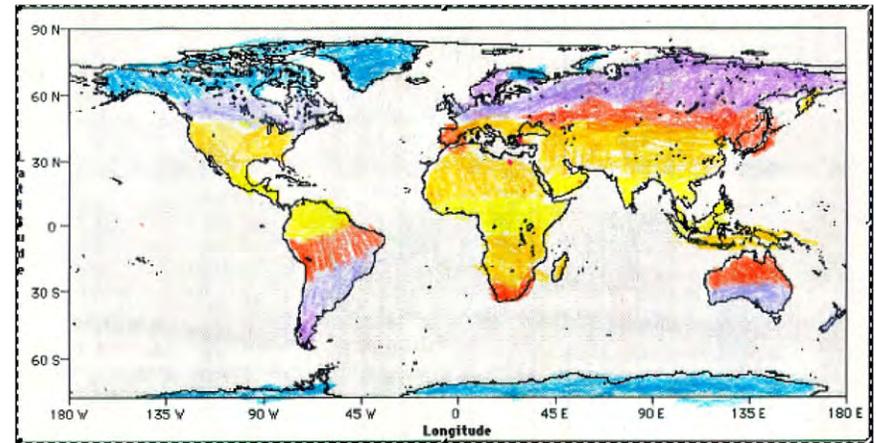
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The Importance of Innovation in Teaching

Giving people an image of what learning could be like is a really important part of improving education. Students, teachers, administrators, parents, policy makers, and community members have remarkably similar views of what education looks like, and those views have not changed much since we were in school.

Despite the fact that the dominant image is in conflict with much of what we know about how children and adolescents learn best, it is deeply ingrained in our culture. It is so ingrained that approaches to education that differ from this model are typically met with resistance by participants and stakeholders.

If you want to make students and teachers uncomfortable, ask them to work in a configuration that goes against convention. Ask most American high school students to sit in a circle or to share their work with others in small groups, and they will squirm with discomfort. Ask most American principals to evaluate the quality of teaching and learning in a classroom in which students are moving around the classroom, talking and arguing, and making messes, and they will conclude that the teacher is unable to control the students and that learning is being undermined by the disorder. And yet, these are precisely the kinds of conditions that have been shown to maximize learning.



Students using crayons and a map of the world can draw their best guesses of what the distribution of temperatures is like all around the world in the month of July. This activity can be engaging to students, giving them a chance to draw on what they know in a way that makes them curious about what they don't know. This lesson is based on research that says that if students are asked to articulate their current understanding of a phenomenon before they are taught something new about it, then they learn the new material more effectively because they can connect it to their existing understanding.

Along with traditional views about the conditions that lead to learning, most of us carry around traditional views about what constitutes learning. Most of us were educated in a system that focused very heavily on learning facts, and we still tend to associate the state of being well-educated with knowing a lot of

facts. Even as we say that 21st-century citizens and workers need to be able to think critically, solve complex problems, and work in teams, we assess the progress of students in terms of what they know.

If we are serious about educating a generation of geo-literate citizens, it is important that we break down our own out-of-date views about learning and replace them with new images of how we should educate young people and what kind of knowledge and skills we should be aiming for. Here's an example.

Consider the following two descriptions of how teachers might teach the first day of a unit on climate for eighth graders. (These are fictionalized composites based on real teachers and students.)

In one classroom, Ms. Brown projects several maps displaying global distribution of temperatures at different times of year and asks her students to identify and discuss interesting patterns.

In her classroom, Ms. Scarlet gives each of her students six crayons and a map of the world displaying continent outlines. She asks them to draw their best guess of what the distribution of temperatures is like all around the world in the month of July.

The day before, when Ms. Scarlet told Ms. Brown about this activity, Ms. Brown warned her she was making a big mistake. Ms. Brown told Ms. Scarlet that her eighth graders will get frustrated because they won't know enough to color the map in. Worse, she argued, the students are likely to draw things that are incorrect,

and it's dangerous to have students do things like that if you won't be able to correct them.

