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Interactive Video Activities for Elementary Education Students

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1. ABSTRACT

Since 1979 we have included interactive video activities as an integral component of a physics course for elementary education majors. The course uses a pedagogical model based on the constructivist approach to learning and, thus, requires the students to participate in a large number of hands-on activities. The students complete videodisc-based, multimedia activities in the same manner in which they perform other laboratory activities. The videodiscs include a range of educational and entertainment discs some of which have been repurposed. Development of the materials has been a long-term effort which has resulted in an evolution of interactive multimedia activities for the future elementary school teachers. As part of the evolutionary process the delivery system for the materials has changed from a stand alone first generation videodisc player controlled by a keypad to an Apple II+ connected to a low-cost videodisc player to an IBM Infowindow multimedia system.

2. IDENTIFICATION

Kansas State Universty is a comprehensive, land-grant university with about 21,000 students and 1200 faculty. The nine colleges of the University offer more than 200 acadmeic majors and grant 3,600 degrees each year. KSU is, by state law, an open admissions institution. All students who have completed successfully a high school education (or equivalent) may enter KSU. Thus, the KSU students represent a broad specturm of abilities and interests and, in turn, a challenge to faculty who wish to address their intellectual needs.

The Department of Physics has twenty-four full-time faculty who teach courses at all levels from introductory physics to the liberal arts students to advanced courses for Ph. D. students. Each year the Department offers introductory physics courses with laboratory components to about 2000 students. The Departmeent also has a strong commitment to research in atomic physics, condensed matter physics, and physics education. Significant funding from external sources support the research efforts. Thus, the Department is a typical of many similar departments except that it has a stronger commitment to education in both its research and teaching efforts.

Young children have a nature interest in science. That interst can be fostered and developed by teachers who are able to respond to the pupils, or it can be stifled by teachers who lack understanding of science and how to teach it. While teachers must have some background in science, they must also be able to select learing experiences which are appropriate to their pupils. Thus learning science and ways to teach it is an important component of the education for students who are preparing to become elementary school teachers.

KSU requires all future elementary school teachers to complete at least three science courses and a course in the teaching of science. However, the implementer of this project felt that it was not sufficeint for students to learn science by sitting in standard lecture-laboratory courses and then take a single course which instructed the students about the teaching of science. Instead, he wished to establish a model of teaching physics in which the students would learn in a manner which was similar to the way in which they should teach. This view led to two imprtant considerations:

> The students should be involved in a large number of hands-on activities which also engaged mind, and
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> The students must see direct connections between the physics learned in the classroom and the rest of the world.

The integration of multimedia into the laboratory activities of the of the course adressed these goals.

3. DESCRIPTION

This project serves the students who are preparing to teach school at the kindergarten through sixth grade level. Approximately 120 sophmore or junior students enroll in the course each year. The primary purpose of the course is to provide these students with sufficient background in physics so that they may teach science at the elementary level. As stated above, an equally improtant goal is to provide a role model for effective science teaching.

The integration of multimedia into the course was an effort to provide engaging ways for the students to learn physics and to learn thorugh active procedures about the connection between the concepts of phyics and the world outside the classroom. Because all of the interactive vidoe materials required that the studens interactive with video and computer images, they provided, automatically, an active learning environment.

Two different types of multimedia activities were created.

Explorations require that the students look at a situation and observe phenomenon without trying to analyze them in detail. These activities form a basis of common experiences for all of the students in the class. They are used as a starting point for discussions which lead to the introduction of physics concepts. By completing activities which have students make observations about a video scene of a pole vault or automobile collision, they are forced to think about the events in mor detail than they might otherwise.

Applications ask the students to apply recently learned conpets to new situations. A multimedia application invovles the students in situations which force them to think about the physics as it applies to events outside the calssroom and laboratory. Fro example, the students see a video of a famous prize fight and are ask to apply momentum conservation to a punch. Was the person who fell down really hit? By controlling the video and viewing the scene one frame at a time, the students may draw some conslusions and justify the conclusions based on their knowledge of an important physics concepts. Likewise they analyze situations such as the forces on a diver as she travels from the diving board to the swimming pool, the motion of a mannequin which is restrain by a seat belt in an automobile collision, and the variety of phenonema which led to the dramatic oscillaions and collapse of the Tacoma Narrows Bridge. These activities make the connections by forcing the students to apply their newly gained knowledge to real and sometimes complex events.

The multimedia activities are not separated from other hnds-on activities in the course. Students move quickly and easily from an experiment which involves standard teaching laboratory materials to a multimedia station and back to laboratory apparatus whithin a single class period. Thus, in addtion to providing examples of engaging the students' minds, the integration of all types of activites proivdes a model for including all types of appropriate activities in the learning experience. No distinction is made between using high technology and low technology. All are simply part of the integrated learning experience.

The major institutional support which enabled this project to be undetaken was a commitment to providing an appropriate, high quality education for future teachers. The Department of Physics provided (and continues to provide) the necessary space, teaching assistants and equipment support to be able to teach a course of this nature. The College of Education provides support through sdvising students to take the course and general support for the approach taken. Thus, the existing infrastructure provided the basis on which the course and its multimedia component could exist.

