

Visualizing Economic Development with ArcGIS Explorer

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GIS in the Cloud

Numerous educators have noted that Geographic Information Systems (GIS) is a powerful tool for social studies teaching and learning. In fact, Joseph Kerski, a leading figure in geography education, noted, "Teaching geography without GIS is like teaching chemistry without the periodic table."¹ Yet the use of GIS has been hampered by issues such as the cost of the software and the management of large spatial data files.² One trend that shows great promise for GIS in education is the move to cloud computing. The "cloud" refers to a virtual network that provides many users with access to files, services, and applications. The advantage of the cloud is that teachers and students are able to access and interact with up-to-date map layers and geographic data without needing to store the data on computers in a lab or purchase expensive software. The Environmental Systems Research Institute (Esri) recently released a GIS application called ArcGIS Explorer that takes advantage of cloud computing to deliver a virtual GIS environment.³ Once the free application is downloaded, students and teachers can interact with maps by performing common GIS tasks, such as adding or subtracting layers, zooming in and out, panning, and identifying features. One of the most exciting features of this tool is the ability to capture a series of maps and build a presentation.

Students can use GIS to analyze geographic patterns discussed in class including politics, population, economics, urban and rural areas, crime, human-environment interaction, and migration patterns. In addition, as students become more technologically connected with mapping devices online and in their cellular phones, it is important to teach them how to use such tools to think spatially.⁴ In this article, we describe how we used ArcGIS Explorer with ninth-grade geography students as they studied economic development. Our project addressed three major social studies themes: ● **People, Places, and Environments**; ● **Production,**

Distribution, and Consumption; and ● **Global Connections.**⁵

Economic Development in the Social Studies Curriculum

The analysis of geographic and economic questions and issues involves a range of data sources and indicators that assist students in making comparisons between countries of the world. As students compare levels of economic development among countries, they gain an understanding of the global implications of issues such as conflict, poverty, illiteracy, disease, and environmental degradation. Despite the importance of

studying economic development in the social studies, there exists an alphabet soup of economic indicators that often confuse or intimidate students (e.g., LDC, MDC, and GDP) leading students and teachers to focus more on memorizing terminology and acronyms than engaging in critical analysis and evaluation of social studies data and concepts.

Given the complexity of economic development, it is beneficial to provide students with multiple opportunities throughout the school year to apply the concepts to their learning. At the beginning of the school year, Megan Webster assigns a Less Developed Country (LDC) to each of her students to research throughout the year while studying the AP Human Geography curriculum. Early in the school year, students study the spatial location of their country and environmental factors that define the land within its political borders. This includes gathering data on the climate, topography, and water resources, in addition to borders shared with neighboring countries. During the unit on population and migration patterns, students investigate the current population and demographics of their country, as well as the causes of migration both internally and internationally. The third unit involves examining the cultural elements within the country—including language, religion, folk and

popular culture, and ethnicity and race. Next, students research the political geography of the country, including conflicts, leaders, government, and elements of nationalism. Through the units leading up to economic development, students were encouraged to conduct research with print resources, such as atlases, *World Factbook*, and *CultureGrams*, as well as online resources, such as the U.S. Central Intelligence Agency (CIA) *World Factbook* (www.cia.gov/cia/publications/factbook/index.html), the U.S. Department of State: Diplomacy in Action "Country and Regions" page (www.state.gov/p/), and Facts on File (www.fofweb.com/Subscription/Default.asp?BID=7). All of the information students gathered up to this point, provided relevant background knowledge about the country they were studying and established a basis for future research. By focusing on a Less Developed Country, students begin to understand the inter-related factors that contribute to the economic development level of various countries, as well as how the countries in the LDC category are similar to and different from one another.

