BioBLAST: A Multimedia Learning Environment to Support Student Inquiry in the Biological Sciences[1]

Goals of Program

- To support an inquiry-based, cooperative-learning approach to teaching biology in accordance with the revised National Science Education Standards
- To design of an adventure/exploration scenario within an engaging graphical environment that focuses on the future of space exploration
- To provide a systems-level approach to the study of biological issues that integrates math, science, and technology education within a problem-solving, research-oriented context
- To work with a select cadre of teachers from schools throughout the United States to investigate how an interactive adventure can integrate computer-based resources, tools, and simulations, as well as hands-on labs, to enhance student learning
- To demonstrate how NASA's Advanced Life Support research and data can be adapted to provide valuable and motivating resources that enrich student learning and performance in science, math, and technology education

Key Words

- Multimedia
- Scientific Inquiry
- Simulation
- QuickTime™ Virtual Reality (QTVR)
- Biology
- Recycling
- Science

Location

NASA Classroom of the Future (COTF)
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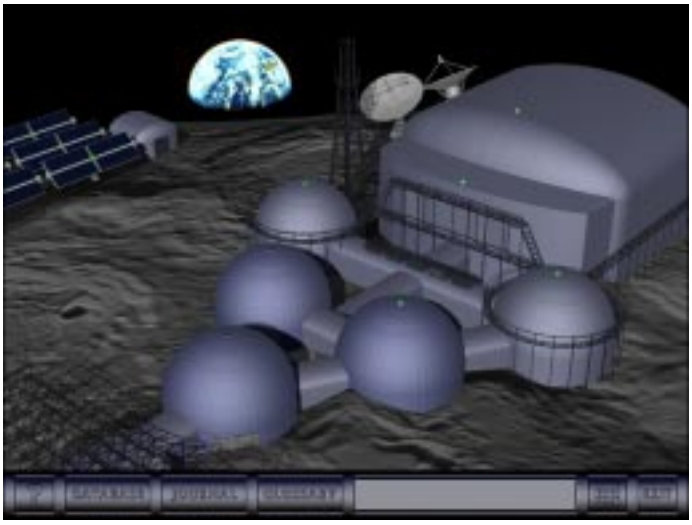

Main interface for BioBLAST's BaBS (Build a BLiSS System) simulator.

Description of School and Community

The NASA Classroom of the Future (COTF) at Wheeling Jesuit University in Wheeling, West Virginia, was funded by the National Aeronautics and Space Administration (NASA) in August 1995 to develop *BioBLAST*™. In addition to the software development group at the COTF, twenty biology teachers from throughout the United States and many scientists affiliated with NASA's Advanced Life Support research program have contributed to the design and development of this product. A final round of classroom testing of *BioBLAST* begins in January of 1998.

The COTF was established in 1993 to serve as a research and development facility for innovative applications of educational technologies designed to improve K-14 math, science, and technology education. The COTF mission is to demonstrate how NASA science and engineering research and resources can be combined with advanced educational technologies to create exemplary education curriculum supplements. The COTF is one program within the Center

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for Educational Technologies (CET) on the Wheeling Jesuit University campus. The CET features video production and broadcasting capabilities as well as educational technologies, computer, and distance-learning facilities, from which pre-service and in-service education programs can be disseminated to schools and teachers nationwide.

Description of Program

BioBLAST is a multimedia curriculum supplement for high school biology classes that incorporates NASA's Advanced Life Support (ALS) research. Students learn about basic and applied life sciences research underway at NASA centers and apply their prior knowledge of biological processes during the course of this program. Students use simulation models built by the COTF based on NASA ALS data to develop and test their own designs for a bioregenerative system to support human life outside the safety of Earth's atmosphere. The interactive adventure/simulation framework includes computer-based tools and resources, telecommunications events, and hands-on experiments.

Using NASA's research on Bioregenerative Life Support Systems (BLiSS) provides a systems approach to the study of key biological principles that helps students integrate many of the segmented concepts they learn in biology, math, chemistry, and physics. In designing a biologically-based, regenerative system to support humans in space, students develop a greater understanding of the interdependence of living systems. In addition, *BioBLAST* brings futuristic scenarios into the classroom, where today's students may be tomorrow's explorers. For example, NASA anticipates having a fully self-sufficient air, water, and food recycling system to support a three-year mission to Mars by the year 2008. This means that students from the age of 15 and up are potential candidates for the projected 2008 international space mission to Mars.

BioBLAST includes the following features:

A virtual-reality interface. *BioBLAST* uses a QuickTime™ VR graphical interface in which interactive objects, or "hotspots," are embedded. The software is designed to draw students into a futuristic, problem-solving scenario in which teams of students are sent to a lunar research facility. The facility's tools and resources are used to prepare students for their ultimate goal, to design and test a model for a bioregenerative life-support system (BLiSS) that can support a crew of six for three years.

View of QTVR setting for graphical access to BioBLAST tools and resources.

An arcade-style game. On their way to the moon, students are introduced to concepts used in the study of closed life-support systems via an animated adventure game. To save the mythical inhabitants of an imaginary world, students must discover the secrets of their ecosystem.

