Making Differences: Uses of GeoBrain in Classroom Teaching of Earth System and Geospatial Information Sciences at Higher Education Institutes Worldwide

Meixia Deng	Center for Spatial Information Science and systems (CSISS), George Mason University, mdeng@gmu.edu
Liping Di	Center for Spatial Information Science and systems (CSISS), George Mason University, ldi@gmu.edu
Mark Abolins	Department of Geosciences, Middle Tennessee State University (MTSU), Murfreesboro, TN 37132, mabolins@mtsu.edu
Hongmian Gong	Department of Geography, Hunter College, The City University of New York (CUNY), gong@hunter.cuny.edu
Guoqing Zhou	Department of Civil Engineering and Technology, Old Dominion University (ODU), Norfolk, VA 23529, gzhou@odu.edu

Abstract

GeoBrain is a standard-compliant, open, distributed, three-tier Web information and knowledge building system developed for helping education and research activities in Earth system and geospatial information sciences. Utilizing latest Web service and knowledge management technologies, the system creates an on-line geospatial data-rich learning and research environment that enables students, faculty members, and researchers from institutes all over the world easily to access, analyze, and model with the huge amount of NASA EOS data just like they possess those vast resources locally at their desktops. Through sharing the experiences and lessons learned from using GeoBrain in classroom teaching at some selected higher education institutes, this paper demonstrates how the GeoBrain system has brought changes to the traditional education in Earth system and geospatial information sciences and how the utilization of GeoBrain in classroom teaching can make great differences in these areas.

Introduction

The GeoBrain project was funded by NASA REASoN program in 2004 to facilitate Earth Science research and education at higher-education institutes with innovative technologies (http://geobrain.laits.gmu.edu). By adopting and developing latest Web service and knowledge management technologies, the project team has implemented the GeoBrain, a standard-compliant, open, distributed, three-tier Web information and knowledge building system. The GeoBrain system not only makes petabytes of NASA Earth Observing System (EOS) data and information easily accessible to users through any Internet connected computers, but also offers interoperable, personalized, on-demand data access and visualization to those huge volumes of NASA EOS data. In addition, the system provides cutting-edge technologies and capabilities, such as on-line data analysis, geoprocessing modeling and knowledge sharing [Di, 2004; 2005]. Thus, GeoBrain can be used as an on-line geospatial data-rich learning and research environment in four major ways: 1) an unlimited global geo-data source, 2) an on-line data analysis system, 3) an on-line platform for geoprocessing modeling, and 4) a platform for geospatial knowledge sharing [Deng and Di, 2006].

Powered with GeoBrain, students, faculty members, and researchers from institutes all over the world can easily access, analyze, and model with the huge amount of NASA EOS data just like they possess those vast resources locally at their desktops. The online learning and research environment enabled by GeoBrain brings great benefits and advantages to the current Earth science academic programs, especially to those universities who lack enough computing resources. The used-to-be very challenging or even impossible teaching tasks can become much easier or practical with the help of GeoBrain. For an instance, dynamic classroom demonstration and training for students to deal with data-intensive issues of global climate and environment changes in real-world applications are possible now through the system. With GeoBrain, each student can be trained to handle multi-terabytes of EOS and other geospatial data in simulation and modeling for solving global-scale problems catering their own interests with a simple Internet connected computer.

The major objective of this paper is to demonstrate that the online Earth system learning and research environment provided by GeoBrain can really help educators, students and researchers. Though the activities utilizing GeoBrain in education and research is myriad, this paper only give some examples of them for illustration purpose, which are experiences of using GeoBrain in classroom teaching at the three selected higher education institutes, namely the Middle Tennessee State University (MTSU), the Hunter College of the City University of New York (CUNY), and 3) Old Dominion University (ODU). These experiences of incorporating the GeoBrain capabilities into the classroom teaching may provide us different perspectives and insights that can be useful to other institutes.

