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ABSTRACT

These four case studies examine the introduction of interactive videodisc technology into three classroom settings by two art and two science teachers at the elementary school level. Five models of videodisc use were employed: (1) teacher presentation or teacher-led class discussion; (2) activity stimulus; (3) programmed disc-based environments (i.e., simulations, games, or other problem-solving contexts); (4) visual databases; and (5) student presentations. It was found that videodisc use was important in both large group and small group instruction, that elementary school classrooms make extensive use of visual information resources, and that videodiscs can be used to meet this information need. Both students and teachers found the videodiscs--which permitted student and teacher control over the pacing, access, and replay of information--to be a stimulating alternative to regular classroom instruction. However, it was also found that, contrary to assumptions held in the videodisc industry, teachers are neither simply consumers of existing videodiscs nor are they designers and programmers who possess the knowledge, time, and energy to redesign and retrofit videodiscs. It is suggested that teachers could, nonetheless, make valuable contributions to the videodisc design process. Four explanatory footnotes are provided. (27 references) (EW)

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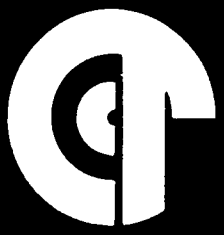

GETTING THE PICTURE: FOUR CLASSROOM CASE STUDIES OF VIDEODISC USE IN SCHOOLS

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GETTING THE PICTURE: FOUR CLASSROOM CASE STUDIES OF VIDEODISC USE IN SCHOOLS*,**

Cynthia Char and William Tally

In this research report, we discuss the findings from an intensive classroom-based study investigating the potential promise and challenges involved in integrating videodisc technology into classroom settings. The research involved four teachers--two art teachers, and two science teachers--and their students in three New York City Schools. The teachers worked closely with our research team to modify and extend a set of existing art and science archival discs, and used the resulting materials in their classrooms over a 3- to 8-week period.

Our study was distinct from previous videodisc research in three major respects. First, guided by our recognition of the different patterns of student learning that occurs in schools, we investigated a variety of organizational formats (e.g., teacher- and student-led classroom presentations, students working alone or in small groups on assignments) of how interactive video might be incorporated into classrooms. As with our approach to disc design (Wilson, Newman, & Char, 1985), we were particularly interested in exploring several models where students are placed in a position of greater control of their own learning paths. At the same time, we also wished to examine the teacher's important role in setting the context for, facilitat-

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ing, and extending this student-guided, disc-based inquiry. In contrast, the majority of previous studies (e.g., Brown & Newman, 1980; Bunderson, Olsen, & Baillio, 1981; Hoffmeister, Engelmann, & Carnine, 1985; Kehrberg & Pollak, 1982) have focused primarily on the videodisc as a teacher's visual aid for lectures, where the control resides with the teacher, or as a CAI instructional package, where the instructional pathways are predetermined in the program rather than guided by the student or facilitated by the teacher.

Second, we examined how teachers and students regard videodisc technology in relation to the information resources they typically rely upon, such as books and television. For example, how might a science videodisc offer something distinct and valuable not afforded by most science textbooks, films, or even hands-on science experiments? In what ways might an art videodisc offer some of the educational opportunities provided through a real-life visit to an art museum? Thus, the study extended the comparative analysis of related media beyond the common focus on schools' audiovisual (AV) expenditures (e.g., Videodisc Design/Production Group, 1979), and examined how videodisc technology might match, or even surpass, the perceived strengths of other, more traditional media.

Third, we closely examined the early phases of integrating videodisc technology into the ongoing curricula and routines of classrooms. As other research has shown (Char, 1983; Char, Hawkins, & Freeman, 1985; Char, Hawkins, Wootten, Sheingold, & Roberts, 1983; Mehan, 1985; Riel, 1984; Sheingold, Hawkins, & Char, 1984), the relationship between educational technology and the learning context is one of complex, bidirectional influences: Teachers significantly interpret and shape how new technologies are used in classrooms, while new technologies offer interesting possibilities for rethinking and reorganizing the goals and types of learning interactions that occur in classrooms.

Thus, we investigated in depth what is entailed in incorporating videodisc technology into schools. For example, how does videodisc technology and the learning it affords relate to traditional curriculum areas and traditional modes of learning? What kinds of time, energy, and expertise are involved when teachers learn about the hardware, videodisc content, and software involved in an interactive videodisc system? What kinds of modifications of disc materials are needed for teachers to find them valuable and useful to students? This type of intensive, critical research approach is in sharp contrast to studies that have simply employed focus groups composed of audiovisual media directors and teachers offering their reactions to a short videodisc demonstration (e.g., Massachusetts Educational Television, 1981; Videodisc Design/Production Group, 1979), or anecdotal accounts of

special learning centers removed from classroom settings (Ferralli & Ferralli, 1985).

These three distinctive research objectives--exploration of multiple models of videodisc usage; identification of the unique and powerful aspects of videodiscs in contrast to more traditional media; critical assessment of the early implementation phases of incorporating videodiscs into classrooms--have allowed us to gain some important insights into the processes involved in incorporating videodisc technology into schools, and the design implications for maximizing successful videodisc implementation. This report summarizes these findings, and concludes with recommendations for researchers, educators and videodisc designers.

The Study

Method

Rationale and process for disc selection. As discussed elsewhere (Char & Newman, 1986), a number of educational videodiscs on the market are little more than former instructional television programs or filmstrips placed on videodiscs, interspersed with occasional frames of text screens or review questions. In contrast, a handful of more innovative applications have been produced that make better use of the videodisc's random-access capabilities and transform the disc into databases and simulations for the user to peruse and explore. However, few such discs currently exist for the precollege student.

Given our interest in exploring videodisc databases and simulations, we elected to draw upon several visual archival discs and to investigate how these high-quality, visually rich disc materials could be reconfigured and adapted for classroom use. Production of many archival discs has been initiated by organizations possessing a wealth of visual material (e.g., photographs, film footage, collections of objects), such as NASA, the Library of Congress, and various museums. As a result, the body of archival discs is, at present, predominantly in the area of science and, to a somewhat lesser extent, in art.

After reviewing the corpus of discs currently on the market, we identified a small set of art and science videodiscs that we felt looked promising for classroom adaptation: the Van Gogh disc (North American Phillips), the National Gallery of Art Disc (Videodisc Publishing), the Apollo and Space Shuttle discs (Video Vision Associates), and the Bio Sci disc (Videodiscovery). (The discs, in their original and modified forms, are described in further detail below.) We then

proceeded to seek out art and science teachers who would be interested in trying out these videodisc materials in their classrooms.

Classrooms. The participants in the study were four teachers--two art teachers and two science teachers--and their students in three New York City schools: the Holden School, the Waterfront School, and Harlem Science.[1] Holden is a private school, prekindergarten through eighth grade, located in Manhattan. The student population is predominantly white, although black, Asian, and hispanic students together make up a significant percentage of the total. The school places social studies at the center of its curriculum, and students are encouraged to assume a strong voice and initiative in their learning.

Located in Manhattan's East Harlem, The Waterfront School (prekindergarten through sixth grade) and Harlem Science (sixth through ninth grade) are part of the city's public school system. The student populations at both schools are predominantly black and hispanic. Although located within the same large building complex, the two schools differ markedly in educational approach. Waterfront is one of the city's three alternative elementary schools based on the British open-classroom model of education. Harlem Science, on the other hand, is a more traditional learning environment: a carefully organized curriculum aimed at high school preparation and regular testing, with an emphasis on teacher-led classes rather than on independent student projects.

