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Simple Geographic Information Systems (GIS): Maps and Information Literacy

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INTRODUCTION

Geographic Information Systems (GIS) are interactive visualizations of data that illustrate how societies and places change over time. According to the Environmental Systems Research Institute (ESRI), the producer of the most widely-used mapping platform, geographic information systems integrate "hardware, software, and data for capturing, managing, analyzing, and displaying geographically referenced data" ("What is GIS?" n.d.). Fundamentally, GIS projects are representations of complex social and cultural processes, and they invite students to locate information, deliver it spatially, and use their findings to pose questions that expand our understanding of the world in which we live. GIS is a way to think and a way to solve problems. The process of information retrieval and analysis that is intrinsic to geospatial research suggests that GIS-based projects can effectively cultivate information literacy learning. However, there are often significant barriers to integrating GIS with information literacy instruction. Many institutions do not have access to expensive, proprietary GIS software packages that are used to produce maps (Sweetkind-Singer, 2009). In other instances, many teaching faculty do not design classes to include the requisite time and support for students to develop proficiency with complicated mapping platforms, let alone with fundamental information resources.

In this presentation, I share a process of using Google Fusion Tables to facilitate a simple GIS project in an undergraduate geography class. After situating GIS within the current environment of educational and professional practice in the United States, I emphasize the progression of creating assignments that pare down the geospatial process into layers that align with the ACRL's Information Literacy Competency Standards for Higher Education. Finally, I will discuss basic resources for supporting students as they discover, visualize, and interpret data.

OVERVIEW

GIS learning not only hones information literacy skills, but also transforms education and society. Just about any research question in any discipline can be explored geographically. Perhaps because of this analytic flexibility, GIS projects are becoming an integral part of student learning throughout U.S. secondary and higher education. In 2006, the National Research Council noted that schools in the K-12 system teach GIS to support problem-based instruction in science, environmental, behavioral, and social studies courses (National Research Council, 2006). Many universities are also developing geospatial literacy initiatives and have launched GIS certificates or degree programs that encourage interdisciplinary inquiry throughout the curriculum (Fagan & Wikle, 2011). Libraries are increasingly supporting collections of geographically-referenced data, acquired from public and private sources, to facilitate GIS inquiry. Finally, industry leaders like ESRI and Google are creating a robust community of educators who support geospatial learning and share ideas with each other. For example, the ESRI EdCommunity has launched a GeoMentor program in which GIS experts adopt a school and support educators, and Google Maps Education has compiled a list of grants and training resources to foster GIS learning at all levels.

Geospatial learning is a foundational skill that applies to many professions, and illustrations of GIS in practice are numerous. In Detroit, for instance, the independent mapping firm Loveland Technologies created a mobile app that allows citizens to locate abandoned properties on maps. The city's Blight Task Force uses crowd sourced data to demolish abandoned properties efficiently, thus maximizing Detroit's limited financial resources (Klinefelter, 2014). GIS products can also be used for activism. A study by The Opportunity Agenda cites a series of maps created by a Los Angeles-based community group that pushes for equity in the wake of the 2005 Staples Center construction (Truehaft, 2009). These maps have become shorthand for talking about the problems associated with the expansion of LA Live (the commercial development adjacent to the Staples Center), and they also chart the victories of the community as its members advocate to maintain fairness for people who live in surrounding neighborhoods. GIS has many applications in social sciences and human services professions as well. As Amy Hillier (2010) says, GIS is a tool of practice that provides a framework for understanding human behavior and community services. Students in social work, environmental studies, and related professions are now, more than ever before, expected to create maps that inform their communities and serve as a public resource.

Because it encourages a cyclical process of finding, evaluating, and applying data, GIS is conducive to accomplishing the goals of information literacy instruction and should be included within traditional library support services (Jaguszewski & Williams, 2013). As Jablonski (2004) and Howser (2005) have suggested, GIS projects align with established information literacy learning outcomes, such as the ACRL's Information Literacy Competency Standards for Higher Education. GIS learning can be integrated into information literacy instruction because it promotes "numeric, geospatial, technological and information evaluation to provide students with the critical thinking skills that apply to all formats of information" (Howser, 2005, p. 2). ESRI's model of the Geographic Approach, which suggests that GIS researchers Ask, Acquire, Examine, Analyze, and Act, dovetails with the existing Competency Standards (Dangermond, 2007). Indeed, it imagines a nearly identical process of finding and using information.

