Chapter XVIII
An eLearning Portal to Teach Geographic Information Sciences

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ABSTRACT
In this chapter the authors describe the implementation of an emerging virtual learning environment to teach GIS and spatial sciences to distance education graduate students. They discuss the benefits and constraints of our mixed architecture with the main focus on the innovative hybrid architecture of the virtual GIS computer laboratory. Criteria that were used to develop the virtual learning environment entailed the following: (i) Facilitating student-instructor, student-computer, and student-student interactivity using a mix of synchronous and asynchronous communication tools; (ii) Developing an interactive online learning environment in which students have access to a suite of passive and active multi-media tools; and (iii) Allowing student access to a mixed web-facilitated / hybrid architecture that stimulates their cognitive geographic skills and provides hands-on experience in using GIS.

INTRODUCTION
Geographic information systems (GIS) are a rapidly evolving technology that is integrated in mainstream undergraduate and graduate curricula. Spatial sciences and GIS are multidisciplinary in nature and have important relevance beyond their traditional disciplinary homes. Currently,
spatial sciences and GIS courses are offered through geography, civil engineering, geomatics, soil, water and environmental science and other programs. A GIS is a computer-based system for managing, storing, analyzing, and presenting spatial data. GIS have three important components – computer hardware, sets of application software modules, and a proper organizational context including skilled people (Burrough and McDonnell, 1998). As such, the GIS curriculum is particularly suited to the development of innovative learning models adaptable to students from different disciplinary backgrounds. GIS courses and programs are also ideally suited to use novel technologies as the discipline itself is technologically enabled, or even technologically driven. Zerger et al. (2002) pointed out that it is important to infuse spatial science theory with practical examples / assignments and projects to optimize learning outcomes. Thus, transforming on-campus GIS courses into a virtual learning environment requires maintaining both lecture and lab components. Spatial sciences aim to stimulate cognitive geographic thinking skills that involve solving geospatial problems, to comprehend and integrate huge amounts of geospatial data, and to facilitate understanding of both large-scale and small-scale geographic features of ecosystems. These cognitive geographic skills are a prerequisite to understanding the underlying mechanisms for spatially-explicit modeling using GIS software. Hands-on GIS assignments and projects facilitate student learning about GIS functionality and help them build their own spatial models.

Distance education courses and programs have adopted a variety of multimedia and Internet technologies. Recent changes in information technology have challenged instructors not only in terms of what they teach, but also which technology they use to teach. The proliferation of web-based and interactive multimedia technologies that are used to teach spatial sciences has transformed numerous on-campus courses into web-facilitated, hybrid (blended) and distance education courses. Hybrid courses mix traditional face-to-face instruction with a substantial portion that is delivered online. Virtual learning environments are diverse, ranging from simple web-pages to complex hard- and software solutions. A virtual learning environment is a set of teaching and learning tools designed to enhance a student’s learning experience by including computers and the Internet in the learning process. Criteria to distinguish virtual learning environments include: (i) delivery type - audio, video-based systems (e.g. Power Point slides, videoclips, compressed interactive video, virtual reality worlds, and others); (ii) delivery media (e.g. books, journal articles, CD, DVD, Internet); (iii) communication type (synchronous and asynchronous) and student involvement – (active and passive); (iv) level of abstraction – content (e.g. text, maps, 3D models, 4D simulations, interactive virtual models); (v) presence of the instructor (e.g. availability and accessibility of instructor by students); (vi) level of interactivity between students, instructor and computerized entities (student-student-, student-, student-instructor-, instructor-, and student-computer centered); and (vii) user access (local e.g. physical lab or field trip that requires the presence of a student at a particular geographic place or remote e.g. Internet-based access or simulated/emulated equipment and instruments). Virtual environments present a multimedia library of shapes, landscapes and sounds that establish a system for construction and symbolic transformation. The virtual environment as projective construction provides an opportunity for participants to collaborate in a variety of multisensory interactions: visual-spatial, audio-spatial, and kinesthetic.

**EXISTING GIS LEARNING SYSTEMS**

Student-instructor interaction including face-to-face interaction and hybrid settings where students interact with an instructor using synchronous (e.g. interactive video, chatroom) or asynchronous (e.g.