Laboratory investigations. A set of hands-on, laboratory-based activities focuses on key components of plant production, human requirements, and resource recycling processes. An understanding of these process helps prepare students to design their own fully-functional BLiSS.

Computer simulations. Simulation software is included to supplement laboratory activities and to enable students to perform investigations not possible in a typical high school biology lab. Three simulations focus on the three topics covered in the laboratory, and a modeling simulation called BaBS (Build a BLiSS System) is used for the design and testing of each student's own BLiSS. These simulations utilize and give high school students access to current NASA basic and applied research data within the context of NASA's Advanced Life Support research program. They also demonstrate to students the use of computational models in the life sciences, and can stimulate student interest in further investigations in this area.

Crop parameter input screen from the BioBLAST Plant Production Simulator.

Computer-based resources. In support of student research, the *BioBLAST* virtual environment contains over 300 documents, 150 images, and over 40 minutes of video. Documents include a variety of articles from scientific journals, popular magazines, and content written for *BioBLAST* by life-science subject-matter experts. Video segments include a virtual "mentor" who provides suggestions relevant to students' research activities, as well as interviews with NASA scientists currently involved in advanced life-support research.

Telecommunications. BioBLAST software beta testing activities, scheduled for the spring of 1998, will include a prototype version of the "Ask a NASA Expert" system. This Web-based resource includes an automated question-and-answer system, together with a "frequently-asked questions" database so that experts are not overwhelmed with repeat questions. The support provided by the automated question answering system is designed to test the possibility of handling thousands of *BioBLAST* student questions being asked on a daily basis. The software is designed to dynamically link student questions with similar questions asked and answered before so that NASA scientists and engineers involved in advanced life-support research are only contacted when new questions are submitted.

Adherence to national education standards. The software is closely linked to the National Research Council Guidelines for Science Education. Student investigations and laboratory experiments built into the sequence of *BioBLAST* activities address specific topics articulated within the national guidelines for biology, math, and technology education. Student research projects address the goals for promoting student abilities and understanding of the methods of scientific inquiry.

Special Outcomes, Results and Accomplishments

Teacher involvement in development. The teachers participating in the formative evaluation of the *BioBLAST* software and related materials have shown that there are many viable alternative ways of using the program. The teacher-leaders participating in an extended design team have provided examples from their classroom applications of *BioBLAST* that show how it can be successfully used with gifted and talented, introductory biology, advanced biology, advanced technology, general biology, and student research elective classes.

Teacher interest and commitment. Teachers who have participated in the formative evaluation activities have been extremely enthusiastic and supportive of this program. This quote from one of the teachers provides an example of the kind of commitment and support teachers have provided to this project: "I get really excited about *BioBLAST*. It's an innovative program that allows my students to reach a higher level of thinking. I feel that I am involved in a program that is really futuristic, is pertinent and meaningful, and is going to change the way we teach."

NASA support. We have received, and continue to enjoy, enthusiastic support by NASA administrators, educators, scientists, and engineers at all levels.

Further development. *BioBLAST* is still under development; therefore, we have only begun to assess its impact. As beta testing continues in the spring of 1998, we will be better able to understand its contributions.

Difficulties (Anticipated and Unanticipated)

Developing accurate, realistic simulations. Difficulties arise in trying to develop fully-functional simulations that address current research areas. The availability of scientific data is not consistent. In some cases the research is currently underway, and the data are either not yet published or incomplete. Another problem is that multiple solutions are being researched simultaneously, and NASA's approach to advanced life-support systems is evolving simultaneously with *BioBLAST* development. The same reasons that make working on a current problem exciting and timely also create challenges for developing simulation models.

Technical problems. Variable levels of technology available in schools and a lack of technical support to teachers have made implementation of *BioBLAST* difficult in some cases. Quick resolution of problems is important since *BioBLAST* testing must be integrated into already tight class schedules. Here is an example of a technical delay in software testing, that was not anticipated. A school in New York was not able to participate in the formative testing of an early version of the BaBS simulation because the school computers were using an out-dated version of the computer's operating system, and this problem was not addressed until after the close of the academic school year.

Support of multiple levels of students. As recommended in the National Science Education Standards (National Academy of Sciences, 1996), *BioBLAST* promotes an inquiry-based approach to learning, which may be a novel approach for both students and teachers. Most students, once they become familiar with this approach, become actively involved in the learning process. However, students who lack the basic science and math knowledge required for successfully applying the resources and tools in this program may not be prepared for the kind of problem-solving activities presented in *BioBLAST*. Some students may need more structure and direct instruction before the material in this program will be useful to them.

Costs

The COTF *BioBLAST* development team includes a project manager/lead designer, two programmers/instructional designers, a graphic designer, three curriculum writers, a web master, a desktop publisher, and part-time participation by video, editing, and copyright specialists. The extended design team includes scientific and technical experts from NASA, outside consultants who contributed specific projects, technical expertise, and content material, and a team of exemplary teachers, who review and test materials as they are created. The software and all related materials will be completed by April of 1998. This project will have taken 30 months to complete. The total cost of supporting the 2.5 years of design, development, and formative evaluation of this project has been approximately 1.5 million dollars.

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