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ABSTRACT

The purpose of the study reported in this paper was to examine the categories of teacher-asked questions while using moving and still frames of science videodisc instruction. Videotapes were made of 12 volunteer, Midwestern, urban, elementary teachers using videodisc instruction. Coding of the teacher-asked questioning categories was determined using an adaptation of The Question Category System for Science (QCSS). Frequencies and percentages of question categories during moving and still frames of videodisc instruction were computed. Statistical analysis showed that there were no significant differences in the questioning categories asked by teachers during the moving or still frames of videodisc instruction. Contains 99 references. (Author)

Questioning Categories Used By Elementary Science Teachers During Moving And Still Frames Of Videodisc Instruction

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Abstract

The purpose of this study was to examine the categories of teacher-asked questions while using moving and still frames of science videodisc instruction. Videotapes were made of 12 volunteer, Midwestern, urban, elementary teachers using videodisc instruction. Coding of the teacher-asked questioning categories was determined using an adaptation of The Question-Category System for Science (QCSS) by Blosser (1973). Frequencies and percentages of question categories during moving and still frames of videodisc instruction were computed. Statistical analysis showed there were no significant differences in the questioning categories asked by teachers during the moving or still frames of videodisc instruction.

Introduction

Concern about education, especially science education, has been frequently voiced during the past decade. This concern stems from the fact that American students frequently perform more poorly on tests of science and mathematics than do their counterparts in other countries. In response to this concern, the United States has made a national priority for the improvement of science and mathematics proficiencies as one of its visible goals for education (Educate America Act of 1993, 1994).

One way that may lead to the improvement of science education is the appropriate use of computers and allied technologies. Major reform initiatives such as the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics(1989), Science for All Americans, (Rutherford & Ahlgren, 1989), and the Educate America Act of 1993 (1994) advocate the use of technology as an important means of promoting science education. In response to the national reform movements, the acceptance of technology in this role has been viewed as the catalyst for this change to occur (Yager, 1991a; Bruder, Buchsbaum, Hill & Orlando, 1992; Hurd, 1993; Hill, 1993; Young, 1993; Donovan & Sneider, 1994).

As early as 1979, Molnar endorsed the use of interactive videodiscs to improve science education by simulating laboratory experiments, demonstrating technical procedures, and conducting dynamic examinations of student learning. Further support for inclusion of videodisc technology was addressed in a review of the implications of the interactive videodisc literature for science education by Smith and Lehman (1988). Their review encouraged the use of videodisc technology to teach students laboratory techniques, maintain visual databases, present visual tutorials, and perform simulations of science laboratories.

Teachers have a wide array of teaching tools to choose from in planning their lessons; videodisc technology is one of the newest. It is a way of promoting effective teaching and learning in the Information Age (Kranch & Forrest, 1990). According to the United States Office of Educational Research and Improvement (OERI, 1993) "...videodisc technology [is] a potentially powerful vehicle for instruction, especially in areas where visual and auditory information are essential to understanding" (p. 18). The elementary school classroom is an environment that advocates the use of visual and auditory information.

During the 1980's, the inclusion of videodisc technology in curricula became more commonplace as a natural outgrowth of the increasing interest in technology in the classroom. There was a proliferation of journals, associations and conferences focusing upon the subject. The United States Office of Technology Assessment's report, Power On! New Tools for Teaching and Learning (1988) identified 41 states that had technology divisions or staff positions for educational technology in their departments of elementary and secondary education. It also indicated 24 states had a long-range plan for technology in education and an additional 13 had such plans under development.

By the early 1990's, it was widely recognized that videodiscs, microcomputers and other elements of educational technology could enhance instruction. ("Teachers speak", 1991). According to Jordan (1993)

> Technologies offer information in a variety of formats - text, video, and audio - providing students an opportunity to use the medium most effective for their learning. Technologies enable teachers to focus their energies on coaching students with their

> individual growth because the general or standard transmission of information is done through the technologies (p. 61).

According to the OERI (1993), the factors that maximize the benefits of educational technology include 1) teacher training to integrate technology into the curriculum; 2) active participation by teachers in the learning activities that incorporate the specific technology; and 3) opportunities to participate in self-directed learning activities and interact with classmates. However, the inclusion of videodisc technology in K-12 science and mathematics education requires that "... good instructional materials should be designed for students but directed at the teacher, because it is the teacher, after all, who is in charge of the learning environment" (OERI, 1992, p.14).

Videodisc instruction in the elementary school classes employs both still frame and moving frame sequences of the chosen subject matter. The use of these two presentation methods is determined by the images contained in the videodisc and by teacher preference. This immediate access to lesson-reinforcing visual images facilitates students' visual experience, what Piaget (1965) considered an important component of providing educational experiences, especially in elementary science education.

