Virtual Expeditions:

Google Earth, GIS, and Geovisualization Technologies in Teaching and Learning

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I just flew into the ocean and checked out the health of a coral reef.

I've visited many of the places in Shakespeare's world including the Globe Theatre.

I'm amazed how much the polar ice caps are changing.

Whether taking a virtual hike to learn more about glaciers and geysers or exploring social issues related to land use or invasive species, online tools such as Google Earth allow young people to take virtual adventures to far off places around the world, under the ocean, and even into space.

We can bring literature alive through visualizing the settings of picture books and novels. Teachers can add relevance to social studies, science, and math activities with access to endless real-world data sources. They can enrich cultural and language studies with an exploration of geography and travel. Immerse young people in history by following the Oregon Trail, tracking the movement of troops through conflicts, and imagining life on the Silk Road using satellite images, photographs, and maps. Finally we can combine place-based learning with global exploration for an engaging, interdisciplinary approach that addresses both standards and individual learning needs.

THE BASICS

Geographic Information Systems (GIS) allow users to identify, gather, organize, analyze, and manage data. The resulting database can be used for problem-solving activities such as determining the environmental impact of a new coal power plant or predicting the spread of wolves introduced to a particular region. Geographic objects such as themes, features, and descriptive information can be displayed on digital maps. The National Atlas, http://www.nationalatlas.gov/, is an example of an online tool that uses GIS.

Specialty software such as ArcView from ESRI is used to create these databases, map views, and models. However, it is a complex program generally used at high school and college levels.

Geovisualization technology combines GIS with elements of Web 2.0 technology making geographic information available to everyone in an easy to use and share format. For instance, geo-tagging occurs when people add key words, text, and other identifying information to maps. Wiki-maps allow participants to collaborate on the creation or enhancement of maps by adding and editing text, graphics, photos, or video. This technology often involves a "mash-up" or combination of technologies such as Google Earth, http://earth.google.com/, and YouTube working together.

Keep in mind that the images and other content at GIS web sites may be copyrighted; before using or sharing images, read the guidelines for use. Consider seeking out open source resources. For instance, NASA's World Wind, http://worldwind.arc.nasa.gov/, generates public domain images.

Although geovisualization technology has produced a wealth of easy-to-access information, it also poses challenges in terms of the quality and authority of this data. Sarah Elwood (2009) notes that "geotagged photos, video, and text and the information shared through interactive geovisualization platforms often represents individuals' observations or interpretations of places experienced in everyday life, described in ordinary 'natural language' rather than the scripted terms of a geospatial database" (p. 259).

GOOGLE GEOGRAPHIC TOOLS

Although many geovisualization tools such as MapQuest, http://www.mapquest.com/, and Yahoo Maps, http://maps.yahoo.com/, are available to the public, Google tools are by far the most popular.

Google Earth. A geographic browser, Google Earth requires specialty software that must be downloaded and launched from

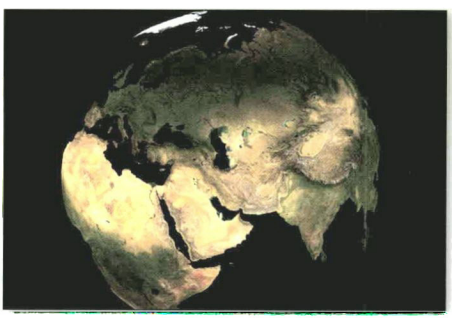

Figure 1. View of the eastern hemisphere from NASA's World Wind.

the computer's hard drive. This browser allows users to search for and explore geographic locations around the globe. Satellite images, aerial photographs, and a GIS generated 3D globe are combined to produce high quality views of the earth. While street views are available in some cities, other areas provide views from a distance.

Use the Layers option to select database information you'd like to view. For instance you can view weather, traffic, roads, borders, and other information.

Google Ocean. A feature within Google Earth, Google Ocean allows users to explore coral reefs, hydrothermal vents, and shipwrecks under the sea. Organizations such as National Geographic and the National Oceanic and Atmospheric Administration (NOAA) have contributed photographs and video clips to enhance the experience. When using Google Ocean, be sure to turn on the Terrain layer for the best images. Use the Search option to find specific locations. Do a search for "Exxon Valdez" to see background information and images of the well-known oil spill off the coast of Alaska.

The following tools are featured within Google Earth. Although web-based versions are available, the Google Earth version is much higher-resolution.

Google Sky. This tool allows users to view stars and other celestial bodies. Animations, constellation lines, and Hubble telescope images are available at **http://sky.google.com/**.

