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ABSTRACT

A study was designed to describe how middle school students select, link, and determine relationships between textual and visual information. Fourteen authoring groups were formed from both eighth-grade earth science classes of one veteran teacher in one school. Each group was challenged to produce an informative interactive laservideodisc project about "weather" for their classmates. Students used hypermedia on Macintosh computers with videodisc players and color monitors for authoring these lessons. Project topics included tornadoes, hurricanes, lightning, storms, clouds, rainbows, and floods. Laservideodisc authoring allows students to define and describe links between visual and textual information. "Authoring" groups used several strategies to complete their projects and were able to produce branching "stacks" on selected weather topics. Student-authored stacks were recorded continuously. These HyperCard records were used to describe the student groups' processes of integrating new information and "authoring." Evidence from student self-reports, audiotape, observations, and products combined to describe a protocol used by students authoring groups with direct control of an intelligent laservideodisc system. (24 references) (Author/KR)

Learning in the Middle School Earth Science Classroom: Students Conceptually Integrate New Knowledge Using Intelligent Laserdiscs

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LEARNING IN THE MIDDLE SCHOOL EARTH SCIENCE CLASSROOM: STUDENTS CONCEPTUALLY INTEGRATE NEW KNOWLEDGE USING LASERDISCS

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ABSTRACT:

National statistics indicate students' overall interest in science declines dramatically in the middle grades. Pascarella et. al. (1981) found that "the extent to which teachers, rather than students, controlled the learning environments was negatively associated with continuing motivation." Studies by Sherwood et. al. (1987) and Bransford et. al. (1988) used videodisc technology to create shared "macrocontexts" between teachers and students to explore a variety of problem solving strategies. These studies build on the assumption that "both children and adults act to solve problems and accomplish purposes which are functional and meaningful within the context." These contexts are visually and semantically rich (Rowe et. al. 1990) with information relevant to the problems posed. It is the richness in vocabulary, phrasing, and visual information of contextual learning that can be uniquely recreated with a hypermedia/laserdisc authoring environment.

To be "meaningful," these contextual learning experiences must be related to prior knowledge and integrated into the student's knowledge framework. Concept maps are schematic representations of an individual's structure of knowledge and have been used by

students to show their extent of relevant prior knowledge, knowledge gains, and change in knowledge structure when engaged in meaningful learning. Gowin and Novak (1984) proposed concept mapping as a tool for learning and for research. Concept maps were used, in this study, to identify students' relevant prior knowledge of "weather" and determine if integration of new content into these maps had occurred.

Similar to concept maps, the software product HyperCard "enables users to idiosyncratically organize information in a manner like that of the user's own thinking" (Hypermedia 1988). Combining hypermedia with the visual database available on optical discs in educational settings provides a unique opportunity to research how students construct new knowledge. This media enables researchers to record students' decision-making as they selectively integrate information into their conceptual frameworks while learning.

This study was designed to describe how middle school students select, link, and determine relationships between textual and visual information. Fourteen authoring groups (3-4 students/group) were formed from both eighth grade earth science classes of one veteran teacher in one school. Each group was challenged to produce an informative interactive laservideodisc project about "weather" for their classmates. Students used hypermedia on Macintosh computers with videodisc players and color monitors for authoring these lessons. Project topics included: tornadoes, hurricanes, lightning, storms, clouds, rainbows, and floods.

Laservideodisc authoring allows students to define and describe links between visual and textual information. "Authoring" groups used several strategies to complete their projects and were able to produce branching "stacks" on selected weather topics. Student authored stacks were recorded continuously. These HyperCard records were used to describe the student groups' processes of integrating new information and "authoring". Evidence from student self-reports, audio tape, observations, and products combine to describe a protocol used by student authoring groups with direct control of an intelligent laservideodisc system.

Results indicate that direct student use of laservideodisc in the middle school classroom extends students' possible learning experiences, motivates students to stay on task, and can be effectively used by students for meaningful learning. This "hands-on" model for introducing students to new content, new technology, and metacognitive strategies promotes cooperative learning and motivation for science learning. This new interactive technology is a particularly powerful tool for research on learning.

