

GOOGLE EARTH: AN EFFECTIVE LEARNING TOOL FOR SPATIAL ENVIRONMENTAL EDUCATION

Education

Dr. Narinder Kaur

ABSTRACT

With growing concern for teaching environmental education, several methods are being used by the educators to enhance the critical thinking and skills among students. Today, various web-based software's and technologies are available that can be effectively utilized in environment education at different academic levels. One of the web-based technologies is Google Earth, which is an ideal technique to engage students in self-inquiry and self-research just by clicking the keyboard and using the mouse on their computer, or laptop or on their mobile. Google Earth is a free computer-based programme that represents the Earth through detailed satellite imageries and aerial photography. The purpose of this paper is to encourage the use of Google Earth as an educational tool in the environmental education curriculum.

KEYWORDS

Google Earth, Environmental Education, Student learning

I. INTRODUCTION:

Environmental Education allows the learners to understand the complex nature of the natural and the built-up environment. It develops critical thinking among the learners to explore various environmental issues and engage them in problem solving to make decisions and to take relevant actions. In this light, the Belgrade Charter (UNESCO, 1975) define Environment education as the goal to develop awareness and concern about the environment and its related problems and to work individually or collectively to solve the present problems and to prevent the new ones. Ramsey. J.M (1993), reveals that the goal of environmental education is to develop responsible environmental behaviour in citizens. One of the themes of environmental education is to examine the relationship between the humans and the environment and another theme is to examine the change over time (Kerski. J.J, 2012). Using Google Earth, these themes can be effectively examined through the satellite imageries such as daily weather, native flora and fauna, water resources, soil, natural hazards, landforms, land use/ land cover change, population change, urban sprawl, etc. Therefore, through integrating Google Earth in environmental education, students will be connected to real-world data and will develop multiple learning.

I.I. Purpose of the paper:

The **purpose** of this paper is to encourage the use of Google Earth as an educational tool in the environmental education curriculum. As this software is pre-loaded with a variety of data and applications, therefore it can be an excellent technology for inquiry-based and research-based activities. It not only helps the teacher to prepare their lesson plan, but also enables the students to search, create and display their own data by exploring different locations and places through different angles. As a software tool, it can enhance the student learning in diverse content areas through 3D satellite images and aerial photography. They can also create their 3D models in order to overlay on the map through the computer screen. Google Earth enables the student to analyze the current environmental issues spatially such as climate change, deforestation, acid rain, land use and land cover changes, global warming, pollution, etc. Spatial analysis through Google Earth helps students to solve problems and can connect the students with real world learning. Hence, the results may offer important teaching-learning pedagogies as well as technology integration strategies.

I.2. Significance of Google Earth in Education

With the increasing applications of web-based technologies, there is also an increase in the usage of these technologies as a tool in educational curriculum. One such widely used educational tool is Google Earth, which offer new opportunities to explore and learn the world in different ways. It is becoming a significant tool, because it has the ability to view the landscape in three dimensions as well as using a combination of digital elevation models through satellite images (Sheppard, 2007) as cited in an article "Evaluation of Google Earth in Classroom" by Mathew P.C, 2010. Google Earth, has opened up potentials for its users, particularly students in the classroom curriculum and provides an understanding of the virtual globe through the computer screen online. As an online tool, it allows the students to learn the virtual tour and adventures around the globe, including the outer space as well as tour under the sea (Lamb and Johnson, 2010). Schultz et al. (2008) point out, that the main purpose for considering

Google Earth in classroom at all levels is, its easily available data, low cost, the ease of use, and its engaging nature. The increasing use of internet technologies has made it possible to access directly to the vast amount of information of the world (Andreopoulou et.al., 2011). Hence, Google Earth is a significant tool in education because it can be used appropriately for education in a wide range of subject areas. As it is pre-loaded with a variety of data, therefore, enables the users to create and display their own data.

I.3. What is Google Earth?

Google Earth is a free downloadable online application, that allows the users to view high resolution satellite imageries and aerial photography of the Earth. Through this virtual globe the users are not only able to interactively display and investigate the landscape data of satellite and aerial images and terrain models, but also view 2D and 3D data, such as land use/land cover, water bodies, buildings, etc. The most powerful and useful aspect of Google Earth from Environmental education point of view is the availability of a variety of environmental related datasets for free on the web.

