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ABSTRACT

NASA Langley Research Center and Christopher Newport University (CNU) provide, free to the public, distance learning programs that focus on math, science, and/or technology over a spectrum of education levels from K-adult. The effort started in 1997, and currently there are a suite of five distance-learning programs. This paper presents the major goals of the distance learning programs, followed by a short history of their development. It then describes each of the programs, outlining the goal, methodology and student outcomes for NASA KSNN (Kids Science News Network), NASA Science Files (formerly NASA Why? Files), NASA CONNECT, NASA LIVE, and NASA's Destination Tomorrow. Two final sections describe the validation and evaluation of the distance learning programs, and future directions. (AEF)

NASA Langley/CNU Distance Learning Programs

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I. Introduction

NASA Langley Research Center and Christopher Newport University (CNU) provide, free to the public, distance learning programs that focus on math, science, and/or technology over a spectrum of education levels from K-adult. The effort started in 1997, and we currently have a suite of five distance-learning programs. We have around 450,000 registered educators and 12.5 million registered students in 60 countries. Partners and affiliates include the American Institute of Aeronautics and Astronautics (AIAA), the Aerospace Education Coordinating Committee (AECC), the Alliance for Community Media, the National Educational Telecommunications Association, Public Broadcasting System (PBS) affiliates, the NASA Learning Technologies Channel, the National Council of Teachers of Mathematics (NCTM), the Council of the Great City Schools, Hampton City Public Schools, Sea World Adventure Parks, Busch Gardens, ePALS.com, and Riverdeep.

II. Major Goals of Distance Learning Programs

Our mission is based on the “Horizon of Learning,” a vision for inspiring learning across a continuum of educational experiences. The programs form a continuum of educational experiences for elementary youth through adult learners. The strategic plan for the programs will evolve to reflect evolving national educational needs, changes within NASA, and emerging system initiatives. Plans for each program component include goals, objectives, learning outcomes, and rely on sound business models.

It is well documented that if technology is used properly it can be a powerful partner in education [1]. Our programs employ both advances in information technology and in effective pedagogy to produce a broad range of materials to complement and enhance other educational efforts. Collectively, the goals of the five programs are to increase educational excellence; enhance and enrich the teaching of mathematics, science, and technology; increase scientific and technological literacy; and communicate the results of NASA discovery, exploration, innovation and research.

All pre-college distance learning programs support the national mathematics, science, and technology standards; support K-12 systemic change; involve educators in their development, implementation, and evaluation; and are based on alliances and partnerships.

In addition the programs seek to invoke a sense of geographic, ethnic and cultural diversity by featuring schools from all over the U.S.; schools from urban, suburban, and rural areas; public, private, and religious schools; and schools with large populations of African-American, Asian and Hispanic students.

III. History of Distance Learning Programs

The Office of Education at NASA Langley began its first distance first learning program, NASA CONNECT, in 1997. The second and third programs, NASA Science Files (formerly NASA Why? Files) and NASA's Destination Tomorrow premiered in 2000. The fourth and fifth programs, NASA's Kids Science News Network (KSNN) and NASA LIVE, premiered in 2001. CNU joined the effort in 1999. The programs have won numerous awards for distance learning, videography, and web design.

IV. Description and Methodology for Distance Learning Programs

We define distance learning as “getting people--and often video images of people--into the same electronic space so they can help one another learn,” and we provide “a system and process that connects learners with distributed sources”[2]. All the programs are appropriate for one or more of the following national audiences: public, private and parochial schools; home schoolers; girls and boys clubs, colleges and universities, parents, teachers, caregivers, and adult learners.

In this section we discuss the methodologies used to create the various distance learning programs. The broadcast components air nationally on PBS stations and on many Cable Access Channels, but are also available on tape, DVD, and the web.

A. NASA KSNN

Goal: Support national efforts to prepare all children to succeed in mathematics, science, and technology.

Description: NASA's KSNN is a series of 1-minute news breaks and associated web support and activities that uses children to explain to people of all ages specific mathematics, science, technology, and computer science concepts that often address misconceptions. Confronting misconceptions at an early age with the combination of lively, kid-oriented newsbreaks and activities will fit well into the grade 3-5 classrooms. The newsbreaks will get wide visibility as interstitials on Public Television and commercial networks. See the web site at ksnn.larc.nasa.gov for more information.