INTRODUCTION

Building on Ausubel's (1961) cognitive theory, Gowin and Novak (1987) have proposed the Vee heuristic and concept mapping as tools for meaningful learning and for research. Concept maps are schematic representations of an individual's structure of knowledge and may be used to show the extent of relevant prior knowledge, knowledge gains, or the change in knowledge structure when engaging students in meaningful learning. Other studies (Okebakola 1990, Novak 1984, and Brumstad 1990) confirm the "potency of the concept mapping technique in fostering meaningful learning."

Concept maps consist of concepts and propositions that an individual selects to place within a hierarchical structure of relationships. More specific events and knowledge are subsumed together under more inclusive concepts creating levels of hierarchy while concepts of similar inclusiveness are distinguished as categories. These relationships show schematically the depth and breadth of an individual's knowledge structure. Constructing a concept map forces students to organize knowledge and enables students to "see" their thinking. This "seeing" enables them to evaluate new experience and knowledge in relationship to their existing cognitive structure and thus begin to understand their understanding.

The Office of Technology Assessment (1988) states "new technologies are making possible imaginative approaches to teaching traditional subjects and are motivating teachers and children to try new ways of information gathering and learning." In this study we describe middle school earth science students' information gathering and learning. Hypermedia software records of video search strategies and links between text and video made by students show patterns of how "authoring" groups explore and make sense of new information.

Ebert-Zawasky (1990) concludes from her work with college biology students and laservideodisc authoring that "students do not need an extensive background in computer use nor exceptional mathematical ability to produce presentations (using laservideodisc) and learn biological content in the process." Adapting Ebert-Zawasky's model for use with middle school students, this study seeks to use concept mapping and continuous records of student group work to examine middle school student learning through their explorations of an intelligent laservideodisc.

Early adolescents experience tremendous changes through the middle grades. Much of their attention and energy is focused on their bodily changes and peer relationships. Students, ages 10-13, are in transition from primarily concrete, experiential thinking to more critical, abstract thinking. Though these students may not become formal operational in all tasks, specific learning experiences may encourage this transition.

Middle school science curricula are generally interdisciplinary courses in earth, life, and physical science. These courses address a wide variety of topics and themes. A broad scope allows many possible teaching models, hands on experiences, and group or independent projects for students. These aspects make middle school a particularly exciting place to do research on the learning process (Abegg 1986).

A survey of Massachusetts Science Supervisors (N=35) indicates that about 35% of secondary schools own or have access to laservideodisc equipment and optical discs. Fewer schools have a computer dedicated to use with the laserdisc but note that computers are available for student use. The increasing availability of these teaching and learning technologies as well as a critical need to improve science education suggest that studies of student learning using intelligent laservideodisc systems are timely.

METHODS

This study adapted the use of concept mapping as an approach to learning and integrating new knowledge. Concept maps identified students' relevant prior knowledge of "weather" and integration of new content into these maps. Group prior knowledge maps were advanced organizers for group work and for authoring stacks using the intelligent laservideodisc.

This study describes how middle school earth science students structure textual and visual information using HyperCard and Voyager software on a Macintosh-laserdisc system. The HyperCard "Home" stack was altered slightly to prevent students from taking an infinite field trip through the stacks. The "Home" card showed only icons relevant to the student's authoring task, including the Voyager Videostacks and a demonstration lesson. Students explored a wide range of videodisc images, drew original pictures, and used the cut and paste resources creatively in their projects.

Middle school student authoring groups created their own links to the visual database and sought out textual information to explain selected images and events. Although students moved freely within the hypermedia environment and accessed images, text, and "authoring tools"* in a non-linear fashion, creating cards and links was done primarily linearly. Middle school students seemed reluctant to discard unnecessary information. Instead, they chose to include all the information they had found by adding additional cards to their project stacks.

RESULTS

The students were highly motivated while working with the laservideodisc system. They frequently made side trips to view additional film clips and extra slides. Watching film clips was a highlight for the students. They seemed to watch the clips passively with only occasional comments about their content. Selecting slide frames, in contrast, stimulated debates about quality, content, and appropriateness to the topic. Since the number of images to be included was unlimited, students often included several images of similar scenes.

