Earth from Above

Students use free online satellite software to explore Earth

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Imagine a group of students riding together above Earth in a hot air balloon. Peering downward, they point out lakes, canyons, fields, houses, and cars. They fly on to make more discoveries from heights they have never experienced before.

What I have described is similar to what students experience on computer monitors when they interact with digital satellite and aircraft images available online. Using free software called Google Earth, students can view Earth by hovering over features and locations they preselect or by serendipitously exploring locations that catch their fascination. Going beyond hovering, they can swoop forward and even tilt images to make more detailed observations of the features they find most interesting.

In this article I present a lesson plan in which students use Google Earth to

- learn basic navigation skills to effectively view images;
- learn ways to determine distance measurements, elevations, and coordinate locations;
- locate and analyze images based on personal research choices; and
- share findings from their research with the class.

What is Google Earth?

In short, Google Earth (produced by the same company that developed the Google search engine) provides a virtual view of Earth. The software offers seamless aerial and satellite imagery and gives the user control to venture to all regions of our planet. Images take on a third dimension as the view tilts and rotates to simulate a flyby perspective while Earth's surface features move by on the screen. Locations such as schools, airports, roads, and boundaries can be layered onto the images. Because Google Earth's screen views are a mosaic of images from several sources, the amount of detail varies by location. The image clarity in most major urban areas distinctly shows buildings, roadways, and vegetation. In these close-up views, the resolution may be about 1 m/pixel. In areas where high resolution is not available, the images show major geologic features and towns in medium resolution of generally 15 m/pixel. With the zooming features of the program, the viewer can see Earth from space and drift downward in some locations to views similar to what would be seen from an aircraft flying less than 0.5 km above the surface.

The basic level of the software is free for personal use, works with newer Windows and Macintosh operating systems, and can be downloaded at *http://earth.google.com*. To accommodate the streams of data, a broadband connection is essential. With a few minutes to explore the controls, students soon become adept at the navigation process that allows them to explore amazing sites of interest.

A treasure chest for classrooms

Earth views provided by Google Earth are intriguing to students. The planet's imagery becomes a manipulative learning tool for understanding Earth's features. The program provides opportunities for students to be curious, to explore, wonder, and discover beyond typically structured lessons. When developing lessons, teachers should always count on students to seek out and share unintended discoveries they stumble across while working and plan

FIGURE 1

Student exploration guide.

Directions:

Search for your community by using your zip code or another search method. Navigate as needed as you explore.

1. What human-made features are seen as you view your community?
2. Locate your school. Record its elevation and its latitude and longitude reading.
3. Zoom in to identify some of the smallest features you can view near your school. List what you see.
4. Click and drag the navigation ring to turn the image. Locate the compass in the left view so you are looking north. Describe what is located north of your school.
5. Tilt the angle of the view of your community. Fly over the area; then rotate the image and fly back over it. What interesting features do you see as you fly over?
6. Describe large, natural features you can see in or near your hometown.
7. Go to the upper menu bar and locate Tools. Inside the Tools menu, activate the Measure tool. Choose two features within your screen view. Measure and record the distance between them in meters or kilometers.
8. Locate and list two or more other interesting features that you see in or near your community.
9. *Extension.* Choose and explore a community in a different part of the United States or world. How is this community different from your own?

for that exploration time. Standards-based learning can be targeted with lessons developed around the software (see "Addressing the Standards," p. 48).

Above-the-Earth images—in the way that Google Earth provides them—become a launch pad for creative approaches for exploring various science topics. Comparisons of volcanic features, river systems, and climate studies are topic examples for the Earth sciences. In biology studies, the mapping of virus outbreaks could be a study topic. Examining ways that humankind has affected regions would be a way to use imagery in environmental science studies. Lesson ideas can also be developed in other disciplines including geography, history, language arts, mathematics, and population and cultural studies.

Lesson overview

The lesson described in this article is centered on the analysis of geologic features and environmental impacts. Initially, the teacher should become comfortable with the navigation tools and other features of the Google Earth program. The teacher should also locate sites of interest in his or her own region as well as sites in distant areas that would be of interest to students.

When I conducted this lesson, I used a computer connected to a projector to show the opening view of Google Earth and engage student interest. Interest peaked as I zoomed Earthward as if descending from space. I then showed how the tilt and rotate controls adjusted the images to show them at various angles and directions. Using zip codes, city and country names, and latitude and longitude, I modeled ways to search for locations. After noticing that some images had more clarity and details than others, we discussed the differences in image resolution, and students sought explanations for why the images in many urban areas frequently had better resolution than those of rural locations. After reviewing aspects of the program, students were eager to take control and make discoveries. Once the goals and expectations of the lessons ahead were laid out, the learning groundwork was in place. Students were ready to begin exploration activities.

FIGURE 2

Image bank for science locations.

Choose to explore several of the following sites. Complete a template organizer for each location you select.

Feature	Location (latitude, longitude)
Alaska glaciers	62.7, –150.5
Stream features in Yellowstone Park, Wyoming	44.68, –110.48
Mount Saint Helens, Washington	46.2, –122.2
Mount Everest	27.98, 86.92
Karst topography, Florida	27.98, –81.72
Entrenched meanders in Big Horn Canyon, Montana	45.02, –108.24
Gold mine at Lead, South Dakota	44.35, –103.77
Niagara Falls, New York and Ontario border	43.082, –79.07
Grand Canyon National Park, Arizona	36.24, –112.40

Explore and explain

For the exploration stage, students began with teacher-directed searches that eventually progressed to open-ended exploration. Students started with a set of problems that allowed them to develop their navigation and

FIGURE 3

Choosing sites of interest.

