

MISSION TO PLANET EARTH ON-LINE EARTH SYSTEMS SCIENCE COURSE

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ABSTRACT

The National Aeronautics and Space Administration (NASA) has a leadership role in Earth Systems Science research for the United States with the Mission to Planet Earth (MTPE) program, which, making use of satellite technology, remote sensing, and image processing, is altering our understanding of our planet.

Although significant effort is going into the MTPE program, and although the implications of this research will have widespread impact on environmental, scientific, social, political, economic, and health policies worldwide, few teachers and far fewer students are aware of these efforts, or have the skills and knowledge necessary to understand them. Typically, students and teachers do not have experience with analyzing problems on an ecosystem or biosphere scale. But MTPE's scientific studies hold great potential to enhance, enrich, and extend the K-12 science and mathematics curricula. Many curriculum materials have been developed for this purpose by MTPE, Project Globe, and others.

In order to provide middle school educators from across the United States with the skills, knowledge, and materials necessary to teach their students about Earth Systems Science and NASA's MTPE research efforts, the NASA Classroom of the Future will design, develop, field test, and disseminate an on-line course making use of World Wide Web and Virtual Reality Mark-up Language (VRML) technologies.

The development of the on-line inservice course will be a collaborative effort involving classroom teachers, education personnel and scientists from NASA's Mission to Planet Earth (MTPE), the Classroom of the Future (COTF), and Space Grant Consortia members.

INTRODUCTION

The Earth as a system and the impact of human beings on that system have become the focus of extensive national and international research efforts. For example, the International Council of Scientific Unions' (ICSU) International Geosphere-Biosphere Programme (IGBP), the United States Global Change Research Program, and the National Research Council have focused on global change as a major part of their research agenda.

The National Aeronautics and Space Administration (NASA) has taken a leadership role in this research for the United States with the Mission to Planet Earth (MTPE) program, which makes use of satellite technology, remote imaging, and image processing, and is altering our understanding of the Earth as a system.

Although significant effort is going into the MTPE program, and although the implications of this research will have widespread impact on environmental, scientific, social, political, economic, and health policies worldwide, few teachers and far fewer students are aware of these efforts, or have the skills and knowledge necessary to understand them. Typically, students and teachers do not have experience analyzing problems on an ecosystem or biosphere scale. MTPE's scientific studies hold great potential to enhance, enrich, and extend the K-12 science and mathematics curricula.

The NASA Classroom of the Future at Wheeling Jesuit College, in cooperation with NASA Headquarters Education and MTPE program personnel, is planning and field testing a World Wide Web-based teacher training program to provide middle school teachers from across the United States with the skills, knowledge, and materials necessary to understand and teach their students about Earth Systems Science and NASA's MTPE research efforts.

This effort includes course development, development of a WWW-based VRML interface, field testing of these materials, and dissemination to NASA-funded Space Grant Consortium for regional implementation. If successful, it is anticipated that the COTF will, in subsequent years, develop similar on-line courses for elementary and high school teachers.

The use of VRML and the World Wide Web, will place this project at the forefront of on-line teacher training initiatives.

Dr. Robert Tinker and Dr. Sarah Haavind, in a recent paper [1], describe the results of a study of the current state of the art in on-line course development. In the paper, they identify "common elements" of such courses:

The majority of netcourses studied utilized conferencing software or bulletin boards for the instructional part of the course. Some required up to four face-to-face meetings with the whole class so participants can "know" who their on-line colleagues are, other courses are marketed nationally, even internationally, and face-to-face meetings are not

possible, with the exception of occasional subgroups who sign up together and build in local meetings. Some courses are augmented by a media package of materials up-front that include such resources as videotapes, software, or information on disk, as well as the traditional photocopied set of readings. The courses we reviewed varied widely in the level of structure, but all synchronized student activity by having topics that changed weekly. (p. 16)

After exploring the strengths and weakness of current efforts in this area, they noted that current implementations were technically limited for a variety of reasons and concluded, "The World Wide Web will become the technology of choice for netcourses because of its universality and openness" (p. 30).

We will use WWW technology for the Earth Systems Science course under development, but to go a step further than that under current consideration by developers. We propose to use Virtual Reality Mark-up Language (VRML) to build an interactive learning environment for use by class members and instructors. (For more information about VRML, see the Chronicle of Higher Education, February 23, 1996, p. A21 or visit the San Diego Supercomputer Center's WWW site at <http://www.sdsc.edu/vrml/>.) Such an environment will allow participants to explore virtual settings and interact with embedded tools and resources.

Curriculum Development

This project will develop the on-line materials for teacher training but will not develop K-12 *classroom* curriculum materials. Instead, the project will identify and incorporate existing K-12 classroom Earth System Science curriculum materials. NASA personnel have developed MTPE materials that can be used in teacher training and by teachers in their classrooms. Many other federally-funded programs are developing Earth Systems Science materials for use in K-12 classrooms. For example, Project GLOBE has developed a nationwide program to prepare teachers to teach Earth Systems Science and a special opportunity exists to collaborate with the NASA HPCC-funded "Exploring the Environment" (ETE) project at the COTF. ETE is developing a WWW site that contains Earth System Science investigations which can be incorporated into the MTPE curriculum (<http://www.cotf.edu/ETE/>).