"Authoring" groups showed several patterns of group work and produced branching "stacks" on selected weather topics. Throughout

* "authoring tools" - HyperCard software provides draw and paint options, button, field, card and stack scripts.

this study, students worked together in small groups. There were no predetermined, assigned, or required roles for group members and no written requirements on length, topic, or structure for their projects. The following anecdotes show typical strategies used by students to define their projects and the roles of individuals within the work groups.

> Absent for the introductory demonstration, one student in this group stands behind the others as they begin to use the paint tools. With "tornadoes" as their topic already chosen, this group uses the spray paint can to scribble a funnel cloud on the screen. They talk excitedly among themselves, draw, erase, and redraw the cloud several times. they don't stop to explain anything to their fellow group member, but they show him how to use the tools.
>
> They learn to "cut" and "copy" rather than erase their picture. They all agree, it is a "good" one. The picture becomes a diagram with the addition of labels and a theme for their project. They spend every minute of every class period working at the interactive laserdisc station. They watch the two tornado movie clips over and over, extracting infromation from the narration and selecting brief sequences to include in their project.
>
> Finally, the group member who had been absent assumes control of the mouse and keyboard. While the other two seek out text information, this student works alone experimenting with and exploring HyperCard and the videodisc materials.
>
> Once the others return, they read him their notes and he begins to type. This is a slow process and eventually another student takes the keyboard while the others dictate from their notes. The three work most closely together on the final card of their project. With animated faces, laughter, and raised voices they choose the picture, video frames, and text for their final "destruction" card.

In this first strategy, each member of the group participated in every aspect of the group project. The original effort in drawing the funnel cloud, attempted by each member, helped to facilitate this group working closely together. Eventually, one keyboard and one mouse expert emerged but every member felt free to alter or make suggestions about each aspect of the project. This group worked hard to agree on each card in their project. This style of working together, deciding on each aspect of the project was typical of six of the fourteen groups.

A second strategy for completing this project was to have a division of labor within the group. This strategy varied from each individual having a particular role to two individuals sharing equally two roles, or one expert performing one role while all others assumed multiple roles. This next description is of a group which split into two smaller groups of two students.

> A debate between tornadoes and lightning as a topic splits this mixed group into two male-female groups. They use several class periods, working together, to view film clips, search slides, and debate these possible topics. One pair takes over control of the mouse and learns to copy cards, use the paint tools, and "cut and paste." The other pair, less assertive than the former pair, willingly surrenders the control of the mouse and keyboard. After several days, they settle on tornadoes as their topic.
>
> One pair researches tornadoes in books and encyclopedias. They take notes on note cards and frequently check in with their technical experts, who are choosing slides and designing the stack. Sometimes the researchers introduce topics to the designers while at other times the designers derive ideas to be researched from the video images. Toward the end, the designers and researchers come together again, taking turns at typing in the information. They edit and correct each other's typing and ask the researchers questions about the information.

There were four groups that used a division of labor to produce a finished project. In each case, a technical expert emerged. This technician was either skilled with the mouse, keyboard, or both. There was also a clear leader who assigned the tasks or had the final say in what went into the project. In some groups this leadership role was shared, while in other groups one student seemed to make the final decision. These groups used more "cut and paste" resources and did not produce original pictures or diagrams. These four projects are each unique. One project uses more than one card design, another is designed as a field trip through storms, and one uses a question and answer format with a quiz at the end. The fourth was the only non-linear project stack produced. This group developed "button-icons" for each of the subtopics in their project and arranged them on the title page. To see each information card and slide, the user must click on the respective button-icon. After viewing the slide and reading the information, the user must return to the title page in order to continue.

In contrast, there were four groups that spent most of their project time negotiating how to work together. Each of these four groups struggled with and eventually completed a project. Despite their slow progress, these groups eventually produced projects comparable in length, content, and creativity to those of the other groups.

> One mixed group includes two best friends and one male student. They struggle with the concept mapping exercise. The two friends disagree on how to organize their ideas and the third contributes little to the debate. The map reflects this struggle with few concepts, little organization, and few propositional links. They ask if they can change groups at the end of the period.
>
> The following sessions are marked with competition for control of the mouse and keyboard. The group members alternate whole class periods in contrtol of each device and seem to work independently whenever they assume control. The group produces several individual cards but does not decide on a topic.