At the beginning of her lesson, Ms. Scarlet grew concerned that Ms. Brown had been right. Even though they were excited about getting crayons, her students were slow to start drawing, and Ms. Scarlet saw them looking nervously at each other's papers. After a few minutes, though, they became very engaged in the temperature-drawing activity. In fact, she only wanted them to spend 5 minutes drawing their temperature maps so she could begin discussing them, but her students insisted on taking 10. When she asked them what they drew and why, two-thirds of the students' hands shot up. Over the course of the discussion, several students shouted questions out of turn about what the "real" temperatures were and why temperatures are different from place to place. At the end of the discussion, in which students voiced many thoughts—some right and some wrong—about the factors that influence temperature, they practically begged her to show them a map of global temperature distributions.

In Ms. Brown's class, on the other hand, the lesson was very different. After Ms. Brown put her global temperature maps on the projector, she had to ask three different prompting questions about what they saw in the map and wait a full 30 seconds—an eternity in front of a classroom—until one student reluctantly raised her hand and said, "It looks like it's warmer closer to the equator." After a few more minutes of discussion, in which a handful of students each identified a pattern, Ms. Brown

instructed them to take out their books and start reading about the causes of temperature variation.

Ms. Scarlet's approach made Ms. Brown uncomfortable. She didn't like the unfamiliar practice of asking students to do a task before they'd been taught to do it. It even made the students uncomfortable at first. They aren't used to speculating, and Ms. Scarlet had to reassure them that they wouldn't be graded on their maps or even asked to hand them in.

However, in the end, Ms. Scarlet's activity was much more engaging to students, and it achieved its goal more effectively than Ms. Brown's. Both activities were intended to get students to notice patterns in global temperature and develop interest in the sources of those patterns. Ms. Brown's assumed that students would be naturally motivated to notice differences and be curious about them. Ms. Scarlet's recognized that they wouldn't be, and it engaged them in an activity in which they had to draw on what they knew in a way that made them curious about what they didn't know. Ms. Scarlet's lesson is also based on research that says that if you ask students to articulate their current understanding of a phenomenon before you teach them something new about it, they learn the new material more effectively because they can connect it to their existing understanding. Ms. Brown was afraid the map-drawing activity might reinforce a student's misconception, but in fact, the reverse is true. By eliciting students' misconceptions, a teacher increases

the likelihood that they will replace the old in their memories with the new.

More Information

Visit the GeoMentor program at geomentor.org and National Geographic Fund for Geo-Literacy at www.nationalgeographic.com/foundation/geographic_literacy.html.

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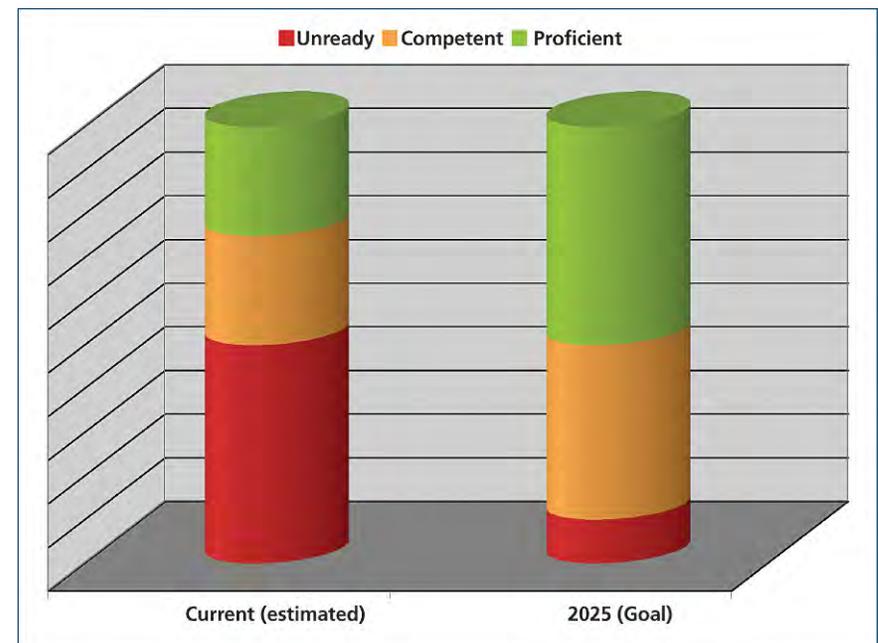
Get Involved with Geo-Education Reform