I.4. Google Earth Pro:

Google Earth Pro is the standard version of the Google Earth desktop application. It is the extended power of the Google Earth with additional and advanced tools designed for the users. Google Earth Pro provides a series of applications and tools that can be utilized by the users through their desktop. These applications let the user to fly anywhere on the Earth to explore the satellite imageries starting from the oceans, land, and to the sky. Even by superimposing or overlaying the satellite images and aerial photography, the users are able to see the locations, places and landscapes from various angles.

II. Literature Review

II.1. Framework:

The review of the literature will discuss the use of Google Earth in Education in general and Google Earth in Environmental Education in particular. As the aim is to develop an understanding and significance of Google Earth as an educational tool with special reference to environmental education, therefore, it focuses on the use of this tool in environmental education curriculum.

II.2. Google Earth in Education:

Integrating geospatial technologies with focus on spatial thinking skills, may provide a platform to achieve educational goals effectively and develop environmentally literate citizens. Google Earth offers a wide variety of geospatial data, including imagery of the globe at varying resolutions that contains visual information. This software allows users to explore the Earth in three dimensions while streaming satellite imagery, elevation, and other data from the Internet. Students can use Google Earth as a tool to find their homes, schools, and other locations that are familiar to them. They can learn to create and displaying their own data and by using different layers of the Google Earth Pro, they can gain knowledge about the world. In light of this, Patterson, 2007 has stated that Google Earth can enable the students to understand spatial information to meet the challenges of various standards-based curricula. Similarly, Schultz, et al. 2008, highlighted that Google Earth can be effectively utilized standard based and inquiry-based lessons to investigate places in three-dimensional

visualization. Patterson, 2007,149 claimed that Google Earth can provide resources for solving problems and thinking logically.

In a number of educational institutions, educators from different disciplines are using Google Earth as an educational tool. For instance, at Old Dominion University, USA, Google Earth teaching materials (Google Earth Science) have been created by Dr. Declan through which the students are able to learn the boundaries of the tectonic plates, volcanoes, atmosphere and also the three-dimensional structure of the Sun, Mercury, Venus, Mars, the Earth, and Moon. Another course named 'Geog493, Exploring the Virtual Earth' is offered by the University of Alaska Fairbanks, that teaches the students how to use Google Earth and offers introductory KML exercises. This course focuses on the applications of digital elevation data and also emphasizes on the methods of the generation, compilation and analysis of data. Educators at Middlebury College, USA, are helping the students to understand how their meals are related to the Earth system in the Food Mapping Project, through the Google Earth. 'Google Lit Trips' is a website with a user interface and KMZ files to supplement specific literature. Therefore, both teachers and students are designing their own literary trips to share with the online community (Boss, 2008).

In India, a non-profit organization 'India Literacy Project' has created the Multidimensional Learning Space initiative during and after school program. This organization is working in more than 1700 villages and 3300 schools to provide opportunities for the students to explore, experiment, discover and learn in multiple ways through Google Earth specifically in social sciences.

II.3. Google Earth in Environmental Education

Google Earth is a relatively new geospatial technology that is changing how people can interact with remotely sensed aerial and satellite images. Therefore, implementation of technology is needed at global and local scale. Integrating technology with environmental education can encourage the students to explore, solve problem, create, investigate, evaluate, analyse and interpret various environmental issues. Andreopoulou et.al. (2011) noted that the increasing use of internet technologies has made it possible to access directly to the vast amount of information of the world. Butler, 2006 noted that the Google Earth's popularity among the growing number of scientists is due to its ability to place spatial data as well as the excellent background imagery as cited in the Book "Geomorphological Mapping, Method and applications by Smith J.M et al (2011). Designing Google Earth Activities for Learning Earth and Environmental Science Remotely sensed images have been used in educational settings as tools for learners to identify and interpret land cover features and view changes on the Earth's surface over time (Huber, 1983). Several studies conducted by scholars have emphasized on the implementation of Google Earth in environmental education curriculum. Bodzin A.M et al (2014), in their article 'Designing Google Earth Activities for Learning Earth and Environmental Science' emphasize on the use and role of Google Earth as a learning technology to promote understandings of Earth and environmental science. They have described two instructional middle school modules based on environmental issues -land use changes and Energy. The role of using educative curriculum materials as a form of professional development with Google Earth is discussed.

