Implementing the curriculum in large lecture courses

We have implemented these materials in several large (150-300 students) introductory courses for non-science majors and a small laboratory-based course for first year geoscience majors with similar results. Two issues must be addressed for successful implementation: 1) providing easy access to the required software and hardware; and 2) providing adequate technical support for first-time users.

To address these issues, 1-year licensed versions of ArcView® GIS software for both Macintosh® and Windows® computers are included on the CD-ROM with the student modules. ESRI®, the publisher of ArcView, also offers low-cost site licenses to educational institutions. In our case, the University of Arizona's site license has allowed us to install ArcView on computers in open-access labs across campus. The combined options for providing access to software allows students to work with these modules at home or on campus.

Providing adequate support to students is another concern when using technology for learning, as computer skills and confidence in learning with technology vary greatly among students. In small laboratory classes most students have had few problems completing a unit in 1.5-2 hours under the guidance of an instructor. However, we have found these materials most useful in large enrollment lecture classes where no laboratory experiences are available to students. In this situation, instructors have assigned individual units as homework and students have had the option of attending help sessions offered for each homework assignment. A five-minute introduction to ArcView was provided at the beginning of each session after which the instructor and teaching assistants helped students as needed. After completing the first homework assignment, most students required minimal assistance with later assignments and only one person was needed to staff a lab serving 45 students.

The quality of an activity's design is often judged by students' ability to accurately complete it in a reasonable amount of time without a lot of intervention by the instructor. Over 90% of the students in our large lecture courses attended the first homework help session. Attendance dropped off to around 55% for the second homework help session and fell to less than 30% for the third homework help session. However, greater than 94% of all students turned in all of the homework assignments and the average score on each was 84-86%. Thus, we can conclude that the

students achieved a moderate to high level of success in learning with GIS. Student attitudes in interviews and course evaluations indicated that they generally enjoyed the exercises. In particular, they especially enjoyed the dynamic nature of the maps and exploring real data.

In the help sessions, we observed that all users would diverge from the assigned activity to explore their own questions when intrigued by a pattern in the data. Similarly, the time spent investigating one's own questions increased as experience with the tool and knowledge of the topic increased. As one might expect, we also observed that the complexity of questions and the observations increased with greater knowledge of the topic. This increased interest in the data often resulted in increased desire to learn more GIS skills. These results are very encouraging signs that our materials can be used broadly in Earth sciences, even in classes where the faculty and students have little prior experience with a GIS.

An added benefit of teaching with a GIS is the opportunity to reach students with different learning styles. In a typical lecture course, the instructor delivers primarily audio information (75% lecturing) supplemented with visual information such as slides and animations (25%). In contrast, approximately 65% of college students learn most effectively with visual tools, while 20-25% are most successful with audio information, and 10-15% excel through kinesthetic or tactile learning. Research shows that learning preferences affects one's ability to learn, and a student may learn more if she or he studies by a method that is consistent with these preferences. Thus, the visual and tactile nature of our GIS-based exercises provides more effective avenues for reaching audiences with diverse learning styles, while incorporating scientific inquiry in the courses.