We've got a problem in our country. The rate of geographic literacy—meaning the number of people who can synthesize geographic information from a variety of sources and draw a sound conclusion—is abysmally low. On the other hand, *ArcNews* goes to almost a million individuals who earn their living by doing that kind of geographic reasoning every day.

So, what we have is an enormous geographic literacy gap. We have a solid core of geographic experts, including the readers of *ArcNews*, but once we get outside that group, there is a dramatic drop-off in the level of geographic understanding and skills. As the companies and agencies that are struggling to fill openings for GIS professionals can attest, we can certainly use more geographic experts in our country. However, from a societal perspective, I believe the gap in expertise between experts and the rest of the population is a much bigger problem.

For our society to function effectively in the modern world, we need the vast majority of our population to be either *geographically competent* or *geographically proficient*. These are terms I use to describe nonexpert levels of geographic literacy. Geographically competent describes individuals who are prepared for everyday geographic reasoning, such as choosing

where to live or evaluating a ballot initiative that would affect land use. In a well-functioning school system, most students would achieve geographic competence by the end of middle school.



A rough estimate of the distribution of geographic literacy among 18-year-olds in the U.S. today (left) and the distribution that *National Geographic* is committed to achieving by 2025 (right).

Geographically proficient describes college readiness in geographic skills and understanding. A geographically fluent individual is prepared for college-level coursework in subjects that require geographic skills and understanding, such as international relations or environmental science. At the National Geographic Society, we have set the goal of achieving a 50 percent rate of geographic fluency among 18-year-olds by 2025.

While there are no statistics on the distribution among different levels of geographic literacy in the United States, there is pretty good evidence that a majority of Americans are not geographically competent. Our goal is to flip this distribution over the next couple of decades. Furthermore, our goal is to have the geographically proficient population be the largest, followed by the geographically competent and geographically expert populations.

One reason that increasing the rate of geographic literacy is more important than increasing the number of geographic experts is that the public is the audience for the work of geographic experts at the end of the day. We can no longer afford for corporate executives, policy makers, politicians, and even the general public to be uneducated about geographic planning and decision making. If they are, then the work of geographic experts is largely wasted. Of course, the other reason is that if we increase the supply of individuals at the other levels of geographic literacy, then the pool for geographic experts gets larger.

If we are serious about reducing this geoliteracy gap, then the question we have to ask ourselves is, Where is the solution to this geoliteracy gap going to come from? It is not going to be solved by the majority. The majority are not even in a position to understand what they are missing. The solution is going to come from the people who can see the price that our society is paying on a daily basis for the lack of geographic literacy among its citizens. It is going to come from the relatively small minority of geographically literate individuals, especially the geographic experts.

So, what actions can individual GIS professionals and other applied geographers take to help move along the incipient campaign to boost geographic literacy?

The first action is personal. It is important that we start building public awareness of why geographic literacy is so important and what a good geographic education would teach our children. Those of us who "do geography" on a daily basis need to start talking to the people in our families and communities about what we do, so they start to understand that geographic literacy is not about knowing where things are but about knowing how to plan and make decisions.

By talking to our family and friends about the kind of geographic problem solving we do, we can start to help them see what their children are missing in their educations. It is possible to talk to people about the kinds of work that GIS professionals do without

using terms like symbology, constraint satisfaction, buffer, and model. It can be good practice for us and eye opening for them.