Kerski. J, 2012 in his paper 'Spatial Environmental Education: Teaching and Learning about the Environment with a Spatial Framework' has discussed about the significance and use of geospatial technology in environmental education. In another article 'Mapping Deforestation with Google Earth' by Goldberg.R (2013), stated that Earth lost about 888,000 square miles of forest between 2000 and 2012 (based on the Geographer, Mathew Hassen's Map, University of Maryland). This article claimed that, the tropical forests prove to be the most susceptible to deforestation in Indonesia showing the most forest decline. Every year, forest in Indonesia is diminishing at a faster rate (above 7000 sq. miles) due to increasing demand for timber as well other developments particularly industrial development. In another study 'Exploring the Use of Google Earth Imagery, and Object-Based Methods in Land Use/Cover Mapping by Qiong Hu. Et al (2013) has recommended object-based method for imagery classification when using GE imagery for mapping land use/cover. The objective of their study was to classify land use/ land cover at regional scale using Google Earth imageries. IINO. N et al (2006) in their paper 'Satellite Images of Air Pollutants and Land Cover for Environmental Education

and Disaster Prevention' have used satellite imageries to observe the air pollutants and natural disasters such as earthquakes, floods, and forest fires occurred in Kyushu.

Haslett. S.K. et al, (2011) have used Google Earth to examine the impact of climate change in North Africa and created an exercise in which, the students were asked to manipulate and interpret the Late Quaternary paleo-climate data from a deep-sea core taken offshore Mauritania, which suggests that warm Atlantic sea-surface temperatures enhance Saharan aridity. Such exercise of Google Earth can enhance the ability of students to view the impact of climate change and distant landscapes from the classroom. They can also explore the landscapes from different angles and scales.

Ghauri and Zaidi (2011) have used the application of remote sensing satellite imageries in environmental issues in monitoring of forest, water courses, agriculture area, regional and urban planning, land use and land cover changes, air and water quality, mineral exploration, natural and man-made hazards etc. They reveal that utilization of the Geo-spatial techniques for environmental monitoring and assessment is a more cost effective and precise option as compared to the traditional approaches. Similarly, a number of educators, corporate personnel, researchers, teachers in Japan have produces lessons using Google Earth to help students in understanding of their cities and their environment. The Saitama Prefectural Board of Education is helping in delivering the lessons using Google Earth, which enable the students to learn independently and interactively. By using this tool, the students explore Mt. Fuji's problems, such as congestion and trash issues, caused by the growing number of tourists and climbers and then propose conservation measures. Therefore, Google Earth acting as a driving force in the educational technology.

Google Earth Pro has the potential to enhance methods for teaching environmental education and helping students to develop their skills such as critical thinking, analysis, inquiry skills, interpretation and evaluation. By integrating technology like Google Earth in environmental learning, educators can not only create an opportunity for the students to make them aware of the environment, but also to learn the technological skills as well. Google Earth as a teaching tool is being used in multiple disciplines at various levels, such as social studies, science, mathematics, English, geology, oceanography, etc. Though, educators are using different Google Earth lesson plans (classroom and online) under various themes such as Water and Food Security (SST), Exploring Earthquakes (science), English Language Art (English), Urban Heat Islands (Geography), Arctic Climate (Geography), Measuring Seacliff Erosion Rates (Oceanography), etc. However, use of Google Earth in Environmental education classroom teaching has not yet been clarified. Literature is missing in using this tool explicitly focusing on environmental education. Although, number of studies have focused on the use of Google Earth and recommended to implement this tool in environmental education curriculum, but little evidence is available for implementation of this tool in Environmental Education curriculum. It is also evident from the previous research studies that Google Earth as an educational tool has the capability to promote environmental protection in the future. However, it is possible only, when educators implement the theory into practice. Therefore, a need is felt to highlight and to implement the use of Google Earth in environmental education classroom teaching. This paper is an attempt to bridge the gap between the theory and practical usage of this tool in Environmental Education in the classroom. Keeping this in mind, the specific aim of this paper is to implement an environmental education curriculum in the educational institutions and to foster a disposition towards environmental education. The related key questions to this aim are:

III. Research questions:

1. Which Google Earth tool is focused on as an educational tool?

The main focus of this paper is to use **Google Earth Pro tool** as an educational tool to study and interpret various global environmental issues.