Newman (1993) stated "Children should experience science directly and personally. Children should understand that science consists of information, inquiry process skills, and attitudes" (p. 185). For understanding or knowledge acquisition to occur, it must arouse personal meaning for the learner. Personal meaning occurs when knowledge is derived from concrete, hands-on, visual or auditory experiences. Knowing "something" results from acting on it or with it (Harris & Pressley, 1991; Novak, 1991, Wheatley, 1991; Yager, 1991b). According to Zeitler and Barufaldi (1988)

> ...clear, concise verbal communications between children and teacher are vital to positive interactions. Verbal communications

> are necessary for transmitting information, giving directions, providing reinforcement, asking questions, discussing topics, reinforcing performance, identifying obstacles to learning, and assessing learning. An effective communication system facilitates interactions from teacher to child, child to teacher, and child to child (p. 61).

Thus, the questions a teacher chooses to ask are an important element in videodisc augmented instruction. Since teachers are in charge of the learning environment, the questions that the teacher chooses to ask becomes the focus of the learning experience of the students.

Hunkins (1976) viewed questions as complex constructs possessing several dimensions. He defined the dynamic level of questioning as containing open-ended and closed-ended questions. Another question classification system that uses the concepts of open and closed questions is the Question Category System for Science (QCSS) (Blosser, 1973, Figure 1). In this system only questions that teachers ask can be classified into four categories: open-ended, closed-ended, managerial, and rhetorical. These categories do not denote a cognitive hierarchy of the question, but do provide response templates to elicit narrow or broad student thinking. Teacher-asked questions in the closed-ended question category result in narrow student thinking, while teacher-asked questions in the open-ended category elicits broad student thinking.

Figure 1.

Question Category System for Science, Blosser (1973, p. 15)

<table>
<tr><th colspan="3">Question Category System for Science</th></tr>
<tr><th>Level I</th><th>Level II</th><th>Level III</th></tr>
<tr><td rowspan="2">I. CLOSED QUESTIONS (Limited number of acceptable responses)</td><td>A. COGNITIVE MEMORY</td><td>1. RECALL: includes repeat, duplicate, memorized definitions
2. IDENTIFY or NAME or OBSERVE</td></tr>
<tr><td>B. CONVERGENT THINKING</td><td>1. ASSOCIATE and/or DISCRIMINATE: CLASSIFY
2. REFORMULATE
3. APPLY: previously acquired information to solution of new and /or different problem
4. SYNTHESIZE
5. CLOSED PREDICTION: limitations imposed by conditions or evidence
6. MAKE "CRITICAL" JUDGMENT</td></tr>
<tr><td rowspan="2">II. OPEN QUESTIONS (greater number of acceptable responses)</td><td>C. DIVERGENT THINKING</td><td>1. GIVE OPINION
2. OPEN PREDICTION: data insufficient to limit response
3. INFER or IMPLY</td></tr>
<tr><td>D. EVALUATIVE THINKING</td><td>1. JUSTIFY: behavior, plan of action, position taken
2. DESIGN: new method(s), formulate hypotheses, conclusions
3. JUDGE A: matters of value, linked with affective behaviors
4. JUDGE B: linked with cognitive behaviors</td></tr>
<tr><td colspan="3">III. MANAGERIAL Teacher uses to facilitate classroom operations, discussions</td></tr>
<tr><td colspan="3">IV. RHETORICAL Teacher uses to reinforce a point; does not expect (or want) a response</td></tr>
</table>

According to Blosser (1980) when a teacher stresses only closed-ended questions the students respond with the retrieval of facts or data. When a teacher uses open-ended questions, the students develop the skills of acquiring and processing data into useful information. She recommended a mix of questions categories to facilitate student learning. However, a specific determination of that mix has not been documented in the literature.

"Since the first studies of teacher-student interaction were conducted, a major assumption has been that a direct and positive relationship exists between the levels of teacher questions and student thought levels" (Wilen, 1991, p. 19). However, this relationship between teacher questions and student thought processes has been documented to show that teachers ask more closed-ended questions that require students to respond with narrow responses (Taba, Levine & Elrey, 1964; Guszak, 1967; Hudgins & Ahlbrand, 1967; Davis, Morse, Rogers, & Tinsley, 1969; Beisenherz, 1971; Blosser, 1979; Gall, 1984).

Background

Two distinct research areas provided the basis for this study. The first research area was the use of videodisc technology in education. The second research area focused upon the questions categories that teachers employ. A combination of both research areas provided the foundation for a unique study into the educational environment using videodisc technology.