Using GeoBrain in Educator Professional Development

MTSU Geosciences faculty and students (the MTSU GeoBrain Group) are using the GeoBrain system to obtain remotely-sensed data for K-12 educator professional development and undergraduate instruction and research. The following section briefly describes the educator professional development work of faculty members Mark Abolins and Laura Collins and undergraduates Travis Estep, Larry Cole and Lisa Travers. They used GeoBrain to obtain images for illustrations of Costa Rican tectonics. Instructor Collins used these illustrations while working in Costa Rica during Summer 2006, and she will use them again during a “Geology for Teachers” course to be held in Costa Rica during Summer 2007.

The GeoBrain system provides fast and convenient access to global image archives, and images from these archives can be used to illustrate the geology of any part of the world. Simple, colorful illustrations (e.g., Abolins, 1997; Gore, 1998; Fisher et al., 1998) make complex research accessible to K-12 teachers. For example, Costa Rica is a great place to teach teachers about the connection between contemporary volcanic activity, on one hand, and features on the seafloor and within the Earth’s interior, on the other (Fig. 1). To create illustrations of Costa Rican tectonics, the MTSU GeoBrain Group used GeoBrain’s freeware Multi-Protocol Geoinformation Client (MPGC) to download free images from the Jet Propulsion Laboratory World Map Service and the Committee on

Earth Observing Satellites (CEOS) European Data Server. Useful illustrations were derived from Shuttle Radar Topography Mapping (SRTM), Blue Marble Next Generation (BMNG), Defense Meteorological Satellite Mapping (DMSP) and Moderate Resolution Imaging Spectroradiometer (MODIS) images. These images would likely have been prohibitively difficult and time-consuming to obtain in any other way.