Methodology: We have a pilot program in place at CNU to develop scripts, activities, and web page content for NASA KSNN. Teams of 3-4 students develop scripts, activities, background material and web page content for one of NASA's KSNN newsbreaks as part of their course work and the teams find a content expert for their project at CNU, NASA, Jefferson Lab, or another appropriate institution. Effective communication with 3-5 graders through the video medium is presented in class; students present their newsbreak for video taping and report on the other components. Finally, a committee of CNU and NASA judges selects the best projects each semester for production. Involving pre-service teachers is valuable for their education and introduces them to NASA distance learning programs that they can use in their classrooms.

Student Outcomes: 1) Stimulate interest in and increase understanding of mathematics, science, and technology; 2) correct commonly held mathematics, science, and technology misconceptions; 3) gain awareness of NASA: programs, projects, and facilities; 4) increase scientific and information technology literacy; 5) increase interest of minority and female students in mathematics, science, technology, and NASA; and 6) improve literacy of students who do not use English as their primary language.

B. NASA Science Files (formerly NASA Why? Files)

Goal: The NASA Science Files television broadcast, web site, and educators' guide use Problem-Based Learning (PBL) to help students in grades 3-5 explore topics through scientific inquiry.

Description: This program consists of a series of four, standards-based instructional programs for grades 3-5 that introduce students to science as inquiry, the scientific method, problem-based learning and NASA. Each 60-minute program is divided into four 15-minute "teachable segments" and is supported by a web site and resource-rich teacher guide. See the web site at scifiles.larc.nasa.gov for more information.

Methodology: In the television broadcast, the tree house detectives are confronted with real-world problems and are provided with the knowledge and tools to attack the problem. The tree house detectives walk through the problem solving process during the four 15-minute instructional segments, reaching a solution in the final segment. The television broadcast features content experts from NASA and the community with careers requiring problem-solving skills, museum resources, experiments, and classroom activities to help the tree house detectives solve the problem. The web component of the NASA Science Files is the nerve center of the learning experience and contains separate sections for students, educators, and parents. The kids' tree house contains content information, experiments and activities, experts to contact, and a variety of other resources to aid student teams in finding possible solutions to the featured online problem. The design of the site encourages the teams to take on roles and approach solving the online problem as a scientist would. An array of Problem-Based Learning tools (action plan, basic design log, PBL questions, "get up and go", problem board, problem log, reflection journal, scientific investigation log, scientific method flowchart, scientific process log, and web site evaluation) is readily available for them to employ as they research the problem. The web site provides resources and guidance for the team's culminating report and presentation. The educators' area of the site is structured so that essential information is one click away and other information a maximum of three clicks away. It contains an overview of the NASA Science Files television broadcast, web site, and educators' guide and is an excellent starting point for professional development in the area of PBL. PBL instructional tools and strategies, worksheets, classroom activities, and assessment tools can also be found on the site. The educators' guide is designed to augment the television broadcast and can be downloaded from the web site or received in the mail. The guide features segment overviews, program objectives, vocabulary, classroom activities, worksheets, literature and Internet resources, and implementation strategies. A team of elementary school teachers, NASA researchers, and NASA Distance Learning Center staff develops the programs and guides.

Student Outcomes: 1) Increase understanding of Problem-Based Learning and science as inquiry; 2) develop the literacy and technology skills needed to use the Internet for investigation and research; 3) increase scientific and technological literacy; 4) gain awareness of careers requiring problem-solving skills, mathematics and science proficiency, and technology application; 5) view mathematics, science, and technology as a process requiring creativity, critical thinking, and problem-solving skills; 6) gain awareness of NASA: programs, projects, and facilities; and 7) overcome stereotyped beliefs by learning about women and minorities actively involved in challenging engineering and scientific tasks.

C. NASA CONNECT

Goal: Support the integration of mathematics, science, and technology in grades 6-8.

Description: NASA CONNECT establishes the “connection” between the mathematics, science, and technology concepts taught in the classroom and NASA research. Each program consists of a 30 minute broadcast (also available on video tape), a classroom activity, and a web activity, which are supported by a web site and resource-rich teacher guide. See the web site at connect.larc.nasa.gov and published articles [3,4] for more information.

