

Using Dynamic Visualizations to Enhance Learning in Physical Geography

Joan Bellou

The University of Ioannina, Greece

INTRODUCTION

Physical geography is a domain where many misconceptions and learning problems have been reported through the years in all ages, from elementary education through to university level (Siegburg, 1987; Schee et al., 1992; Neighbour, 1992; Harwood & Jackson, 1993; Purnell & Solman, 1993; Forsyth, 1995; Keliher, 1997; Livni & Bar, 1998; Bartlett, 1999; LeVasseur, 1999; Gobert, 2000; Gerber, 2001; Verdi & Kulhavy, 2002; Morgan & Tidmarsh, 2004; Pedersen et al., 2005; Cooshna Naik & Teelock, 2006).

According to the literature, the problems that appear in Physical Geography teaching and learning can be classified in the following five categories:

1. **Terminology:** Students cannot describe geographic characteristics using geographic terminology (Harwood & Jackson, 1993; Keliher, 1997; Golledge, 2005).
2. **Interpretation:** There are misconceptions and difficulties in the interpretation and explanation of geographic characteristics and phenomena. This is quite often observed among elementary students (Schee et al., 1992; Neighbour, 1992; Livni & Bar, 1998; Pedersen et al., 2005).
3. **Language:** There is a difficulty for students to express themselves verbally, especially using geographic terminology. Pupils perform better using alternative methods, such as sketching geomorphologic evolution. There is not a problem in perception, but rather in the usage of language (Harwood & Jackson, 1993; Keliher, 1997; Gobert, 2000; Golledge, 2005).
4. **Symbols:** Misconceptions and difficulties arise from the frequent use of symbols for geographic characteristics rendering. Symbols mainly concern the color attribution of hypsometric levels, discrimination between mountains, hills, valleys and plains, catchment basins and erosion levels (Fredrich & Fuller, 1998; Nordstrom & Jackson, 2001; Livni & Bar, 2001; Verdi & Kulhavy, 2002).
5. **Static media:** Natural phenomena have a dynamic character that is difficult or impossible to be represented in a static way (Siegburg, 1987; Schee et al., 1992; Neighbour, 1992; Livni & Bar, 1998; Cooshna Naik & Teelock, 2006). Misconceptions mainly concern changes on the earth anaglyph and especially the phenomenon of erosion (Gregg, 2001).

The proposals for the solution of these problems can be classified in the following three categories, as the critical review of the preceding literature shows.

1. **Integrated learning environments:** The design and implementation of integrated learning environments involving active participation of the students is of major importance. Specific didactic goals and learning activities, as well as the elimination of cognitive overload resulting from the huge volume and density of information are also important elements.
2. **Diversity in expression:** Variety in the way students express themselves beyond the verbal method is proposed, both for the construction of geographic knowledge and for evaluation purposes.
3. **Experience enhancement:** The huge space and time scales concerning geographic phenomena are the main cause of misconceptions. Realistic representations with natural semantics as well as different spatial and temporal scales appear to offer a solution for the difficulties in physical geography teaching and learning.

Information and communication technologies (ICT) support integrated learning environments, diversity in expression, and experience enhancement.

This article presents a critical review of the ICT used in physical geography learning. It also proposes interactive dynamic visualizations with an example on the phenomenon of erosion, and presents the results of a qualitative empirical research involving elementary school pupils.

ICT IN PHYSICAL GEOGRAPHY TEACHING

Computer assisted instruction and learning (CAI, CAL) have been applied to geography education for more than 30 years. Integrated educational applications were developed during the nineties, with the first positive learning outcomes appearing only recently.

The main reasons are the late technological boom in graphics and spatial representations, and the delayed development of interactive computer-based educational environments dedicated to geographic knowledge construction.

We believe that physical geography is a domain of special interest for the design of CAI and CAL applications, exploiting spatial technologies and high resolution graphics. Various types of ICT are proposed for students' motivation and active participation in the didactic process.

