GeoMapApp Mini-Lessons and the K-12 Classroom:
Transformative Resources for the 21st Century Educator

Rationale for Proposed Work

Intellectual Merit By their very nature many geoscience concepts are inimitably tied to spatially-arranged data. So, familiarity with map-based learning systems and an ability to explore and visualize map-based data sets must form an integral part of geoscience education in the 21st Century.

Recommendations identified in a 2004 NSF Geoscience Education and Cyberinfrastructure DLESE report (*Marlino et al., 2004*), highlighted the important role that cyber-learning tools will play in the nation's classrooms. To increase the impact of NSF-funded research and resources at the K-12 level, we propose to use GeoMapApp (www.geomapapp.org), a free, map-based data exploration and visualization tool, to develop a set of on-line learning activities for use in middle and high school earth science classrooms. Called GeoMapApp "mini-lessons", these ready-to-use activities will, we believe, help teachers convey earth science literacy principals (*ESLI, 2009*) in a more efficient and relevant manner. The mini-lessons will enhance the learning experience of middle and high school earth science students while broadly addressing STEM technology, content and inquiry standards.

We believe that this proposal directly captures three of the four main areas highlighted in this GeoEd solicitation (NSF10-512), namely:

- *Advance Earth system science literacy through strengthening geoscience education in grades K-14;*
- *Foster development and training of the diverse scientific and technical workforce required for 21st century geoscience careers;*
- *Use modern technologies to facilitate and increase access to geoscience data for educational purposes.*

Whilst many active teachers enjoy creating their own curriculum, the considerable popularity of lesson-sharing websites and listservs indicate significant teacher interest in access to pre-made "off-the-shelf" lessons. However, the use of cutting-edge technology to deliver high-impact learning experiences has yet to be widely adopted in the classroom. In fact, at the recent NSF-sponsored workshop *The Future of Cyber-Education in the Geosciences* (January 2010, Arlington VA – report is currently being written) the Project Tomorrow team reported that the majority of teachers tend to focus upon using technology for communication instead of for content learning. In particular, making the link from web-based scientific data sets and resources to the physical world concepts may be a barrier for some teachers.

Here, we propose a two-year pilot project to help address the gap between content delivery and technology. Goodwillie and Kluge will develop an initial integrated suite of GeoMapApp mini-lessons tied to New York state standards. GeoMapApp provides the tool, and GeoMapApp mini-lessons provide the educational context.

Broader Impacts This pilot project creates an on-going conversation and collaboration between the data resource provider, educators and education specialists. Goodwillie is a member of the Lamont-based group that develops GeoMapApp; Kluge, a long-experienced, award-winning teacher and professional development consultant, is also author of a nationally-used manual on geoscience web resources; and, a range of participating teachers will take the resources into their classrooms.

The mini-lessons will thus form a link between school teachers and students and NSF-funded cyber-infrastructure resources through the creation of a vertically-integrated educator/data provider team.

It is hoped that following a successful pilot, a future award would be sought to fund the development and uptake of a wider range of mini-lessons tied to national science literacy benchmarks and standards for other states.

Key project personnel are Goodwillie and Kluge who will create the GeoMapApp mini-lessons, Cathy Manduca and her team at SERC-Carleton who will create the web page infrastructure for the mini-lessons, and Susan Lynds at CIRES who working under the supervision of CIRES director Susan Buhr, will perform the outside evaluation of the pilot project. Finally, the project could not progress without the participation of a number of active geoscience K-12 teachers in the New York City and suburbs area. The details for entraining these teachers are given in the Management Plan section. The GeoMapApp mini-lesson project aligns strongly with SERC's current numerous geoscience education projects and with other projects evaluated by CIRES. For example, SERC is host to the National Association of Geoscience Teachers (NAGT, with Cathy Manduca as executive director) and SERC K-12 portals including the SERC-hosted NAGT web site will be used to help disseminate the GeoMapApp mini-lessons.

Prior Geoscience Education Experience

Goodwillie, a member of the Marine Geoscience Data System group at Lamont-Doherty Earth Observatory that develops the GeoMapApp application, has direct experience of the MARGINS mini-lessons program and of running many GeoMapApp-based workshops in a range of settings including for K-12 educators. He has created exercise sheets and multimedia tutorials demonstrating GeoMapApp's functionality, has organised successful exhibit booths to demonstrate GeoMapApp at national AGU and GSA meetings, and was the prime author of the GeoMapApp User Guide. He has been an informal mentor for teachers spending a summer internship at Lamont, is ex-officio member of the MARGINS Education Advisory Committee, and was co-convener of the MARGINS Successor Education workshop and co-convener of MARGINS mini-lessons workshops. Goodwillie created the GeoMapApp webinar, hosted on the SERC web site, and runs an annual GeoMapApp display at the Lamont Open House for children and families. By taking education classes at Columbia's Teachers College, he has direct links with high school earth science teachers in urban NYC schools. In Fall 2010, he will teach an Earth Science Concepts class at Teachers College, for pre-service and in-service K-12 geoscience educators.