Videodisc Use

The business and military sectors were among the first to value videodisc technology; it was extensively put to use as a training tool during the 1980's. Training consisted of combining high quality videodisc visual images with interactive computer modules that allowed the trainee to simulate actual situations. The videodiscs played only on specific players and recording additional information on the discs was not possible. Despite those limitations, the videodisc training was viewed with positive results (May, 1984; DeBloois & Woolley, 1981; Lewis, 1988, 1991).

In time, the continually improving videodisc technology entered the public sector as movies began to be transferred to the videodisc format. However, videodiscs faced stiff competition in the face of newly affordable video cassette recording (VCR) technology. Marketing for VCR technology emphasized its multiple recording capabilities and the ability to play the VCR cassettes through a regular television. This contributed to the public's accepting VCR's, while business and the military continued to focus on videodisc technology.

Public education was not included in the early usage of the emerging technologies. There are several factors that prohibited early videodisc use in K-12 education. Although some companies were producing videodisc titles for education -- like Optical Data Corporation, which produced the first commercial elementary science videodisc in 1982 (Mageau, 1990) -- the majority of videodisc companies were not initially interested in developing programs for education, and the ones available from those who did were limited in content. Moreover, the programs were expensive and were not portable in regards to the types of videodisc equipment they could be used with. Teachers also lacked training in computer technology and videodisc implementation.

By the late 1980's, videodisc technology was becoming more accessible to public education. Programs aimed at the educational market were growing in numbers (Phillipo, 1988). In 1985 there were 100 educational videodisc titles available, while in 1988 this number grew to over 400. Between 1988 and 1991 the number of titles increased to over 1,800. Fritz (1991) projected 800 new educational videodisc titles would be announced in 1992 alone.

In 1994, Pioneer New Media Technologies announced that over 3,000 educational titles existed and dozens more titles were slated to be added each month. A published analysis to document this announcement has not been completed. However, the number of videodisc producers has grown from 50 companies in 1989 to over 200 companies in 1994. An analysis of videodisc players, software and producers for specifically the K-6 elementary grade levels has not been documented.

During 1989 to 1991 the availability of content specific videodisc software in the areas of art, business, classic films, electronics, foreign languages, law, mathematics, and music, had risen over 14%. A 30% increase in the number of content-specific titles that are specific to content occurred in the areas of computers, language arts, trade and industry, and software. A 50% increase happened in health and social science during the same time period. The largest increase -- over 100% -- which occurred during this time was in science (Fritz, 1991).

As titles became more available, the cost of videodisc implementation decreased. In 1988, videodisc players cost $500, discs began at $25 but could cost several thousand dollars, a master to produce a one hour videodisc was in excess of $100,000, the hardware for using a Level III interactive system cost about $10,000, and a video system that would run the system without the computers and discs was about $1,400 (Rickelman, 1988). In contrast, in 1994, a videodisc player, bar code reader, computer cables, seven computer software programs with teacher resource guides, and seven videodiscs could have been purchased from MacMillan/McGraw-Hill for $2,738.85. In addition, during

1994, the cost to produce a one hour videodisc had declined to $3,000 (Farnsworth, 1994).

The use of videodisc technology in public education can be traced to the mid 1980's. In the fall of 1985, fewer than 2% of schools owned videodisc players (Salpeter, 1987). In 1986, there were estimated to be 7,000 videodisc players in schools (Helsel, 1987). By 1993, the use of videodiscs in school districts had been reported at a range of 21% (Looms, 1993) to 54% of the schools across the nation (Bruder, 1993).

Videodisc use in science education has dramatically grown since 1985 due to the production of materials aimed at the science education market and teacher training (Enos, 1991). The increased use of videodisc instruction in elementary school science classes reflects the curriculum design of not exclusively using science textbooks (Schroeder & Tyckoson, 1986) which according to Yager and Hofstein (1986) is an attribute of exemplary science programs.

In a study of the first educational videodisc that was developed in response to a National Science Foundation initiative, students who studied biology using the interactive videodisc materials were reported to learn faster and retain more than students who had completed a traditional biology course (Bunderson, Olsen, & Baillio, 1981). Mellin (1987), in an observational study of 116 middle school students utilizing videodisc science instruction, found the students enjoyed using the videodisc and looked forward to the science instruction. Mellin also investigated the teachers' perceptions of videodisc instruction. The teachers perceived that the technology encouraged them to act as guides or facilitators, but many of them had difficulty actually assuming the role. Callahan (1990) and Louie, Sweatt, Gresham and Smith (1994) all confirmed that videodisc instruction enhanced student retention and achievement in science as well as increased interest and positive attitudes toward the subject.

