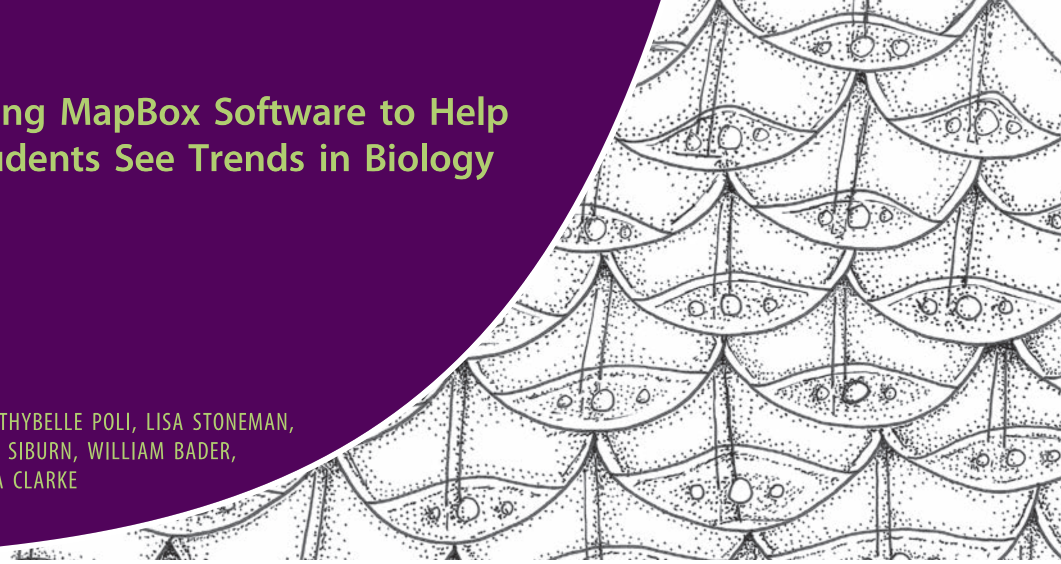
TIPS, TRICKS & TECHNIQUES

Using MapBox Software to Help Students See Trends in Biology



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Abstract

Technology applications can offer an accessible way for teachers to bring the real world into science classes. Using MapBox Studio, a free mapping software program, our cross-disciplinary student teams were able to visually conceptualize large datasets and see emerging trends for themselves, facilitating the research process while making student learning more active and engaged.

Key Words: *Mapping; imaging; large data visualization; visualization; multidisciplinary.*

American science literacy is low: vaccination controversy, evolution skepticism, and climate change denial, in addition to the general distrust in science, show the state of public understanding of science and technology. Feinstein (2010) suggests that in order to increase science literacy across a community, one must connect and engage students with the usefulness of science to help them become “competent outsiders.” But the problem is more than just the knowledge of facts; our students struggle with applying those facts to the real world. The *National Geographic*–Roper survey (National Geographic Education Foundation, 2002) reveals that students’ knowledge of world geography lags behind that in eight other industrialized nations. In addition, Fournier (2002) calls for attention to problem-solving using spatial relations. *Bio2010* (National Research Council, 2003) and *Vision and Change* (AAAS, 2011) both suggest that exposure to real-world datasets is a key component of future biological training.

During a multidisciplinary project, students researched Carboniferous fossil plants (i.e., lycopods), folklore, castles, and quarries – searching for connecting trends related to dragons. The student team consisted of 60% mixed science (biology, biochemistry, computer science), 20% humanities (English, creative writing, fine arts), and 20% social science majors (business and education). Originally, all team members used Microsoft Word tables to organize their primary literature sources by location or country. One of the advantages of the tables was the revelation of areas of weakness in the data (e.g., countries not represented). However, as the datasets grew larger, tables proved overwhelming and confusing. When datasets are too large for students to physically see or readily conceptualize, educators must find ways to make data accessible if students are to facilitate critical thinking and connection to deeper conceptual contexts. Therefore, we needed a better way to organize data so that all researchers had a place to put their findings and all could easily interpret the information provided. Mapping provided the students with a way of visualizing and merging complex datasets.

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Given the need to see data geographically, several mapping tools were investigated. We chose MapBox (http://www.mapbox.com) because it has a free online mapping tool (MapBox Editor) and is simple to learn after only a few trial runs. Our students created individual maps for the locations of lycopod fossils, dragon folktales, castles, trade routes, and dragon-related plants (Figure 1). Science students extracted fossil locality and then mapped accordingly. Some data points required additional investigation before they could be accurately mapped, because GIS data were not available; students gathered these data by using other applications and websites such as Google Earth or Wikipedia. Literature and social-science students read folktales and other historical documents, analyzing the text for common descriptors that allowed for mapping the locations of stories and trade. It was useful to students in visualizing large datasets and did not require advanced, scientific mapping (GIS) or statistics skills, but our students compared these maps using two-point statistical analysis to determine correlations among data points.