Goodwillie will partner with Kluge who has considerable experience in teaching high school earth sciences, in curriculum development and in teacher professional development consultancy especially with regard to using technology in the classroom. Kluge is author of the widely-used manual *Designing and Creating Earth Science Lessons with Google Earth™*, and of *Encounter Earth*, a lab manual that combines digital visualizations with guided inquiry explorations of earth science phenomena. Kluge is winner of a number of education awards and was a finalist for the Presidential Award for Excellence in Science and Mathematics Teaching.

Cathy Manduca is executive director of the Science Education Resource Center at Carleton College. Manduca's team at SERC has been a key driver in recent years for promoting and disseminating geoscience education methods and activities. SERC hosts numerous web-based projects, including the MARGINS mini-lesson effort and the web site for the National Association of Geoscience Teachers. Each year, SERC organizes a number of well-attended On the Cutting Edge workshops. Susan Lynds, part of the Cooperative Institute for Research in Environmental Sciences (CIRES) team at the University of Colorado at Boulder, has significant experience in the formal outside evaluation of education-based projects.

GeoMapApp: What is it?

GeoMapApp is a free map-based data exploration, analysis and visualization tool developed with NSF funding by the Marine Geoscience Data System group at Lamont-Doherty Earth Observatory of Columbia University (Fig 1). GeoMapApp works on any machine – Apple Mac, Windows PC, Linux, UNIX, and, since initial release in 2003, its functionality and scope have increased significantly.

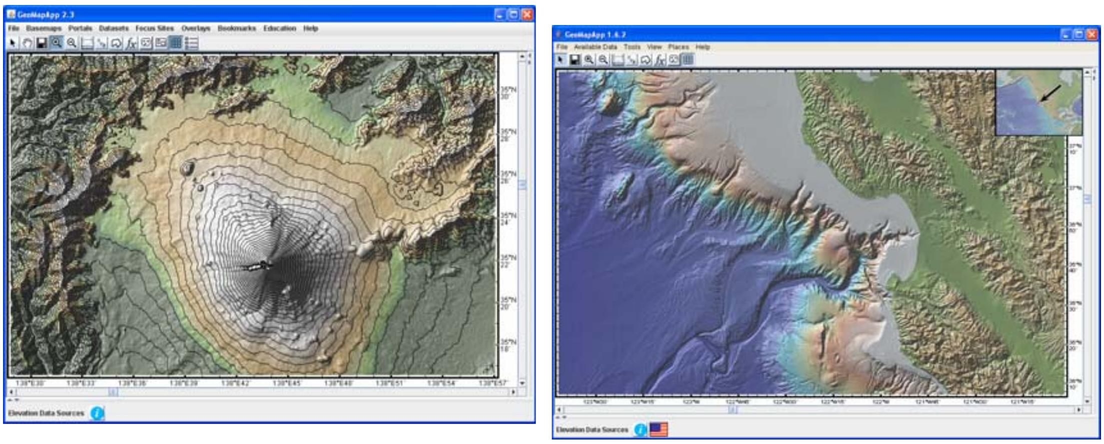


Fig 1: High-resolution land and undersea elevation data are built into the GeoMapApp base map (on the left, Mt Fuji, contoured; on the right, Monterey Bay bathymetry with artificial sun illumination to enhance structural elements of the submarine canyon).

GeoMapApp offers a wide range of built-in data sets, satellite and video-capture imagery, high-resolution underwater bathymetry and on-land topography. The ability to quickly customise and generate maps and images for use in reports and papers is particularly popular. Additionally, users can conveniently import spreadsheets, data tables, shape files and grids, and instantly have access to the full GeoMapApp functionality on the imported data. A series of data portals provides enhanced exploration for certain data sets including earthquake animations, magnetic anomaly information and ship track profiles.

GeoMapApp data sets and capabilities are directly relevant to content standards requirements of the New York State Regents Physical Setting: Earth Science Core Curriculum. These include:

- Geology and geophysics (plate tectonics, seafloor spreading/destruction, earthquakes and volcanoes, geology maps, topography and physiography, earth's magnetic field; Fig 2);
- Physical oceanography (ocean temperatures and water column properties, for example);
- Climatology (e.g. dynamics of land temperatures, precipitation);

- Human/political realms (political boundaries, population density, natural hazards, night lights, etc).