The two art teachers, Anna (Holden) and Susan (Waterfront), each elected to use the videodisc materials with their 10- and 11-year-old students (roughly fifth grade). Both classes were "half group" (i.e., half the number of students in the regular classroom). consisting of about 12 to 15 students.

Janet, the Holden science teacher, also used the materials with "half group" classes of about 12 to 14 students aged 12 or 13 (roughly sixth/seventh grade). In contrast, Elenore, the Harlem science teacher, used the materials with her entire eighth grade class of 31 students, aged 13 to 15.

Anna, Susan, and Elenore were experienced teachers with 10 to 15 years of teaching background. Janet had taught for only four years but, unlike the others, had had previous home and classroom computer experience. While she encouraged students to use word processing and other utilities for their science reports, she had not used any science software in her class.

Original Disc Materials

For the art classes, we chose to focus on the Van Gogh disc, which included a diverse assortment of visual segments, including narrated motion video sequences describing the life and work of Van Gogh, large collections of still-frame photographs of paintings, and a "reference series" of still-frame images and accompanying text information. The National Gallery of Art Disc, another archival disc, was made available to the classrooms as supplementary material.

For the science classes, we selected two discs from the Space Archives series, Apollo and Space Shuttle, and a biology archive called the Bio Sci disc. Each of the Space discs contains thousands of still-frame photographs as well as motion video sequences from various NASA space flights. The Bio Sci disc contains numerous video clips from different educational biology films and thousands of still-frame images, including photographs of myriad plants, animals, and protozoa, and pictures of their natural habitats.

Initially, we had planned to use only the Space discs in Harlem Science and the Holden School (in order to compare their use in the two schools), but found that Holden's science curriculum focused mainly on the biological sciences. Thus, rather than force an unnatural fit between the physics-oriented Space discs and Holden's biological focus, we added Bio Sci to our sample of tested disc materials.

Methods and procedure. We first held an orientation meeting with interested teachers and administrators from the three schools. The meeting was designed to provide an overview of the videodisc system, to introduce the suggested sample of discs and the objectives of our research, and to solicit their participation in the field test. We informed the teachers that we were interested in trying out a number of different models for using videodiscs--as a visual aid for teacher lectures, as a programmed environment for student exploration, and as a resource for students' independent research projects--and that we hoped they would consider implementing more than one model.

Following their agreement to participate in the study, we arranged an initial teacher interview with each of the four field-test teachers. The teachers were interviewed individually for about one hour in order to provide background information concerning their teaching experience, curriculum focus and goals, and types of media resources they used in their classrooms. They then were encouraged to spend some time becoming familiar with the contents of the discs they would be using.

Each teacher then met with a member of the research team for a planning and design meeting, during which the teacher and researcher discussed ways to create learning activities utilizing the discs. While teachers were free to use the discs in their "raw form" (i.e., pulling up different isolated still images or playing long motion sequences in a manner similar to showing an instructional film), we encouraged teachers to explore more in-depth, videodisc-based student projects. Most of these ideas involved creating either print materials to accompany the disc or videodisc software to reformat the disc. The value and soundness of the design ideas were mutually agreed upon by both researcher and teacher. Given the necessity for quickly produced materials to begin the field test and rejecting the assumption that teachers would have the time or inclination to master a programming language or authoring system, a member of the research team, with help from a programmer, was responsible for the actual production of these materials. For the adaptation of the Space materials, a computer science teacher in Harlem Science assisted in the programming of software.

Final Disc Materials

Van Gogh Disc. Based on the teachers' input and some of our own design ideas, we created a new piece of software to control the Van Gogh disc. The availability of this software augmented the disc-only experience in three major respects: First, a "front end" and structure was created to change the chapter-based, book-like disc into a simulated museum visit. We grouped intact disc chapters to correspond to the different types of experience one might encounter in an art museum through bus tours, gallery halls, or in its library. For example, Daytrips consists of five motion video chapters in which the viewer tours around the European countryside to follow the chronological and geographical path of Van Gogh's life; Galleries consists of five chapters of still-frame photographs of works corresponding to Van Gogh's painting periods. The disc's reference series was redubbed Filmstrips, and features various still-frame series of photographs and text frames on such topics as Vincent's Art Techniques.

Second, we created several new groupings based on the ideas and curriculum foci of the two field-test teachers. During the teachers' initial interviews, we learned that, when doing their own artwork, children at times need pictorial models for new art ideas or techniques. In order to provide such a visual resource, we created a Portfolio section of different types of paintings. Four portfolios (portraits, self-portraits, still lifes, landscapes) were a further breakdown of one disc chapter, while three new groupings were based on the teachers' input (Suns, Moons and Stars, Humans in Motion,

and Studies, a collection of different studies of a particular work [e.g., a pen drawing, quick sketch, and final painting of a single landscape]). To add greater flexibility and adaptability to the software, we also provided a "Create your own portfolio" option, so that additional portfolios could be created and updated once the disc was placed in the classroom. Teachers or students could enter the frame numbers of the paintings of their choice to produce their own personalized set of paintings stored in the software.

Third, we created an Art Mystery Room, which featured two original disc-based art games for students. In Museum Mugshots, children had to identify members of an art smuggling ring by matching a text description of a criminal with the correct portrait from a "lineup" of paintings. In Theo's Letters, children had to match excerpts from Van Gogh's letters with the corresponding paintings described by the passages in order to know which paintings Theo Van Gogh, Vincent's art dealer brother, should sell or keep. We also created print materials to accompany the games in order to encourage children to take notes on the various paintings, writing down the visual clues they used for choosing a particular painting.

The software program was written in Sony BASIC. The level 3 (computer-controlled) hardware system used in the art classrooms consisted of a Sony LDP 1000/A videodisc player and a Sony SMC-70 computer.

Space discs. Both print materials and software were created to accompany the Space discs (Apollo and Space Shuttle). The Lunar Gravity activities were designed for a level 1 (videodisc player-only) system and entailed the development of a new set of print materials. The paper guide and worksheet directed students to search various segments on the disc, and to consider questions that called attention to aspects of the visuals. For example, in one activity--a laboratory-type experiment on gravity--students were asked to generate a hypothesis of whether objects on the moon would fall faster, slower, or at the same speed as objects on earth. They then tested their hypothesis by timing a video segment of an astronaut dropping a hammer and a feather onto the lunar surface, and compared the result with their measures of the time it took a pencil to fall the same distance to the floor of their classroom.

In contrast to the level 1 Lunar Gravity unit, a set of Spaceflight and Orbit materials was designed for a level 3, computer-controlled videodisc system. Thus, we developed new software for the disc, in addition to new print materials. "Spacecraft or Aircraft?" was a program intended to provoke students to think about the different physical forces involved in space flight and airplane flight, such as

air resistance, lift, and thrust. The program called up a series of eight motion sequences and still frames, and students had to scrutinize each scene and decide whether they thought the shuttle was operating as an aircraft or spacecraft.

In "Orbit Adventure," a fictional game environment, students had to guide a wayward spacecraft back to its mother ship or risk being burned up in the earth's atmosphere or stranded in deep space. The adventure was a series of carefully sequenced motion segments from the Space Shuttle disc, combined with computer-generated text to produce the story scenario. In the course of the adventure, students encountered problems dealing with such topics as inertia, centripetal force, action/reaction, and thrust.

