Integrating GIS and Spatial Thinking into K-12 Curricula

1Angela C. Keel, Dr. Suresh Muthukrishnan, Dr. John Kaup
2Science Department, Woodmont Middle School, Greenville, SC 29673
3Earth and Environmental Sciences, Office of Integrative Research in the Sciences, Furman University, Greenville, SC 29613

Pedagogy – Teacher Perspective

Through a series of online training modules developed by ESRI, I was able to learn the basics of GIS: methods of data import and export, cartography, and analysis methods. GIS is a powerful tool for teachers to incorporate into their coursework to help their students develop critical thinking, problem solving, collaboration, media literacy, information and communications technology literacy, initiative and self-direction, leadership and responsibility (Brantingham 2008). GIS can be applied to literally all disciplines, and as a result integrating GIS into existing curriculum does not necessitate compromising content.

Methods

One of the time consuming aspects of GIS is data collection or conversion of existing data from native format to GIS format. All of the data used in developing the activities related to the world energy and US energy were derived from The United States Department of Energy and the Open Energy Information web sites. For the US, complete data for each state on the total energy, EPA goal, and the breakdown of energy used by individual states based on sources such as coal, natural gas, petroleum, hydroelectricity, nuclear, and other renewable energy sources were used (BREE 2011). The world’s energy was disaggregated in the traditional factor analysis approach (Table 1).

As a first step, the data from the web pages were compiled in Excel spreadsheet and regrouped appropriately to be able to import it into ArcGIS. Two GIS shape files containing the states and the countries boundaries were added to the GIS project from ESRI Data. Using a common attribute between the GIS shape file and the Excel file, the Excel data was joined with the attribute table of the shape files. This enables us to make thematic maps of any of the energy types.

Then, the map was exported to files in order to be easily accessed by my students to go through a module and ultimately create a final project of their choice using the GIS model. As a result, this model was setup to take the students through the different properties of maps to investigate the amount of energy consumed and to compare these amounts to other parts of the world and specifically the US.

Benefits and Challenges

1. The students in a middle school classroom prefer active rather than passive learning model (Anderson and Krathwohl 2010). In a previous experience teaching GIS in the high school classroom teaching can be a challenge for many teachers (Brantingham 2008). GIS is a tool; all middle school classrooms would engage the students who are most interested in GIS.

2. The challenges for implementing GIS are similar to implementing any technology based program in a school (Brantingham 2008). The cost of the equipment, (computer, and maintenance fees), time for training, data collection and transformation, and establishing a routine schedule for use of the lab that has the ArcGIS software installed.

Outcomes / Future Directions

The process of data collection, modification and creating a GIS map in ArcGIS, and use of that map by students to answer important questions, clearly provides a deeper engagement for the students the topic being discussed in class. We can achieve better comprehension and retention of the material and at the same make science learning fun and meaningful from various temporal and spatial scales. In an effort to meet the STEM and South Carolina state standards, specific existing science content and concepts are integrated with a new hands-on spatial data analysis module that will enable students to engage and explore. Such activities and integrated approaches have been proven to enhance student learning and retention (Bloom 1956 and Anderson & Krathwohl 2001).

The STEM standards integrate science, technology, engineering and math concepts to support students in K-12 classrooms (STEMTO). The use of GIS in classroom actually facilitates this integration in a flawless manner since one single activity or module in GIS can be used to cover variety of scientific or engineering learning objectives. A simple thematic map created in a GIS system can facilitate exploration and discussions on geometry, data collection, data quality, applicability, limitations, methods in manipulation, and direct problem solving.

Literature Cited