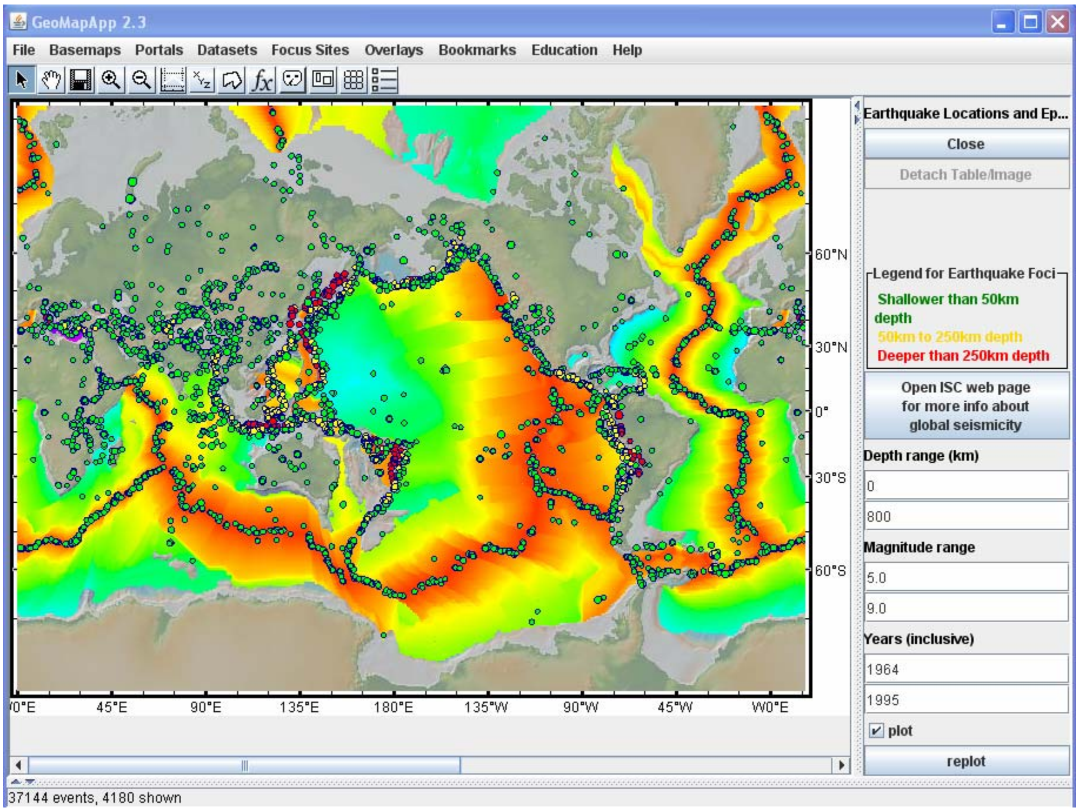


Fig 2: On the map, bright colors in the ocean basins show the age of the seafloor. Overlain, filterable earthquake locations from the International Seismological Centre reveal a three-decade pattern of major earthquakes. Dynamic links to IRIS earthquake services allow GeoMapApp users to plot and explore earthquake in almost-real-time.

GeoMapApp is a cutting-edge, web-based resource and has, we believe, tremendous potential in the middle and high school classroom as a transformative cyber-learning tool that can help students to grow independently in their ability to analyze and critically evaluate a wide range of scientific data. GeoMapApp allowing content to be learnt effectively through exciting and innovative student-centered activities.

Definition of GeoMapApp mini-lessons

We view a mini-lesson to be a self-contained hands-on teaching activity that can be used in a variety of ways. The duration of a mini-lesson will range from short in-class activities that can be performed on an individual or group collaboration basis, to homework assignments, to multi-class modules covering broader content.

GeoMapApp mini-lessons will be based in structure upon the undergraduate-level MARGINS mini-lessons – a project stemming from an NSF CCLI grant (award 0633081) to leverage scientific results flowing from the NSF MARGINS program. Goodwillie has been closely involved in that MARGINS education effort.

A template for GeoMapApp mini-lessons is laid out below on page C-7.

Earth data browsers already exist. Why use GeoMapApp?

Anecdotal evidence suggests that the majority of school students and teachers have viewed their house and local areas in Google Maps and Google Earth. This alone shows the power of a simple map-based interface to engage non-specialists.

One strand of NSF funding for an integrated computer-based application for teaching earth systems science content resulted in development of the EarthView Explorer K-12 application (*The Learning Team*, 2002). Although it allowed teachers to introduce students to learning with scientific data, adoption of the software was limited factors which included its PC-only platform compatibility, the use of static data sets, and by its release through a third-party for-profit commercial vendor.

Since then, an explosion of the internet has fostered creation of a bewildering range of web-based products. Modern browsers and applications that use geoscience data to enhance the student experience include the Google Earth and Google Ocean display tools, NASA World Wind, NASA Sun-Earth Viewer, NASA Giovanni, MyWorld (developed by the Northwestern University GEODE Initiative, part of a research program on the adaptation of scientific visualization and data analysis tools to support inquiry-based learning), USGS EarthNow!, USGS GloVis, the IRIS Earthquake Browser, and various ESRI Arc products. A user wishing to incorporate elements of these display tools and applications into the classroom faces several obstacles: most are free but some (MyWorld, ESRI products) must be purchased; each is a separate browser/application forcing the user to learn and navigate many new interfaces; ease-of-use ranges from easy to quite complex; support and on-line tutorials may be lacking.