The Lunar Gravity materials were used with a Sylvania VP7200 videodisc player. The Spaceflight and Orbit software was written using an authoring program called Laserwrite (Video Vision Associates). This software ran on an Apple+ microcomputer, which controlled the Sylvania videodisc player equipped with an interface device (Video Vision VAI-135).

Bio Sci Disc. The development of new materials was least extensive for the Bio Sci disc as compared with the above-mentioned videodiscs. Used as a resource for a student research project, it was incorporated into a "mock hearing" class project to determine the fate of Central Park. In order to access images off the disc, a new paper index of relevant images (e.g., featuring animal and plant species found in the park, pictures of soil erosion) was created to supplement the general, more extensive index already accompanying the disc. A small software program, written in Sony BASIC, also allowed children to enter frame numbers of pictures to construct their own "slide series," which could be played back in sequence. The videodisc was played on a Sony LDP 1000/A videodisc player, at times controlled by a Sony SMC-70 microcomputer.

Research measures. Data collection for the field test was conducted in a variety of ways. These included initial teacher interviews, classroom observations and, at the completion of the field test, final interviews with each of the teachers and with approximately half of the students in each classroom.

Results and Discussion

The results and discussion of our field test have been organized into two major sections. First, we present a classroom profile of how videodiscs were used in each of the four classrooms. These individ-

ual classroom profiles are followed by a discussion of the five models of videodisc use that we observed across the classrooms.

We then turn to a discussion of three key issues influencing the directions and success of videodisc use in schools: (a) ease of fit between different videodisc models and traditional modes of classroom learning; (b) videodiscs as an alternative to traditional media; and (c) the role of the teacher in incorporating videodisc technology into schools. We conclude with a summary of our recommendations to educators and disc developers.

Classroom Profiles of Disc Use

Holden art class. Students used the videodisc over the course of three weeks.[2] Since Anna only met with her class once a week, small groups of students were allowed to work with the disc during lunch periods, three days a week for two of the three weeks.

Anna began by showing the disc, much like an art film, to the entire class. She focused on the motion video chapters, playing through all of them chronologically, while skipping over the still-frame chapters which featured photographs of different paintings. For the following two class sessions, the videodisc player was available to be used by small groups of students in the corner of the room, while other students in the class worked on hands-on art projects. These projects related to various aspects of Van Gogh's work, such as a construction paper assignment on complementary colors, or a still-life painting of a vase of lilacs.

During classroom sessions, and especially during lunch sessions, students tended to gravitate toward the two art mystery games. In musing over the various problems, children often conducted short discussions and made comments concerning the various art compositional aspects that were guiding their guesses. Children generally refrained from taking many notes on their paper handouts and relied instead on their collective memory in order to guess the right solutions, which, with very high frequency, were correct.

Anna generally focused most of her attention on the children working on the hands-on projects, seeing to it that they had the appropriate materials and commenting on the work they were creating. She allowed the children at the videodisc to work independently, and rarely went over to observe or talk with the children interacting with the videodisc. The first session, where the class viewed most of the disc narrative, seemed to serve as the lead-in to the Van Gogh-related, hands-on activities, and Anna did not explicitly make connec-

tions between their work and the contents of the available disc resource.

Waterfront art class. Children worked with the disc over a 5-week period. For the first session, Susan conducted a class discussion where students raised questions of interest concerning Van Gogh's life and work. The second session focused on the level 1 use of the player, with a demonstration of what a disc player is, how it works, and what kinds of content were on the disc. In the third session, Susan introduced the level 3, computer-controlled disc player and showed a sampling of what was on the software program-driven disc.

Following these three class sessions, small groups of children worked independently with the videodisc player. In order to maximize children's interactions with the videodisc (given cancelled art classes due to end-of-the-year field trips), these sessions were held in the library outside of the regular art class period. Since Susan often had another class during these times, she was unable to be with the students to supervise the entire session. However, she would stop by at various points to observe what students were doing, and help guide their focus by interjecting various questions and generating discussion.

Students generally explored most of what was present on the disc. They selected a number of Daytrips, Galleries, and Filmstrips, but often exercised their option to leave a sequence and return to the main menu to make another selection. Attention and involvement was most sustained with the two art mystery games. However, spontaneous student discussion concerning the visual cues leading to game choices was less extensive than with Holden students.

When Susan was present, her role was to bring certain aspects of the paintings to the children's attention, to clarify vocabulary (e.g., "What do you think 'peasant' means? What would a peasant look like?"), and to probe the children's reasons for certain game choices. She also used the pictures featured in the game to generate discussion about art composition and trends in Van Gogh's work, for example, by pointing out the frequent references to the color yellow in Van Gogh's letters. As the sessions progressed, students were increasingly eager to share their art-related comments with their classmates without much prompting from Susan.

In the final regular class session, the entire class viewed the "filmstrip" on the disc, which featured a sequence describing how Van Gogh worked with different art media such as pen or charcoal when doing a study for an oil painting. Children then created their own

charcoal drawings, based on a still-life photograph of jugs that was a still frame on the disc. Several students added finishing touches to their drawings during a later session, with the disc player present and the still life of jugs displayed on the screen.

Harlem science class. Elenore used the Space discs for approximately eight weeks. For the first 2-hour session, Elenore used the disc to introduce her class to the technology, the materials they would be using, and the kinds of activities they would engage in.

Over the next four weeks, students worked in small groups outside of the classroom and under the supervision of the researcher, while Elenore worked with the remainder of the class. The class was broken down into 10 groups of three or four students each. Elenore chose to have roughly half the groups focus on the Lunar Gravity unit, while the remaining groups engaged in the Spaceflight and Orbit activities.

The four Lunar Gravity groups worked in a manner analogous to their work in science labs. Using a paper guide, they used the keypad to call up a particular segment, considered questions concerning aspects of the visual phenomenon they were observing, and recorded their responses on the paper handouts. While students seemed engaged and were noticeably absorbed in the visuals, discussion among them was generally limited.

The six Spaceflight and Orbit groups worked with the computer-controlled videodisc, where the software program rather than the print guide provided the context for the videodisc activity. In general, students were more animated and engaged with "Orbit Adventure" than with the other activities. In both programmed activities, students worked collaboratively, often talking about which was the best answer and supporting one another when someone made a mistake. Overall, they depended much less on the researcher for direction and support than did students in the Lunar Gravity (level 1) activities.

The third and last phase of videodisc work in Harlem Science consisted of two preparatory sessions and three hours of student presentations, where students articulated the issues raised in the Space discs and shared what they had been doing.

In reviewing the segments, we found that students were a great deal more relaxed and animated than in the prior work sessions. Students in the Lunar Gravity group called out frame numbers to the student in charge of the hand unit, and talked freely about what they remembered to be significant about the segments. The Spaceflight and

Orbit groups played through the game for review, and pairs of students volunteered to be responsible for presenting different series of screens to the class.

The student presentations were productive, and there were lively exchanges among them concerning aspects of the Space disc visuals and related scientific ideas. For the Lunar Gravity presentations, some students simply called attention to particular visual details of the segment. Others took the role of teacher and asked the class questions, which were often variations of those posed on the activity sheets they had used in their small-group sessions. Those segments which presented visually provocative material--due to either their ambiguous or counter-intuitive nature (e.g., why does a flag look like it's waving on the moon if there's no air)--generated the strongest reaction and fostered lively debate.

