article:1275

Embracing the Future: Bioinformatics for High School Women

Background of the Study

Competent female and minority students tend to withdraw from studying science and technology. Their reasons include lack of confidence, support, or encouragement, coupled with negative images of scientists, and weak math and science teaching, as reported by the American Association for the Advancement of Science, the National Science Foundation, and the Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. At the same time, businesses, universities, and government, concerned about competing globally, seek American workers to fill positions in science and technology.

Research Questions

We decided to create a residential summer program to encourage high school women and minorities to pursue their interest in science. We selected bioinformatics as the content, since it connects biology with technology and offers opportunities as a new scientific field. We chose problem-based learning (PBL) as the teaching method, because it allows students to pose problems that are important to them, then learn purposively to investigate these problems. Our complex learning environment immersed students with direct instruction through laboratory and technology experiences, an environment of individual and cooperative learning, speakers from scientific occupations, and trips to scientific centers using bioinformatics. We posed three research questions: 1. What will be the impact of a summer residential program in bioinformatics on high school women? 2. How will the choice of bioinformatics as the content area affect how high school women incorporate science into their lives? 3. How will a complex learning environment enable the learning process?

Theoretical Framework

Problem-based learning is a constructivist teaching method, where students construct their understandings through complex learning activities. They are motivated to learn because the problems they select to solve are real and important to them. Working in cooperative learning groups, students investigate using strategies that scientists would use, and they gather the information, methods, and tools that will provide meaning to their problem. Instructors have a very different role: rather than teach, they support and guide students, often through posing questions that will enable students to clarify their thinking. Students "own" the problem, and this investment carries them through the inevitable frustrations.

Principles of cooperative learning include positive interdependence, simultaneous interaction, and individual accountability. As students work in cooperative learning groups, team building and group processing activities ensure that all are actively involved participants. The complex learning environment is built on the concepts of distributed intelligence and situated learning.

Methodology

We sought applicants who were completing their junior year in high school and met specific academic requirements. Among the 16 participants were 7 Caucasian, 4 Asian, 4 African American, and 1 Hispanic. We also chose two female resident assistants (RAs) to manage dormitory living and help with academic activities. The program was held at Immaculata University for five weeks.

During the day, students received instruction in molecular biology and bioinformatics tools. They participated in wet labs, gathered information from resources such as the National Library of Medicine, used the National Center for Biotechnology Information for locating data sequences, and analyzed data with bioinformatics tools available on the Biology WorkBench. In the evening, they conversed with female scientists, learned Web page design, or watched relevant movies. Weekly trips gave students the opportunity to see sites where bioinformatics is used, including the Academy of Sciences, University of Pennsylvania Bioinformatics Center, GlaxoSmithKline Pharmaceutical Company, the National Institutes of Health and The Institute for Genomic Research (TIGR).

Students completed five individual projects, each at successively higher cognitive levels. They defined bioinformatics terms (knowledge), explained a bioinformatics site or image (comprehension), described and illustrated a bioinformatics tool (application), analyzed a female scientist's life and career (analysis), and evaluated a current event about bioinformatics (evaluation).

At the same time, participants engaged in group investigations using PBL methods. Students brainstormed ideas for scientific questions that aroused their curiosity, then investigated their questions using all the resources that the complex learning environment provided. At the end of the program, students presented their projects at a gathering of school and family members. Once home, each student presented her work to peers. Six months later, everyone attended our reunion. During the next three years, we heard from the students as they entered college and selected a major. Many were selected for internships and research programs, which they attributed to the summer program and experience with bioinformatics.

Collecting Data

We used qualitative research methodology to collect data. We sought triangulation through surveys, observations, and the outcomes of projects.

We surveyed participants at the beginning and end of the program to ascertain content strengths and learning styles. Participants also completed surveys longitudinally four times. We surveyed parents at the end of the five-week program. Students wrote daily in journals about topics of their own choosing.

We observed students continually and kept field logs throughout the program, as did the RAs. The outside evaluator observed weekly and conducted focus group interviews during the final week.

We examined students' individual and group projects, and the Web pages that documented them.

Analyzing Data

We analyzed data by qualitative research techniques. We read student surveys and journals, plus field log observations from researchers, RAs, and outside evaluator. We coded each item, organized them into categories, and then wrote theme statements. We assessed the projects for content, higher order thinking, and use of research methods.

Major Findings

Question 1. The residential five-week program enabled the development of a culturally diverse learning community where students grew academically and socially. They developed multicultural awareness, bonded, and became friends.

Question 2. Students enjoyed biology wet labs and became confident about their understanding of biology. They used Biology WorkBench and appreciated the value of data from genomic analyses. They increased their interest in a science major and realized the role that women can achieve as female scientists.

Question 3. Through the complex learning environment, students experienced science through multiple lenses, developed higher order thinking skills, became productive members of cooperative groups, and learned the value of persistence during research.

Recommendations

We promote exposure to bioinformatics in high school, especially for encouraging women to connect biology with information technology. We support programs conducted at critical transition points, since they can be important in maintaining student interest in science. We conclude that a complex learning environment enables constructivist learning.

Support

Our program was supported by a National Science Foundation grant under the Program for Gender Equity in Science, Mathematics, Engineering, and Technology (HRD 00-86360), principal investigators Susan J. Cronin, IHM, and Charlotte R. Zales.

Author 1: Charlotte Rappe Zales email: crzales@moravian.edu

Author 2: Susan Cronin email: scronin@immaculata.edu

: Back to 2006 Winter Issue Vol. 2, No. 1

: Back to List of Issues

: Back to Table of Contents