GeoMapApp is also a web-based resource but it offers an integration of hundreds of geoscience data sets unavailable elsewhere in one intuitive supported, map-based data discovery, analysis and visualization application. GeoMapApp has been enthusiastically embraced by a wide range of researchers and educators (Fig 3). It is downloaded by about 1,800 unique users each month, with around 6,000-8,000 user sessions per month over the most recent quarter. GeoMapApp is also a popular data access tool: about 5 GBytes of data is downloaded each month directly through the GeoMapApp interface. Anecdotal evidence shows an increasing number of GeoMapApp-produced images on AGU posters and talks.

GeoMapApp partnerships

The backbone of GeoMapApp is a multi-resolution base map comprising ocean depth data (bathymetry) and land elevations (*Ryan et al*, 2009). This topographic synthesis is believed to offer the most accurate publically-available global bathymetry data set. As a result, the base map is used by a number of NSF-funded partner organisations including the US Antarctic Data Coordination Program, the EarthChem, PetDB, SedDB, SESAR databases, and the Rolling Deck-to-Repository centralised research vessel cataloguing system. Development of the GeoMapApp software continues as part of the wider database efforts at Lamont-Doherty Earth Observatory. Goodwillie is part of that database group.

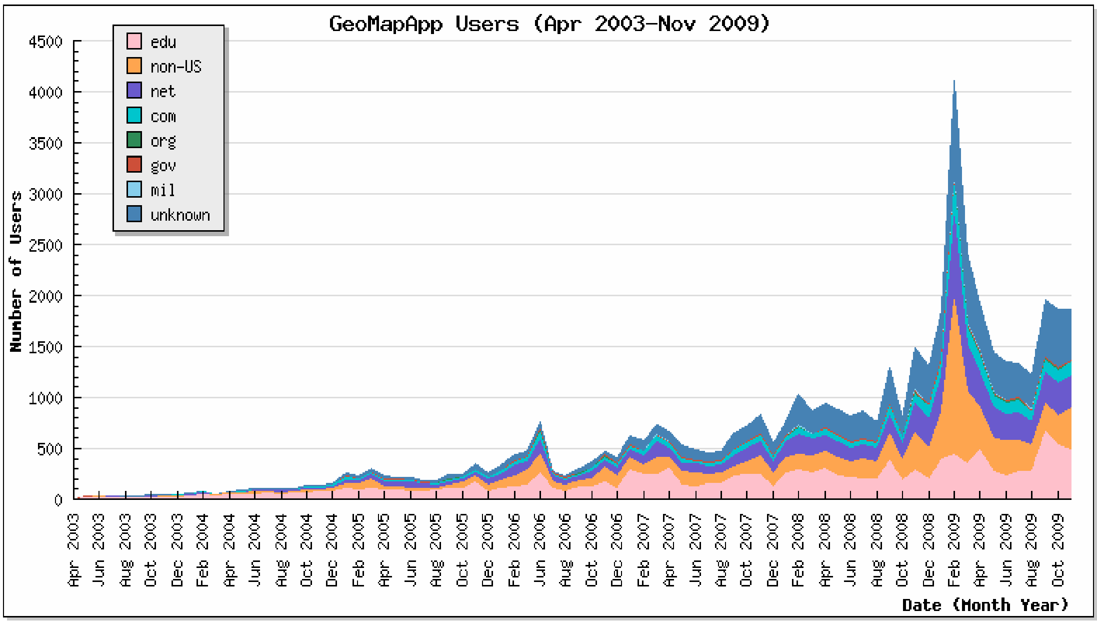


Fig 3: Download statistics (unique IP addresses) for GeoMapApp show the increasing adoption of this resource within the earth sciences community. The spike in early 2009 corresponds to the release of GeoMapApp version 2. The spike in late 2009 is thought to tie with expanded use of GeoMapApp in the university classroom, reflecting a concerted effort to improve awareness of the tool at that level.

