GIS FREEWARE AND GEOSCIENCE EDUCATION IN LOW RESOURCE SETTINGS

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Abstract: The development of Geographic Information System (GIS) has played very important role in understanding and communicating geoscience in the last couple of decades around the world. Now a days Geoscience teachers and students make extensive use of spatial data, spatial data base management, spatial data retrieval, visualization and spatial data analysis. GIS software tools are playing an important role in geoscience education and hence considered an integral part of geoscience teaching and learning. Commercial or proprietary GIS tools such as ENVI, ArcGIS and ERDAS are highly useful but despite of their demonstrated utility these tools have perceived problems in low resource settings. Commercial GIS software are often very expensive and highly complex for free available spatial data which is often low quality data. Free and open source software tools such GRASS, SAGA, ILWIS are now available which are impacting and have potential to impact further the geoscience education in low resource settings.

The aim of this paper is to enlist the available free and open source GIS software tools and present our experience with these tools to assist teachers at low budget institutes towards understanding the potential of GIS free and open source software tools in geoscience education in low resource settings. This paper also explores the possibility presented by the free and open source GIS software tools, provides categorizes and describes their use in geoscience education. Our search on the availability and utility of free and open source GIS tools reveals that for all categories of commercial and proprietary software used in geoscience education a free and/or open source tool is available. In low resource settings these free and open source tools have huge advantage over commercial and proprietary software tools because these tools are available without any cost and mostly fit for handling low quality freely available spatial data.

Keywords: Freeware, Open Source Software, GIS, Proprietary, Low Resource Settings

Introduction

Geoscience is the study of Earth. Understanding the Earth's past, investigating how it changes over time, understanding what stages of development it is in now, what may happen to it in future and how we need to care for our planet and live in balance with it, is important for our survival. Geoscience teaching and learning involves the investigation of the Earth and how its systems work. Geoscience is the study of the Earth in space in relationship with our solar system and the wider universe. It is the study of the thin and finely balanced atmosphere, its solid surface, its water and the components and structures that lay deep inside (Nawaz and Shaw 2011). Geoscience is also about the study of the change of the Earth over time, from the begging of the planet 4.6 billion years ago through all the ages of geologic time to the present and beyond (Patyk-Kara, Bykhovsky et al. 2001).

Geoscience education has benefited significantly through the application of contemporary pedagogy, and in particular the use of ICT (Manduca, Mogk et al. 2010). Through computer-generated animations students who study geosciences today are able to see the un-seeable. For example, the Earth's crust from side view or from above and through the use of computer generated imaging technology, students can see how former ice ages might have looked, if they have been to be there to see them. Students of geoscience see how rock is used as source of minerals and how catastrophic events in the past have had dramatic effects on the landscape that we see today, and they can virtually go where nobody has gone before, to study what happens underground. The use of computer-generated animations is also useful in other undergraduate teaching, such as in agriculture (McGregor, Griffeth et al. 2008).

Geoscience is combination of sciences and draws upon all other sciences to unlock the Earth's mysteries. It surrounds us and includes us, a world in which everyone is affected by Earth's processes and is guardian of assets now and generations to come. We know that there are some significant issues that humans need to address, such as climate change (Mirza and Ahmad 2005) natural hazards such as earthquake (Tapponnier, King et al. 2006; Monalisa, Khwaja et al. 2007) and the increasing pressure on natural resources, and their availability, such

as energy, clean water and soil to grow food. In order to address and manage these issues, and to continue to discover new geoscience knowledge we need to continue to produce new generation of geoscientists.

Geoscience teaching and learning covers a broad range of topics related to earth and its landscape including mountain building, structure of earth, the erosion of continents, and the location of natural resources, volcanoes, paleoclimate and evolution. Geoscience teaching and learning involves understanding how our planet works, which is essential to properly manage our environment and predict how the environment will change in future. Through Geoscience education students can understand and appreciate our complex planet (Nawaz and Shaw 2011).

Geoscience today is a space-age science making extensive use of remote sensing data, high performance computing, and state of the art data visualizations. Geovisualization is attracting widespread attention in the geosciences (Andrienko, Andrienko et al. 2008; Elwood 2008; Kowalczuk 2010). Geoscience students need to access and visualizes data related to the Earth and its landscape and systems and software that provide spatial data analysis, organization and visual representations provide tools for learning and understanding (McAdams and Nikov 2011).

Commercial or proprietary GIS software tools are available to assist in the understanding of geoscience; its processes, systems and components. Such software provides teachers with tools to construct learning environments that provide significant advantages to learning beyond traditional knowledge dissemination techniques. For learners, GIS software tools often provides the break through link for understanding the complexities being studied. Some examples of the software used by geoscientiests, geoscience teachers and geoscience students are: ENVI, Autodesk, Intergraph, ArcGIS and ERDAS IMAGINE. However, most of this software is expensive and this creates problems for the institution, teacher or student when the software is out of reach because of lack of financial resources. This is typically the case in developing countries where institutions are poorly resourced. However, free and open source GIS software tools such as ILWIS, GRASS, SAGA, Open Jump and several others (see: http://tinyurl.com/freeGISsoft) offer an alternative to expensive proprietary software in geoscience teaching and learning.