The Visualizing Economic Development Project

As students began the unit on economic development, we sought to harness the capabilities of ArcGIS Explorer to help students visualize abstract economic indicators while also providing an opportunity for them to critically examine the way in which countries are classified as more or less developed. To begin this project, we reviewed with students several economic development indicators that are used to define More Developed Countries (MDCs) and Less Developed Countries (LDCs). These lessons focused on developing students' understanding of the purpose of measuring economic development, the use of this measurement to make comparisons between countries to determine patterns, and how economic development can progress over time. Specifically, students learned about the United Nations

Human Development Index (HDI), the Gender Development Index (GDI), and the Gender Empowerment Measure (GEM) to develop an understanding of how development is measured.⁶ To encourage critical thinking about the topic, we asked students to identify other economic development factors that might be worth measuring, in addition to those established by the United Nations.

Following the review of economic indicators, students were assigned a project to be completed during approximately three hours of class time in a computer lab at their high school. The expected final product was a slide presentation using the ArcGIS Explorer presentation tool. Students were to determine whether or not their assigned country should be considered less developed. They were encouraged to explore data beyond those used by the United Nations to consider how well the label "less developed" applied to their country. Their presentation was to include a series of maps they created in ArcGIS Explorer to illustrate the development level of their country. Students were expected to explore and evaluate the ways in which labels, such as Less Developed Country, are constructed and to examine alternative ways of categorizing and comparing the economy and human well-being of the world's countries.

Students began the project by using ArcGIS Explorer to view economic data for their assigned country. We provided them with a list of approximately 16 data layers.⁷ After students viewed the basic data layers for their country, they were guided to explore web resources such as the United Nations Human Development Index (<http://hdr.undp.org/en/>), which included links to most GDI and GEM levels of development measures for each country, and The World Database of Happiness website, (<http://worlddatabaseofhappiness.eur.nl/>). They also used the search feature of ArcGIS Explorer to identify additional data that might reflect alternative perspectives on the development level of their country. Following their exploration of data and

maps, the students selected maps they believed captured an important aspect of the development level of their country. For example, a student who was assigned Sierra Leone might have viewed a map of child labor by country in Africa and determined that the relatively high rate in Sierra Leone was an important factor in the development status (See Figure 1). Students created maps of indicators that they believed to be important and saved these as slides using the ArcGIS Explorer presentation feature. Students were instructed to document all resources used during their study in a Microsoft Word document labeled "Bibliography." Finally, students created presentations with a minimum of six slides and were expected to explain their choices of maps and data when they presented their slide shows to the class.

Students' Learning

It is clear to us that the use of ArcGIS Explorer as a tool for visualizing economic development was successful in promoting student learning. In the past, we have found that students tend to memorize the labels and definitions for economic indicators and indices without understanding what they mean or how they are used. Rarely do students question why a set of indicators was selected to represent an abstract concept like the standard of living or health of people in a country. Rarely do they consider how development might be uneven within a country. Moreover, it is common for students to rely on the maps, graphs, and tables printed in their text as the only way to define development. Through this project, students analyzed and evaluated the labels and definitions associated with the concept of economic development. The visualization of maps allowed them to make these abstract labels more meaningful and nuanced. In the process, they thought critically about questions such as "What does it mean for a country to be developed?" "To what degree does the selection of factors such as years of schooling, gross national income per capita, and life expectancy at



Figure 1. Child Labor by Country for Africa displayed in ArcGIS Explorer

birth, capture the development status of a country?" "What other factors should be considered as important indicators of human well-being?" Instead of simply memorizing social studies terminology, students inquired into the meaning of social studies concepts and evaluated the validity of these principles for understanding global issues.

Technical Advantages and Challenges

Within only four, 50-minute class periods, students were able to learn how to successfully use the software, help fellow students with any areas in which they experienced difficulty, and explore new ways to use the software tools in order to make their presentations intriguing and attractive. One important advantage of ArcGIS Explorer is that students needed only minimal guidance from the teacher on how to download layers, turn layers of data on and off, add pictures and text to slides, and design a slide presentation. The interface and tools proved to be very intuitive, and thus easy for students to use. Second, we found the presentation feature of ArcGIS Explorer to be a significant advantage over other Web-based GIS that we have used in the past.⁸ Instead of copying and pasting maps from one program into another, ArcGIS Explorer

allows one to capture maps as slides that can be arranged into a presentation with transitions. A third advantage is that the search feature of ArcGIS Explorer allows one to access data layers from other web resources. Instead of searching, downloading, and making changes to the data to make it compatible with GIS software, one simply searches for a layer and opens it for viewing in ArcGIS Explorer. This feature saves time, enables less-technically knowledgeable users to import GIS data, and increases the likelihood that data layers are up-to-date.