For the Spaceflight and Orbit presentations, students demonstrated the "Orbit Adventure" game, read the text screens to the class, and asked for input whenever there were questions on the screen. There was less talk about scientific aspects of the visuals; students were absorbed by the adventure/survival component and were most animated when a critical discrimination needed to be made, such as identifying a view of Hawaii from space. Here the students argued different interpretations of the images, much like during the Lunar Gravity presentations.

Holden science class. Janet used the Bio Sci disc over the course of five weeks. During the first three weeks, she used the disc to provide visual material for class discussion of such topics as cell division and meiosis. Calling up carefully selected pictures on the disc, Janet reviewed them and generated discussion concerning the connections between ideas students had covered so far and the images on the disc. The disc-player keypad was passed around the class and students took turns controlling the disc player. Freely using the play and scan buttons on the keypad, they often stumbled on interesting visuals other than those that had been selected beforehand by the teacher. These images, such as a sequence showing the splitting of chromosomes, were deeply absorbing for the class, and Janet picked up on this interest as an opportunity to introduce a new topic for discussion.

In the final two weeks, the disc was used as a resource of visual images for students putting together hypothetical proposals for alternative uses for Central Park. The disc became integrated as one of a variety of media resources for students' research. While a cluster of students worked with the videodisc, elsewhere in the classroom children were occupied in writing their proposals at the word processor,

reading reports on park use, printing out banners via a graphics utility, and drawing maps and slides to illustrate their proposed uses of the park.

In a corner of the classroom, two small groups of students used the keypad and a paper index to search for pictures that would be useful in their reports. Some students scanned the paper indexes, wrote down frame numbers, and then searched individual frames, while others refrained from using the index and simply flipped through the images at random, looking for interesting visuals. At times, Janet helped the students to use the index to place themselves in an appropriate section of the disc, review the local images using the hand unit options, and judge the appropriateness of the images for their particular proposals.

At the end of the five weeks, students used the disc as a visual aid in presenting their proposals to a mock planning commission in the school auditorium before an audience of parents, teachers, and children. The videodisc system was one of several visual aids used, including videotapes, overhead projections, and wall maps. As the group leaders read their proposals to the audience, images were displayed on a large color monitor beside them. One group in particular effectively integrated the videodisc images into its proposal. Having arranged them in a coherent sequence according to categories of plants and animals, they gave each series of pictures a polemical lead-in, such as: "Unless the park is protected, 250 types of birds will have to find other homes--for example, loons, gulls, swallows..." Audience reaction was audible for many of the animal pictures, especially for those considered to be repulsive (rats, snakes) or cute (rabbits, raccoons).

Multiple Models of Videodisc Use

Across the classrooms, five different models of using videodiscs were employed. As we had hoped, all four classrooms tried out more than one model. Each model possessed particular strengths and differed from the others in the ways in which it supported student learning, and in the ease with which it could be integrated into regular classroom routines.

1. Teacher presentation or teacher-led class discussion. In this model, the videodisc provides provocative visual accompaniment to a teacher's lecture and/or a visual stimulus to elicit class discussion or introduce an upcoming nondisc-based activity. Thus, the disc is used in a way that is analogous to how a teacher might use a set of slides, images from an overhead projector, or a film.

All four teachers used the videodisc in this way, generally as the first type of videodisc experience for their students. For example, Anna showed the Van Gogh disc as a lead-in to an art assignment on complementary colors, while Susan showed the Van Gogh disc to elicit discussion of Van Gogh's life as a painter, and to focus children's attention on aspects of his painting techniques. Both Elenore and Janet showed the science discs to the whole class and encouraged students to offer scientific explanations for the phenomena they were observing.

2. Activity stimulus. In this model, the disc provides the "raw data" for hands-on, nontechnology-based activities. Rather than providing a lead-in to a nondisc activity, the disc images provide the object of study for the activity, where disc and nondisc activity are totally integrated. Thus, the videodisc is used the way a teacher might use real objects or real physical phenomena.

Two of the teachers used the videodisc in this way. Susan used a still-frame photograph of a group of jugs as the basis for a still-life drawing activity. Elenore's students used a motion sequence of an astronaut dropping a hammer and a feather on the moon as the basis for a timing experiment concerning lunar gravity.

3. Programmed disc-based environments. In this model, the disc provides the photographs or motion footage for computer-driven simulations, games, or other problem-solving contexts. Thus, the disc program itself becomes the activity, much like a computer-based activity.

Such programs were created for and used by students in three of the four classrooms. Both Anna's and Susan's students heavily used the two art mystery games, which generated thinking and discussion around content and compositional aspects of paintings (e.g., what kinds of visual details in a portrait reveal something about its subject?). Elenore's students used "Orbit Adventure," which provided a motivating context for grappling with scientific ideas such as inertia and centripetal force.

4. Visual database. In this model, the disc provides an information resource for students for their own personal inquiry, much like a classroom and library resource such as a book, encyclopedia, film, or filmstrip.

The majority of options on the Van Gogh disc offered this type of resource. Some of Anna's students, and to a greater extent Susan's, independently explored much of the art disc's contents. While the disc could have been used for student reports on Van Gogh, it was

used instead as a general body of information for children to examine freely, with no particular goal or classroom assignment in mind.

The science discs also might have served this database role had more computer software been written to provide an index of images, or if there had been text frames with background information to identify and describe the different images. However, in their tested form they presented more of a massive picture file or archive than a stand-alone information resource for children.

5. Student presentations. In this model, the disc provides a visual accompaniment to student reports and class presentations. Thus, as with the teacher-presentation model, the disc is much like a set of slides or overhead projections to enhance an oral report.

Janet's science class at Holden used the Bio Sci disc in this way for their presentations of the proposed plans for Central Park. In preparation, children independently viewed the images, selected which images would be most appropriate, and modified their oral presentations to capitalize upon these visual enhancements.

Elenore, like Janet, felt it was important to have her students conduct presentations to provide "closure" for the science unit. In this case, however, Harlem Science students presented the "programmed environment" that they had worked with in small groups rather than independently selected images accompanying an original oral report. Nonetheless, such a presentation generated a great deal of student interest and lively discussion in the class.

In sum, the five models differed with respect to the ways in which videodiscs were utilized as visual information resources in classroom learning. Furthermore, certain models (e.g., teacher- and student-led presentations) lent themselves to large-group instruction, while other models (e.g., programmed disc-based environments and visual databases) were more conducive to small-group work. In the next section, we discuss the implications of these different models of videodisc use for their ease of implementation in the classroom. This discussion centers around three important issues: (a) ease of fit between the different models of videodisc use and traditional models of learning in the classroom; (b) videodiscs as an alternative to traditional media; and (c) the role of teachers in incorporating videodisc technology into schools.

Issues Related to Classroom Implementation

Ease of Fit between the Different Models of Videodisc Use and Traditional Modes of Learning in the Classroom

We found that large-group instruction and small-group learning with the videodiscs each had an important place in classrooms. Large-group instruction allowed the teacher to present classroom-wide, cohesive learning experiences to frame upcoming activities and focus classroom discussion, and to provide closure to units and student projects. In contrast, small-group work with videodiscs provided more student-controlled inquiry- and game-strategy-motivated learning, and more active yet informal discussion among students concerning videodisc content. During our interviews with teachers, they discussed the relative advantages and disadvantages of the two formats of learning interaction.

