Lessons Learned from the ITEST *Ocean Explorers* Project

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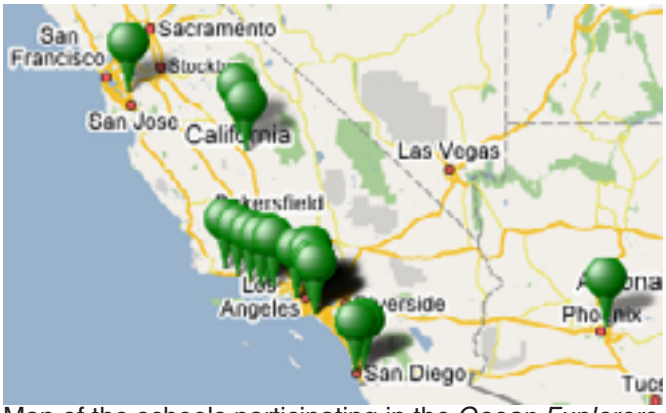
ABSTRACT

This paper will present evaluation findings of the *Ocean Explorers* project, an effort funded by the Information Technology Experiences for Students and Teachers (ITEST) program of the National Science Foundation. The goal of the project was to use ocean science and GIS as hooks to introduce information technologies to middle and high school teachers in California. This paper will review lessons learned from working with a single cohort of teachers as they constructed ArcView 3.x, ArcGIS 9, My World, and ArcExplorer–Java Edition for Education projects over a three-year period. A focus of the paper will be the barriers teachers experienced in implementing GIS as an instructional technology and how the project worked to help teachers overcome those barriers.

BACKGROUND

With primary project activities completed in August, 2006, *Ocean Explorers* was a three-year project funded by the Information Technology Experiences for Students and Teachers program at the National Science Foundation (NSF) and implemented by the Center for Image Processing in Education (CIPE). The project employed GIS, digital image analysis, and ocean science as ways of incorporating information technology (IT) into science and mathematics education in California. *Ocean Explorers* was created as an outgrowth of the *Mapping an Ocean Sanctuary* project funded by the Geoscience Education program at the NSF. For *Mapping an Ocean Sanctuary*, CIPE collaborated with the Channel Islands National Marine Sanctuary (CINMS) to produce a set of six lessons designed to help teachers explore ocean ecology and ocean resources management issues with GIS. The set was published as a 128-page book and CD-ROM in 2003.

Ocean Explorers gave support to a select group of educators over an extended period of time. It formed teams of teachers that served as local user groups for the exploration of GIS as an educational technology. Teachers participating in the project received mentoring, software, equipment, funding, and training on how to design



Map of the schools participating in the *Ocean Explorers* program.

inquiry-based activities that support achievement of state and national science, technology, mathematics, and reading standards. *Ocean Explorers* recruited twenty teams of three to five teachers from middle and high schools in California, thus creating for each participant a local cadre of peers implementing the new technology. Schools participating in the project included large, inner-city high schools such as Roosevelt High School and Woodrow Wilson High School in east Los Angeles; a charter high school in Venice, California; suburban middle schools and high schools; private middle schools; and three alternative schools. Each team committed to participation for the entire duration of the three-year project. Likewise, the project committed to support and mentor each team for three years.

In its first year, *Ocean Explorers* provided each team with basic and advanced training with ArcView 3.x GIS and handheld global positioning system technologies. The training continued during project year two. Activities engaged in at project workshops were designed to demonstrate how the technologies could be used to study the ocean. Project workshops were held on beaches, aboard vessels, and on the Channel Islands. Field research institutes were also held during the summer of year one, providing teachers with grounding in transect sampling, water quality and beach assessments, marine life observations, and documentation techniques commonly employed in ocean science. CIPE's Mapping an Ocean Sanctuary materials and ESRI's Mapping Our World book and CD-ROM (Malone, Palmer, and Voigt 2002) were used as the primary teaching materials at the workshops and institutes.

During the first year of the project, training was provided on how to employ the *Understanding by Design* methodology of Wiggins and McTighe (1998) to begin with targeted reading, mathematics, science, and technology standards (the "Content standards for California public schools" [California Department of Education 2002]) to develop GIS-based educational activities for students. From the standards, the teams created activities and assessments that involved students in GIS-based learning about the ocean in a manner that supports state mandates for satisfactory achievement by students and schools.

The activities and assessments were developed during years two and three of the project with mentoring and assistance by project staff, education specialists and scientists from CINMS, practicing and retired teachers, faculty from academic institutions, education specialists from ESRI, and other advisors. Extended "think tanks," teleconferences, and weekend work sessions were employed to engage the teachers, give them time to work together, and provide needed support and troubleshooting. Special training on alternative GIS software programs—particularly ArcExplorer – Java Edition for Education (ESRI 2007); My World (GEODE Initiative 2006); and ArcGIS 9.x (ESRI 2007)—was provided at project events. Teachers eventually developed activities on four GIS platforms (ArcView 3.x, ArcExplorer – Java Edition for Education, My World GIS, and ArcGIS 9.x).

