

# Project Title: Geographical visualization as a pedagogical practice in a Physical Geology course

Robert L. Hopkins II, Ph.D.

The screenshot displays a Dell Precision M6400 laptop configuration page. At the top, there are navigation tabs: 1 Customize, 2 Accessories, 3 Recommended Add-ons & Services, and 4 Review & Add to Cart. The Intel logo is visible in the top right corner, along with 'LIVE CHAT' and 'CLICK TO CHAT' buttons, and a 'HELP VIA PHONE' button with the number 888-782-3355. Below the navigation, there is a 'Print Summary' link, an 'Add to My Saved Items' button, and an 'Add To Cart' button. A message reads: 'Congratulations! Your system is ready to be built. We have some recommendations for you highlighted in green below.' A laptop image is shown on the left. The 'My System Details' section lists various components with their specifications and an 'edit' link for each:

Component	Specification	Action
PROCESSOR	Intel® Core™ 2 Duo T9900 (3.06GHz, 6M L2 Cache, 1066MHz FSB)	edit
OPERATING SYSTEM	Genuine Windows® 7 Professional, 32-bit	edit
LCD	17" UltraSharp™ WXGA+ (1440x900) LCD Display	edit
OFFICE SOFTWARE	Software® Adobe Acrobat Reader 9.0, English-French MLANG	edit
WARRANTY & SERVICE	3 Year Basic Limited Warranty and 3 Year NBD On-Site Service	edit
VIDEO CARD	NVIDIA Quadro FX 3700M, 1.0GB Discrete	edit
MEMORY	4.0GB, DDR3-1066MHz SDRAM, 2 DIMMS	edit
RAID CONFIGURATION	All Hard Drives, Non-RAID, 1 or 2 drive total configuration	edit
HARD DRIVE	320GB Hard Drive, 7200RPM with Free Fall Sensor	edit
OPTICAL DRIVE	8X DVD with Cyberlink Power DVD™	edit
BATTERY OPTIONS	9 Cell Battery	edit
WIRELESS CARD	Dell Wireless™ 1397 802.11b/g Mini Card	edit
INTERNAL KEYBOARD	Internal English Backlit Keyboard	edit
FINGERPRINT READER	Internal Swipe Fingerprint Reader	edit
OPTION		
WEBCAM / MICROPHONE	Integrated 2.0 MP webcam with dual digital array microphone	edit
SYSTEM DOCUMENTATION	Resource DVD - Contains Diagnostics and Drivers	edit
MODEM	No Modem	edit

On the right side, the 'Precision M6400' pricing is shown: Starting Price \$3,217, Instant Savings \$599, and Subtotal \$2,618. Below this, there is a promotional message: 'Quickly create your own professional-looking custom forms, such as customer estimates, invoices and reports by using any of the over 100 included templates. Upgrade to Quickbooks Software Now! Lease from \$70/mo. (48 pmts)¹'. There is a 'Dell Business Credit | Apply' button and a 'Discount Details' link. A 'Preliminary Ship Date: 11/19/2009' is also displayed. The 'ESSENTIAL ADD-ONS' section includes a 'Microsoft Wireless Optical Notebook Mouse' for \$28 (reduced from \$24) and an 'Upgrade to Norton Internet Security™ 2009 15 Month' for \$79. An 'Add to system' button is present for the mouse.

Assistant Professor of Biology  
University of Rio Grande  
School of Sciences  
PO Box 500  
Rio Grande, OH 45674

phone: 740.245.7252

email: rhopkins@rio.edu

## **Purpose and Rationale**

Spatial thinking is the process of deciphering meaning from the shape, dimension, orientation, locality, and pattern of objects distributed in space (National Research Council 2006). Thus, spatial thinking is an essential skill in a Physical Geology course, where the study of complex geological phenomena distributed across space and time is the norm. There are three components of spatial thinking: spatial visualization, spatial orientation, and spatial relations (Golledge and Stimson 1997), with spatial visualization being the foundational element.