As might be predicted, the videodisc models that allowed teachers to keep the classroom unit together were the most easily integrated into the existing classroom learning patterns, while those models requiring small groups of children working independently of their classmates were more challenging for teachers to orchestrate.

With respect to large-group instruction, all four teachers used the discs as audiovisual aids for lectures and class discussions. The two science teachers set aside class time for student presentations to the class, while an art teacher had her class do a drawing based on a photographic image from the videodisc.

Large-group instruction with the videodiscs during class time appeared to be, in part, a pragmatic outcome of the limited amount of time children actually spent in art and science classes. Art and science were taught as "special" subjects in the three field-test schools (as is done in many schools), with children leaving their regular classrooms to go to the art/science room for only one to three periods a week. As a result, the amount of time an individual child had with an art or science videodisc was minimal in contrast to what might have been possible if students had continual access to a videodisc player in their home rooms. Thus, large-group instruction helped to maximize the average amount of time each child might have with the videodisc materials.

However, teachers also recognized the value of small-group sessions where children had more direct control over the videodisc experience. Despite this perceived value, three of the four teachers expressed their difficulty with having some children work with the videodisc while the rest of the class was engaged in nondisc work. While all

four teachers regularly engaged students in small-group, hands-on work such as art projects and science experiments, students typically did the same type of work and fulfilled the same assignment. The coordination of different types of learning activities occurring simultaneously proved somewhat problematic. It should be noted that all four teacher made a special effort to maximize children's small-group work with the disc by arranging additional sessions outside of regular class time, during lunch time or other periods.

With respect to small-group work during class time, teachers differed in their views and solutions to the challenges posed by small-group work with the disc. Anna, one of the art teachers, voiced some concern about coordinating children in her classroom:

> I like it to be a group experience, with everyone talking [together] about what's happening. I found it distracting and hard to keep people working that were working [with regular hands-on materials], and having some see parts of the disc, in a different kind of atmosphere, in a different kind of way."

Anna saw increased hardware resources, housed in a computer lab, as a somewhat better arrangement, but said that she also felt that children's work with an art disc was best supervised by an art teacher rather than by a computer lab teacher.

Susan, the other art teacher, anticipated the same problem in coordinating different learning activities, and elected to have small groups of students work with the disc in the library across from her room rather than in the art classroom. She felt that the library

> was a more studious and more conducive place. My art room doesn't lend itself to high tech equipment--I would have been very nervous about getting clay on it. It would have had to have its own separate space, requiring me to give up other space.

However, given the short distance between the library and her art room, Susan was able to "have her cake and eat it too." Her students worked in a quiet, separate spot where she could visit them frequently to supervise their work with the disc.

Interestingly, it was the difference in classroom patterns that heightened the success of the videodisc use in Elenore's class. She felt that students benefited from the exposure to something new that was a break in their daily routine:

> Everything is so regimented and disciplined here that just the format--the way they left the rest of the class to work on it, the fact that they didn't have to get it right all the time--made for a more relaxing way to learn, which I think was very good.

It should be noted, however, that such an alternative arrangement was possible only because a member of our research team was available to accompany the students, unlike Harlem Science, where students were not allowed to be unsupervised and without an adult present.

Small-group work was most easily integrated into Janet's class because she recognized that the videodisc could be incorporated into her students' project-oriented research tasks. Janet specially selected the Central Park proposals as the focus for small-group work with the videodisc because she knew that she would be having small groups of students working independently to gather information for that project. The videodisc simply served as one of the many different resources in the room for students to seek out and use.

In sum, the various models of videodisc use provided teachers with multiple ways to experiment with how videodisc technology might play a useful role in their classroom curricula and routines. As others have noted (Fuller, 1985; Glenn, 1983; Withrow & Roberts, 1984), videodiscs can serve as important audiovisual aids for large-group instruction in a way that is easily incorporated into the learning patterns in many classrooms while still offering superior visuals under user control. On the other hand, small-group or single-learning videodisc stations may challenge certain established classroom management strategies, yet have the potential to offer interesting, highly interactive learning opportunities for children.

Videodiscs as an Alternative to Traditional Media

As our other research has shown (Char, Hawkins, & Freeman, in preparation), elementary school classrooms make extensive use of information resources which are highly visual, such as films, magazines, maps, hands-on experiences, and field trips. In the present study, we found that videodiscs clearly addressed these visual information needs in classrooms. Furthermore, teachers and students recognized that videodiscs have the potential of offering them a learning resource that has distinct advantages over the media and hands-on activities traditionally available in schools.

One of the major advantages of the videodiscs was that they provided a vehicle for presenting provocative, realistic, and high-quality visual

material. The archival discs offered visuals that were important and relevant to teachers and students, expanded the visual world in classrooms, and generated new types of visually based activities and learning by students.

For example, students who used the Space discs felt that the video-disc images were more interesting and motivating than the usual focus of their classwork, made certain space and science concepts "come alive," and that the visual motion sequences afforded them a better grasp of certain ideas in physics:

> In class we have talk sessions, copy sessions...we discuss, we write a lot, and we memorize...but you forget, because you don't want to go back and read your notes. With the laser disc you see it, and it leaves an impression, and you want to go back and see it again so you understand it better.
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> * * * * *
>
> It's easier to understand when you can see things, better than when you just talk about it. Like the hammer and the feather [being dropped on the moon's surface]--I know why that works now.
>
> * * * * *
>
> It's exciting because you see footage that's real. You don't just have to imagine it, or make believe that you're there. You feel like you're really there...with the laser disc, the pictures are more real than with books--you feel like you're really there.
>
> * * * * *
>
> The only time I saw space stuff was on the news--they just take off and land. On the disc you see things like how they eat, and how they walk around on the moon....Space is more fun, interesting, and human than what they usually show on TV.

Elenore also agreed that a major impact of the Space discs was that they helped broaden student's conceptions of what science is:

> These kids think of science as room 232, as a certain teacher, as their textbook. The space material made sci-

ence more real for them, helped them make connections to the real world.

Similarly, Janet felt that the photographs and moving footage on the Bio Sci disc provided her students with powerful visual verification of scientific phenomena analogous to hands-on experiences:

> There are two different kinds of concreteness which can verify something for you--there's the manipulative approach where you move things around and see what happens; and there's seeing that it's part of the real world, that things really work the way you've learned they do. And they're two different ways of verifying for yourself instead of just reading it or hearing somebody talk about it.

Janet felt the disc was particularly important since it could provide students with visuals that show phenomena at the microscopic level, such as cell division.