2. What knowledge is required to understand the tool?

Students should have little previous knowledge to operate computers in order to open the Google Earth Pro on their computer desktop so that they work individually or in pairs in a computer lab. The instructor should have enough prior knowledge of Google Earth to sort out errors or issues related to the tools, that the students may make.

3. What kind of teaching strategies is required to understand this tool?

To understand the tool, engaged inquiry-based pedagogies are required to provide insights into why, what and how. This strategy should be based on active learning, research-based learning, interactive engagement, and self-inquiry based learning. As Meyers and Jones (1993), have stated that the active learning allows students to talk, listen, read, write reflect through problem solving exercises.

4. Which are the environmental issues that can be well addressed by using the Google Earth Pro?

Google Earth provides a combination of information to understand many subjects ranging from natural sciences to social sciences, history, art, engineering and many more. A number of environmental issues can be analyzed and interpreted through Google Earth Pro such as change in land use/land cover, deforestation, weather pattern, climate change, identifying the natural hazards, acid rain, water pollution, etc.

5. How to interpret environmental data through Google Earth?

Satellite images comprise of useful and interesting information. Through these images we can identify various environmental data such as changes in a city, agricultural land, forest, where a fire is burning, or when a storm is coming etc., To interpret this information, five steps are needed - 1. Scale 2. Patterns, shapes, and texture 3. Colour 4. Find North 5. Consider prior knowledge. (Details in APPENDIX I.)

IV. Final Discussion

It is evident from the literature that Google Earth is being used as an educational tool in multiple disciplines such as science, social studies, geography, oceanography, etc. and various features of environmental education is also being taught. However, literature is missing on using this tool explicitly focusing on environmental education curriculum as a distinct subject. The strength of this paper is that, it is addressing the use of Google Earth Pro in the Education specifically in environmental education curriculum. Although other disciplines are teaching environmental issues using this tool, however, not as a distinct subject. The aim is to teach its values, disposition and practices and developing curriculum in serving the environmental education. This is a mere gateway through which, students will become aware of the real-life environmental issues by observing different satellite images. However, the students can also use this tool to explore their own local area to search the vegetation type, types of trees, number of industries, proximity to the railway line, highway, protected area. After identifying these locations, they can visit these locations to collect the water or soil samples to analyze the pH at the local government organizations. The analysis will determine the environmental status of such areas which will help the students to develop their own data and make an interpretation.

V. Conclusion:

Implementation of Google Earth Pro in environmental education curriculum will help the students to visualize and understand various man-made and natural features globally. It can be used as an effective environmental, educational tool, when accompanied by appropriate supporting material and learning design. The most powerful and useful aspect of Google Earth from Environmental education point of view is the availability of a variety of environmental related data sets. Working together, educators, scientists and environmentalists can design and develop instructional materials that present earth and environmental content and concepts in appropriate and engaging ways for learners. The main benefit of the Google Earth in environmental education is the ability to view distant landscapes and changes in the landscape features from the classroom, and to explore them at different scales and from different viewpoints or angles. In addition, it will allow the users to compare the data by superimposing or overlaying images to interpret the visual data in time and space. This paper may open new avenues for future research on the implementing of Google Earth pro in environmental education and can provide a base for further discussion on environmental education curriculum. Hence, the technology by itself is worthless, but as a tool, technology offers enormous potential to extend our capabilities.

APPENDIX-I.

1. Scale: Before interpreting any feature, scale must be set up to view high resolution satellite imagery. Different things can be learned at different scales. For example, for tracking a flood in an area, high resolution view will show homes surrounded by water, A broader view

will show the entire region and the hemispheric view would show the movement of weather systems connected with the floods.



Image 1.

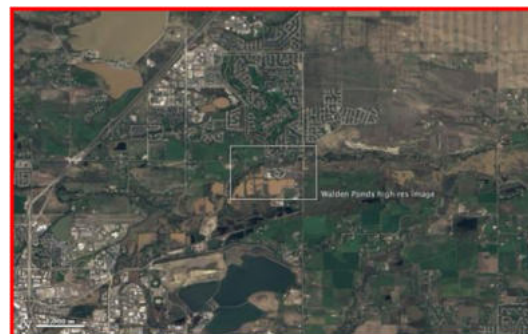


Image 2.