GeoMapApp mini-lessons

We seek funds for a two-year pilot program for Goodwillie and Kluge to develop a suite of inquiry-based GeoMapApp mini-lessons that cover a range of earth science content knowledge required at the middle and high school level. Real scientific data will be used throughout – the mini-lessons provide the context and framework for accessing these data sets. Examples on GeoMapApp mini-lessons might include:

- Plate tectonics: Earthquakes, volcanoes and trenches (explore different-sized earthquakes, view images of volcanoes, location of creation and destruction of oceanic plates, etc).
- Plate tectonics: Earthquakes, catastrophic stress release, and transform faults. San Andreas Fault: When is the Big One coming?
- Plate tectonics: Spreading plates, seafloor age, depth-age-density relationship, mantle plumes and hotspots (Hawaii, Yellowstone), global heat flow.
- Topographic map interpretation in Monterey/Maine bays (explore and manipulate 3-D grid, draw contours, take profiles; representing data with different views; navigation for ships and submarines; channelling by bathymetry, safety at sea, etc. Fig 4).
- Geomorphology: Bedrock geology and resultant landforms (geology maps, NY State landscape regions).
- Geomorphology: Landslides ancient and modern (Marianas Western Insular Margin, Hawaii, Central America).
- Geomorphology: Glacial versus non-glacial terrains (compare and contrast high-resolution topography in, for example, Colorado and the Adirondacks).
- Geomorphology: Streams, rivers, and drainage basins (take profiles along stream/river, gradient along river, nick points, river valley profile, transverse profile). Stream gauge

data and watersheds. Rivers on land and under the sea (Marianas Western Insular Margin, Monterey Bay).

- Exotic life: Explore undersea hydrothermal vents using video-capture imagery from Alvin deep submersible dives along the East Pacific Rise.
- Sediments from the land and the sea: Deltas, sediment deposition, sediment thickness, rivers overlay; terrigenous (land-derived) sediment production versus marine organisms (ocean productivity) (base maps, ocean productivity, sea surface temperature).
- Salinity (compare-contrast profiles from different water bodies).
- Tropical storm/hurricane tracks.
- Presentation of geoscience data: 3-D surfaces and ways of visualization, profiles, vertical exaggeration, shading and contouring, topography mapping and image resolution, various forms of graphs with unusual but more intuitive axes (example: water column temperature profiles).

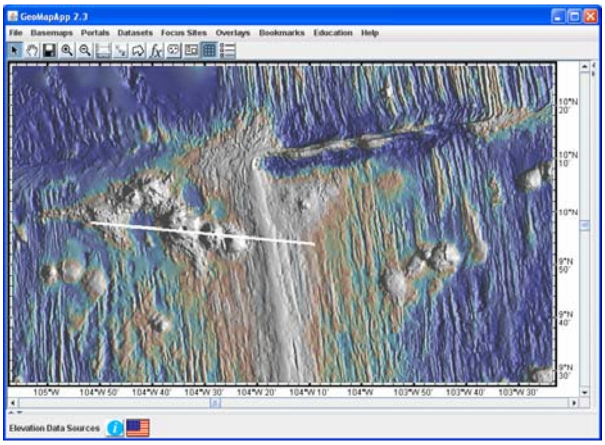
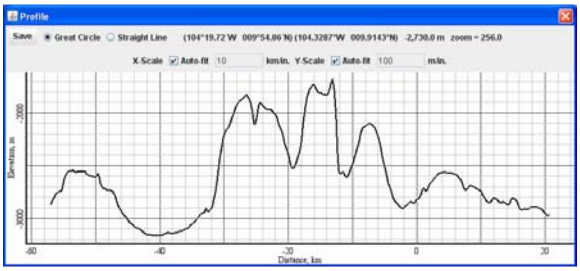


Fig 4: (left) High-resolution map of the East Pacific rise mid-ocean ridge; (below) Topographic profile across the off-axis seamounts.



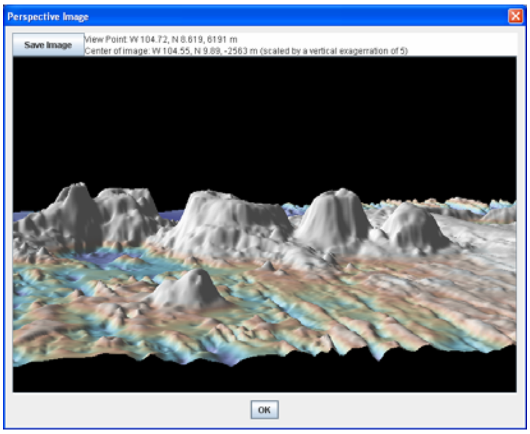
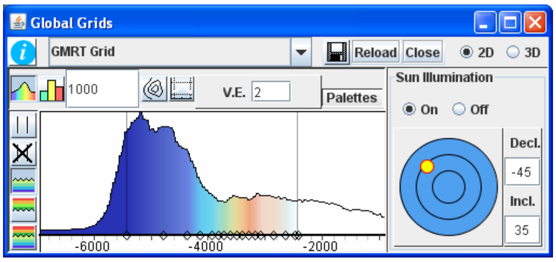


Fig 4 cont.: (left) 3-D perspective view of the same seamounts; (below) A simple interface allows students to change the viewing angle, shading, color and vertical exaggeration, and draw contours.