Figure 1: Table comparing the Geographic Approach to Information Literacy SLOs

The Geographic Approach parallels essential critical thinking moves outlined in the Competency Standards; therefore, creating assignments that pair GIS with information literacy instruction provides an ideal vehicle for students to achieve the learning outcomes.

Recognizing significant changes in higher education and in our digital culture more broadly, the ACRL has appointed a task force to revisit the Competency Standards and redress the "limited, almost formulaic approach to understanding a complex information ecosystem" implied by the existing Standards (Gibson & Jacobson, 2014, p. 3). Although the project is currently in the draft stage, it envisions information literacy as a series of interwoven threshold concepts, each of which acknowledge that the process of becoming information literate is recursive and involves creativity and ethical participation in communities of scholarship and learning. In the draft, Gibson and Jacobson write:

> Students in the humanities and social sciences are also engaging in new types of digital projects along with their faculty members, such as creating interactive maps of cities where authors worked or annotating and linking classic texts. These students need to navigate information systems, use data sources, and integrate various technology applications to learn ways of thinking and practicing within disciplines. (p.1)

GIS projects allow students to find data, interpret it in context, and display it interactively and on digital platforms. Thus, when designing instruction sessions, librarians can easily identify one of the new threshold concepts, like "Research and Inquiry," and express the learning elements of GIS work in terms of the knowledge practices and dispositions the concepts emphasize.

Figure 2: Table comparing the Geographic Approach to Information Literacy SLOs

GIS research demands that students engage in each of these processes. Maps produced with GIS platforms are an apt example of multimodal creativity and analytic sophistication to which the new Threshold Concepts gesture.

PROJECT IMPLEMENTATION

To encourage this kind of dynamic information literacy learning, I facilitated a simple GIS project in a 200-level undergraduate geography class at the University of Montevallo. Lacking access to ESRI's ArcGIS software, the course instructor and I turned to Google Fusion Tables, an open-source data visualization web application that allows users to create interactive maps ("About Fusion Tables," n.d.). Students could frame questions, compile data on spreadsheets (often downloaded from the U.S. Census, National Center for Education Statistics, or other government agencies), and merge that data with existing maps that represented appropriate administrative boundaries. Although the class was titled "World Regional Geography," we strongly encouraged students to develop research questions that pertain to the United States, since finding reliable data associated with other countries is difficult (Kerski & Clark, 2012).

Students began the project by forming groups, framing research questions, and exploring data sources. In class, we worked through facets of the project and began to think about the design, provenance, and purpose of the maps they were to create (see Appendix A). Maps can include information that is embedded in specific points or displayed within larger polygon boundary areas, like states, school districts, or counties. At the initial stage, we encouraged the groups to develop questions that could be expressed as a cause and effect relationship. For instance, if students indicated interest in education, we had them articulate their question scientifically. Could they identify another variable, like poverty, health, or access to parks that would show a relationship between two things? A research question on education could be phrased more specifically as, "does the presence of parks in a place improve the quality of education?" This process of forming questions and setting parameters is vital to the experience of making and interpreting maps.

Data Discovery

Once groups identified their research questions, they began to shape their projects according to the indicators and data available. According to Kerski and Clark (2012), there cannot be a single "comprehensive and all-inclusive one-stop shop for finding spatial data" (p. 9). Instead, users must navigate an increasingly broad landscape of georeferenced data sources to find information that they can incorporate into their projects. To assist students, I created a research guide (http://libguides.montevallo.edu/gis) that linked to multi-purpose data sources and contained a list of commonly-used boundary level maps that could be copied into individual Google Drive accounts (e.g., U.S. States, individual counties in Alabama). I also provided examples on taking a research question beyond the provisional stage to a place in which specific indicators, empirical measures, and datasets are specified. For example, a question about the relationship between parks and education could be expressed as, "does the percentage of people who graduate from high school correlate with the number of parks per capita in a state?" Or, "do places that have more parks also have a more educated population?" In order to visualize this question, students needed to locate data on population, education attainment, and park locations.

Support

About halfway through the project, I held a Google Fusion Tables workshop in which students practiced turning their emerging data collections into maps. The process is intuitive, and Google Fusion Tables also provides a substantial collection of tutorials ("Create with Fusion Tables," n.d.). However, there are many small steps to creating with Google Fusion Tables that take time to learn. The workshop was designed to be an informal time for students to ask questions and troubleshoot logistical steps within the platform. I also met with each group on an as-needed basis throughout the semester.