Free and Open Source GIS Software Tools

Free software also known as ‘software libre’ or ‘libre software’ is software that can be used, modified, copied and redistributed either without any restriction or with restrictions allowed by the manufacture and are generally available without any charge (Subramanyam and Xia 2008). Open source software (OSS) is software that is available in source code under a software license that permits the users to study, modify, improve and distribute to other users (Hauge, Ayala et al. 2010). Some open source software is available within the public domain and it is very often developed collaboratively by individuals who have expertise in software development and an interest in its free distribution. Free and open source software does not necessarily mean inferior or substandard software. There are some very significant open source software that have revolutionized many areas of activity. Probably the most famous open source software is the operating system UNIX. Using open source software can provide some advantages, the most significant being usually a cost advantage (Ven, Verelst et al. 2008).

One of the problems faced by teachers who are interested in using free and open source software as alternatives to commercial software for geoscience education is first identifying what alternative software is available, what the software does, and where it can be accessed from. Currently there is no one place with information on free and open source software for geoscience education. In undertaking the research for this paper, to identify appropriate free and open source software, 6 categories of software were identified. These are: Desktop RS and GIS Software, Spatial Database Management System (SDBMS) Tools, Spatial Data Viewers, Virtual Browsers, Mapping Applications, and Miscellaneous RS and GIS Tools. Desktop RS and GIS software are used for spatial data creation and map generation; SDBMS for storage of spatial data; spatial data viewers for viewing satellite and aerial photo imagery; virtual browsers to map the earth by superimposition of images obtained from satellite imagery and aerial photography. Miscellaneous RS and GIS tools category includes the small applications useful for manipulation and visualization of various kinds of spatial data.

The software that has been identified is displayed in tables from the following location: see: http://tinyurl.com/freeGISsoft. This site provides a range of useful software, free and open source, with a brief description for each including the current version and a web link to the site where the software can be obtained.

In general, these free and open source software offer many of the data handling, visualization and mapping basics needed for geoscience teaching and learning. Some of the software has been extensively used for a wide variety of spatial data handling and analysis. Applications of these software fit many aspects of geoscience teaching in geology, hydrology, and environmental mapping requirements. For example, application guide (http://www.itc.nl/ilwis/documentation/version_2/aguide.asp) of the ILWIS 2.1 contains 25 geoscience discipline-oriented case studies. ILWIS 2.1 is freeware, which provides the core functionality data acquisition, management, analysis and display and handles both raster and vector data sets. The case studies available in support of the software show advanced procedures in working with ILWIS and also demonstrate some specific questions from various research disciplines that can be solved with ILWIS software.

We have taught various postgraduate GIS courses at different universities over 15 years including Charles Darwin University, Australia, Faculty of Geo-Information Science and earth Observation (ITC), University of Twente, Netherlands and GIS Centre, University of the Punjab, Pakistan and has used many tools including commercial propriety software, such as Erdas Imagine and ArcGIS and also freeware tools such as ILWIS and GRASS. At Charles Darwin University Erdas Imagine and ENVI and ArcGIS (state of the art GIS software) are being used for teaching RS courses. We have taught the same RS and GIS courses at GIS Centre, Punjab University, Pakistan using the open source product ILWIS 2.1 to achieve very similar learning outcomes.

Literature shows successful application of various GIS free and open source software in geoscience teaching and learning. Fisher and Myers (2011) have shown the successful application of the free and simple GIS software 'Open Jump' for teaching health mapping in eastern Indonesia. Guenther (2009) described the use of Google Earth (free browser) for teaching geoscience. Husa (2009) elaborates on the visualization capabilities and use of Goggle Earth as geoscience teaching tool.

Geoscience teaching mainly involves spatial data (both raster and vector) management, analysis, visualization and mapping. This is what propriety software such as ArcGIS and Erdas Imagine are designed for. However, various free and open source software often provide the same functionalities. Free and open source software may not have all the features of more expensive systems. However, and very often they are more than adequate in achieving the outcomes desired and at the least deserve examining as an alternative to buying or using complex software.

We have already indicated one of the main adventures in using open source software that is they are generally free. However, the cost of operating and using software is not always just to do with the purchase of that software, but may also include maintenance and support of the software installation, and indeed, may require the purchase of additional hardware. Any teacher or institution considering implementing an open source solution, will need to weigh up all of the advantages and disadvantages of doing so. In any case, a full evaluation of an installation should be undertaken before opening up software to staff and students.

A further advantage of using open source software is that it ensures that users are compliant with copyright. Copyright is an important consideration in the application of any software within education institutions. However, quite often in institutions in developing countries, administrators and teachers are less concerned about copyright issues and there have been instances where pirated copyrighted software have been used illegally. The use of open source and free software, clearly makes issues of copyright less a problem.

In addition to the software tools listed that are useful for teaching and learning in geoscience, there are other useful and often quite sophisticated open source software available for education purposes. For example, Moodle is an open source Learning Management System used by many universities throughout the world including some of the largest universities (for example, UK Open University). Also, the open source office suite of programs provided by OpenOffice.org are an excellent free substitute to the Microsoft Office suite.

Conclusions

Almost all free and open source GIS software tools have potential value in one way or other but that value can only be realized if we use these software tools. Our review shows that for all areas where GIS software is used for geoscience teaching and learning, the free and / or open source software tools are available. Several free and open source GIS software tools are able to compete with proprietary software, in particular for raster and vector data processing, visualization and mapping. However, if an institute chooses to use free and open source tools for geoscience teaching and learning then the appropriateness of the particular software tool needs to be assessed. The licenses used by free and open source tools typically ensure that there is no cost for the software itself and low or no cost for its acquisition and installation. Much open source software is customizable and adaptable to different

teaching and learning context. In short, we believe that the use of free and open source GIS software can provide a viable alternative to proprietary software – and we hope that this review helps to increase access and use of free and open source GIS software for geoscience teaching and learning particularly in low resource settings.

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