A second advantage of the videodisc over other media stemmed from the medium's massive storage capacity and quick frame-accurate, random-access capability. Due to these technical features, teachers and students saw that videodiscs could provide them with an impressive array of visuals and greater control over accessing and replaying images:

> Clearly, it would have been very costly, time consuming for a teacher to have been able to get a hold of all those slides....I could never have gotten the range; even if you got every Van Gogh book out of the library, it wouldn't offer his complete works the way that disc did....[And with the videodisc keypad] it becomes a more individual thing, where children make choices and pick out where the computer should go and [become more personally invested in the experience]. [Susan, Van Gogh teacher]

* * * * *

> I liked it because you can go back and see it again, like a memory bank....With a museum guide, even if you don't like him, you have to go with him. With a computer, you can jump around. [Van Gogh students in Susan's class]

A third major advantage of the videodiscs was that they allowed teachers and students to exercise control over the pacing and directionality of motion footage in ways not usually possible with television

or films, thereby leading to greater focus and possibly new types of insights about physical phenomena:

> What I liked best was that I could get right to what I wanted immediately; and sections that were film, like cell division, I could go through in slow motion, and retrace back. [Janet, Bio Sci teacher]
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> * * * * *
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> You could really see the [frog] cells split up--it was amazing. And you could back up fast, make it all one again, then start it over....We got to control it ourselves. I liked that....You can move around more, and do more--like back it up, and go fast forward. [Bio Sci students]
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> * * * * *
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> You can stop it [with the picture left on] and talk about it for awhile. [Van Gogh students in Anna's class]

Another major advantage of videodiscs over other media was their programmability, and the ability to create simulations, games and other problem-solving contexts to motivate and focus children's visual inquiry and thinking. "Orbit Adventure" and the two art mystery games were often cited as students' favorite videodisc experience, and the teachers acknowledged the importance of story premises for establishing the problem contexts that are interesting and motivating to children:

> [With the "Orbit Adventure" game] you have to make choices and you get more involved....It's exciting--you feel like you're under pressure. You get into the problems because you don't want to die [in the game]....You really have to figure it out in order to make the right move--if you don't, you'll get burned up [in the earth's atmosphere] ....You can program it, and make it something else, like a game. [Space students]
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> * * * * *
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> The "Orbit Adventure" game really got them involved. It put kids at the center so they had to make choices. [It really encouraged them to think critically, which doesn't happen enough in school]. [Elenore, Space teacher]

* * * * *

It [art mystery game] made you smarter every minute. Like a detective. Like it had questions, and made you take out your brain and really react to it. [Van Gogh student, in Susan's class]

* * * * *

I remembered that they gravitated exclusively toward the [art mystery] games....I think they liked them because they like solving puzzles, and the game aspects....They really like figuring out how things work. [Anna, Van Gogh teacher]

* * * * *

[It was the mystery games where] they were the most animated, where the most discussion went on amongst themselves. They had the greatest stake, a vested interest, where the kids really had to think, really being called on to know detail. I think more of those kinds of games would be the most intriguing part of the disc....I think the [software] program directs them in a way that makes more sense than just looking at the different chapters. [Susan]

In sum, videodisc technology can offer an exciting alternative to the information resources traditionally available to schools. These potential strengths lie in the presentation of superior, high-quality visuals of real-world phenomena, greater user control over the accessing and displaying of visual images, and the availability of interactive, problem-solving contexts for children's learning.

It also should be noted that accompanying this new medium was the novelty of the hardware itself. All the teachers found it necessary to describe to their students some of the special features of the technology, such as how it worked and what a disc was like. A few teachers expressed some initial anxiety with the hardware, such as knowing how to work the buttons on the videodisc keypad, how to boot the disc, or how to deal with the system if it crashed. A few mentioned that a major issue to be considered was hardware cost, but were curious about the price of different systems and discs and remained enthusiastic about the advantages of the technology.

The Role of Teachers in Incorporating Videodisc Technology into Schools

Findings from our study challenge two common but diametrically opposed assumptions held by professionals in the videodisc industry: that teachers are simply consumers of existing videodiscs; or that teachers are designers and programmers who possess the knowledge, time, and energy to redesign and retrofit videodiscs. We found that teachers could be valuable contributors to the videodisc design process, but could not (or should not) be expected to invest the sizable amounts of time required to reprogram videodiscs.

The role of the teacher in adapting disc materials. The teachers proved to be extremely important contributors to the design process. During initial teacher interviews and planning sessions, our field-test teachers were extremely helpful in discussing which aspects of the discs seemed most relevant and promising with respect to their curricula, and offered various ideas for disc design and accompanying print materials. For example, both art teachers had ideas for different portfolio groupings and pointed to the importance of offering the programmed option where teachers and students could "on-line" create their own portfolios. The two art teachers also discussed their ideas concerning what they hoped children would gain from looking at and creating portraits, and from describing their art work using the words that formed the pedagogical bases for the two art mystery games. In general, the teachers were more interested in focusing on issues of content, art technique, and what is was like to be an artist in Van Gogh's time rather than on an art history approach (i.e., the distinctive characteristics of different art periods) or study of an individual artist per se.

Similarly, Janet helped to create the supplementary cross-references for the print index, which allowed children to select appropriate images from the Bio Sci disc. Using her knowledge of the subject area, the children's background knowledge in biology, the classroom organizational patterns, and the nature of the assignment, Janet was able to bridge the gap and create a good match between the massive archival videodisc and her students' needs, interests, and abilities.

One of the most important results of the field test was a realistic assessment of the significant amount of time, expertise, and energy needed to create high-quality materials, even when retrofitting excellent existing visual archival videodiscs. Even our research team, who had previous experience in software design and development, underestimated the work entailed in retrofitting discs.

When planning the field test, our research team purposively made the

decision to work collaboratively with teachers and assist them in the creation and adaptation of materials. The teachers' role in disc design was primarily that of reviewing the contents of the disc and discussing their reactions and ideas with the researchers.

Despite the more limited role played by the teachers, they devoted a considerable amount of time to the planning and design of the discs. For example, Elenore, the teacher who used the Space discs, spent approximately 18 hours reviewing the contents of the disc, meeting with the researchers to plan and approve the disc design, and reviewing the final disc materials. Although the production effort invested in the two other discs (Van Gogh and Bio Sci) was less extensive than for the Space discs, it was still considerable.[3] Elenore described the design process in the following way:

> First you have to run through the disc and see what's available, then you make notations about exactly what footage you want, then there's your own mental planning of what you're going to do. If it's level 1, you search out the frames in class; if it's level 3, you put it together and program it--that's where most of the work is.

If one adds the time required in learning a new computer language or an authoring language, programming and debugging a piece of software, the time investment increases exponentially. Furthermore, as noted by McLaughlin (1984):

> While an authoring system can reduce the amount of jargon that a teacher must learn before beginning to create a lesson-script, it won't reduce the need for spending hours on the details of the script, specifying screen positions for text, videodisc frame numbers, alternative responses to count as correct, and so forth. (p. 11)

The role of the teacher in focusing students' visual inquiry. Another key role played by the teachers during classroom use of the videodiscs was helping to focus students' attention on particular aspects of the disc visuals. They played a significant part in extending and enhancing student discussion, probing children's understanding of what they were seeing, and getting them to articulate their reactions to the videodisc images.

Susan, one of the art teachers, assumed an active role in bringing certain visual aspects of the paintings to the children's attention, having students verbalize their ideas and feelings about a painting, and generating discussion about art composition and art history. For instance, when the children were working alone without Susan, they

were still highly engaged with the disc and often discussed elements of the pictures. However, their comments tended to be along the lines of pointing out specific content features of the picture, making free associations with other paintings they had seen, or aesthetic appreciation (e.g., "Look at the dog"; "That looks like George Washington"; "Oh, that's pretty") with relatively little follow through or elaboration. With Susan, the discussions were much more focused and extended. For example, when a child commented that an impressionist painting on the National Gallery of Art disc did not resemble a Van Gogh work, Susan encouraged the child to explain why, and the child proceeded to discuss contrasts in use of color and brush stroke.