The physics course for elementary eduction majors began inapproximately its present format in 1977. The mulitmedia integration was introduced in 1979 with the use of a stand-alone MCA-DiscoVision videodisc player which was controlled by a small keypad. Since that time the course and the multimedia component have continued to evolve. Because of the evolutionary nature of the project, separating the time periods for desgin and impletmentation is essentially impossible. Each year since 1979 new interactive video materials have been added to the activities performed by the students. Each activity is designed over a period of a few weeks and then implemented into the next offering of the course. Revision of materials is a continuing process.

Major implementation changes have occurred when the hardware was change. In 1981 the stand-alone player was replaced by a set of Apple II+ computers which were connected to consumer level videodisc players. These systems, which involved two video screens and limited computer capabilities, were replaced in 1990 by IBM InfoWindow multimedia systems. Each change in the hardware has required about three months to convert the activities to new software and to up grade the activites so that they take advantage of capabilites of the new hardware.

The multimedia activities are now an intgeral part of the physics course for elementary education majors. The course, in turn, is a standard offering of the Department. Further, other science and math courses for elementary education students are now being developed and are following the general model of this course. Thus, the porject is very well integrated into the University's academic offerings and in being used as a model for further efforts.

Funds for this project have come from several sources. The design of intial lessons and several of the videodiscs were parts of grants from the National Science Foundation. The purchase of the Apple II computers and videodiscs player were made possible by a funds from NSF and the University. The Infowindow systems were part of a grant from the IBM Corporation. The ongoing design work and the programming involved in implemenation is part of the instructional efforts of the Department of Physics. Thus, a combination of governmental, industrial and institutional support has been used to bring this project to its present stage.

4. HUMAN RESOURCES

All design work as been completed by a professor of physics, Dr. Dean Zollman. The design effort probably required about three to five months of his time. The development of the design into computer programs was completed by undergraduate student programmers who were working in Apple Pascal. This effort required a estimated total of about one person year.

When the materials were converted to InfoWindow and upgraded, Professor Zollman contributed about one person week. The conversion to Learning Systems/1 authoring system required about two months of a student programmer's time.

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The continuing effort is primarily to revised exsiting materials and to create additional materials for students use. The revision of existing materials invovles about three days per year of student programer time and a few hours of Professor Zollman's time. Dr. Zollman spents about one day per year designing new materials. The student programmer completes the programs in about two to three weeks.

To duplicate this effort in a similar physics course would require very little human resources. The software could be made available at no charge so an interested physics instructor could easily work the multimedia experiences into the laboatroy activities. A greater effort may be necessary to create a course which establishes the type of environment for these types of materials.

5. TECHNOLOGICAL RESOURCES

To design, develop and conplete the initial implementation of the multimedia component of this course requires the availablility of multimedia stations for development and student use. We have used two sytems which are used for development purposes during the periods when the course is not being taught and for delivery at ohter times. With these two IBM InfoWindow systems we have been able to develop the materials and deliver them to 120 students per semester. These same sytems are used to continue offerring the materials on annual basis. For another institution to implement a similar project the requirement would be similar hardware and software or equivalents such as PS/2s with M-Motion boards or PCs with a Videologic DVA4000 board. If the materials are made available in an open laboratory environment and as an integral part of other activities, one system per 50 students should be minimally sufficient.

6. BENEFITS

The project met the goals which were established for it. The quality of teaching was improved because the students were able to make better connections between physics in the classroom and the outside world. Because they saw an effective and appropriate use of technology, they were able to experience a model which they could emulate in their teaching. Thus, the materials offer an effective way for future elementary school teachers to learn about physics and ways to teach it.

Most of the material which is presented through the use of multimedia could not have been presented in an interactive way through any other media or teaching technique short of extensive field expereinces which use sophisticated measuement apparatus. The time and equipment for such filed expereinces is not avaialble, and the appartus would be far too complex for this audience. Thus, multimedia is the only method by which we could interactively present this material to this group of students.

At this time we have not conducted a formal evaluation of the materials. Thus, we have not data or formal evidence upon which to base the above conclusions. We have, however, interacted with and observed students using these materials for over ten years. Our judgement is that they are meeting the goals which we have established for them.

7. CRITICAL SUCCESS FACTORS

The most important factor is faculty who are committed to the style of teaching which emphasizes hands-on, engaging activities as the primary way in which students learn science. This project depends heavily on a pedagogical model that stresses this type of learning. Without it the material developed for this project could not succeed.

Once the pedagogical approach is accepted other factors fall into place rather easily. One must have a institutional or depatmental committment to provide the resources, which are somewhat greater than the standard lecture laboratory course.

Finally, one needs a long-term committment to be able to complete this project in a style which we have. By making such a long-term committment we have been able to have a project evolve over many years with a relatively low strain on the resources of the institution.

8. RATIONALE

One of the institutional goals is to prepare high quality teachers for elementary schools. As part of that goal the Department of Physics offers a course for future teachers. The primary rationale for this course is that we are committed to improving science eduation at all levels. By providing an appropriatte education to future elementary teachers we can hope to create a classrom envirnment where teachers and children enjoy and learn science. One does not need to dwell on the need for reaching this goal in the United States.

Once one has accepted this goal, the need for concrete experiences related to the outside world becomes apparent. In looking at the various means to provide these experiences, interactive multimedia presents the only cost-effective and mind-engaging approach.