Twenty-nine early studies comparing videodisc instruction to conventional instruction methods were reviewed by Bosco (1986). The studies were distributed as follows: 10 evaluations in the area of military usage, eight evaluations in higher education, four in elementary education, two in junior high education, two in high school education, two in industry, and one in the area of social services. The most commonly used dependent variables in the studies were achievement, user attitude, learning time, and performance. These studies commonly reported benefits using videodisc instruction over conventional instruction in the areas of user attitude and learning time. In addition, Bosco (1986) found there were statistically higher achievement results reported in seven of the 12 studies.

In Arizona, The Office of the Cochise County Superintendent (1992) reported that combining videodisc technology with hands-on instruction and textbooks in grades four though eight contributed to increased science achievement scores as measured on the Iowa Test of Basic Skills (ITBS). The ITBS was and continues to be a required testing program for all Arizona public K-8 schools. At the conclusion of the 1990-91 school year the ITBS was administered to the students. The grade equivalent scores of the students were compared to the previous years' grade equivalent scores in the science component. The results show a mean growth of 2.13 years per student in all grade levels. The largest gains were made in fifth and sixth grades. In fifth grade the mean gain was 2.34 years, while in sixth grade the mean gain was 3.75 years. The range of years gained was 0.0 in one group in fourth grade to 6.5 in one group in sixth grade.

> For the first time since this testing program began, both the teachers and the County Coordinator were anticipating a better than average growth for the science component of the ITBS battery... Although ...this data should not be viewed by educators as an exact research study ... these scores form the basis for expanding the Windows on Science™ Science Program... (Office of Cochise County, 1992, p. 2).

McWhirter (1991) measured sixth-grade Texas students' achievement after using weather videodisc instruction. He concluded that students who had received videodisc instruction outperformed those who had been taught the same subject using a traditional, non-videodisc-complemented approach. Student performance was determined by comparisons of mean raw scores on a researcher-generated post-test. The post-test consisted of 50 multiple choice items designed to address 10 objectives. Each objective on the post-test had four to six questions with four choices each. Every question was categorized by thinking level (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956).

In a quasi-experimental study in Texas using weather videodisc instruction with sixth grade students, Petty (1992) studied the influence of a Level I videodisc instruction format on student achievement in science, as measured by performance on a researcher designed post-test. Students from three elementary campuses (K-6) participated in this two week study. There were no controls for ethnicity, socio-economic income or special populations.

The conclusion associated with this study was that a Level I videodisc instructional format can influence student achievement in science. One of the study's recommendations was the need for further research on the most effective teaching strategies to use with videodisc instruction.

Anthony (1992) analyzed student and teacher attitudes toward videodisc science instruction and textbook instruction in a one year study in Illinois. Students in third through sixth-grade and teachers in first through sixth-grade reflected favorably upon the use of videodisc instruction compared to the standard science textbook approach. Their attitudes were assessed via seven questions posed using a Likert scale. For the two groups, all mean scores except one showed a favorable response to videodisc instruction. The one question that did not show a favorable response was, Are there enough experiments to help students learn? In addition, when comparing male to female student and teacher responses on the seven questions, Anthony determined the attitudes toward videodisc instruction were higher in males as compared to females.

A case study conducted by Chagas and Abegg (1993) focused on the role of the teacher and the impact in the teacher-student interactions before and during the introduction of interactive videodisc science lessons in the middle school science class environment. Using a combination of observations and interviews, they reported positive changes in observable teacher and student behaviors during the implementation of videodisc usage. However, the specific question levels that teachers used were not addressed.

Chuckran and Abegg's 1993 study in an environmental science course at a comprehensive regional high school in Massachusetts evaluated a teaching model using an interactive videodisc format in regards to student content acquisition, attitude and self-efficacy. The teaching model for the study utilized student-authored modules as a learning format and as a method of videodisc presentation. The results, as measured by a researcher designed multiple choice criterion referenced test, established that the students did learn content as they developed interactive modules and participated in cooperative learning groups. In addition, the students' self-efficacy/outcome expectancy pre and post tests revealed that self-efficacy was constant with females and increased with males, while the outcome expectancy was constant with females and decreased in males. Although this study supports the use of videodisc technology, the role of the teacher was not addressed.

A study conducted by Freitag (1993) examined middle school students' content acquisition of weather concepts utilizing videodisc student authoring technologies. Content acquisition was measured by using pre and post concept maps. The results of this study indicate that the students did accumulate new terms from the videodisc instruction, but that further analysis is needed to distinguish this vocabulary increase from concept attainment. As in the Chuckran and Abegg (1993) study, the role of the teacher utilizing videodisc technology was not addressed.

Two studies comparing videodisc instruction to conventional biology dissection laboratories in a high school environment were conducted by Leonard (1989) and Strauss and Kinzie (1994). Leonard (1989) determined that students in introductory biology laboratories using videodisc dissection instruction gave significantly more positive responses to post-laboratory questionnaire items on time efficiency, level of attention, understanding of experimental results, confidence in following instruction and overall general satisfaction in the learning process than the students who were in the conventional dissection biology laboratories.