Alarming, the preponderance of undergraduate students find difficulty in visualizing three-dimensional data and processes from static, one or two-dimensional representations which are commonly employed in textbooks (Hemler and Repine 2006). This problem is amplified, and the negative effects are particularly manifest, when two or more types of data are to be considered concurrently – which is the case for Physical Geology students studying geomorphological processes involved in landscape evolution (e.g. hydrologic cycle, plate tectonics, and mass wasting). Consequently, the failure to acquire the basic skill of spatial visualization precludes any meaningful understanding of spatially-based processes.

In the context of Physical Geology, the ability to analyze and accurately interpret topographical maps (spatial visualization and orientation) is a fundamental requirement for student success. For example, the understanding of erosional processes, seasonal flooding, surface and groundwater flow, and patterns of landslide occurrences (all elements of spatial relation) are contingent upon the student being able to comprehend and make inferences from the spatial information contained in a topographic map. From a pattern of contour lines, students should be able to make coherent conjectures concerning attributes of slope, elevation, relief, surface erodibility, and even geological history (Marshak 2008). For that reason, a students' misunderstanding of topographic maps creates a major impediment to continued learning.

Studies have shown that geographical information system (GIS) technology can improve student spatial thinking through an inquiry-based approach using geographical visualization (Audet and Ludwig 2000). Using GIS-technology, students can analyze, visualize, interrogate, generate, and manipulate spatial data in a one, two, or three-dimensional context. In essence, using such technology allows students to inspect a computer-based visualization of a landscape, evaluate the native data, and even explore how those native data are transformed into a schematic representation. I posit that employing GIS technology in a Physical Geology course will not only complement traditional hands-on mapping activities, but, will enhance development of students' spatial visualization skills and, ultimately, result in a more sophisticated and accurate understanding of spatially-based processes. Such technology-enhanced, constructivist approaches have been deemed successful pedagogical practices (Keiper 1999) and have been used in a variety of disciplines ranging from Biology to Sociology.

Furthermore, in addition to teaching students *about* GIS and how to use it for geographical visualization, I intend to teach *with* GIS and utilize the tool as a teaching-technology throughout the course. As Audet and Ludwig (2000) point out, the pedagogy behind using GIS as teaching tool remains underdeveloped despite a considerable amount of research (e.g. Lloyd 2001, West 2003, Wigglesworth 2003) demonstrating the effectiveness of using GIS in education. I surmise that incorporating GIS technology into the classroom will augment content delivery and facilitate the teaching of complex, spatially-based processes.

## **Investigate Process and Assessment**

The aim of the proposed project is two-fold. The principal objective is to determine if participation in a GIS-based exercise enhances student spatial thinking. Specifically, does an inquiry-based geographical visualization project improve a student's ability to analyze, interpret, and make inferences from topographical data? The first objective will be accomplished using a series of assessment tests. A pre-test will be administered prior to presentation of lecture material on landforms to assess initial understanding of topography and topographic data. Upon covering the material in class, an identical post-test will be given to gauge student learning. Subsequently, 50% of the students will be randomly selected to participate in an instructor-designed geographical visualization exercise. The exercise will be formulated to allow students not only to visualize a landform in three-dimensions, but, also to explore the native spatial data and reconstruct the process of producing a three-dimensional model of the landscape. The remaining 50% will participate in a traditional field-based exercise in which students will explore the

local landscape on the URG campus using a topographic map. This project has an equivalent function to the GIS project and is intended to further develop the ability to visualize landscape features by directly comparing the actual feature itself with the two-dimensional representation.

Upon completion of the projects, all students will then be given a second post-test to examine the effects of the geographical visualization project on student ability to understand topographic data. The second post-test will consist of different questions, but, will be identical in content to the first (Appling and Peake 2004). The data will then be analyzed using appropriate statistical techniques to test for significant or notable effects of the geographical visualization project on student learning. Upon completion of the second post-test, to assure all students

have exposure to GIS technology, the geographical visualization project will be assigned to the students who were not initially selected to complete the GIS exercise.

The secondary objective is to determine if using GIS as a teaching tool promotes a better understanding of geomorphological processes discussed throughout the course. For several course topics (e.g. tectonic activity, energy resources, mass wasting, and landform evolution), I will develop GIS-based demos and graphics to complement traditional lecture techniques and aid in delivery of course content. At the conclusion of the course, students will be given a survey designed by the instructor to rate the efficacy of GIS as a teaching tool and provide comments and criticism. The overarching objective is to gain insight as to what methods and strategies have the most impact on the development of student spatial thinking.

