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GIS IN THE CLOUD: USING WEBGIS FOR TEACHING SECONDARY GEOGRAPHY

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The move to cloud computing is one trend that is promising for GIS in education. The "cloud" refers to a virtual network that provides many users with access to files, services, and applications. The advantage of the cloud for GIS in education 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 technical issues of geographic data acquisition, software licensing, storage of large data files, and the need for substantial processing power have been persistent problems for teachers. Often school computers are not powerful enough and do not have the regular maintenance required for high level GIS work. One primary purpose of cloud computing is to move data and software applications off of local computers and onto a large network of computers that can share storage and processing capacity. Multiple users can have access to data and applications through the web browser on their local computer without needing to store large datasets or run software applications on that computer.

The intersection of GIS and cloud computing has been called WebGIS. Consistent with cloud-based applications, one does not need to store large digital geographic data files on the local computer to view and analyze those data. Beyond the easing of barriers related to data acquisition, software licensing, data storage, and processing power, WebGIS and similar cloud-based applications offer teachers and students a tool for producing and publishing user-generated geographic content. The following three cases describe how WebGIS tools like ArcGIS Explorer can be used to transform geography education.

The first example describes how WebGIS and other online sources were used by secondary school geography students to study sub-Saharan Africa. The task for each group of students was to prepare to represent their region of Africa at an upcoming Pan-African summit. Each group was directed to collect relevant data about the countries of their region, to identify what they believed to be the most significant issue facing their region, and to create a presentation for the summit that argued

persuasively for the importance of devoting resources to this issue. The presentation tool with ArcGIS Explorer provides students with a simple way to present a series of maps. Students were encouraged to support their position with maps, charts, images and tables. The groups also were required to develop a formal proposal for addressing the issue they selected.

We observed that all of these students explored a variety of economic indicators and geographic attributes beyond what they would find in a common textbook. They compared and contrasted the data across countries, regions, and continents to identify trends. They recognized how these geographic data can serve to illustrate human development issues. With the aid of WebGIS, they constructed maps and graphs of their data sources to support their assertions regarding the significance of issues facing the people of their regions. As students struggled with developing a proposal for addressing their chosen issue, they came to recognize the complexity of geographic phenomena. Finally, they simulated a Pan-African summit in order to report their findings publicly and to educate their classmates about the issues evident in various regions of the African continent.

Web GIS can also be a valuable tool when studying themes within human geography. One of the more difficult subjects for students is economic development due to the number of economic concepts and economic indicators. The goals for students in this project were to use ArcGIS Explorer to: (1) download layers and create maps displaying the development indicators for a given country, (2) use information from the HDI, GDI, and GEM to determine whether their country is more developed or less developed, (3) consider how other economic and social indicators could alter how 'development' is defined and measured in particular countries, and (4) design a presentation using ArcGIS Explorer that exhibits the findings/results of their analysis.

During follow up interviews, several students remarked that the project helped them to "see" economic development and to understand better why some countries are more or less developed. Students also took on the role of teachers of GIS as they became comfortable in exploring the plentiful capabilities of mapping with online data. 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 quickly. This understanding comes more slowly when using the charts or graphs common in the textbook.

The final case describes how WebGIS can be used to introduce students to real-world uses for geography. Many GIS professionals use GIS to determine the optimal location for a business, hospital, school, apartment complex or other establishment. We asked students to play the role of an entrepreneur who is opening a new business. Their task was to locate the best city for a new business that they want to open. We divided the project into 4 stages to guided the students' through the process. We labeled these four stages Planning, Exploring, Analyzing, Deciding. Students were confronted with the need to critically evaluate the data available to them to determine

which data were relevant to their proposal and their decision making process. Furthermore, the students had to prioritize and defend their selection of data to include in their analysis. Using WebGIS, students can explore a variety of data layers and gain an understanding of differing scales of data (city versus county level). These tasks involved students in spatial thinking about how geographic data had been represented in the GIS, as well as important spatial concepts such as scale. During the final stage of the project, the students selected a particular city as their "target city" for locating their business. Before making the final selection though, students were guided to think about the additional information they would need to make a good decision. Once students made their selections, they constructed presentations that included at least six slides with maps to justify the selection of the city for their business.

The results of this project reveal much about spatial thinking with WebGIS. Most importantly, the project demonstrates that WebGIS can be used successfully in a classroom environment to promote students' spatial thinking. The task must be structured in a way that guides students through the thinking process without doing the thinking for them. The four stages of the project modeled the workflow that a professional GIS user would follow while also stimulating spatial thinking and problem-solving throughout the process. In addition to the spatial thinking benefits of the project, we found that students were engaged by the authenticity of the site selection analysis task. They commented positively about the opportunity to see how geography and GIS are applied in the real world. The students also were enthusiastic about the freedom they were given to choose their own businesses and to make decisions about the data that they viewed to be important to their proposals. A few of the more advanced students even suggested that additional online or library research should be a required component of the project so they would be able to make a more informed choice. Given an authentic task and a powerful geospatial technology tool, these students engaged in spatial thinking with GIS.

Given the high cost of geospatial data collection, the storage space required for quality geospatial data, and the skills required to effectively manipulate those data, it is not surprising that implementation of GIS in secondary schools has been slow. Due to ease of use, accessibility, low cost, and interactivity, WebGIS is much more likely to be embraced by the educational community than professional GIS software. The potential for WebGIS may be even greater when opportunities for collaborative environments are paired with WebGIS and other cloud-based tools. The cases presented in this article suggest how WebGIS might transform geography education. In addition to improving students' basic geographical knowledge, the infusion of WebGIS will supply meaningful contexts for expanding students' spatial thinking, decision-making, problem-solving, and critical thinking abilities.