Methodology: The three components complement one another and produce a cohesive, flexible unit for classroom use. The broadcast intersperses classes of students from diverse backgrounds and geographical locations doing the classroom and web activities with NASA experts from diverse backgrounds who describe their research and use of mathematics. Two dynamic hosts weave the story together and take the students on an adventure in learning. Throughout the video, the cartoon character Norbert invites the viewers to pause and consider questions on what they are learning. Short animated mathematics activities are featured during the video as reinforcement. The script for the video is produced in conjunction with educators and the scientists featured in the video to be an effective learning experience for middle school students. The activities are developed and tested by educators who provide an overview, connections to national standards, resources, a glossary, a complete description of the activity, and extensions and questions. In practice a teacher would ideally first use the video with the class, next do the classroom activity, and finally act as a facilitator for the web activity. However, teachers often don't have the time for all three components so they are designed as independent units.

Student Outcomes: 1) Make connections between the mathematics, science, and technology taught in their classroom and the real world applications by observing NASA engineers and scientists; 2) increase understanding of mathematics, science, and technology concepts through hands-on and interactive web activities; 3) develop the literacy and technology skills needed to use the Internet for investigation and research; 4) view mathematics, science, and technology as a process requiring creativity, critical thinking, and problem-solving skills; 5) gain awareness of careers requiring problem-solving skills, mathematics and science proficiency, and technology application; 6) gain awareness of NASA: programs, projects, and facilities; and 7) overcome stereotyped beliefs by learning about women and minorities actively involved in challenging engineering and scientific tasks.

D. NASA LIVE

Goal: Increase the understanding of mathematics, science, technology, and NASA among: K-12 students and educators, 13-18 students and faculty, and adult (life long) learners in formal and informal settings.

Description: NASA LIVE consists of a series of synchronous (two-way), interactive videoconferencing sessions designed to communicate NASA Langley research, educational programs and career opportunities to educators and students in grades K-12, grades 13-18, and adult learners. A 30 topic series is currently available on the NASA LIVE web site at live.larc.nasa.gov.

Methodology: The programs address the educational need to connect students to real problems and real world applications of mathematics, science, engineering and technology (MSET). Therefore, program topics are chosen based on an educational need to complement university courses relating to MSET as well as aeronautics. After completing the online registration and confirming the presentation date and time, participants (i.e., a NASA researcher with faculty and students) are engaged in an interactive videoconference live from NASA Langley. Each videoconference consists of a 60-minute session divided into a 30-minute presentation, a 20-minute Q&A segment, and a 10-minute overview of educational and professional opportunities.

Outcomes: 1) Stimulate and increase scientific and technological inquiry and literacy; 2) enhance, enrich, and facilitate the learning process; 3) model the effective use and integration of instructional technology; 4) raise awareness of NASA pre-college, college/university, and distance learning programs; 5) gain awareness of NASA: programs, projects, and facilities; 6) increase NASA and university collaboration; 7) increase outreach to the informal education community; 8) increase interest of under-represented groups in mathematics, science, technology, and NASA; 9) improve literacy of students who do not use English as their primary language.

E. NASA's Destination Tomorrow

Goal: Create and heighten the interest of high school students and adult learners in mathematics, science, technology, and NASA.

Description: Destination Tomorrow is a series of five 30-minute nationally aired video programs designed to increase the scientific literacy of educators, parents and lifelong learners. The material is drawn from current research and spin-offs developed at NASA Centers – primarily the NASA Langley Research Center. See the web site at destination.larc.nasa.gov for more information.

Methodology: Research, theory and principles of adult learning guide the developers. Topics are chosen to broaden the public's perception of NASA beyond space and flight by discussing less known spin-offs of NASA researchers. The 30-minute show is divided into five 5-minute segments: Behind the Scenes, How It Works, On the Runway, Future/Tech Watch, and Retrospective and two 30-second "Did You Know?" vignettes. Two hosts set the tone of the show and introduce the segments. Individual correspondents cover the segments in depth and interview one or two researchers.

Outcomes: 1) Stimulate and increase scientific and technological inquiry and literacy; 2) enhance, enrich, and facilitate the learning process; 3) gain awareness of NASA: programs, projects, and facilities; 4) interest NASA and university collaboration; 5) increase outreach to the informal education community; 6) increase interest of under-represented groups in mathematics, science, technology, and NASA; 7) improve literacy of students who do not use English as their primary language.