Source: <https://earthobservatory.nasa.gov/Features>

2. Patterns, shapes, and texture: Satellite imageries have different patterns, shapes and texture. For example, water bodies such as rivers, lakes or oceans are the simplest features to identify. They have linear shapes, while agricultural land generally has geometric shapes- circles or rectangular depending upon the way people use the land. Deforested land is often square in shape, volcanoes and craters are circular, mountain ranges tend to run in length, and look like bumps. A straight line anywhere in an image is almost certainly human-made, and maybe a road, a canal, or some kind of boundary made visible by land use.



Image 3.



Image 4.

Source: <https://earthobservatory.nasa.gov/Features>

3. Colour: The colours in an image depend on false colour light or the true colour light. True-colour images use visible light—red, green and blue wavelengths—so the colours are similar to what a person would see from space. False-colour images incorporate infrared light and may take on unexpected colours.



Image 5.

Source: <https://earthobservatory.nasa.gov/Features>

As water absorbs light, so it usually looks black or dark blue in colour. Sunlight reflecting off the surface of the water makes the water look grey, silver, or white. This phenomenon, known as sun glint, can highlight wave features or oil slicks, but it also masks the presence of sediment or phytoplankton. Frozen water—snow and ice—is white, grey, and sometimes slightly blue.

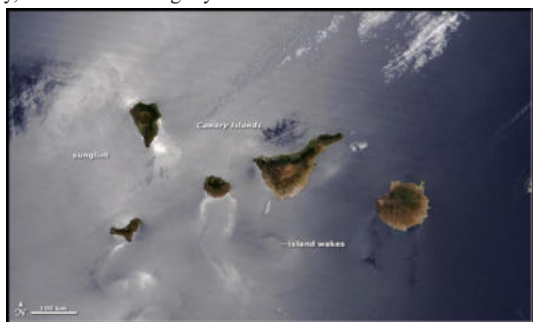


Image 6.

Source: <https://earthobservatory.nasa.gov/Features>

Plants have different shades of green. Grasslands generally look pale green, while forests are very dark green. Land used for agriculture is often much brighter in tone than natural vegetation. In some locations, plant colour depends on the season. Spring vegetation tends to be paler than dense summer vegetation. Fall vegetation can be red, orange, yellow, and tan; leafless and withered winter vegetation is brown. For these reasons, it is helpful to know when the image was collected.



Image 7.

Source: <https://earthobservatory.nasa.gov/Features>

Bare or very lightly vegetated ground is usually looked brown or tan. The colour depends on the mineral content of the soil. In some deserts such as the Australian Outback and the southwestern United States, exposed earth is red or pink because it contains iron oxides like Hematite. Densely built up areas look silver or grey silver or grey while; some cities have a more brown or red tone depending on the materials used for rooftops.

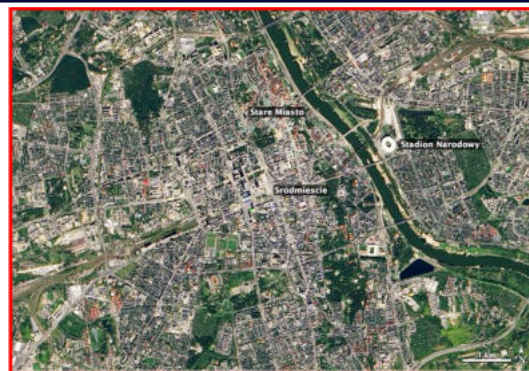


Image 8.

Source: <https://earthobservatory.nasa.gov/Features>

4. Finding North: If North is known to the learner, then it will become easier to find out the directions of the location or a place. For example, North can help the learners to figure out the mountain range, whether running from north to south or east to west.

5. Prior Knowledge: Little prior knowledge of the place or location, will help the learner to interpret and analyze the satellite images in an effective way. For example, if you know that last year, the forest fire occurred at this place, then it will become easy to detect the dark brown patches of the forest. If you lack knowledge of the area, a reference map can be useful.

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