Activities developed by the teams were tested during field experiences for students conducted after school, during weekend field trips, and during the summer. The field experiences were implemented with the teachers' own students. After testing, the activities were revised and prepared for sharing on the project Web site (http://www.exploreoceans.org).

During the summer of year three, seven teachers from *Ocean Explorers*—with the support of project staff—conducted a three-day workshop for teachers. The workshop was attended by 15 middle school and high school teachers from the region and across the United States. At the workshop, the teachers led the participants through the activities they had created during their tenure with *Ocean Explorers*. A unique component of the workshop was that instruction was provided on three GIS software programs: ArcView 3.x, My World, and ArcGIS 9.x.

Capping off *Ocean Explorers* were presentations by the teacher-teams at the 2006 ESRI Education User Conference (EDUC) in San Diego. The project rented exhibit booth space in the EDUC Expo and teachers presented their activities from computers in the booth.

EVALUATION

Evaluation of the *Ocean Explorers* project was conducted by WestEd, who used the following sources of data to prepare a summative evaluation of the project: journal responses from teachers; responses to a lesson development retreat evaluation survey from April 2006; pre- and post- project survey responses; and three case study reports that incorporated interview data, observations, and student test data.

Four questions and two sub-questions were addressed in the summative evaluation:

1. What were the characteristics (race/ethnicity, type of school, etc.) of the teachers and students in the project?

2. Did the activities and materials developed by participating teachers achieve the desired student learning goals (changes in attitudes, knowledge and skills) related to the defined learning standards?
   A. What elements of the OE professional development (amount of time, support, group participation) appeared to influence teachers' knowledge of and attitudes toward IT?
   B. What supported teacher integration of technology into their teaching?
3. How did the workshops and professional development activities change teachers' instructional practices, IT skills, awareness of IT careers, and science content knowledge?
4. What barriers (within their schools, the project, etc.) did teachers encounter in implementing the lessons?

WestEd concluded that the *Ocean Explorers* project achieved its major goals of changing teacher knowledge and practice about using information technology, and ensuring student exposure to information technology tools and resources. The evaluators noted that by working with one cohort of teachers over a three year period, the project was able to offer teachers high quality professional development activities that resulted in content knowledge learning as well as pedagogical learning related to both ocean science and the use of IT tools. According to WestEd, the *Ocean Explorers* experience "identified IT learning and teaching challenges and important lessons for the design and implementation of professional development activities for science teachers in the current school environment" (Goldsmith, Dailey, and Holmes 2006).

Evaluation of the *Ocean Explorers* project underscored the fact that teachers appreciate GIS as a powerful tool for unlimited exploration and analysis of many kinds of data. They enjoyed its usefulness for engaging students in active discovery of patterns in mapped data of many kinds and making connections between Earth science, environmental, cultural, sociological, municipal, student-gathered, and other kinds of data. And, students appeared to have success in mastering content related to the GIS explorations.

However, tracking the single cohort of teachers for three years in the *Ocean Explorers* project revealed how challenging implementation of GIS-based education can be for mainstream educators. Many teachers in the cohort had difficulty mastering complex GIS software and maintaining competency over time; developing the knowledge and skills needed to pose a research question that can be validly explored with GIS; understanding how to acquire geospatial data and prepare it for use in localized GIS projects; knowing how to interpret mapped representations of information and make spatial and time-referenced comparisons of data; integrating GIS-based learning into an already packed curriculum; working with other teachers as a design team to create and implement a student project; and overcoming daunting bureaucratic obstacles to implementation, such as getting software installed on school computers, allocating network and server space for student work, and overcoming security issues.

LESSONS LEARNED

These challenges mirror the reports of other investigators (Kerski 2003; Parsons 2005) and point to several lessons relevant to projects such as *Ocean Explorers*:

1. Teachers enjoy receiving ready-to-use lessons that they can quickly deploy in their teaching situation. The lessons must be easy-to-use, able to be quickly implemented, and contain everything needed for classroom use (including the GIS software.
2. Workshops that introduce GIS to teachers must show a direct connection to classroom instruction and, in particular, help educators teach concepts that will foster student success on standardized examinations.
3. Mainstream teachers need GIS-based classroom activities that target concepts already taught with other instructional methods, but do so in a manner that is more engaging for students and more effective pedagogically.
4. Beginning GIS users benefit from highly scaffolded professional development and and a simplified GIS interface that allows them to view and analyze map layers and add field data of their own without having to sift through the complexity of a professional software program.
5. The key to successful implementation of GIS by mainstream teachers is face-to-face professional development by patient and competent mentors.
6. GIS-based professional development programs need to understand and build upon the experience base and motivations of the participating teachers.