Strauss and Kinzie (1994) examined student achievement and attitudes in a pilot study comparing interactive video simulation instruction to conventional dissection in two high school biology classes. An interactive frog dissection videodisc in the test group of nine students was utilized. A traditional instructional dissection method of frog dissection was utilized for 11 students. Research questions consisted of the students' learning levels concerning the frog's anatomy between the two groups and students' attitudes towards the use of dissection of animals between the two groups. Additional gathered data were students' impressions of the activities, students' preferences of the instructional activities and students' preferences of other subject areas. In addition, gender was included as an independent variable.

Results of this study showed the differences between the gain scores of the pretest and posttest and pretest and delayed posttests were significant in both groups. In addition, upon further examination of the mean scores of the immediate posttest for both groups there was not a significant difference. Male and female students' achievement in either the immediate or delayed posttests did not indicate a significant difference in achievement. Student attitude outcomes did show a more positive attitude in the traditional dissection group. There was not a difference in attitude based upon gender. The results of the pilot study supported previous research that achievement was significantly higher in the test group that used instructional videodisc, while at the same time refuted a more positive attitude in the test group. The findings from their earlier study did not support other research findings that reported increased user attitudes while using videodisc dissection instruction.

Rock and Cummings (1994) reported initial and future research by Optical Data Corporation and 15 schools that ranged from kindergarten through high school levels. Initial research began in the fall of 1991 in New York. One middle and one secondary school were selected to receive courseware, hardware, and staff development to facilitate research. The preliminary research indicated increased student enthusiasm for science and an apparent increase in student self-confidence in both schools. The following academic year, 1992 - 1993, Optical Data Corporation extended the research partnership to include 13 additional schools in seven other states. In one of the 13 schools, the preliminary research trends supported earlier research that showed students who participated in videodisc instruction achieved more than students who were taught using traditional science strategies. These preliminary results suggests that teachers "... can begin to integrate the technology with their teaching styles and develop more effective strategies that provide consistent applications of the technology" (Rock & Cummings, 1994, p. 50).

The use of videodisc technology in the educational environment has been documented to show improved student achievement, increased student and teacher attitudes, increased student motivation, increased student attendance and improved student communications. Lehman and Brickner (1995) state, "Further research is needed to identify the underlying causes of the learning benefits of interactive video"(p.3). However, there is a lack of research that investigates the teaching strategies, or possible causes, of the learning benefits. In particular, there is a lack of research that investigates the use of questioning categories utilized by elementary science teachers, who are trained in using videodisc technology, while utilizing still and moving frames of videodisc instruction.

Questions Used By Teachers

Questions asked by teachers are part of the normal classroom environment. The teacher's role in asking questions is the critical link between the information presented and the children's responses to the information (Martin, 1987, 1993). Science educators have identified forms of exchanges that occur in science classrooms that relate to the likelihood of children acquiring science concepts.

This type of exchange is the categories of questions asked by a teacher (Blosser, 1973, 1979, 1980, 1989, 1991). The Question Category System for Science (QCSS) was developed by Blosser (1973) for prospective secondary science teachers to improve their questioning, to preplan questions and analyze them, and to determine questions categories. Although Blosser suggests that the QCSS allowed for analysis of the question categories to determine if there are too many questions of one category and too few of another to fit the lesson's objectives, she did not specify the recommended question category amounts.

The QCSS is composed of three levels (See Figure 1). The first level denotes the category of questions as open-ended , closed-ended, managerial, or rhetorical. The next subdivision of questions occurs within each of the two question category of open-ended and closed-ended questions. Within the open-ended question category, there are divergent thinking and evaluative questions. Divergent thinking question are those with many possible responses used to stimulate original responses. Evaluative thinking questions are those that involve the use of standards or criteria and deal with matters of value, cognitive and or affective domains. Within the closed-ended question category, there are two levels consisting of cognitive-memory and convergent thinking questions. Cognitive-memory questions are those questions in which the students' memory is stimulated involving factual recall and involve recognition. Convergent thinking questions are those questions in which the student utilizes analysis or integration of given or remembered data and focuses thinking toward a possible answer.

The QCSS further delineates questions within Level I and Level II. Closed-ended questions are cognitive memory, are subdivided into either recall or identify/name/observe levels. Recall includes repeat, duplicate, or memorized definitions. Identify, name or observe is a recall of a basic identification. Closed-ended questions that are convergent thinking questions are classified into five levels: associate, reformulate, synthesize, closed predication, and critical judgment levels. The associate level includes questions that are utilized to discriminate and classify responses. The reformulate level requires reformation of a response from the asked question. The apply level uses previously gathered information to solve a new or different problem. The synthesize level requires the student to combine parts of answers to formulate a response. Closed prediction questions have limitations imposed by conditions or the evidence. Critical judgment questions call for a student to make judgment responses by using standards commonly known by the class.