Janet also played a significant role in helping children to use the Bio Sci disc, helping them to locate appropriate pictures for their presentations. She encouraged them to use the paper references and often directed them toward the general section of the disc where they could most fruitfully explore. Janet also helped to steer children in the right direction when they tended to regard the disc image literally rather than taking interpretive license with the pictures. "That's not Central Park" was a frequent student comment and the basis for a judgment that a picture was not appropriate, even though certain pictorial elements might have enhanced the child's presentation. For example, some children would see a picture of a green, grassy field as an example of the kind of terrain they would like to see in the park, but reject it on the grounds that it featured a mountain in the background (and thus could not be Central Park). With Janet's help, students began to see how they could incorporate such pictures into their presentations by verbally directing the audience to focus on the relevant aspects of the picture.

Elenore also spoke about the pedagogical advantages of the videodisc medium as well as their implications for how active a role a teacher must play during a class session:

> You can manipulate it more [than film]--go back, slow it down, stop, and get to a particular frame you want to show....[However, it requires more work than film]. The videodisc is not a show and tell--not like where you sit at your desk and say to the class, "Now watch this"...instead you have to go through and search frame by frame for the different things you want to show. [Elenore, Space teacher]

Conclusion: Summary of Findings and Implications for Videodisc Development

Our field test turned out to be far more involving than the usual

classroom research situation in which teachers are given educational materials to try out. Our method was to work closely with teachers to find ways of integrating the technology into their classrooms. We did some of the leg work involved in reviewing the disc materials to find appropriate images, created software and print materials to be used in class presentations and small-group activities, and were even involved at times with supervising small groups of children. These activities, however, gave us a more realistic picture of the level of effort that is required to take advantage of the unique features of the videodisc. We were also able to see very clearly some of the excitement the medium can generate when used to its full potential.

This final section summarizes the results of our field test by offering seven major clusters of findings. We then discuss, for each cluster, the implications for design recommendations in order to address the concerns of professionals interested in videodisc design and in the success of videodisc technology in the schools.

1. The Visual Power of the Medium: Substance Not Just Quantity

Teachers and students alike clearly recognized some of the advantages of videodiscs over other more traditional media. The rich visual resource provided through the videodisc--in the number and types of visual images offered--was one of the most positive aspects of the medium noted by teachers and students. Obviously, the sheer quantity of available images is not sufficient: The value of a massive compilation of videodisc images is limited unless the visuals themselves are important and relevant to teachers, students, and other users. As one teacher noted, any program or game you can write for the disc will only be as good as the visuals you have to work with.

Our choice of archival discs for the study was a significant factor in the observed success of videodisc use in the classrooms. By definition, archival discs contain images that have been deemed significant enough in their own right within a real-world context to merit being stored in an archive--footage of an astronaut in space, a microscopic world of cells, or art masterpieces of the world. It is not surprising that both teachers and students immediately grasped the importance of the images on the disc and regarded them as meaningful and pertinent to classroom learning. As a result, teachers' ideas about how the videodiscs might be incorporated into the classroom were generated with enthusiasm, and students engaged in the videodisc activities as valid, educational experiences.

Design implications: The need for important, high-quality visuals. Disc designers should seek out visuals that are important in and of themselves, and that do not trivialize the importance of visual

inquiry and the knowledge gained by examining visual objects, actions, and phenomena. Furthermore, visuals should be pertinent to common topics and themes in a variety of classroom subjects. Such images can provide powerful visual foundations for databases, simulations, and game applications. The appearance of archival discs in the marketplace is a step in the right direction. However, as will be discussed below, massive archival discs can prove unwieldly, and need to be accompanied by adequate and appropriate indexing, software support, and curriculum frameworks.

On a different note, the majority of archival discs currently on the market are in the area of science. While this is understandable, given increased national recognition of the importance of science education and the natural coupling of technology with science, designers should not lose sight of the applicability of this highly visual medium to other subject areas, such as language arts, art, social studies, and history. Moving on all these curricular fronts will help to increase the medium's acceptance in schools and expand its user base among teachers.

2. User Control Over Video Options

User control over the flow and direction of visual images (e.g., calling up different video frames, pausing, slowing down and speeding up motion sequences, playing sequences in forward or reverse) was extremely valuable in students' exploration of and learning from videodiscs. As we found in our other studies (Char & Newman, 1986; Tally & Char, 1985), these types of manipulations of the video allowed students to see things again, examine objects and actions in different ways, and chance upon interesting and unexpected visual phenomena.

Often, such user control over visuals is overridden by level 3: computer controlled videodisc authoring systems. For example, the authoring system we used to create our Space games was one that allowed the creation of two common instructional design formats--multiple choice and true/false questions--and was selected for its ease of use. However, other than allowing users to replay a previous sequence in exactly the same fashion as it was first presented, it was extremely difficult to program in any other types of user control over viewing the video, in altering the speed or directionality of the flow of images. Thus, almost all of the flexibility of level 1 (keypad controlled) user control was relinquished when using the authoring system, to the detriment (in our opinion) of the videodisc experience.

Design implications: Consider and encourage user control over video options. Allowing students to control the flow of pictures can be an enlightening experiencing; that is, allowing them to peruse

details of objects and manipulate units of real time (e.g., seeing things in slow or fast motion). User control should be maximized whenever possible, guiding the inclusion of particular types of video sequences on the disc (see Char & Newman, 1986, for exemplary discs), and the clarity and ease with which visual control is prompted and encouraged (see Tally & Char, 1985). We also strongly urge designers of level 3 computer-controlled discs and authoring systems to preserve as much as possible this user manipulation of visuals.

3. Importance of Audio and Text: The Role of Language in Elucidating Pictures

The importance of the linguistic and auditory component of videodiscs was evident in the four classrooms. Segments on the Space disc that featured the astronauts' voices were particularly exciting to students and enhanced the realism of the scenes. Both art teachers complained that the adult-oriented Van Gogh audio narrative was too lofty and dry for children, and felt that a narration more tailored for children's interests would have been preferable. While the Bio Sci teacher said she liked the absence of audio throughout the disc since it allowed her to narrate the sequence in her own way, it sometimes proved problematic when both she and the students were uncertain what it was that they were seeing (exacerbated by the lack of text frames or overlays). As one of the Bio Sci students suggested: "Put the names of things on the pictures--that would help."

Design implications: Inclusion of audio and text. Disc designers should pay special attention to the audio and text components of videodiscs, both of which are critical in helping the user to identify, interpret, and become involved with the visuals being presented. Designers should strongly consider including informative or appealing audio material to accompany motion video visual sequences. Using the keypad or computer, the teacher can always elect to turn off or leave on the soundtrack. Furthermore, clever use of the disc's multiple audio tracks can offer different points of entry and address the range of users' background knowledge, special interests, and language abilities.

Similarly, computer-generated text overlays and screens (as opposed to strictly disc-based text frames, which can not be altered once the disc is pressed) can offer a variety of pairings between pictures and words, and can be utilized to expand the user base. At a minimum, appropriate text information identifying the content and topic of the visuals should be included as part of the disc, disc software, or print materials.

4. Indexes and Databases

The sheer quantity of images on the archival discs was somewhat unwieldly for researchers, teachers, and students alike. To acquire a relatively fair grasp of the contents of the disc was no simple task, despite the fact that all discs were published with a print index. For example, the print index for the Bio Sci disc, while extensive, proved to be problematic: A number of the pictures were identified by their Latin species terminology, which were obscure for the students and many teachers. Furthermore, the images on the disc often were sequenced in seemingly random order rather than in clear, coherent groupings, which increased the difficulty of accessing and displaying appropriate images for a particular topic. The Space discs posed similar problems.