Google Moon. Explore satellite images of the Moon and photos from Moon landings at **http://moon.google.com/**.

Google Mars. View shaded relief and infrared images along with high-resolution panoramic images from NASA expeditions to Mars at **http://mars.google.com/**.

Google Maps. This tool allows users to see maps, satellite images, and terrain views. It also provides directions, business, and other information at **http://maps.google.com/**.

Google Mash-ups. Google Earth can also be combined with other Google products such as Google SketchUp, **http://sketchup.google.com/** or YouTube to extend the experience.

Figure 2. Screen shot of Civil Rights Digital Library: Places.

GEOGRAPHY AND GEOVISUALIZATION ACROSS THE CURRICULUM

Knowledge of geography is essential across subject areas. Students will have difficulty understanding the war in Afghanistan without seeing the geography of the Middle East. To empathize with the Inuit Indians, children need to understand the impact of global warming on the landscape of the Arctic.

Geovisualization tools are being used by professionals across disciplines. In the article "Tracking the Polio Virus Down the Congo River," Raoul Kamadjeu (2009) described how Google Earth was used in public health planning and mapping. These maps were used to dispatch vaccination teams and allocate resources.

Let us explore some examples in teaching and learning.

FINE ARTS

Google Earth allows visitors to explore some of the world's greatest works of art. From Velasquez to Rembrandt, The Prado in Spain, **http://www.google.com/intl/en/landing/prado/**, provides 3D reproductions of artwork in Google Earth.

The aerial photography in Google Earth can also inspire original artwork. See examples at **Google Earth Art** at **http://googleearthart.blogspot.com/**.

Language and Literature. Google Earth is particularly useful for reluctant readers. For some students, seeing close-up views of Alcatraz will draw them into a book like *Al Capone Does My Shirts* by Gennifer Choldenko (2009).

As young people read books related to the Civil Rights Movement such as *The Watsons Go to Birmingham 1963* by Christopher Paul Curtis (2000), think about ways to bring the time period and location alive. For instance, the **Civil Rights Digital Library, http://crdl.usg.edu/places/,** uses Google Maps to browse key locations from the Civil Rights movement and locate archival materials in their digital collection.

Involve students in selecting set locations for their favorite novels. Start by exploring the locations where *The Lord of the Rings* (2001) was filmed using the **Google Earth File, http://bbs.keyhole.com/ubb/download.php?Number=69500.** Noel Jenkins (2009) asked his students to visualize the geography of Svalbard in the book *Northern Lights* by Philip Pullman (2007) and select film locations.

It is also possible to connect Google Earth with travel stories. High school students can track the experiences of Christopher McCandless as they read the nonfiction book *Into the Wild* by Jon Krakauer (2007). Many of the books by Sharon Creech involve travel. Take a virtual flight from New Mexico to the American School in Switzerland as you read *Bloomability* (2008), or track the drive across American in *Walk Two Moons* (2007).

The web site **Google Lit Trips, http://www.googlelittrips.org/,** is well-known for their wonderful literature adventures.

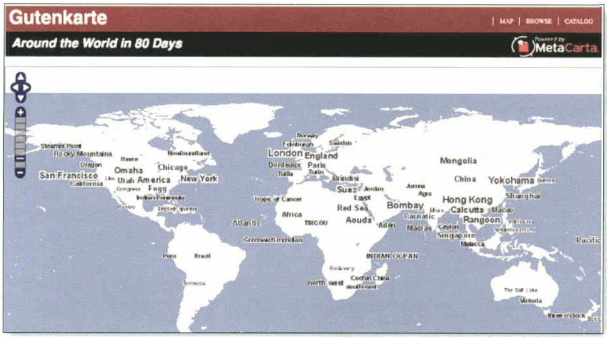

Figure 3. Screen shot of locations found in *Around the World in 80 Days*.

Google Earth files that show author homes and literary landmarks are available. Students can explore Philadelphia while reading *Fever 1793* by Laurie Halse Anderson (2002) or explore the stops on the Orphan Trains described in *A Family Apart* by Joan Lowery Nixon (1995).

Finally, **Gutenkarte, http://gutenkarte.org/**, is a geographic text browser that shows the geographic locations found in public domain texts such as *Around the World in 80 Days* by Jules Vernes (2004).

SOCIAL STUDIES

Whether analyzing Southern American trade or examining world population density, Google Earth contains endless opportunities to see how geography and social topics connect. Students learning about immigration issues and reading the book *Crossing the Wire* by Will Hobbs (2007) might track Victor's movement across the Mexican-US border.