In the pilot program, we intend to create 6-10 mini-lessons working towards an integrated suite of interactive cyber-learning activities designed to focus and convey key concepts in the NY state STEM standards and the NY *Physical Setting: Earth Science* core curriculum. The progressive curriculum of NY state means that these standards are closely aligned with national standards and with those of other states which have earth system science components.

Management Plan

(a) Role of SERC

The middle/high school-level GeoMapApp mini-lessons will be hosted by the Science Education Resource Center (SERC), Carleton College, MN, directed by Cathy Manduca. SERC has much experience in providing successful on-line educational resources across a range of levels, and the computational infrastructure to host the mini-lessons already exists. Goodwillie's in-depth involvement with MARGINS educational efforts has ensured close and productive collaboration with SERC personnel.

SERC will create a home page for the GeoMapApp mini-lessons. This will display a short description of the mini-lesson approach. A table will list the mini-lessons, providing a link to each as well as a downloadable PDF lesson plan and student handout. Goodwillie and Kluge will be given full administrative rights to the mini-lessons web pages to add and modify content. In addition to providing the necessary web infrastructure, existing SERC K-12 portals will be used for increased dissemination of the mini-lessons.

(b) Template for each GeoMapApp mini-lesson web page

The web page for each mini-lesson will be in a standard easy-to-navigate format will the following sections:

Header block:
- Title.
- One-sentence summary of concepts/content.
- Goal.
- Intended learning outcomes.
- Recommended duration of mini-lesson (short in-class or homework activity, whole-class group collaboration, multi-lesson module, and so on).
- Prep time.
- Grade level.
- Required prior knowledge.

More information:
- Introduction.
- Short summary of concepts/content.
- NY state standards (hyperlinks).
- List of guiding questions.
- Relevant questions taken from recent NY state Regents exams.
- Description of data sets.

Procedure and help:
- Step-by-step guide.
- Link to on-line multimedia 1-minute tutorial.
- Link to downloadable PDF file student handout.
- Suggested questions.
- Pre- and post quizzes to assess knowledge.
- Check list for testing the GeoMapApp installation.

Related:
- Links to associated mini-lessons.
- Suggested topics and ideas for further work to expand content knowledge.

(c) Entraining teachers

The university-level MARGINS mini-lessons faced significant early-adoption hurdles. But, more coordinated community engagement and greater efforts with visibility has seen an increase in their use.

Experience gained from the MARGINS efforts will be taken onboard for the GeoMapApp K-12 mini-lessons proposed here. However, we recognize that school teachers may have a somewhat different approach to lesson planning and content delivery than do university educators. Primarily, teachers often demand grab-and-go lesson plans, fool-proof resources, clear explanations and a low barrier to entry. If a resource does not work first time, teachers are often loath to pursue it further. As a result, we believe that it is vital to enlist a cohort of practising teachers as the testers of GeoMapApp K-12 mini-lessons. We envision teachers using a number of mini-lessons throughout the school year and we will work closely with these teachers to ensure that implementation is smooth.

We initially intend to enlist a cohort of around fifteen middle/high school earth sciences teachers in two settings: at urban schools in New York City in areas that traditionally serve under-represented student populations, and at schools in the Westchester and Rockland suburbs. Teachers will be identified in several ways: from participant lists of past professional development and Earth2Class workshops, through the NY ESPRIT earth science teachers' listserv, and through the membership of professional bodies (STANYS, NSTA, NESTA, NAGT). Blank *et al*. (2007) noted the significant number of under-qualified NY state earth science teachers: we hope to reach out to them in particular during this project.

In recognizing potential hesitancy that some teachers may have when introduced to a new technological resource, we will create on-line short (1-minute) multimedia tutorials that lead the teacher step-by-step through each mini-lesson.

In this project we envision building a community of local and regional teachers on three fronts:

- Professional development courses led by Goodwillie and Kluge at regional Board of Cooperative Educational Services (BOCES) centers will be used to bolster teacher familiarity with GeoMapApp and GeoMapApp mini-lessons through hands-on workshops. Kluge is already an on-site consultant.
- By directly encouraging selected teachers to use and critique the mini-lessons.
- Via workshops and other forms of outreach at regional K-12 science education conferences such as NE section meetings of NAGT and NESTA.

At the national level, we will reach out to teachers across the country:

- Through attendance at annual meetings of major education-related organisations such as NSTA, GSA, and AGU (presentations, run workshops, exhibit booth sharing).
- By publishing articles describing the GeoMapApp mini-lessons.

In this enterprise, teachers are viewed not merely as end users but, through their willingness to employ mini-lessons, offer feedback and share experiences, as collaborators. Community buy-in is key to any project such as this and every effort will be made to engage the community.

Another component of the management plan is the outside evaluation, described below.

Support for GeoMapApp

We recognize the importance to structure and scaffold the teacher experience of GeoMapApp mini-lessons in a way that teachers embrace these resources. Support will be offered via a number of avenues:

- Goodwillie and Kluge will interact closely with the initial roll-out teachers through BOCES workshops, school visits, telephone, Skype and e-mail.