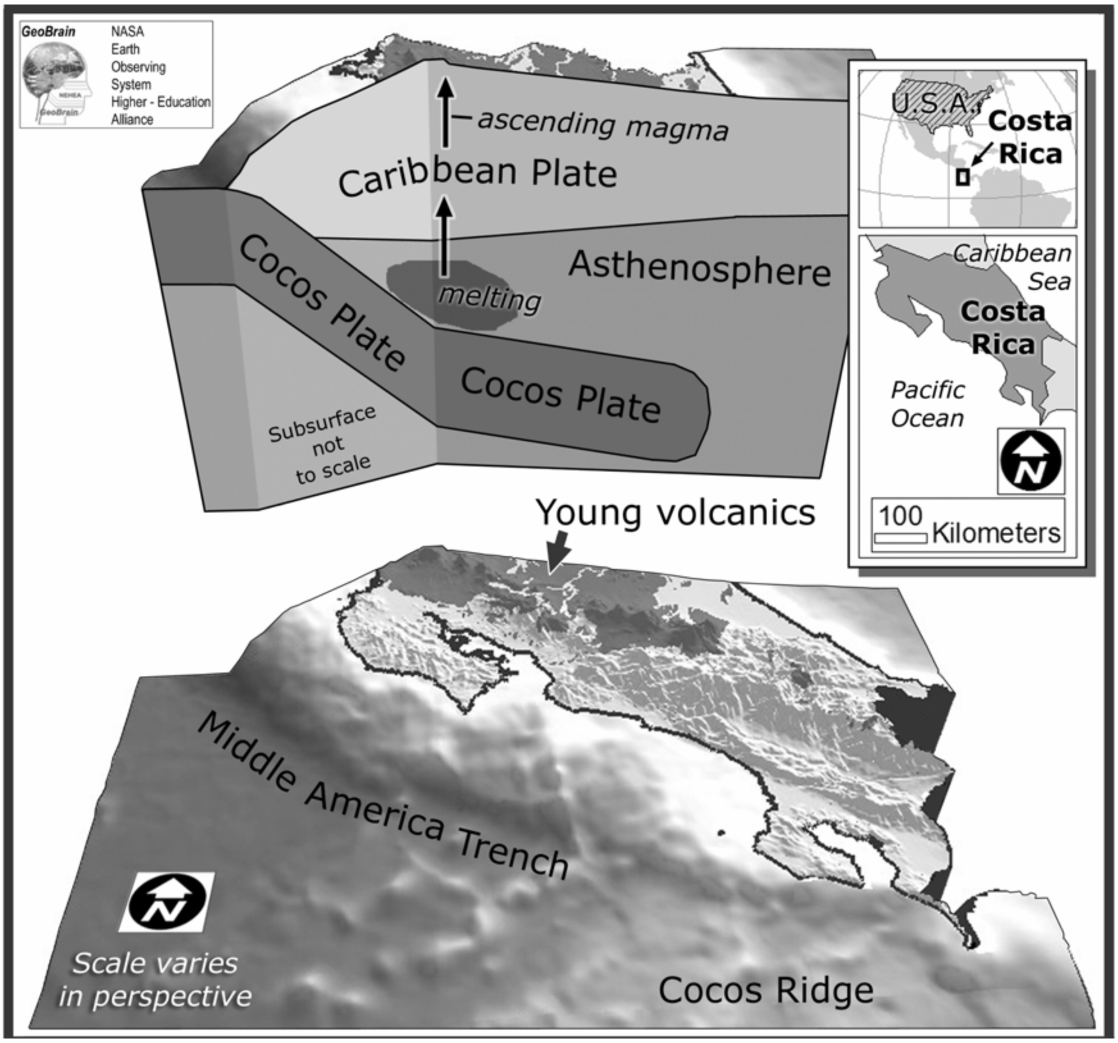

Fig. 1 Volcanic and tectonic features of Costa Rica and the adjacent Pacific seafloor

Subduction of the Cocos Plate drives volcanic activity in northern Costa Rica and has created the Middle America Trench off the Pacific Coast. In southern Costa Rica, volcanic activity has ceased because of tectonic processes directly or indirectly related to subduction of the Cocos Ridge (Marshall et al., 2003; MacMillan et al., 2004). As outlined in the text, key features related to subduction and volcanism are easily seen on color images downloaded with GeoBrain's Multi-Protocol Geoinformation Client (MPGC).

Teaching Effectiveness Improvement through GeoBrain at ODU

ODU delivers GIS and advanced GIS courses for graduate students and undergraduate students to 15 states, 50 higher education centers, and 4 oversee navy bases (Japan, Koera, Mid-East, and Canada) via both the regular classroom and ODU TTN (Tele-Tech-Net) system (active satellites, stream video, video tapes, DVD, etc.). Usually, these courses are mainly focused on introducing students with basic concepts due to the difficulties of distance education and shortage of computing sources. However, in the semester of Spring 2006, Dr. Guoqing Zhou started to welcome quite big changes in teaching these courses after the introduction of GeoBrain.

First, new concepts and technologies related to the GeoBrain system are introduced to students, including 1) Geo-object and geo-tree concepts as well as their applications in geospatial data analysis, 2) Geospatial interoperability and Interoperable geospatial Web services, 3) Standard-based Web information and knowledge system and its application in the dynamic and interactive construction and running of interoperable geospatial service modules and models, 4) Characteristics of Open GIS Consortium (OGC), Web Coverage Service (WCS), Web Feature Service (WFS), and Web Registries Service (WRS).

After these concepts are introduced, the GeoBrain system is introduced and provided to students for free exploration and homework. Assignments are designed and developed for undergraduate and graduate students based on GIS theories, concepts and the GeoBrain functionalities.

Finally, the effectiveness of developed education materials and teaching style is assessed through the questionnaire survey. The questionnaires include such as

- How could the GeoBrain better support your course knowledge and improve your learning?
- What (which component) did you like best/least about the GeoBrain system?
- What problems have you encountered when operating GeoBrain system?
- Did these chapters related to GeoBrain system show interesting ways of applying knowledge?
- Did these activities help you develop a better understanding to web-based GIS?
- What did you like best/least about these chapters and exercises?