There were a few technical problems that we encountered when using ArcGIS Explorer for the first time. First, it was not possible with the version of ArcGIS Explorer that we used to create a slide presentation with a mixture of both 2D and 3D maps. This lack of functionality interfered with some students' ability to select maps based purely on their merits since many students preferred the 3D views and selected them regardless of their explanatory power. Second, some students found that they had to import a data layer more than one time because it would not show on the map. Once the map was refreshed, the new layer appeared in most cases. There were also standard technical problems that we have come to expect when working in a school com-

puter lab. Several computers "froze" during the process of downloading data and had to be restarted. Some students forgot to save files to their personally assigned folder on the school server rather than the desktop where they were erased each night. All in all, these proved to be minor inconveniences that were outweighed by the pedagogical and technical advantages of using ArcGIS Explorer.

Conclusion

The use of technology in the classroom as a learning tool is significant in promoting 21st century skills.⁹ GIS applications such as ArcGIS Explorer can add to students' skills and possibly lead to greater interest in geography and future professions. ArcGIS Explorer provides an easy-to-use tool for teachers and students to successfully address both the National Curriculum Standards for Social Studies and the National Geography Standards. Using this application to support the study of economic development proved to be very successful. During follow-up interviews, several students remarked that the project helped them to better understand why some countries are labeled more or less developed and to understand the meaning of the various indicators used when studying economic development. One student commented, "I

could actually see economic development instead of just reading about it." One observation we found most gratifying was that students were able to understand similarities and differences of economic development between countries on a regional and global level within minutes. This understanding comes more slowly when using the charts or graphs common in the textbook. Remarkably, the students managed to teach the authors a few functions and tricks that we had not yet discovered. This fact demonstrates how well students adapt when assignments leave opportunities for them to explore and shine in their own way. ■

Notes

1. Joseph J. Kerki, personal communication, June 2010; Kerki, "The Implementation and Effectiveness of Geographic Information Systems Technology and Methods in Secondary Education," *Journal of Geography* 102, no. 3 (2003): 128-137.
2. See Andrew J. Milson and Marsha Allbrandt, eds., *Digital Geography: Geospatial Technologies in the Social Studies Classroom* (Charlotte, N.C.: Information Age Publishing, 2005).
3. To download the application, go to www.esri.com and search for ArcGIS Explorer. It is also possible to view a limited version of the application by directing your browser to <http://explorer.arcgis.com/>.
4. See Alec M. Bodzin, Thomas C. Hammond, Jane Carr, and Serena Calarin, "Finding Their Way with GIS," *Learning and Leading with Technology* (2009): 34-35.
5. National Council for the Social Studies, *National Curriculum Standards for Social Studies: A Framework for Teaching, Learning, and Assessment* (Silver Spring, MD: NCSS, 2003).
6. To further their understanding and comprehension of the various types of economic development measurement, students used their textbook, *An Introduction to Human Geography: The Cultural Landscape*, by James M. Rubenstein; supplementary materials such as the text, *Contemporary Human Geography*, by James M. Rubenstein; and the Power of Place video series that focus on numerous topics including measurement of development.
 7. The data layers students were guided to view include
 - World Population Density
 - Major World Cities
 - Mobile Phone Subscriptions
 - Main Telephone Lines per capita
 - Internet Users
 - World Projected Population Change
 - World Life Expectancy at Birth
 - World Large Urban Areas
 - World Physical Map
 - World Boundaries and Places
 - World Population per country
 - World Transportation
 - World Regions
 - Major Rivers
 - Earth at Night
 - GDP Per capita
 8. See Andrew J. Milson and Brian D. Earle, "Internet-Based GIS in an Inductive Learning Environment: A Case Study of Ninth Grade Geography Students," *Journal of Geography* 106, no. 6, (2007): 227-232.
 9. See the Partnership for 21st Century Skills at www.p21.org/

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