- Each mini-lesson will include:
    - A multimedia, web-based 1-minute tutorial showing all the steps covered in the mini-lesson. (Goodwillie has created similar tutorials to highlight GeoMapApp functionality.)
    - A downloadable comprehensive teacher guide and student handout (instructions and worksheet).
    - Quick links to practical information on installation/start-up.
    - Ideas for follow-up activities and materials for teachers to evaluate student achievement.

- User Guide: In summer 2009, a comprehensive GeoMapApp User Guide and step-by-step cookbook (lead-author Goodwillie) was released that covers all GeoMapApp functionality, including downloading and starting the application (http://www.geomapapp.org/GMA/newHelp/GMAHelp_2.html).

- A series of on-line multimedia 1-minute tutorials cover a additional general GeoMapApp functions (zooming, importing spreadsheets, taking profiles, for example) and data sets (loading and exploring gridded topography, for instance).

- GeoMapApp on-line help: The Lamont-based GeoMapApp development team maintains an efficient e-mail support system (through a prominent Contact Us button) for answering questions in a timely manner, usually on the same day.

Working with partner organisations

To further broaden the reach of the mini-lessons and help bring state-of-the-art tools to the K-12 classroom, collaborations will be sought with colleagues at the Beacon Institute, NY, which specializes in promoting ocean sciences studies in NY-area schools, and with regional NSF-COSEE centers that offer many resources to their constituents.

Evaluation Plan – Assessment by Outside Evaluator

A key element to gauging the impact on learning of GeoMapApp mini-lessons is formal assessment of their usage and effectiveness. Amongst other avenues, we will tailor existing SERC assessment protocols to create a well-constructed, convenient web page that allows teachers to readily evaluate the mini-lessons after each use. This approach has been valuable in the MARGINS educational efforts. Additionally, we will provide participating teachers with student “quizzes” to gather pre- and post-activity feedback on the effectiveness of using mini-lessons to enhance the student-driven learning experience.

Susan Lynds, from CIRES (Cooperative Institute for Research in Environmental Science) at the University of Colorado at Boulder has agreed to act as Evaluator for this project. The evaluator will obtain IRB approval from the University of Colorado at Boulder Human Research Committee.

The formal evaluation will be based upon the matrix shown in Table 1. Evaluation data will be collected to monitor how well the proposal goals have been achieved. Data will include results from participant teacher surveys, workshop observation data, web statistics, and anonymous student score data.

Student scores from quizzes of mini-lessons will be reported to the evaluator as anonymous data. Teachers who attend workshops and courses will be given a registration survey (pre-test) and an exit survey (post-test). Participant teachers will also be encouraged to complete a reflection survey of the lessons after they have used them. All surveys will be on-line. Surveys submitted through the mini-lesson web pages will be provided to the evaluator. Other surveys will be undertaken via SurveyMonkey. Web statistics from SERC-Carleton will be used to monitor and evaluate lesson website usage.

Project evaluation reports will include analysis of data from the on-line resources created, web statistics, survey results, and the preliminary workshop observations. A formative report will be prepared after the completion of year 1. A summative report will be prepared after year 2.

Goal	**Evaluation Method**
Create 6-10 mini-lessons focussed to convey key concepts, to be used in an interactive cyber-learning environment	product review
Mini-lessons will allow classroom teachers to more effectively teach content using real scientific data and engaging visualizations, thus enhancing the experience of the high school earth science student.	reflection survey, student score data
Each stand-alone mini-lesson will list the New York State standards addressed by the content as well as the goals of the mini-lesson, the intended learning outcomes and suggested methods of student assessment.	product review
Each mini-lesson will also include an introduction and a further work section providing avenues that the teacher may adopt to broaden its scope and application.	product review, reflection survey
The mini-lessons will have a standard format and will contain links to associated mini-lessons	product review
Create short multi-media tutorials on-line that lead the teacher step-by-step through each mini-lesson	product review, reflection survey
Broadening the reach of the mini-lessons	workshop/course surveys, web statistics
We envision teachers adopting a number of the mini-lessons for use throughout the school year and we will work closely with them to ensure that the implementation is smooth	reflection survey

Table 1: Evaluation matrix for GeoMapApp mini-lesson project.

Updating the mini-lessons

Feedback from teachers and students and feedback garnered through the project's formal assessment mechanisms will be used to improve the GeoMapApp mini-lessons developed in this pilot project.

The main functionality of GeoMapApp has remained largely stable over the last few years and we do not expected that major changes to the GeoMapApp interface will occur. However, through the life of the grant we will ensure that teachers have access to the most current information, updating the GeoMapApp mini-lessons where necessary.