Regarding the evaluation of CAI and CAL systems for geography teaching, the results are poor and mainly concern university students. A worldwide empirical research showed that the use of ICT in Geography education was limited, whilst featuring their effectiveness in geography teaching and learning (Gerber, 2001). This is also highlighted by the recent published work (Morgan & Tidmarsh, 2004; Golledge, 2005; Pedersen et al., 2005; Shin, 2006 and references therein).

The purpose of the review that follows is the search of the proper technological approach for the design of an integrated computer-based learning environment. Thus, the research papers are classified according to the type of technologies used in geography education.

Geographic Information Systems

Geographic information systems (GIS) provide a powerful environment for the management and presentation of geographic information using different levels for the representation of different types of information.

Nellis (1994) and Keiper (1999) reported on the difficulty in GIS use at elementary level. Even for university students the results were not encouraging when they were taught spatial skills using GIS (Chen, 1998). The same problems were found by O'Kelly (2000) and Lloyd (2001) in all educational levels. Huang et al. (2001) spotted the problems with GIS in their lack of three-dimensional visualization and interactivity. Kerski in his survey of 1520 high schools that use GIS software reported that the effectiveness of GIS in teaching and learning is limited (2003). Positive learning outcomes reported only recently by Shin in her study with fourth grade students. The author found that using GIS with a well designed instructional module helps students improve their geographic knowledge and map skills (2006).

Almost all the researchers propose constructivism as the pedagogical support concerning the use of GIS in education, proposing authentic learning activities. It seems that GIS are difficult to introduce in education and offer a limited method of geographic information representation for knowledge construction and meta-cognitive skills acquisition.

Internet Tools and Applications

Internet, Web sites and portals are a huge resource of dynamic information. Virtual universities, geological institutes, meteorological stations and satellites are some of the resources for geographic information. Their immediate exploitation in the educational process is often difficult, since the material is not provided through an educational context.

Suthren (1998) proposed the replacement of educational geomorphologic posters with virtual representations published in web pages. Although the author pointed out the exploitation of ICT in cases where other media are not appropriate, he simply transferred geographic information from a traditional to an electronic format. Hill and Solem (1999), Hurley et al. (1999) and Taylor (2000) summarized the value of the Internet as an environment for up to date content delivery, online hypermedia context, interactive evaluation, tool for communication and collaborative learning. The authors proposed online collaborative learning environments based on social constructivism. Harrison et al. in their large scale study on the use of ICT and its relationship with performance in examinations reported a relatively

12 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/using-dynamic-visualizations-enhance-learning/13437

Related Content

Use Cases and the UML

Brian Dohingand Jeffrey Parsons (2005). *Encyclopedia of Information Science and Technology, First Edition* (pp. 2949-2953).

www.irma-international.org/chapter/use-cases-uml/14724

Gg

(2013). *Dictionary of Information Science and Technology (2nd Edition)* (pp. 379-419).

www.irma-international.org/chapter/gg/76416

Application of Enterprise Architecture to Guide the Integration of Health Information Systems in Namibia

Laizah Mutasa, Martin Mabeifam Ujakpa, Wandisa Nyikana, Irja N. Shaanikaand Tiko Iyamu (2025). *Information Resources Management Journal* (pp. 1-22).

www.irma-international.org/article/application-of-enterprise-architecture-to-guide-the-integration-of-health-information-systems-in-namibia/367274

Moral Decision Training Platform AI and Psychological Modeling for Information Management

Jianming Zhangand Shu Zhang (2026). *Information Resources Management Journal* (pp. 1-17).

www.irma-international.org/article/moral-decision-training-platform-ai-and-psychological-modeling-for-information-management/404755

An Image Classification Algorithm and its Parallel Implementation Based on ANL-RBM

Haifeng Song, Guangsheng Chenand Weiwei Yang (2018). *Journal of Information Technology Research* (pp. 29-46).

www.irma-international.org/article/an-image-classification-algorithm-and-its-parallel-implementation-based-on-anl-rbm/206213