RAD WORLD—COMPUTER-ANIMATED VIDEO RADIATION AND HAZARDOUS WASTE-MANAGEMENT SCIENCE CURRICULUM

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ABSTRACT The Rad World computer-animated video and curriculum materials were developed through a grant from the Waste-management Education and Research Consortium. The package, which includes a computer-animated video, hands-on activities, and multidisciplinary lessons concerning radiation and hazardous-waste management, was created to approach these subjects in an informative, yet entertaining, manner. The lessons and video, designed to supplement studies of energy and physical science at the middle school and high school level, also implement quality and consistent science education as outlined by the New Mexico Science Standards and Benchmarks (1995). Consistent with the curriculum standards and benchmarks, the curriculum includes library research, collaborative learning, hands-on-science, and discovery learning. Pre- and post-tests are included.

KEYWORDS: computer-animation, education, radiation, hazardous waste

PRESENTATION

We must ensure that all students become informed decision makers concerning scientific and technological impacts on environment, society, economy, and politics.

Source: The NM Science Benchmarks Committee 1995

INTRODUCTION: THE NEED TO CREATE A SOCIETY OF INFORMED DECISION-MAKERS

The U.S. Department of Energy forecasts that no underground repository for high-level waste at Yucca Mountain could open until 2015, owing to funding cuts in the DoE waste program voted recently by Congress. Meanwhile, of the $315 million appropriated for FY ‘96, $85 million will be used to develop an above-ground interim storage site [1].

Examples of temporary storage sites replacing permanent, high-capacity nuclear waste sites are becoming commonplace. The cost to society for the deferral of the task of permanent storage is high, and many scientists believe that the reason for our nation’s paralysis with regard to this very serious issue is the lack of information on the part of the general public.

Dr. William A. Suk, of the National Institute of Environmental Health Sciences, was the keynote speaker at the WERC/HSRC and Networking ‘96 conference in Albuquerque, New Mexico. He made the observation that the aforementioned problem is due to the lack of appropriate methods of communication on the part of politicians and technical professionals who are devising and implementing the environmental remedies. He stated that “the education and information investment must be directed toward the children” [2], observing that the adult population has become inflexible in its mistrust and unwillingness to confront

environmental and energy issues with realistic scientific, social, and economic objectives in mind.

Public opinion and concern for issues of environmental restoration as well as questions concerning energy production and consumption have oscillated from passionate rallying to passive indifference within the past two decades. Unfortunately, neither of these public response patterns benefits the long-term direction of policy regarding environmental restoration and the management of our planet's finite supply of natural energy resources.

These issues are already critical and must be addressed intelligently. Children must become actively engaged in researching benefits and risks of alternatives. This will empower them with the critical thinking skills to evaluate the most pressing social, economic, and political concern of their lifetime—our environmental and energy consumption and waste-storage policies.

SCIENCE STANDARDS AND BENCHMARKS

New standards and systemic initiatives throughout the nation embrace the multidisciplinary approach to education. Indeed, to succeed in an effort to produce a society capable of making informed decisions with regard to technological issues, teachers must foster broad-based critical-thinking skills in their students from an early age.

The goal of creating a workforce of technically-literate individuals has steered science and mathematics education through a transition from the traditional textbook approach to a student-centered approach to learning, employing hands-on activities as well as other strategies. The purpose for this transition is to accommodate a variety of learners who differ in technical information-processing strengths.

PARADIGM SHIFT

The paradigm shift in science education as described by the New Mexico Science Standards and Benchmarks are shown in Table 1.

TV EARTH VIDEOS

For the past four years, the TV Earth staff has been creating environmental science videos targeted toward middle and high school students. The primary purpose, earlier, was to inform students about environmental restoration research being

TABLE 1. PARADIGM SHIFT IN SCIENCE EDUCATION AS DESCRIBED BY THE NEW MEXICO SCIENCE STANDARDS AND BENCHMARKS.

From:	To:
* Instruction based on lecture	* Inquiry-based, hands-on activities
* Dependence on textbooks, worksheets	* Reliance on scientific process skills
* Individualistic, competitive learning	* Combination of collaborative and competitive learning
* Memorization of facts	* Understanding of concepts
* Testing focused on memorization of detail	* Variety of assessment models focused on scientific concepts
* Isolation of science from the rest of students' lives	* Relevance of science in students' lives
* Science in isolation from other subjects	* Integration of science with other content areas
* Teacher only as expert in subject matter	* Teacher facilitating students' investigations

conducted by WERC. The focus was on research projects that could be represented visually with computer animation, in an entertaining and informative fashion appropriate for middle school students. Most recently, curriculum support materials have been added to the project with an emphasis on achieving the science standards as outlined above. The videos produced are as follows:

1) ***Captain Polymer and the Colloid Caper*** is a journey through the underground aquifers of northern New Mexico in a microscopic submarine. Students learn of the waste-migration villain, the colloid, and look at WERC's research (Dr. Eric Nuttall, UNM) into plutonium immobilization by polymers.