Planning Team

This spring, the COTF is bringing together a course development team consisting of representatives from NASA Headquarters (MTPE and Education Division), COTF, Space Grant Consortia, a VRML software developer Earth System scientists, and middle school science teachers. The group will meet at the COTF for

three days to develop the outline for the course, supporting materials and the virtual environment. Once this meeting is completed, development will continue with the participants collaborating using the Internet as the medium for communications. The materials will be ready for field testing in the winter of 1996-97.

COURSE DESCRIPTION

The content of the class will be Earth Systems Science, appropriate for middle school teachers and students, as well as an introduction to curriculum materials developed by NASA and other federal agencies for use in middle school science classes. The class will be delivered on-line, making use of WWW technology, including VRML to enable multimedia and virtual environments to be part of the educational experience. The project will do preliminary work developing interactive environments that enable participants to "enter" a virtual environment and interact with other participants as well as embedded tools and resources.

Each participant in the class will receive a class "kit" that will contain materials such as print media, software, manipulatives, videotape, and curriculum materials from MTPE, GLOBE, and other federally-funded Earth System Science projects.

The class will be taught by an Earth System scientist and middle school science teacher, both of whom will help in its development. The class will be held on-line, with group problem solving, discussion, and peer support central to the activities. Original videotape in support of the curriculum will be developed as well.

The on-line course materials will be field tested by 40 middle school science teachers across the country during the winter '96-'97. Participants in the field test will receive the course, course kit of materials, and two continuing education credits for participation. In addition, these individuals will attend a two-day workshop at the COTF during the fall of 1996 to receive instruction related to data collection and materials use during the field test.

COTF will make the class available to Space Grant Consortia colleges and universities to install on local Internet servers. By doing so, it will be possible for participating Space Grant Consortia members to offer it to teachers in their geographic region.

This approach--regional dissemination and delivery--may seem counterintuitive due to the Internet's ability to deliver the course anywhere. However, such an approach will help address two critical issues--scalability (How does one mentor 50,000 teachers on-line?) and degree bearing credit (each participating institution will award credit to its participants). It is also anticipated that because of this approach, participating institutions will also be able to modify the course to meet local needs, integrating it into existing efforts.

RESEARCH AND EVALUATION

Both formative and summative evaluation will be an integral part of the project, with a formal research agenda developed as part of the program that will further the COTF's research mission. Dr. Steven McGee, COTF Educational Research, will be part of the development team from the inception of the project.

As mentioned earlier, the on-line course will be piloted in the fall of 1996 with 40 teachers across the country being recruited to participate in the field test and being awarded 2 CEUs for their efforts.

Each participants' interactions with the course materials on the Web site and with the instructors and each other will be monitored and analyzed. Participants in the field test will be required to participate in an on-going dialog about the effectiveness of both the on-line course materials and discussions as well as the classroom science activities and materials implemented as part of the course requisites.

COTF DEVELOPMENT TEAM

Craig Blurton, Ph.D.

Dr. Blurton, Associate Director of the NASA Classroom of the Future, will serve as principal investigator for this project. Dr. Blurton's duties will include coordinating the work of the various participants, arranging and facilitating meetings, managing the field test of the on-line course, and as science education advisor to the development team.

Stuart Ullman, Ph.D.

Dr. Ullman will serve as co-principal investigator and computer scientist on the project, responsible for the development of the Virtual Reality Mark-up Language (VRML) environment which will be created for use on the COTF web site. Dr. Ullman's current position at Carderock Division, Naval Surface Warfare Center in Maryland is as computer scientist and operations research analyst for the Methodology and Computation Branch, Operations Research Department.

Dr. Steven McGee

Dr. Steven McGee, COTF Educational Research, will serve as program evaluator and researcher. Dr. McGee will be responsible for developing the project's research design. Dr. McGee's work will capture lessons learned both during the development process and the field test

Mr. Bruce Rosen

Mr. Bruce Rosen, Computer Support Analyst at the COTF, will serve as "Webmaster" for the duration of the

project, assisting in the development of the VRML interface, installing and testing software, and maintaining the system during the field test. Mr. Rosen has a Bachelors of Science in Computer Science with a minor in mathematics and currently is developing the COTF web site and manages the COTF Internet server.

Other Team Members

As of this writing, other members of the development team can only be identified by role. Specific individuals will be selected to fill these positions in consultation with NASA Headquarters personnel from Education, MTPE, and Space Grant.

Earth System Scientists– These individuals will provide the content expertise to the group. One of these individuals will serve as the on-line course instructor during the field test of the course materials.

Middle School Earth Science Teachers– These individuals, selected because of leadership in the field of Earth Science as well as exemplary teaching skills and an understanding of the National Science Education Standards, will assist with the development of the on-line instructional content and serve as on-line mentors during the field test of the course materials.

NASA Headquarters Personnel – At least one NASA Headquarters staff from MTPE, Education, and Space Grant will be invited to participate in the development process. Staff participation will ensure that the project developed meets NASA's education goals and is well connected to NASA human and material resources.

Space Grant Consortium Representatives – One or two representatives from colleges and universities that are members of NASA Space Grant Consortium will participate in the development process. Their inclusion will ensure that the project staff are informed about existing Space Grant resources and activities related to teacher training in Earth System Science and that the materials developed will be such that they can be integrated into Space Grant Consortium activities once development and field testing are completed.

CONCLUSION

Making use of high performance computing and communications technologies, the COTF, in collaboration with NASA personnel, is designing, producing, and delivering a high quality on-line Earth System Science course to educators across the United States making use of cutting edge technologies in support of NASA's Mission to Planet Earth.

[1] R. Tinker and S. Haavind, "Netcourses and netseminars: current practice and new designs," in press.