Synthesis

In the final step of the project, students published the maps they created on a blog. Fusion Tables allows users to generate an iframe code, which can be used to embed the interactive maps on any third-party website. This step allowed students to close the loop on their investigation and reflect on their process of research, analysis, and interpretation. One successful instance of this synthesis was a group that studied the economic impact of Disney World on the four largest counties in Central Florida. Culling data from the U.S. Census Bureau and the Bureau of Labor Statistics, the group concluded that although their maps revealed economic growth in the Orlando area, other social problems, like crime and inflated property values, could be attributed to Disney's arrival (Falletta, J. et al., 2013). The blogs served as a place for students to share their results with a public audience and link their visualizations with other forms of investigation they do in the class. Furthermore, they had the space to reflect on the data displayed in their maps and pose more questions about the economic, cultural, and social factors that could have influenced their findings.

CONCLUSION

GIS research is an ideal project for delivering information literacy instruction and should be integrated into library services. The work that our students produced suggests that simple GIS assignments are attainable and are beneficial to undergraduates, even in the context of a general education class that enrolls over 40 students. However, there are specific goals of GIS assignments that should be emphasized to encourage critical thinking and expand research with traditional forms of evidence (e.g., books, scholarly journals, and mainstream journalism). All GIS projects should invite students to explore questions from a spatial perspective and to account for changes in time (Goodchild, 2008). A map that shows data alone dwells simply in the realm of data visualization, which is an effective skill but does not constitute the full extent of GIS analysis (Kerski & Clark, 2012). In order to show temporal changes with Google Fusion Tables, users must measure an indicator over time and come up with a single statistic, like percent difference, that is isolated in one data column. For example, a group that investigated the effect of state lottery revenues on educational success charted the percentage of change in the rate that students who graduated from high school and attended a higher education institution immediately afterwards between the years 2000 and 2010 (Coggins et al., 2014).

Figure 3: Map from a completed Google Fusion Tables project that shows change over time

The group looked at the rate of students who attended college immediately after graduating high school because they saw that indicator as a measure of education attainability. Presumably, those states which have higher contributions of lottery revenues to higher education would have higher quality education and lower tuition rates, thus increasing the likelihood that its citizens would choose to attend college once they graduated from high school. This hypothesis proved to be false, as states like Texas, which receives a large amount of higher education revenue from its state lottery, had one of the sharpest declines in college attendance between 2000 and 2010. Again, this instance demonstrates that when spatial and temporal thinking are combined, students have the occasion to expand their range of questions to account for external factors. They sought additional information to determine if students that attend state universities with more lottery revenues graduate with lower levels of debt, or if other factors, like agricultural industry, may have inflected their results. GIS encourages this kind of thinking and invites students to synthesize and interpret diverse kinds of information.

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Appendix A

In-class exercise: GIS project worksheet

Group Topic ____________________________________

These questions will help your group focus and start the process of finding information to construct datasets and embed ideas into a series of maps. Talk with each other and write down preliminary answers to these questions. What you say here can change as your map develops, and that's okay.

1. Sources of Information

List at least three sources you plan to reference (or could reference) to generate *datasets* for your map.

Example answer: Our group is interested in the relationship between locations of public and private schools in New York and crime rates. Possible sources include National Center for Education Statistics, Bureau of Justice Statistics, or the *New York Times*.

2. Boundaries

What boundary levels will you use to frame your analysis? Why does this make sense? Write down your rationale here. I highly recommend using a boundary set that already exists in the public database in Google Fusion Tables (e.g., national, state, county, or congressional district boundaries).

Example answer: We are interested in determining whether or not states that have more wildlife reservations have fewer documented instances of animal cruelty. Thus, we will use state boundaries so we can compare different states.

3. Locations

What locations (if any) will you pin on your map? What are the limits of the area where you will mark locations? Why do these limits make sense?

Example answer: We are interested in the presence of Islam in the Southern Bible Belt. Thus, we will define the Southern Bible Belt as Louisiana, Mississippi, Alabama, Georgia, and Florida, and we will place a marker for every mosque in those states. We feel like it's important to map every mosque to show where they are concentrated. We might also pick one state, like Alabama, and mark all of the mosques and all of the Baptist churches just to show the disparity. We're not sure.

4. Annotations

What do you want the annotations (pop-up windows) on location place markers or polygon area shapes on your map to look like? What information will they have in them?