The art disc indexes listed artist, title, and date, but no further content or technique information. In general, teachers were more interested in focusing on issues of subject matter, art technique, and what it was like to be an artist in Van Gogh's time than on utilizing the art history approach of the disc (i.e., what are distinctive characteristics of different art periods, the study of an individual artist per se). They also gravitated toward groupings of paintings that highlighted the contrasts rather than the subtle distinctions between paintings, feeling that such pairings more clearly conveyed points that students would grasp. For example, one teacher said that she wished she could have pulled up a collection of pictures that contrasted how different artists (e.g., realist, impressionist, analytical cubist, surrealist, pop artist) might depict a particular still life of fruit, rather than simply having students flip through the National Gallery of Art disc.

Design implications: The importance of adequate indexing and database systems. Raw archives, no matter how beautiful, do not necessarily constitute valuable educational materials unless they contain adequate referencing components. While exhaustive indexing of disc contents would be impossible (and ludicrous), archival discs should be well indexed, preferably via software, but at least in print. The indexing system should utilize central features that are most likely to be important to teachers and appropriate to students in vocabulary, key words, organization, and groupings. Also, since photographs contain many pictorial elements, a multiple referencing system, as opposed to one using a single label per picture, is preferable. Ideally, teachers and students should be able to search for and sort various topic words and variables and see the resulting set of images. The search system should allow the user both to engage in specific, focused searches for pictures and to browse through an assortment of images and types of information.

Second, we recommend the creation of a good database software utility that can be used with archival discs, and updated and adapted by the user. The software package, in addition to its function of creating videodisc slide shows, should allow teachers easily to search for and access images off the videodisc, and to further custom fit the disc by adding additional groupings and fields of information in order to address student needs. Furthermore, a utility that can also accept user input for new text screens and overlays (rather than simply names for new picture files) to accompany videodisc images would further enhance the disc's educational value and its applicability to a wide range of classrooms. A "generic" database interface--one that could be used with any archival disc--would be preferable so that it would not be necessary for teachers to learn a new application each time they used a different videodisc archive or archive series.

5. Simulations, Games, and Problem-Solving Activities

The appeal and educational value of game scenarios and problem contexts created through level 3 systems was evident in all four classrooms. These materials clearly heightened students' motivation to learn with the disc, helped to guide their visual focus and thinking concerning particular elements of the images, and encouraged various kinds of problem solving.

Design implications: Videodiscs as programmed environments for problem solving. Disc designers are urged to provide more creative examples of ways to organize video images into games, simulations, and other problem-solving contexts for level 3 computer-controlled systems. Furthermore, authoring systems not only should support traditional instructional design approaches, but should allow teachers to create videodisc-based simulations and game scenarios of their own.

6. Classroom Management Problems Introduced by Scarce Videodisc Resources

In our field test there seemed to be particular challenges in classroom management posed by small-group work with the videodisc.[4] While videodiscs could be viewed by a whole class, some of the videodisc activities that were most successful, such as games and simulations, were best used by small groups of children at a time. Thus, teachers found it necessary to orchestrate both disc-related and nondisc activities in order to engage all their students. It is to be hoped that, in time, hardware and disc resources will become increasingly available to and affordable by schools, which would help to minimize the problems in juggling disc-related and nondisc activities. However, even if we were to see a dramatic increase of videodisc

resources in schools, there is unlikely to be a significant number of videodisc players available to each classroom in the near term.

Design and practical implications: Multiple models of use and the inclusion of ideas for nondisc-based activities. We recommend that disc developers pursue a wide range of development activity and address the multiple models of videodisc use possible in terms of a variety of classroom-wide, small-group, and individual use applications. Small-group videodisc activities should be well contexted within a learning framework and carried out without requiring continual teacher intervention and supervision. We also urge disc designers and publishers to include print materials of ideas for related, hands-on learning activities, which children can use in conjunction with their disc activities.

7. The Role of Teachers in the Videodisc Arena

Our field test revealed that rather than simply being passive consumers of existing videodiscs, teachers can contribute important insights to the process of identifying the educational potential of videodiscs. However, we believe that it is overly optimistic to expect many teachers to program, retrofit, or produce their own videodiscs, at least during the early phases of introducing videodiscs to the school market. Furthermore, the teachers who are most likely to have the programming expertise and interest are the computer specialists (as was the case in our field test), rather than the regular classroom teachers who are in command of their subject areas.

Design implications: Involvement of educators in the design process. We strongly recommend that videodisc designers involve teachers in the design process. As we found in our video and software development efforts for The Voyage of the Mimi (Char & Hawkins, in press), teachers can be invaluable assets as consultants, field-test teachers, and members of design teams. Videodisc designers can utilize the expertise of teachers in numerous aspects of disc design, such as content, organization, programmed learning activities, indexes, and accompanying documentation and print materials.

Footnotes

[1]All the names of the schools and teachers in this report are pseudonyms.

[2]There was a considerable range across classrooms in the duration of videodisc use, from Anna's three weeks to Elenore's eight weeks. This range, rather than reflecting teachers' interest in the technology, was largely due to the hardware and disc resources available for the field test and the time constraints which accompany the final months of the academic year. There were three videodisc systems available: two Sonys and one Apple, and only single copies of each of the art and science discs.

Since the two art classrooms had to share one Sony system and one set of art discs, the materials were used in a non-overlapping, 2-phase schedule. Electing to delay implementation until after the spring break, Anna was able to use the disc for only three weeks before it was scheduled to go into Susan's class for its 5-week stint (Susan chose to have the children use the disc throughout the last week of school). Janet's science class had partial and then full access to a second Sony disc player, which led to her 5-week disc use. Elenore's class--the only one that used the Apple system--was able to use the disc materials for the full 8-week period.

[3]For the Van Gogh disc, we estimate that the researcher spent approximately 40 hours designing the disc program, meeting with the teachers in planning sessions, finding the appropriate images and recording frame numbers, creating text screens, and supervising the programmer. Finding certain pictures, such as the ones for the Suns, Moons and Stars portfolio, required going through all the images on the disc, since no content features were listed in the disc index. Similarly, the creation of the two art mystery games required considerable time and study for constructing appropriate and interesting problem sets.

The assisting programmer spent roughly 20 hours programming the Van Gogh disc. Although an experienced programming teacher and a competent programmer, she was not familiar with Sony BASIC, the language for the disc player, and had to learn both the system and the language. She was undoubtedly a "best case" quick study for a novice; thus, the 20-hour estimate is probably low for what might have been entailed in programming the software.

The creation of new materials for the Bio Sci disc was less extensive than for the other videodiscs. However, identifying most relevant images on the disc, creating the index, and facilitating the program

which allowed children to show a "slide show" during their presentation, took the researcher approximately 12 hours.

[4]It is important to note that three of the four teachers had minimal experience with computers or other technology, and had never before integrated educational technologies into their classrooms. Thus, some of the difficulty and anxiety they were experiencing might have been heightened in light of their backgrounds and the fact that we were studying the initial phases of implementing videodiscs in their classrooms. We would hope that with increased use there might be a gradual adaptation to alternative media and learning patterns.

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