The feedback from students unanimously demonstrated that the GeoBrain system enhances their learning effectiveness and change their learning manner. With the GeoBrain technology, the remote students successfully implement their homework that the traditional teaching mode can not do because they easily access the large volume of geospatial data through their Internet-connected desktop computers without requiring the fast Internet connection.

Teaching and Studying Urban GIS applications at Hunter College of CUNY

For three quarters of the semester in spring 2006, Dr. Hongmian Gong's Urban GIS applications class at Hunter College of CUNY has been struggling hard to teach students techniques and models used to analyze complex urban phenomena. However, all exercises and analyses had been executed exclusively on vector data within the ArcGIS platform, the wealth of remotely-sensed imagery could never been made available to students through this traditional platform. Most students have not gotten a profound sense to do analysis for determining the change over time of the racial and ethnic composition of a neighborhood, or for explaining the clustering of industrial activity of various types using a location quotient analysis, or defining urban extent within the study area more accurately.

At this point, GeoBrain is introduced into the urban extent lab to help both the professor and students. Equipped with GeoBrain, Professor Gong has been really relieved from working hard to prepare appropriate data. For most students without prior knowledge about data types and sources, GeoBrain immediately piques their interests. It serves as a great introduction to the various types of remotely-sensed data that could be applied to the analysis of urban phenomena, adding another level of complexity to, and enriching the students' potential for understanding urban dynamics. Best of all, the data are made available to them at no cost. Several students comment that they have been under the impression that the only way to obtain such data is to buy it. One first-year graduate student in geography who has taken an introductory remote sensing course during the previous semester is excited to learn that both MODIS and ASTER data could be downloaded from a single location using GeoBrain's intuitive interface, which he says could potentially be a "major time saver". Even the students who have never worked with satellite data could appreciate the ease and speed with which a wide range of data products can be obtained; many of them are already all too familiar with having to conduct difficult and time consuming searches for shape files.

Once armed with the Landsat data they downloaded from GeoBrain, the students learn how to import it into a remote sensing software suite in which it could be processed and manipulated in a multitude of ways. In this way, GeoBrain products allow students who were unfamiliar with remote sensing software to be introduced to it. Furthermore, through the use and analysis of several data types from different sources—including vector data from the city, USGS, and census, and the raster data from the GeoBrain website—students are able to more thoroughly understand the concept of urban extent. Students find that Landsat data from GeoBrain is more accurate than both the census and USGS data in defining the urban extent of the New York metro area.

At the end of the lab session, a second year master's student who is also taking a remote sensing class that semester, comments that it is the first time he has been able to integrate remotely-sensed data with the GIS. Echoing what another student has mentioned earlier in the period, he says that he has had no idea that satellite data could be so simple to obtain through the GeoBrain website.

An undergraduate in her senior year majoring in geography observes that the Landsat data is great for comparing seemingly arbitrary census-defined boundaries to the extent of the urbanized region. She also mentions that the GeoBrain website serves as an excellent introduction to remotely-sensed data because it offers free, high-quality data products through an intuitive, straight-forward user interface. Much of Professor Gong's class agrees with her statements, concluding that GeoBrain plays an important role in providing a clear introduction to a field that can be quite difficult to understand.

Words of GeoBrain quickly spread among many of the graduate and undergraduate students in the geography department in the days following the lab. Many students who are still new to the field of remote sensing and who have been struggling to locate satellite data for class projects find GeoBrain to be an excellent, comprehensive resource for their data needs.

Conclusions

The GeoBarin system provides Earth science data and analysis services to worldwide users. The service statistics for the GeoBrain access log show users from over 1,700 computers all over the world access the GeoBrain data and services. This paper only summarizes the experiences of using the GeoBrain system in three higher-education institutes. These experiences demonstrate that GeoBrain has brought significant, positive changes to the Earth system and geoinformation science education in those institutes. Both students and professors are all benefited from the capabilities provided by the GeoBrain system which make the access and analysis of huge volumes of Earth system data much easier.

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