### **Dissemination and Application of Findings**

A synopsis of the project results will be made available to SEOCEMS for publishing on the website. Depending upon sample size (student enrollment) and quality of the data, project results may be publishable or presentable in an appropriate journal or conference setting. Methodologies and strategies deemed effective will be incorporated into future courses in which spatially-based processes are examined such as Landscape Ecology, Applied Population Biology, and Limnology. Ideally, the use of GIS in the classroom will continue to be examined and, as data accumulates, a more comprehensive assessment of geographical visualization as a valid pedagogical practice can be made.

Because more than 75% of my courses are taught on the Hocking College campus, having the GIS software installed on a mobile workstation will: 1) allow me to use the technology in those courses, 2) avoid the purchase of multiple site licenses, and, most importantly, 3) will allow the use of the technology in field-based research and laboratory exercises. Furthermore, a high-end system is needed due to computational demands of the GIS software. Based on personal experience, I have observed that conducting GIS exercises on subpar systems results in students becoming disengaged from the project due to geoprocessing modules running too slowly.

### **Project Timeline**

November 2009

- a) order Dell Mobile Precision Workstation
- b) order ESRI ArcGIS software

December 2009 – January 2010

- a) install ArcGIS software
- b) develop geographical visualization exercise
- c) develop pre-test and post-tests

Spring Semester 2010

- a) complete geographical visualization project
- b) administer pre-test and post-tests
- c) administer course survey
- d) develop and incorporate GIS demos and graphics for lecture presentations

May 2010

- a) analyze data from tests and survey
- b) create synopsis of project results and submit to SEOCEMS
- c) assess publication viability

### **Budget**

- I. Dell Mobile Precision M6400 Workstation – \$2,800
  - a. Running GIS software requires high-end computing and graphics products. A mobile unit is necessary to allow effective use of the software as a teaching tool, allowing transport to different venues and permitting completion of the geographical visualization exercise in a classroom setting.
  - b. Pricing information is attached. Budgeted amount is slightly elevated to cover any potential price changes.
- II. ArcGIS Teaching and Research Master Lab Kit – \$700
  - a. Price includes base software (ArcInfo) and three extensions – Spatial Analyst, 3-D Analyst, and Geostatistical Analyst.
  - b. Pricing information is attached.
- III. Stipend for project development – \$1000
- IV. URG stipend overhead – \$500

**Total Requested Amount – \$5,000**

### **Literature Cited**

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Wigglesworth, J. 2003. What is the best route? Route-finding strategies of middle school students using GIS. *Journal of Geography* 102:282-291.

## **I. Dell Mobile Precision M6400 Workstation pricing information from website**

## **II. ArcGIS software pricing information from ESRI sales representative Sara Evich**

“Teaching & Research Lab Kit” licenses are limited to teaching and research use.

- ❖ ArcInfo, ArcEditor, OR ArcView Teaching & Research Lab Kit Master \$250
- ❖ ArcInfo, ArcEditor, OR ArcView Teaching & Research Lab Kit per Additional end user \$100

Extensions can be purchased to open up additional functionality in the software, regardless of which core license you choose above (ArcInfo, ArcEditor, or ArcView):

- ❖ ArcGIS Extension Master Lab Kit \$150 PER extension
- ❖ ArcGIS Extension Lab Kit tied to the Additional licenses \$100 PER extension
- ❖ ArcGIS Extension Lab “31” Pak \$500 PER extension
- ❖ ArcGIS Extension Lab “10” Pak \$300 PER extension

The following extensions are available to add to the license(s): ArcGIS Spatial Analyst, ArcGIS 3D Analyst, ArcGIS Geostatistical Analyst, ArcGIS Network Analyst, ArcGIS Schematics, ArcGIS Publisher, ArcScan for ArcGIS, Maplex for ArcGIS, ArcGIS Survey Analyst, ArcGIS Tracking Analyst, and ArcGIS Data Interoperability. To read their descriptions, please look at the first two sections (Analysis and Productivity) on [http://www.esri.com/software/arcgis/about/desktop\\_extensions.html](http://www.esri.com/software/arcgis/about/desktop_extensions.html) .