Locate and analyze at least two scientifically significant features. Complete template organizers (Figure 4) for these areas. You are free to choose your own topics, but try the following features if you need suggested topics: sand dune, lava flow, island arc, landslide, mudflow, cirque lake, ice cap, beach, sea stack, rain shadow area, volcanic island, spit (Homer, Alaska), and deforested area.

(Right): A screenshot of an Alaska glacier from Google Earth.

GOOGLE EARTH/DIGITALGLOBE/TERRAMETRICS

FIGURE 4

Template organizer.

Exploring geologic locations.

Site name or description	
Latitude and longitude	
Reasons for visiting this site	
Elevation and/or relief	
Your discoveries	
Description of feature or topography	
Other interesting aspects from this site	

FIGURE 5

Sample of a completed organizer.

Site name or description	Alaskan glaciers
Latitude and longitude	62.7, –150.5
Reasons for visiting this site	To look for ways that valley glaciers change from mountaintop areas to where they end
Elevation and/or relief	About 350 m at the glacier's end with mountain peak elevations of over 3600 m
Your discoveries	Terminal moraine visible at the end; medial moraines form from tributary glaciers; crevasses visible on steep slopes
Description of feature or topography	Rugged, heavily glaciated, mountainous region surrounded by lower U-shaped valleys and outwash plains
Other interesting aspects from this site	Rivers have several inter-webbed channels as they move across flat land, but eventually become one main channel

image analysis skills. As students searched for images to answer the guided questions, they soon passed from novice operators to proficient explorers. Before long they began to come up with locations and features to search out on their own. Figure 1 (p. 45) provides a set of problems used to hone student observation and technology skills.

Once students were able to navigate easily through Google Earth's image locations, several geologic sites were provided as choices for students to select as possible search locations. I provided a list of Earth science-related features from which students could search for these locations. Students used information gleaned from the site images to complete template organizers for each site visited. Figure 2 (p. 46) shows the site choices and the latitude and longitude coordinates for areas related to geology and environmental science.

After visiting the sites I had selected for exploration and practice, students were expected to explore other locations—student-selected locations of scientific significance. Figure 3 (p. 46) provides directions to challenge students to explore their areas of interest.

Students were asked to compile information for each of their search areas by completing an organizer template as shown in Figure 4 (p. 47). The templates allowed students to focus on several aspects found at each location. A completed template is shown in Figure 5 (p. 47) and can be shared with students at the beginning of the lesson as a model for completing their templates.

Teachers can gather references such as world maps, state highway maps, and atlases to help students independently select places to view. This encourages students to use their map-reading skills, compare landscape regions, and then transfer their thinking to successfully navigate to those locations within Google Earth.

Extensions

Students can continue their exploration of Earth's views by selecting a theme to research. Students can pick a feature or process to focus their exploration on. Topic themes might include glaciers, deserts, volcanic features, rivers, population density, or even the impact of irrigation. Students who research volcanoes can activate Google's layer called National Geographic Magazine that allows placemarks to be seen on the Google images. These placemarks are symbols that rest over specific locations and with a click of the mouse may display photos, information, or even links to photo galleries or video segments that can be viewed. Additionally, the Smithsonian Volcanism Program website *(www.volcano.si.edu)* provides vast amounts of information for research including Google Earth volcano layer placemarks of Holocence volcanoes.

Screen shots of features that students find can be made. These images can then be printed or shown with a projector so what students learned in one group can be shared with their classmates. Group members may use a set of questions they created to see if their classmates can observe and analyze the images carefully enough to come up with expected answers. If the images are saved, a year-to-year reference archive can be created to allow students to monitor changes over time, for example, the melting of glaciers.

Evaluation

At various steps along the way, learning can be assessed. As students work, the teacher can note how successfully students navigate and use the functions available. The templates completed with the image locations become pieces for assessment as well. As noted earlier, some students tend to drift to unusal locations. It might be interesting to find someone's trampoline, but the completed organizers for sites they choose should show exploration and thinking related to science.

Keep exploring

Teachers should keep Google Earth handy on their desktops and use it frequently. As local, regional, and world events occur, they could show students the images of these locations. Teachers could also consider picking a place everyday to explore briefly to start or end the teaching period. One way to challenge students is to help locate interesting discoveries that can be flown over or examined from above. These smooth, hang-gliding-like episodes can reveal so much about our planet. Young learners are thirsty for the realism that Google Earth quietly streams to the viewing screen. ■

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References

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.

Addressing the Standards.

The National Science Education Standards addressed in this lesson include:

Earth and Space Science (NRC 1996, p. 158)
- Structure of the Earth system (5–8)

Science as Inquiry (NRC 1996, p. 173)
- Understandings about scientific inquiry (5–12)

Science and Technology (NRC 1996, p. 190)
- Understandings about science and technology (5–12)

Science in Personal and Social Perspectives (NRC 1996, p. 193)
- Populations, resources, and environments (5–8)
- Natural and human induced hazards (5–12)
- Science and technology in society (5–8)

History and Nature of Science (NRC 1996, p. 200)
- Historical perspectives (9–12)