At long last, they decide to work on "clouds." They preview the cloud images and write down the names of the cloud typos from the image directory. The following period, they divide the list and take notes from texts and encyclopedias about each cloud type.

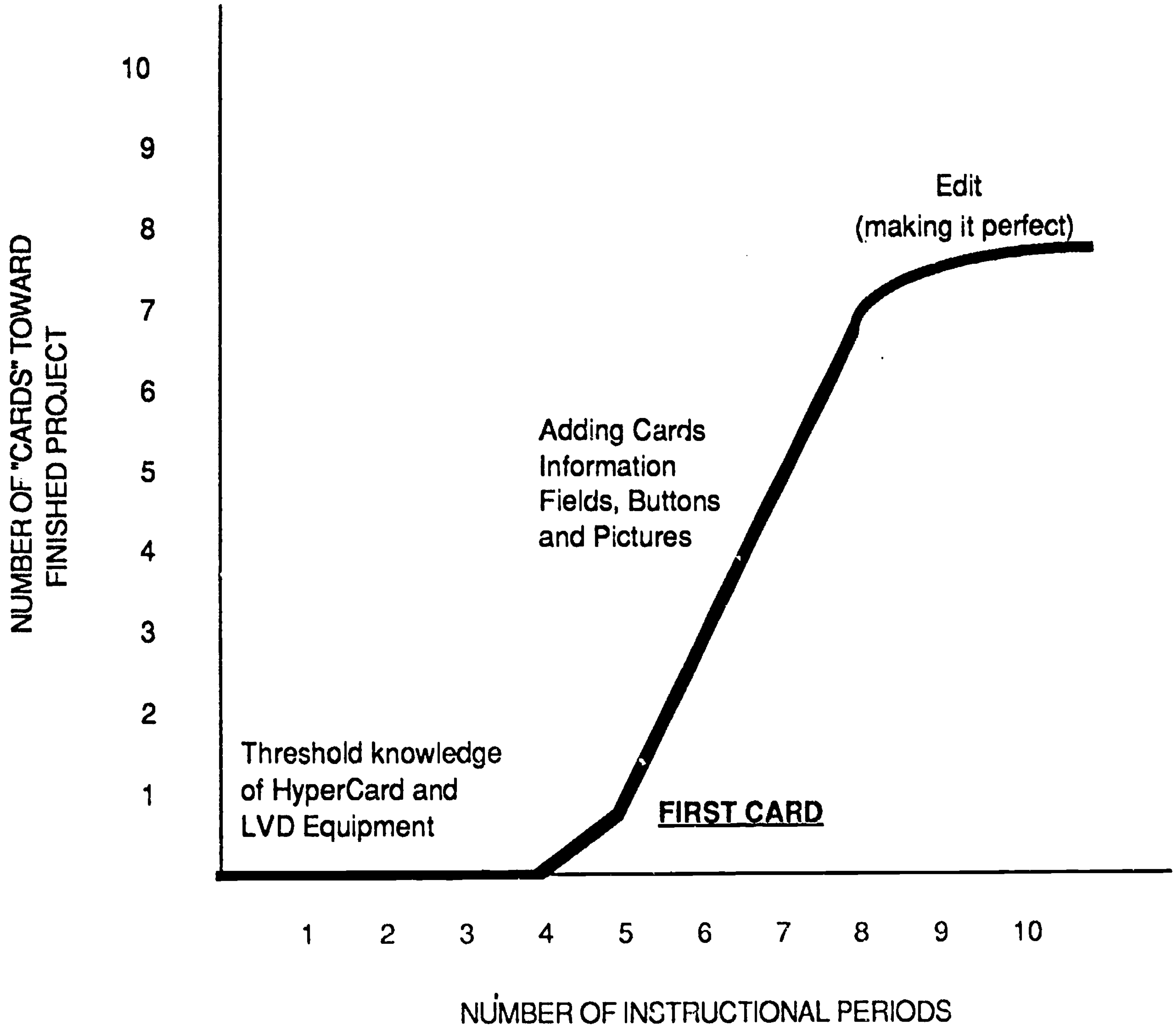
Back at the workstation, they create a "button" named for each cloud type. Next, they add a "field" with the descriptive information. Each student puts their own "cards'" information into the stack.