Open-ended questions that are Level II, divergent thinking questions, are further subdivided into the classifications of opinion, open prediction, and inference. Opinion questions require the student to state his or her opinion without a specific desired response. Open prediction questions occur when there is data insufficient to limit a response. The infer classification requires a student to conclude by reasoning from something previously known.

Open-ended questions that are Level II, evaluative thinking questions, are subdivided into the classifications of justify, design, judge A, and judge B. Justify questions are those in which the student responds with a plan of action, behavior, or a position taken. Design questions require the student to utilize new methods to formulate hypotheses, and conclusions. Judge A questions require the student to respond within the affective domain by making judgments as a matter of value. Judge B questions require the student to evaluate and make judgments based upon the students' cognitive behaviors.

Other classifications of teacher generated questions have been utilized in research. Beisenherz (1971) measured the use and effectiveness of a Seattle-based televised science series for grades 1 - 4. Two areas of his research were related to questioning types: analysis of the televised teachers' and classroom teachers' questions. An adaptation of the Gallagher and Aschner (1963) system of analyzing questions was employed. Beisenherz reported a higher proportion of convergent, or narrow, questions were asked by both the televised and classroom teachers as compared to the other question types in the Gallagher and Aschner system.

Taba, Levine, and Elrey (1964) found a positive correlation between the levels of thought students display in their answers to teachers' questions and the categories of questions asked by their teachers. Their findings supported the conclusion that students respond with a narrow, or closed-ended response when teachers ask a narrow, or closed-ended question. In their study, it was determined that the teachers asked more closed-ended questions than any other category of question.

Guszak (1967), in a study of questions used by Texas reading teachers in grades two, four, and six, determined that 56.9% of the total questions asked during a three day time span were classified as recall questions. An additional 13.5% of the total questions were classified as recognition types of questions. In contrast, .6% of the total questions were classified as translation types of questions, or open-ended questions. These findings correspond to the predominant use of closed-ended questions by teachers in other studies.

Davis, Morse, Rogers, and Tinsley (1969) reviewed the early work of the 1960's in teachers' questions. They noted three separate developments in that time period: attention to intellectual achievements of the students, interest in the direct study of teaching, and a lack research on the role of teachers' questioning behaviors.

Blosser (1970) investigated the effectiveness of an instructional procedure to develop questioning skills in secondary school science teachers. Forty-two preservice secondary school science teachers' lessons were video and audio taped. The teacher-asked question categories, using the QCSS (Blosser, 1973) was determined. Blosser determined that there were no significant changes in the teacher-asked category of open-ended questions. She also determined that pausing behaviors (wait time) could be developed through practice.

In 1972, Blosser continued this line of research with a second investigation involving 27 college juniors who were preservice science teachers (Blosser, 1989). In this experimental study, the preservice teachers were randomly assigned to one of three treatment groups. One group received instruction in questioning distributed over a 14 - week period across two quarters. The remaining two groups received the same questioning instruction during a seven week period, but in different quarters. During quarter one the preservice teachers worked as tutors and teachers' assistants in junior high school, while during the second quarter the preservice teachers taught elementary science. Data was gathered by audio taping lessons during quarter two. Blosser found no significant differences between treatment groups for the variable of use of open-ended questions.

In a overview of her two studies, Blosser (1980) reported the results of the second study supported her first study's determination that there were no differences in the use of open-ended questioning following questioning instruction. Further analysis found no significant trend over time in asking open-ended questions by preservice teachers.

Gall, Ward, Berliner, Cahen, Winne, Elashoff, and Stanton (1978) studied the effects of higher-cognitive questioning categories on the achievement of sixth-grade students' achievement during an ecology unit. In their first study, the students in three experimental groups received 15 minutes of ecology content delivered in a lecture format followed by 25 minutes of recitation. The control group engaged in ecology art activities following the 15 minutes of lecture. They determined the three groups receiving recitation learned more than the activity-based group, but there was no evidence that the questioning techniques used within the recitation groups was the impetus.

In a second study, (Gall, et al., 1978) examined students' retention of facts and performance on higher-cognitive tasks. Three experimental groups received either 25%, 50%, or 75% higher-cognitive level questions during recitation following a 15 minute lecture. It was determined the experimental group receiving 50% of total questions at a higher-cognitive level was less effective in retention of facts, but slightly more effective for promoting performance on higher-cognitive level tasks than the groups receiving either 25% or 75% higher-cognitive level questions. These two studies suggested that students benefit from experiencing recitation involving questions, but do not support the benefits of using higher-level questioning.