The second action is political. At both the state and federal levels, it is important that people who understand the importance of geographic literacy advocate for improved geographic education in our schools. As a result of hard work by a large number of "geoevangelists," all 50 states, the District of Columbia, and Puerto Rico have social studies, science, and technology standards that call for geographic literacy. However, these state standards are revised every few years, and if we don't stay vigilant, they can be changed. If you are interested in finding out about the current policy situation in your state, you can contact your state geographic alliance (find yours at www.ngsednet.org/communities).

At the federal level, there is legislation pending in Congress right now to establish a fund for the improvement of geography teaching. Geography is the only subject listed in No Child Left Behind as a core academic subject that has no federal funding program. The bill in Congress, called the Teaching Geography is Fundamental Act, has strong bipartisan support, but it will not pass unless legislators know that there are constituents who care. All it takes is a few minutes to make a phone call or write a letter, and it can make a huge difference. National Geographic has information about the bill and how to contact your legislators at www.nationalgeographic.com/foundation/policy_initiative.html.

The third action is educational. There are valuable roles for geography professionals to play in their local educational system. Many GIS professionals teach at community colleges and in professional seminars. This is very important for filling the pipeline for geographic experts, but there are things we can do in the K–12 system that will start to boost the numbers of geographically competent and proficient individuals. However, finding and developing opportunities to work in schools can be tricky. So, National Geographic and Esri are teaming up on a GeoMentoring program to pair geography professionals with K–12 teachers to bring their expertise into the classroom.

At the Esri International User Conference this summer, we will be introducing this new program that will provide geography professionals with guidelines for working with schools and materials for activities they can do with teachers in their local schools. These activities will range from "pre-GIS" activities using paper maps, crayons, and cutouts for lower grades and schools with limited technology access to real GIS activities using Esri software in schools.

The fourth action is financial. In most of the scientific disciplines, a substantial stream of funding for educational improvement comes from scientists and the companies that employ them. Over time, the cause of geographic literacy is going to require that same level of support. In a future column, I will describe some giving opportunities for individuals and organizations to support

the improvement of geographic education at local, state, and national levels.

In closing, I have two points to make. One is that the problem is urgent. The second is that the solution we are seeking will, at best, come slowly and only through serious and prolonged effort. There are things that we, as geographic experts, can and should do today, and I encourage you to begin right away. I must also caution you, though, that improving education is more about tortoises than it is about hares. So, if you do talk to a neighbor, call your senator, or become a GeoMentor, don't do it as a quick fix. Be prepared to stick with it for a while. If we all do, we will be able to make a change.

(This article originally appeared in the Summer 2009 issue of *ArcNews*.)

Geographic Literacy in U.S. by 2025

For more than a decade, the National Geographic Society and Esri have worked together to advance the cause of geographic literacy in the United States.

This new *ArcNews* column represents the next step in that collaboration. We are reaching out to the Esri user community, the largest organization of GIS professionals in the world, to engage you in this important campaign.

In this inaugural column, I will address the questions of what geographic literacy is and why GIS professionals have such an important role to play in our campaign to increase the rate of geographic literacy in the United States. In future "Geo Learning" columns, I will describe specific ways that you can get involved in this effort.

It's no secret that Americans know next to nothing about geography. The most recent National Geographic/Roper Poll (2006) found that half the 18–24-year-old Americans surveyed could not locate New York on a map of the United States, and nearly 6 in 10 could not locate Ohio.

One-third of the young adults in the survey gave the wrong answer when asked to name the continent where the Amazon

rainforest is located. And, after being at war with Iraq for three years, 63 percent of young Americans could not identify Iraq on a map of the Middle East.

If you're like me, you find it hard to believe those statistics because they are so discouraging, but they are true. However, by paying too much attention to these statistics, we could easily teach American schoolchildren a lot of disconnected geographic facts about the world that distract us from what people really need.

Knowing geography facts does little good if you can't do something with those facts. People don't need to know geography, they need to be able to do geography. To me, doing geography is what geographic literacy is all about.

The problem facing American society right now is that most people don't even know what it means to do geography. So who does know what it means to do geography and understand why it is so important? You do.