2) ***The Underground Enemy - What Goes Down Must Come Up*** explores WERC's research (Dr. Edward Hensel, NMSU) on underground imaging techniques for buried waste detection. It also examines WERC's research (Dr. Jerzey Rajtar, NM Tech) on advance oil-leak detection. Students see this research through the eyes of an interstellar heroine, Daione, who hails from a planet very much in need of these technologies.

3) ***Rad World*** studies radiation and hazardous waste management. It examines the half-life of radioactive isotopes, the operation of a Geiger counter, and much more. These topics are studied from the point of view of Alpha, Beta, and Gamma, three "rad" characters who resemble a sophisticated version of the cast of Wayne's World (more intelligent and low-key while maintaining some of the humor that the students at this age find appealing). A visit to Marie Curie's lab in 1919 and a tour of the WIPP site are featured in this video.

The third video, Rad World, has an extensive supplementary curriculum guide, intended to provide hands-on and multidisciplinary activities. It was created by middle and high school educators in accordance with the New Mexico Science Standards and Benchmarks.

Supplementary Rad World curriculum package contents:

* Four inch Rad World binder containing lessons, video, and reference materials
* Curriculum guide including notes on grade levels and lesson time constraints
* Pre- and Post-tests for the teacher's use
* Vocabulary for crossword and word search games provided
* Other pre-video activities
* Video tape in three-ring video cassette tray
* Post-video hands-on science and multidisciplinary lessons
* Nuclear age timeline classroom poster and accompanying student booklet
* Periodic Table (credit card size) with instructions for acquiring classroom set
* Information pamphlets for the teacher from the Office of Civilian Radioactive Waste-management
* 225 million year old rock salt in zip-lock bag, from 2150 ft. underground waste facility (WIPP site)

* Reference publications (student editions were included to save space in binder):
    1) Environmental Restoration and Waste Management—An Introduction (DoE publication EM-0104)
    2) 50 Years of Progress (Teacher compiled publication—1992)
    3) Is Salt a Grain or a Crystal? (from Students Touching Technology series—WIPP site publication)
    4) Science, Society, and America's Nuclear Waste (4 units) (DoE publications RW-0361-0364)
* Teacher Evaluation Sheet

PROCESS FOR VIDEO DEVELOPMENT

Each video included middle and high school students in its creation. Students participated in the efforts during summer vacation, spending from four to six weeks researching, brainstorming, storyboarding the video, and working on the computer-animations, music, and sound effects. The process of editing, in the case of Rad World, required many months due to the size of the technical task of producing a half-hour of computer animated video footage. Some of the students continued to contribute to the development process throughout the year.

TECHNICAL DETAILS OF VIDEO DEVELOPMENT

Rad World is a combination of hand-drawn and computer animation composited over 24-bit computer-generated backgrounds. It contains 2D cell animation, 3D computer generated animation, live action, video sound effects, and music.

The video contains 27,000 unique frames, each 752 x 480 x 24 bits deep. Uncompressed, the video would run at 25 megs/second, while 8:1 VTASC compression takes the data rate down to about 3 megs/second. The entire project utilized 45 recordable CD-ROMS. Each CD-ROM stores 650 megabytes of data. The video was spooled to tape in real time using a 7 gigabyte RAID (Redundant Array Integrated Disk) system.

As a point of comparison on a commercial level, Toy Story, the computer-animated motion picture released about a year ago, was made up of 130,000 frames, entirely of 3D animation, making it many times the size of our project. The rendering time for the Toy Story scenes averaged 45 minutes per frame and this task was accomplished over a two-year period. The whole project including the sequence of storyboarding, artwork, rendering, and editing took four full years to accomplish.

Computer animation is very time-intensive and, to be practical, requires robust equipment and special knowledge. Nonetheless, it is gaining popularity as a medium for technical training and visualization of difficult concepts. It is ideal for spatial-oriented demonstrations requiring 3-dimensional presentations.

As computer technology forges ahead, increasing memory and speed capabilities in phenomenal increments, computer animation will become even more practical as an educational format for classroom instruction.

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REFERENCES

1. Stuck on site, Nuclear Engineering International, 41:501 (April 1996) 4.

2. Dr. William A. Suk at the HSRC/WERC Joint Conference on the Environment, May 1996.