Past research in the area of questioning by teachers has consisted of four types. The first type of research concerned questions embedded in science textbooks and in science videotapes. The second involved the improvement of teachers' questioning abilities. The third focus has been the effects that new questioning techniques have upon students' achievement, critical thinking and attitudes. The fourth area of research concerned the use of wait time between questions and responses (White & Tisher, 1990).

Results from a study of questions in science textbooks by Rothkopf (1970) showed a positive effect on student learning when the questions were embedded in the text, as opposed to listing the questions at the end of the chapters. In further research, Holliday, Whittaker, and Loose (1978) determined embedded questions within the text made no difference in the performance of high-ability students and lowered the performance of the lower-ability students. The results of these studies provide opposing views concerning the use of embedded questions within the text.

Additional support for the utilization of embedded questions was determined by Barden, Holliday, Carifio, and Kermis (1992). Their results of a study of embedded questions in high school science videotapes determined questions inserted after segments of a single topic enhanced the students' ability to recall information that related to specific information, but had neither a negative nor positive effect on recall of non-questioned information. They concluded the high-ordered responses were a result of the higher-ordered embedded questions and that embedded higher-ordered questions produced positive changes in attention as compared to questions that produced lower-ordered responses.

Early observational studies during the 1960s and 1970s included research on questioning in science classrooms. In a review of the literature of that period, Blosser (1980) summarized the observational studies:

> It appears that science teachers function at the level of cognitive-memory thinking operations in their questioning behavior regardless of educational level involved (elementary or secondary). None of the studies reviewed was concerned with making a direct improvement on teacher questioning as a part of

the research but only with the observing what took place during science lessons (p. 5).

In addition to the observational studies involving teacher questioning behaviors, experimental studies involving inservice elementary school science teacher questioning behaviors were reported by Blosser (1980). Her summaries of three experimental studies conclude that questioning behaviors of inservice elementary science teachers can be changed, but the change may be dependent upon the availability of science equipment and materials.

In a meta-analysis of experimental research on teacher questioning behavior by Redfield and Rousseau (1981) where twenty studies on teachers' use of higher and lower cognitive questions were reviewed. The use of higher cognitive questions required students to manipulate information to formulate an answer to a question, while lower cognitive questions required the students to recall facts or recognize factual information. Redfield and Rousseau concluded that gains in achievement could be expected when higher cognitive questioning behaviors where utilized. In addition, Soled (1994), studied the effects of higher-level cognitive questions in four seventh grade meteorology classes. Her findings from this study and her earlier research support the use of higher level cognitive questioning to increase the achievement of higher-level and lower-level student achievement (Soled, 1989, 1994). In addition, Tobin and Capie (1982) reported negligible effects on science achievement when teachers utilized high cognitive level questions with students in grades six, seven and eight.

In opposition to Redfield and Rousseau (1981) and Soled (1989, 1994), Riley (1981) conducted an experimental study on the cognitive level of question used on assessment of students' achievement. He constructed separate tests that contained either 100% high cognitive questions, 50% high cognitive questions, or 0% high cognitive questions. The results of the tests on primary and intermediate students' achievement showed no significant differences due to the cognitive level of the questions. The use of higher-ordered questioning to increase student achievement and attention has been reported in several past studies (Rothkopf, 1970; Barden, Holliday, Carifio, & Kermis, 1992; Blosser, 1989; Redfield & Rousseau, 1981; Soled, 1994). However, several studies refute the use of higher-ordered questions to increase student achievement (Gall, 1970; Riley, 1981; Tobin & Capie, 1982). In the meta-analysis by Redfield and Rousseau (1981), they conclude "...regardless of type of study or degree of experimental validity, teachers' predominant use of higher cognitive questions has a positive effect on student achievement" (p. 131). Further support of their findings is provided by White and Tishner (1990):

> No doubt the recent meta-analysis by Redfield and Rousseau (1981), which concludes that higher cognitive questions have a greater impact on pupils' achievement than lower ones, will be accepted by some researchers as a vindication of their persistence (p. 878).

The second type of research on questioning concerns the improvement of teacher questioning abilities and the effects the new questioning strategies have upon students' achievement, critical thinking, and attitudes. This type has been limited to short-term projects using predominately preservice teachers. According to White and Tishner (1990), the results of these short-term projects support the contention that teachers can be trained to use a wider variety of cognitive questions, but there is "... little detail is given about the nature and the quality of the treatments designed to improve teachers' skills. As a consequence researchers cannot replicate studies and practitioners cannot implement the training programs" (p.879).