GIS professionals know what it means to analyze and solve geospatial problems. GIS professionals routinely apply geographic analysis to complex situations, predict consequences,

construct plans, and make decisions. Not only do GIS professionals know what it means to do geography, they also understand how valuable the ability to do geography is to them individually, to their employers, and to our society.

To me, GIS professionals represent the standard against which we should measure geographic literacy. I do not mean that every individual should have the level of expertise that GIS professionals have. That's neither appropriate nor realistic.

However, we should aspire to having all Americans be able to conduct basic geographic analysis in order to make sound personal, political, and professional decisions. This is not about technology, either; I'm not arguing that all Americans need to be able to use a GIS.

My point is about analysis. I believe that every American should understand how the attributes of a location and its relationship to other locations affect that location. Every adult should understand that his or her actions have predictable effects elsewhere and that what happens elsewhere affects them. Today, most Americans go from kindergarten through college without ever being taught how to trace causes forward or backward across space or to analyze spatial relationships in order to predict or explain.

Without this analytic ability, how would we ever expect them to make good decisions about where to live and work, how to transport themselves, what to buy and how to dispose of it, how

to prepare for natural disasters, whether to go to war abroad, where to locate a store or factory, or how to market goods abroad? The list goes on and on.

An even bigger problem than the low rate of geographic literacy in this country is that Americans don't even know enough to see the price that they are paying individually and as a society. Most Americans don't have any idea how much better their lives and our world could be if they could all do geography. Once again, the largest group that does understand the value of geographic literacy is the community of GIS professionals, and that is why the National Geographic Society and Esri want to enlist you in our long-term campaign to create a geographically literate society.

So, what have we done historically, where are we now, and where do we hope to go with your help?

Beginning more than 20 years ago, the National Geographic Society took up the cause of geographic literacy and created an education foundation to fund geography education initiatives. Since then, we established a national network of state "geography alliances," which are university-based organizations that advocate for geography education and provide professional development for teachers. Funded by a combination of proceeds from National Geographic programs, state governments, and private philanthropies, these alliances were successful in establishing K–12 standards for geographic literacy in all 50 U.S. states; Washington, D.C.; and Puerto Rico.

The state geography alliances also created geography education materials and trained thousands of K–12 teachers in their states. While teacher professional development is the key to improving geographic literacy, it is also the biggest challenge. Most teachers who are responsible for teaching geographic content, whether it's in the context of science or social studies, have never received any training in geography themselves.

In 20 years, the National Geographic-funded Alliance Network has had an impressive impact in raw numbers, but percentage-wise, it is just a drop in the bucket. That means, today, we face a situation in which we have a powerful infrastructure for reforming education, but we do not have the resources to bring about that reform.

For that reason, we are in the process of launching the second phase of our campaign for geographic literacy. The goal of this campaign is to approach universal geographic literacy. Specifically, we set a goal to achieve 80 percent rates of geographic literacy in all 50 states by 2025, where geographic literacy is defined as the ability of students to apply geographic skills and understanding in their personal and civic lives. We set a second goal to achieve 50 percent geographic fluency in all 50 states at the same time. Geographic fluency is a higher standard, which we define as preparation sufficient for successful postsecondary study in subjects that require geographic skills and understanding (e.g., international affairs or environmental science).

The year 2025 seems far away, but because educational reform is a slow process, and we don't currently have the necessary resources, this reform is an ambitious goal. To achieve our goal, we are working with the Alliance Network and other like-minded organizations, such as the Association of American Geographers, National Council for Geographic Education, and Esri, on three parallel tasks:

- Create a combination of top-down policy and bottom-up consumer demand for geographic literacy.
- Obtain sufficient resources in the form of federal, state, and philanthropic funding to mount a large-scale reform effort.
- Create and implement plans for large-scale educational reform at the state and local levels.

There are important roles for GIS professionals and other applied geographers to play in all three of these strands, and in upcoming columns I will challenge you, the Esri user community, to play your part.

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