TOWARD A MODEL OF PROFESSIONAL DEVELOPMENT

Drawing upon these lessons and distilling impressions from the *Ocean Explorers* experience, a model of teacher professional development can be outlined that supports implementation by promoting commitment, developing empowerment, instilling relevance, encouraging comfort, and growing competence (Figure 1). The professional development should engage learners by appealing to their interests and base of experience (Bybee et al. 2006; National Research Council 2003; Donovan and Bransford 2005); consciously target federal and state standards as a way of ensuring that instruction is relevant to the needs of the curriculum (Wiggins and McTighe 2005); use data visualization with GIS as a vehicle for promoting creative and effective ways of thinking (National Research Council 2006); introduce strategies that promote student success in the classroom (Rodriguez and Knuth 2000); prepare teachers so that they experience success and develop comfort in using the technology (Lockwood and McAuliffe 2005); and use appropriate role models and mentors to enhance the relevance of project strategies to diverse learners (Turner, Bernt, and Pecora 2002; Mendoza and Johnson 2000; Margolis and Fisher 2002; ITEST Learning Resource Center 2006; InterAcademy Council 2000).

CONCLUSION

The *Ocean Explorers* project provided a unique opportunity to follow one cohort of teachers over a three-year period of implementation. The experience was challenging for the participants and project staff alike, as each got intimately involved in overcoming

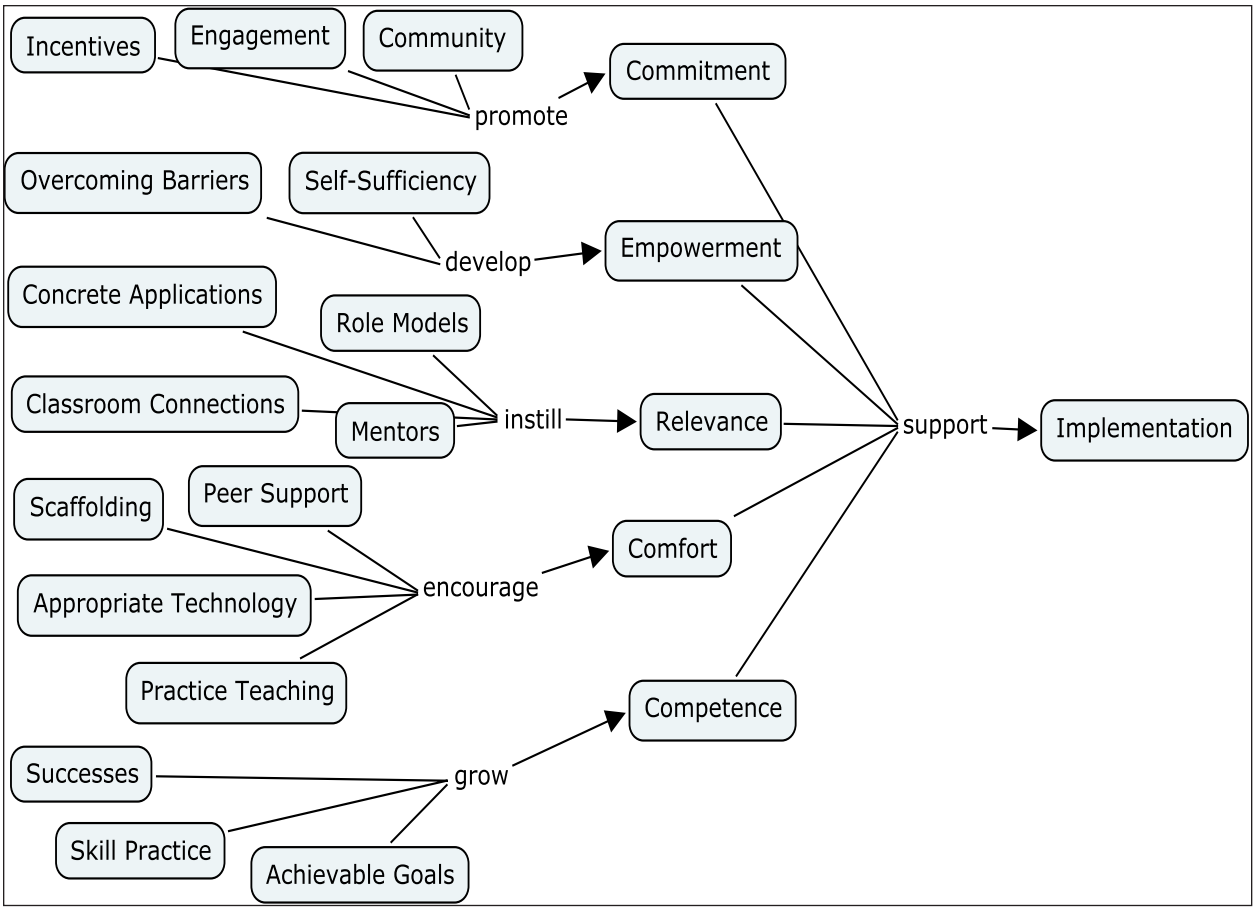


Figure 1. A professional development model derived from *Ocean Explorers'* lessons.

daunting personal, professional, and technical challenges. The project generated many successful implementations of GIS in schools and lessons that can be applied to the development of a model for GIS-based professional development.

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