As students study social issues, use **Google Earth Outreach, http://earth.google.com/outreach**, to see how nonprofits and public benefit organizations use Google Earth to visualize their cause and tell their story.

Historical sites worldwide can be explored on Google Earth. Experience Ancient Rome in Google Earth with 3D layers, **http://earth.google.com/rome**. When using Google Earth, enter the name of a battlefield, historical building, or famous landmark to explore a specific historical location.

When Google Earth is paired with historical maps, students can make interesting comparisons in history classes. To view historical maps, choose the Layers option and select Rumsey Historical Maps from the Gallery.

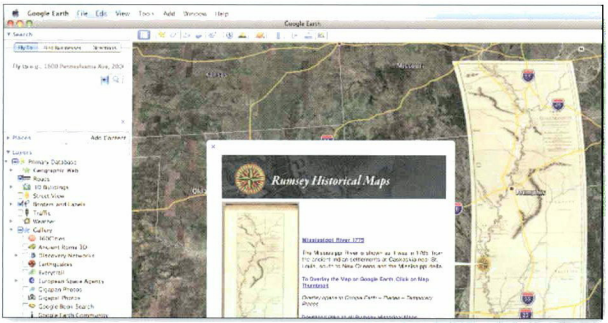

Figure 4. Screen shot of Google Earth with Rumsey Historical Map overlay.

Google Earth can bring historical novels to life. Imagine life in 12th-century Korea while reading *A Single Shard* by Linda Sue Park (2003); then, use Google Earth to examine the setting of Tree Ear's pilgrimage.

Read *Lizzie Bright and the Buckminster Boy* by Gary Schmidt (2008) and ask students to compare the coast of Maine in 1912 with today. Explore the settings of Depression era books such as the travels of the Joad family in *The Grapes of Wrath* by John Steinbeck (2006) and Bud's travels in Michigan during *Bud, Not Buddy* by Christopher Paul Curtis (2004).

From the effects of earthquakes and fire to human aggressions, historical sites around the world are threatened by human and natural disasters. **CyArk, http://archive.cyark.org/**, is a project involved in digitally preserving and sharing the world's cultural heritage. Google Maps is used to identify the sites. Informational and educational materials are aligned with each location. Activities include virtual tours, digital storytelling, and scavenger hunts that help students study topics such as erosion, the effect of rising sea levels, and history.

SCIENCE

Whether studying earthquakes, geysers, or volcanoes, Google Earth provides a wonderful way to visualize the topic. To see volcanoes, simply choose the Layers option and select Volcanoes under Gallery. It is easy for students to see the line of volcanoes known as the "Ring of Fire" along the western coast of North and South America. Students can trace the volcanic evidence around the Pacific Plate. The Smithsonian Institution provides information about many of the volcanoes.

Many well-known organizations such as the Cousteau Society contribute images and video clips to Google Earth. To learn more, visit the **Cousteau Expedition** at **http://www.cousteau.org/expeditions**.

Projects such as **Crossing Boundaries, http://crossingboundariesproject.org/**, involve teachers and students in using information technologies to explore biodiversity conservation. In their article "From Local

Figure 5. Screen shot of volcanoes in Google Earth.

to Global: A Birds-Eye View of Changing Landscapes", Courtney Wilson and others (2009) describe how middle school students used historical photographs and current satellite images to examine the changes in biomes around the world. Young people used Google Earth to explore "a variety of landscape change agents and their potential effects on associated plant and animal communities" (p. 412).

The **Atlas of Our Changing Environment**, **http://na.unep.net/digital_atlas2/google.php**, contains many satellite images that could be integrated into the science classroom.

Saving threatened species, identifying migration patterns, and tracking endangered species are just a few of the ways geovisualization tools are being used in environmental science. Projects such as **Journey North**, **http://www.learner.org/**, rely on data provided by participants to generate observation maps, while the **Sea Turtle** project, **http://www.seaturtle.org/tracking/explorer/**, post data from tagged wildlife.

CREATE AND SHARE VIRTUAL ADVENTURES

Images from Google Earth are easy to export for use in word processing and presentation software. These images can also add interest to projects created in Comic Life.

As you explore GIS resources, you'll begin to notice that people are sharing their favorite projects in a file format with the KML or KMZ file extension. For lots of examples, go to the **Google Earth Gallery**, **http://earth.google.com/gallery/**.