In the end, they begin to take pride in their work as they run out of time. Rather than editing on the last day, this group creates one of their first few original drawings to illustrate the chosen cloud types.

Particularly in this last case, more time would have enhanced the quality of the student projects. In all cases, students expressed interest in continuing to work with the laservideodisc. Many groups indicated that they would continue to study the topic they had chosen. In each case the groups produced stacks of 6-17 cards. All fourteen groups used the roles of researcher, technician, designer, and editor. In most groups, each student participated in all of these roles. Unfortunately, printed copy of the project stacks cannot show the video images associated with the individual cards, nor give a "feel" for the interactive component of using hypermedia.

There was a four day period of confusion when the students were first exposed to the intelligent laservideodisc. HyperCard was new to them and they had little vision of what their project topics might be. During this period, each group explored the equipment, software, and videodisc in various ways. Students worked hard to learn how to navigate in HyperCard. There were many questions. The researcher moved form group to group, answering questions about the videodisc, the creation of new stacks, cards, buttons, and fields, and what sort of topics would be "good." Obviously it was impossible to respond to more than one group at a time and the students soon learned to try things out on their own first. These first independent experiments gave the students confidence in each other and helped students to feel comfortable with the equipment. In contrast, for the researcher this was an anxious time of

Figure 1. DESCRIPTIVE GRAPH OF STUDENT PROGRESS TOWARD PROJECT COMPLETION VERSUS THE NUMBER OF INSTRUCTIONAL PERIODS



wondering whether or not any group would move ahead on their project.

The descriptive graph (Figure 1) shows the rate of student progress toward the finished projects in terms of the number of instructional periods. This pattern was derived from review of the electronically recorded project stacks saved by each group after each day's work.

After the first card, the groups produced one or two cards a day. Some groups chose a basic form for all their cards and made each card similar. In other groups, each member contributed cards in his or her own style. A few groups selected the video slides and clips first and added information to describe the pictures they found. These groups would structure the stack around the pictures and add fields to each card to hold the information.

The most obvious evidence of the videodisc influence on the student projects was the limited selection of topics. Four groups chose "Tornadoes." Three projects were on "Lightning, " two were on "Hurricanes," and two were on "Storms." These were all topics supported by movie clips on the Earth Science videodisc. There were many more topics available from the prior knowledge concept maps and supported by video imagery that could have been selected as project topics. The overwhelming choice of topics supported by movie clips rather than slides may be due to the students' interest in the narrated film. It is also possible that the attraction to these clips was due to the fact that the slide descriptions in the image directory were cryptic and contained many terms unfamiliar to the students.

DISCUSSION

Ebert-Zawasky's model (1990) of students contributing information to the class through "authoring" informative interactive laservideodisc lessons was successfully adapted for use in the middle school science classroom. Students were highly motivated to learn content and about the technology by being challenged to produce meaningful projects for their classmates. Each student became a valued contributor of information and technical expertise. Within each group students depended on each other and worked together to solve technical problems, settle design issues, and seek out anwers to questions they raised about weather topics. The experience of using the intelligent laservideodisc technology to its fullest capacity gave students a "new" and "fun" way to learn science. This model significantly changes the role of the teacher. Students were in control of vast information resources and were responsible for developing critical lenses about what information was relevant and important. The teacher, no longer the gate-keeper or disseminator of facts, was able to explore student's thinking and understanding through inquiry and by becoming a partner with them in learning.

As a tool for science learning, the laservideodisc provided a "real" context in the classroom. Students were stimulated to ask questions about and seek out explanations of the video images. In turn, reading texts spurred on intense searches for relevant images. Students recognized the synergy of these components of the learning environment and stated that the science project should not be separated from learning about the technology. The integration of learning new content within the rich context of the laservideodisc "reality" was a complex task. The students were not overwhelmed, but rather motivated by this complexity and took great ownership in their project topic, production, and presentation.

Middle school students are capable of learning about and using the intelligent laservideodisc for science learning and to produce meaningful projects. They are not only enthusiastic, capable, and creative in this endeavor but also willing to "teach their teacher how to do this."

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