Example answer: We are interested in state parks in California, so we'd like to mark the location of each state park and include a photo of it, a link to its website, stats about how many people visit there each year, a link to an article about it, and a space for us to add commentary. We also might want to include how much money is spent each year on upkeep of the individual park, if we can find that data.

5. Temporal Element

How will you or could you show changes over time on your map?

Example answer: We are interested in finding out whether or not there were more high school dropouts in Alabama in 2000 than 2010. Is the problem getting better or worse? Did the No Child Left Behind legislation make a difference? What we might do is track the dropout rates in those years and convert the change between 2000 and 2010 into a percentage point. Then, we will assign a different color code to map the intensity of the problem.

Appendix B

Geographic Approach	Information Literacy Competency Standards for Higher Education
Ask	Determine the nature and extent of information needed
Acquire	Access needed information effectively and efficiently
Examine	Evaluate information and its sources critically
Analyze	Incorporate selected knowledge into knowledge base or value system
Act	Use information effectively to accomplish a specific purpose

Figure 1 – Table showing overlap between ESRI's Geographic Approach and the existing ACRL Information Literacy Competency Standards for Higher Education

Geographic Approach	Revised ACRL Framework of Threshold Concepts – Research as Inquiry
Ask	Shape questions based on currency of topic, geographical scope, or discipline
Acquire	Formulate questions for research based on gaps in information or data available
Examine	Understand that new knowledge creation is a varied process
Analyze	Demonstrate ability to think critically in context
Act	Seek opportunities to transform current research-related practices

Figure 2 – Table showing overlap between ESRI's Geographic Approach and the draft of revised ACRL Framework of Threshold Concepts (Research as Inquiry)

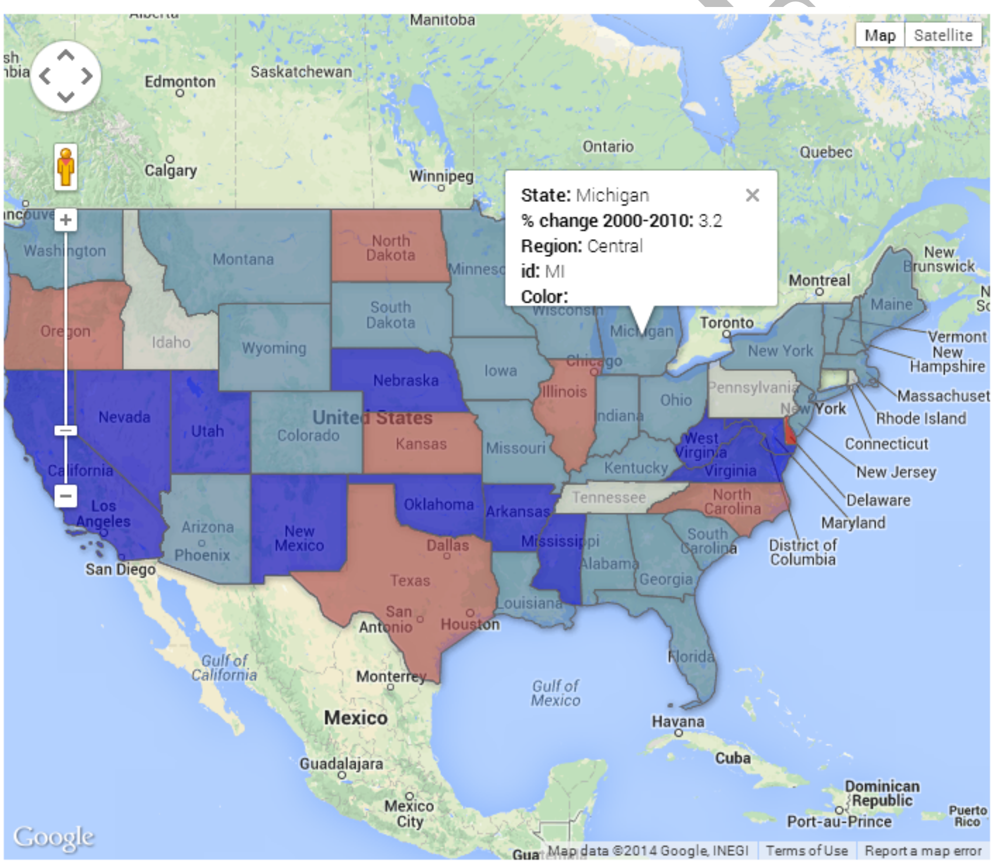

Figure 3 – Map from a completed Google Fusion Tables project that shows change over time