Implementing a Web-Integrated High School Biology Program

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In 2000, the National Science Foundation provided funds to guide the development of the *Biology: Exploring Life* program using a research-based evaluation process over a three year period. The two main project goals are:

(1) To develop a general biology curriculum based on constructivist learning and focused on biological themes

(2) To develop student-centered materials for active learning of biology.

The curriculum is based on the *National Science Education Standards* and uses a 4 E's learning cycle model. The "E's" represent various phases of the constructivist learning cycle (***e****ngage,* ***e****xplore,* ***e****xplain,* ***e****valuate*). The product integrates a concept-oriented textbook, a collection of inquiry-based lab and field activities, and an extensive World Wide Web site that provides an interactive learning environment for students. These components are designed to work together to help teachers provide a more interactive learning experience in their classrooms, one in which computers support and enhance delivery of the curriculum.

Purpose of the Evaluation

The purpose of the evaluation was to assess the materials in terms of their ease of use, pedagogy, program performance, and clarity and depth of content. The four major evaluation issues were,

1. Do the materials address the important goals of biological science teaching and learning?
2. Are inquiry and activity the basis of the learning experiences?
3. Are the topics of the unit and the modes of instruction developmentally appropriate?
4. How are teachers implementing the materials?

Evaluation Procedure

Over the course of the first two years of the grant's implementation period, sixty-three participants pilot-tested *Biology: Exploring Life* materials with 4456 students. The methods and instruments used to investigate the evaluation questions included curricular analysis procedures, usability analyses with classroom teachers and students, site-based field observations, focus groups, interviews, implementation surveys, and teacher and student attitude measures. The attitude measures were completed after using each prototype chapter in the classroom. Content knowledge assessments were administered to 9^{th} and 10^{th} grade biology students before and after using each of the three sample chapters and semi-structured interviews were conducted with a sample of students on their perceptions of learning with the materials.

Preliminary Evaluation Results

The evaluation feedback resulted in substantive improvements to the product. The resulting curricular modifications include additional teacher support materials that reflect pedagogical content knowledge concerning the curriculum and promote flexible use of the curriculum by teachers. The revised "teacher resource" section includes discussions of expected prior knowledge, ways to assess prior knowledge, and ways to carry out formative assessments. Content adjustments were made to the labs, the book and the Web site. The Web site interface design was revised for greater clarity and ease of use.

Data from two years of pilot testing support the following conclusions:

- The materials offer many activities that correspond to the National Science Education-Standards' definition of active learning.
- The materials employ a logical progression for developing conceptual understanding of the biology content in reviewed chapters.
- The materials contain modes of instruction that are developmentally appropriate for a wide range of learners and are interesting, engaging and effective for both female and male students, as well as under-represented and under-served students (e.g., ethnic, urban, rural, with disabilities).
- The interactivities and graphics on the Web site help lower level students and low-level readers understand the main concepts.
- The design of the Web-based materials supports the 4E learning cycle model. A variety of inquiry-based activities are provided to accommodate diverse learning styles.
- Features of the Web-based instruction assist student learning. These include receiving immediate feedback to responses, being able to perform activities over and over again, and user control of interactivity.
- The online laboratory procedure previews and the hands-on classroom laboratories help students understand the biology concepts.
- Pre- and posttest results of biology content knowledge reveal students are learning biology concepts and content using the materials.
- Through the use of thought-provoking questions embedded within the materials, the product provides students opportunities to develop deep understanding of the biological concepts. Similarly, the product enhances reflective reasoning by providing learners with opportunities to monitor their understanding through immediate feedback functions on the Web site.
- *Biology: Exploring Life* is a flexible product that allows biology teachers to pick and choose from a variety of types of activities for their students. That is, materials are adaptable to the unique needs of teachers and students and provide a broad range of resources that can be integrated into the curriculum selectively.
- As a result of using the materials, some teachers "see potential for higher implementation of technology integration" in the biology classroom.

For a more detailed report, please visit the Exploring Life Evaluation Web site at: http://www.lehigh.edu/~inexlife/

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