Depending on the style of map chosen, students may focus on different map characteristics: topography, bodies of water, streets, scale. Large datasets can be imported as different file types

The American Biology Teacher, Vol. 78, No 5, pages. 426–427, ISSN 0002-7685, electronic ISSN 1938-4211. DOI: 10.1525/abt.2016.78.5.426.

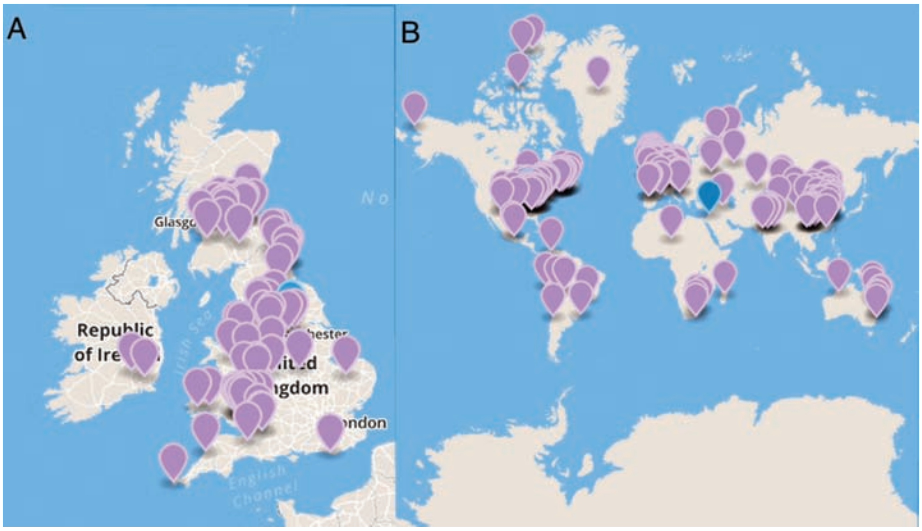

Figure 1. (**A**) Map of *Lepidodendron* fossils across the United Kingdom. (**B**) Map of *Lepidodendron* fossils around the world.

(.geojson, .csv, .kml, .gpx) or entered through a search feature using addresses, town names, or latitude and longitude. The simple toolbar provides several ways to represent and connect data: different symbols to represent data points, polygons to group points, and lines to connect them. Adding notes to each location and titling data points is user-friendly. The streamlined platform gave us the control to document and pinpoint exact locations, visualize our data, and see trends that would otherwise have been lost. A free tutorial is provided on the MapBox website. The free version, MapBox Editor, had several limitations. For instance, direct comparison of two or more maps is not possible, a problem that can be overcome by overlapping the images in a separate graphics program such as Photoshop. Additionally, map images cannot be downloaded in the free version. To mitigate this problem, we used a screen capture program such as SnipIt. Both problems could be resolved by purchasing MapBox Studio, which allows for customization within one program. Maps can be made interactive using MapBox.js (Java Script). We did not purchase either of these services, though education pricing is available at a much reduced cost.

Sharing of diverse perspectives in smaller groups led to reconceptualizing data across the fossil and folklore areas. Beyond the ability to present data points, students were able to discuss regions of the world in geographic detail (locations of coal seams, names of towns, and country locations). All students were able to present the combined, mapped data and discuss the synthesis of knowledge across disciplines.

Lawson et al. (1989) refer to the learning-cycle model that requires students to engage in an inquiry process that draws them deeper into data collection through questioning and formulation of answers. Use of MapBox Studio allowed our team to become investigators, drawing real-world conclusions and presenting complex ideas to diverse people. Students even had to deal with language translations in researching a number of data points. *Vision and Change*'s Core Competences are reached by proper visualization of large datasets. While using MapBox Editor online, students learned much more than how to locate data points on a map. They made inferences, built hypotheses, synthesized information, revealed and examined patterns, and taught all of that information to others both within and outside the team. Once these patterns were established, the students formed new hypotheses in regard to why they might be seeing these potential correlations among data. These steps helped the students create what Eldredge (1999), in *The Pattern of Evolution*, called "the real data of all science."

This tool could be used in teaching cell biology (protein evolution), ecology (species range), immunology (disease outbreak), human health (race differences), and environmental science (pollution distribution) at many grade levels. Mapping also provides a way for the sciences to interact with nonscientists. We all know that the world is interconnected; mapping helps us see it.

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