Dissemination and Sustainability Plan

Three main avenues are planned for disseminating experiences and results from this pilot project: (a) Presentations at the national AGU and GSA meetings, at the annual meeting of NSTA, and at regional NESTA and NAGT meetings; (b) Through publication in peer-reviewed geoscience journals. We plan to target an article for one or more of: Eos, GSA Today, and Journal of Geoscience Education; and, (c) Through teaming up with SERC, experiences will be noted at relevant SERC On the Cutting Edge workshops.

It is hoped that this pilot project is a success in that it not only provides a valuable, relevant resource for hard-pressed, targeted teachers but also, through the dissemination plan, garners enthusiasm from the broader geoscience K-12 community. We hope that it would lead to a larger proposal, probably to NSF-HER, for a follow-on project to create a wider suite of GeoMapApp mini-lessons applicable to more national and state standards.

Work Plan – Project Time Line

In the first six months of the two-year pilot project, an initial set of GeoMapApp mini-lessons will be created by Goodwillie and Kluge, the web pages will be created at SERC, a cohort of practising teachers will be formed and one BOCES professional development workshop run. These early-adopter teachers will be supported in their usage of the GeoMapApp mini-lessons through the remainder of their academic year. Additional mini-lessons will be developed during year 1 and the suite will be presented at meetings.

Based upon the assessment results and report of the first year, feedback will be used to improve the mini-lessons as we recruit additional teachers locally and regionally for year 2. Another BOCES workshop and participation at regional and national meetings will widen the pool of teachers. Improvements to the mini-lessons will continue to be made.

The final summative assessment of the project at the end of year 2 will, we hope, allow us to propose new funding for a larger project.

Funding for this pilot project – in the form of salary support, sub-contracts to SERC and CIRES, consultancy fees, meeting attendance, and participation support for teachers at the BOCES workshops – will be used to cover all above aspects of this work plan.

Summary of scope of work and responsibilities

- Goodwillie and Kluge develop K-12 standards-based GeoMapApp mini-lessons.
- SERC-Carleton provides web page infrastructure and hosts the mini-lessons.
- Through workshops and outreach, practising teachers take up mini-lessons.
- Surveys and quizzes gauge teacher experiences and impact on learning.
- Teacher collaboration and feedback used to improve mini-lessons.
- Lynds performs formal project assessment.

Requirements for running GeoMapApp

There are some practical applications to using GeoMapApp in the classroom so each mini-lesson will include a standard checklist to ensure installation.

(i) Compatibility
The GeoMapApp software application is written in the Java™ programming language. As a result it works on any computer platform – Windows PC, Apple Macintosh, Linux and UNIX, from mainframe servers to latest-generation barebones netbooks. Users can either launch the application directly from a web page (www.geomapapp.org) or download a small (6 MByte) executable file.

(ii) Type of internet connection
Any standard internet broadband connection (wireless or hard-wire) can be used successfully to run GeoMapApp. Certain GeoMapApp operations require an underlying data set to be loaded behind-the-scenes from the Lamont server, as indicated by a progress bar. The loading process usually takes no more than a few seconds.

(iii) Will schools have suitable computer resources and internet access?
Information technology infrastructure in the NYC school district has seen rapid advances in recent years. Of direct relevance to this proposal is that as of June 2009, 98% of all NYC classrooms have both hardwire and wireless internet access connected to a fibre optic backbone (*page 35, Brodheim et al*, 2009). Over the next four years, according to that report, school network infrastructure will continue to be expanded to further improve coverage, bandwidth and robustness.

Physical access to a computer is less of an issue than a few years ago. School-owned laptops are common. These, and school computer labs, could be used for running GeoMapApp mini-lessons. We would also encourage teachers to assign GeoMapApp mini-lessons as homework, the activity being done in either the school library, computer lab, or at home.

(iv) How will GeoMapApp be installed on school computers?
Teachers using a central computer lab will need to request that GeoMapApp and Java™ are loaded ahead of time on the machines. The school technology officer will perform this administrative task. We note that the NYC five-year plan includes the convenient requesting and response for such software installation (*page 69, Brodheim et al*, 2009). For shared or personal laptops in which administrative rights are available, it is recommended that the teacher ensures at the start of the unit that GeoMapApp and Java™ are loaded.

Our experience suggests that some principals may be wary of loading GeoMapApp onto their school computers. In these cases, we will provide a letter to the principal assuring them that the software is benign and cannot be abused by students.

Project summary

We propose using GeoMapApp to develop effective, convenient mini-lessons for middle and high school earth science classrooms, with content and learning goals ties to NY state standards. By engaging teachers both in the classroom and via workshops and meetings we hope to enhance and encourage teacher professional development and empower teachers in the use of scientific data and cutting-edge technology in the geoscience classroom. We believe this to be an exciting, high-impact approach to provide teachers with transformative state-of-the-art cyber-education learning resources. We further believe that this approach has significant broader implications and commonality for use at the community college and introductory undergraduate levels.