V. Validation and Evaluation of Distance Learning Programs

A. Testing and Evaluation of Activities and Web Site

All NASA CONNECT activities are tested by teachers during a special summer program and during the school year in nearby school systems. During the academic year, focus groups of middle school teachers select three NASA CONNECT programs. The teacher and students are observed by NASA distance learning educators as the teachers use the three program components with their students. The observations, informal discussions, and final evaluation report from the teachers serve as tools to continually improve the program. Activities from other NASA centers are tested by the providers. As part of the NASA Science Files web site development, formative evaluation and usability tests are conducted before and during each season with the help of public and home-based educators in grades 3-5. The results are evaluated and used to improve the usability and structure of the web site. Testing in the development cycle is essential to ensure a quality product.

B. Analysis of Survey Data

NASA CONNECT has been evaluated by surveys sent to registrants for three years and NASA Science Files for one year. Although the original questions have been included each year, new questions have been added to improve the survey. For the NASA CONNECT 1999-2000 season [5], 1000 registrants were selected randomly and 27% of the responses were usable (out of a 34% response rate). A total of 99 questions in 9 categories were asked regarding instructional technology and programming in the classroom. Generally, the respondents agreed that instructional technology has a positive impact on learning, is supported by the administration, and that facilities are available for its use. In particular, they strongly supported web-based activities and would like to see more NASA web activities. The assessment of the NASA CONNECT programs was very positive, with overall ratings ranging from 4.17 to 4.63 on a 5-point Likert scale (compared to 4.09 to 4.61 for the 1998-1999 season [6] and 3.97 to 4.56 for the 2000-2001 season). The videos, lesson guides, classroom activities, web activities, and web site were all very highly rated. The use of the videos ranged from 19% to 44%, lesson guides from 22% to 50%, classroom activities from 18% to 42%, and web activities from 9% to 13%. The low use of NASA web activities is in contradiction with the high ratings for positive impact on learning, availability of technology, and desire for more web activities. The low usage may simply reflect that the web activities are the last in the chain of the NASA CONNECT learning offerings (video, classroom activity, web activity). Further, the three lowest ratings for the NASA web activities were: content easily integrated into curriculum (4.09), able to complete in reasonable time (3.86), and appropriate for my students (4.04). Survey data for NASA Science Files for 2000-2001 have overall ratings from 4.39 to 4.64. Both programs have been given consistently high ratings for their program offerings.

Continental Research Associates (Norfolk, VA) conducted an evaluation of NASA's Destination Tomorrow. The methodology included telephone interviews with 400 (out of 537) managers of cable access television stations across the United States that aired the programs in the 2000-2001 season. Overall, the findings were extremely positive. Significant among the findings were (1) 73.5% of the station managers said that the quality of the programs in the series is "better than average" when compared to other educational programming their station airs; (2) 90.5% indicated the five programs in the 2000-2001 series have been successful in educating people about what NASA Langley does; (3) 64.8% of the stations airing NASA's Destination Tomorrow reported that the programs have been "very well received" by their audience; and (4) about 80% of those television station managers interviewed stated that the information provided by NASA Langley in the five programs is "very credible."

VI. Future Directions

NASA's KSNM is in its first season and the one-minute newsbreaks appear to be on target for programming demand in the grade 3-5 category. Spanish versions of NASA's KSNM programs and web site are complete for the first year and 12 more are planned. Once we have had experience developing the content, we will open up the newsbreaks and web content to a statewide competition. NASA Science Files had a very successful first two seasons and the web page will continue to evolve into a more useful learning center. NASA CONNECT is the most mature of the programs and will continue its present course using the survey results to improve the programs. We are currently streaming some of the video broadcasts from our web site. In the future a complete year's programs (video broadcasts, lesson plans, and web activities) will be collected on one DVD for dissemination. NASA LIVE is in its infancy but promises to be a very useful program for on-demand video conferencing and has already progressed towards including the K-12 audience in the future. The current mode of video conferencing is directly through ISDN connections. In the future we plan to move to web conferencing and increase the number of available topics. Faculty and students will assess the quality of the content, web-based materials, method of delivery, and the presenter by using an online evaluation. NASA's Destination Tomorrow also had a very successful first season and will continue along the same lines to produce quality programs that we plan to market to commercial TV. The 5-minute segments are available in Spanish and on DVD. For all the programs, we will continue to promote dissemination and use of the many learning opportunities for all ages. It is clear that it is important to train teachers in the use of our technology-based activities in general and to promote the use of our web activities. We plan to address the need for training in using technology because of the concern expressed in the educational community [7,8]. We will develop web-based training, including technology training for teachers so that they can use our program's components effectively in the classroom.

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