KML (Keyhole Markup Language) is used to record and share placemarks and other information you want to share in Google Earth. You can create KML files with the Google Earth user interface, or you can use an XML or simple text editor to enter "raw" KML from scratch. To share your KML files, you can e-mail them, share them on a local network, or host them publicly on a web server. Just as web browsers display HTML files, geographic browsers such as Google Earth display KML files. Learn more about creating KML documents at **http://code.google.com/apis/kml/**.

ISSUES WITH GEOVISUALIZATION IN SCHOOLS

When using Google Earth and other GIS resources, consider the following issues:

Versions. Google Earth often releases new versions of their software. For the best access, be sure the new version has been downloaded to your computer.

Bandwidth. If Internet access is slow at your school, consider using the web-based tools rather than Google Earth. For instance, if you are looking for satellite images of famous places, try **TerraServer USA**, **http://terraserver-usa.com/famous.aspx**.

Filtered Images. If you are having trouble viewing images, animations, or video in Google Earth, you may need to adjust your school's filter. In some cases, the filter can also affect the speed of access.

GIS Sources. Online tools use images from a variety of sources. Sometimes it's useful to compare sources. Enter the name of a place at the **Geographic Names Information System** from the United States Geological Survey at **http://geonames.usgs.gov/**. This page will provide the coordinates of the location and give you links to many different mapping options including Google Map and MapQuest.

Google Earth Files. Setting and sharing your own placemarks can be time consuming. Before developing your own, see if others have already created virtual trips. Explore blogs such as **Google Earth Blog**, **www.gearthblog.com/**, for ideas.

GOOGLE EARTH AND THE TEACHER-LIBRARIAN

Although Google Earth is fun to explore, it is important that students and teachers

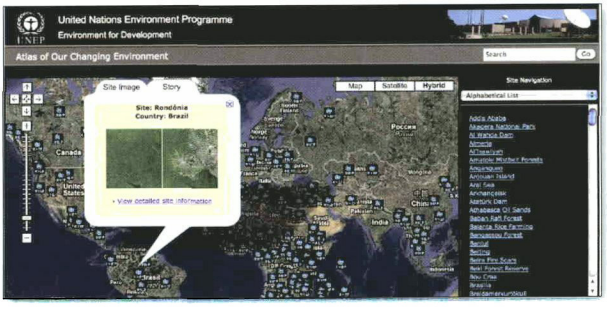

Figure 6. Screen shot of Atlas of Our Changing Environment.

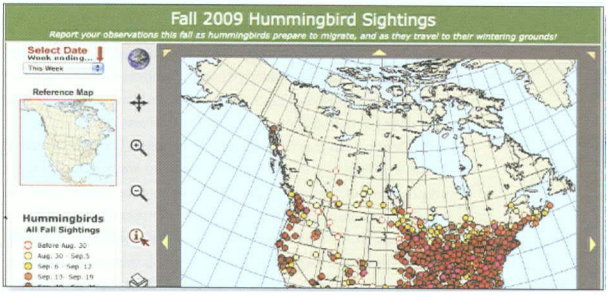

Figure 7. Screen shot of Hummingbird Sighting in Journey North project.

see practical applications that can be connected to the curriculum.

In the article "The Genocide Project", library media specialist Shannon Bomar (2009) shared a unit that combined geography, literature, and history. After reading Elie Wiesel's (2006) *Night*, students discussed their responsibility as global citizens to ensure that genocide never happens again. Pairs of students designed a tour in Google Earth using placemarks to identify locations related to the Holocaust and developed online presentations.

If you are looking for ways to partner with teachers who rarely come to the library, try geovisualization activities. Douglas Butler (2008) uses Google Earth to make mathematics more effective, efficient, and appealing to students. Students can study the angle of airport runways, parabolic sound mirrors used by the military, and the shapes of structures such as the Pentagon and the pyramids.

Rather than thinking about Google Earth in isolation, look for ways to connect it with books, videos, and other resources. For instance, at **Digital Karnak, http://dlib.etc.ucla.edu/projects/Karnak**, students can explore the ancient Egyptian site of Karnak through a timemap, web-based resources, and Google Earth.

Finally, join national and global projects. Use **Geography Awareness Week, http://www.mywonderfulworld.org/gaw.html**, to promote the use of Google Earth and geovisualization activities.

If you are considering the use of Google Earth in your library, be sure to apply for your free educator's copy of Google Earth Pro. Google provides an excellent tutorial and resources to get started using **Google Earth** in learning; go to **Google for Educators, http://www.google.com/educators/p_earth.html**.

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Note: Adapted from a presentation by Annette Lamb and Larry Johnson available at **http://eduscapes.com/sessions/gis/**.