Taba, Levine, and Elrey (1964) found a positive correlation between the levels of thought pupils display in their answers to teachers' questions and the categories of questions asked by their teachers. Their findings supported the premise when teachers ask narrow, or closed-ended, questions the students responded with a narrow, or closed-ended response. In the study, it was determined that the teachers asked more closed-ended questions than any other category of question.

The third type of research concerning questions explored the use of wait time after questions. The use of wait time by elementary science teachers who were using hands-on science materials has been reported by Blosser (1973, 1979, 1980, 1991). She reported that when teachers extended the amount of wait time to two to three seconds or more the length of the students' responses increased, the number of unsolicited but appropriate responses by students increased, failures to respond decreased, student confidence increased, the incidence of student speculative thinking increased, teacher-centered lecturing decreased, the number of student questions increased, contributions by slow learners increased, and the use of teacher discipline decreased.

Rowe (1973, 1974) found that teachers asked between three to five questions each minute, with some teachers asking over ten questions each minute. The mean wait time between the initial teachers' question and the student's response was found to be one second (wait time I). If the student did not respond within the one second, the teacher either repeated the question or rephrased the question, asked another question, or called on another student. After receiving a response, the average teacher waited only 0.9 seconds before reacting or asking another question (Rowe, 1974). After training teachers to increase wait time I and wait time II, she determined that increasing the length of the pauses between a teacher's question and a pupil's response (wait time I) to three to five seconds and increasing the length of pauses between the student's response and the teacher's next reaction (wait time II) to three to five seconds led to an increased length of student answers, more student alternative answers, more students participated, and more positive confidence in the student's answers was displayed (Rowe, 1974). In addition, the effectiveness of the teachers' questioning abilities increased while employing wait time I and wait time II for three to five seconds (Rowe, 1978). She further suggested that student responses to questions calling for critical or creative thinking may be enhanced by using wait time I or wait time II for up to two or more minutes (Rowe, 1978).

Lake (1973) agreed with Rowe about the importance of the use of wait time, but differentiated between wait time I and wait time II. He defined wait time I as being student controlled and wait time II as being teacher controlled. His rationale was that although the teacher may allow the class to take time to answer, it is the student who chooses to respond. In addition, during wait time II, the teacher makes the decision to respond, not the student.

A review of 50 published studies of wait-time research over a 20-year time period by Tobin (1987) reported similar findings of the importance of increasing wait time. Tobin identified fewer student interruptions and higher levels of student achievement with extended wait time. In addition, he reported that teachers who increased the amount of wait time changed their teaching behaviors. Those changes included decreases in the amount of time the teacher talked, decreases in the repetition of the teachers' questions, and fewer questions asked by the teacher. The questions that were asked allowed for more than one response from more than one student, lower levels of questions were not as frequently utilized, higher levels of questions increased, and some teachers reported higher levels of anxiety as they increased the amount of wait time. However, in his review, Tobin reported that several of the researchers speculated that the use of wait time was unnecessary when asking for factual material, but necessary when asking higher-level questions from the student.

The results of the studies to support higher-ordered questioning and the use of wait time provide conclusions to continue support of both. However, the question remains: What categories of questions do elementary science teachers employ in their classrooms?

In response to this question, Gall, Dunning, and Weathersby (1971) reported approximately 60% of teacher asked questions require only recall of facts, 20% of teacher asked questions required students to think, and 20% of teacher asked questions were procedural. The kinds of questions teachers ask influence the level of thinking operations in which students engage (Rowe, 1973, 1974, 1978). Teachers are consistently encouraged to utilize higher-ordered questions in teaching (Gage & Berliner, 1988), but there is little empirical evidence available to support this recommendation.

In science education, research findings have shown that the use of open-ended questions by the teacher provide the basis for broad student responses. (Blosser, 1980, 1991; Newman, 1993; Soled, 1989, 1994). Wilen (1991) provides a summary for this situation by stating: "While there is a positive relationship between teachers' use of low-cognitive-level questions and gains in student achievement, the findings of studies on the relationship between higher-level questions and student achievement are mixed" (p.32).

However, with the increasing usage of videodisc instruction, descriptive research in the area of teacher asked questions is needed. "Application of videodisc systems should not be limited to lower levels of behavioral or cognitive functioning. The visual and symbolic capabilities of videodisc make it possible to enhance more complex levels of cognitive learning as well as to aid learners..." (Deshler & Gay, 1986, p. 12).

With the information presented in videodisc format as either still frame or moving frame presentation, what are the categories of questions that teachers utilize? There is no present research data to address this question, however past research in the area of questioning by teachers provides a basis for addressing this question.

Methodology

This research study was an analysis of videotaped science lessons to determine the frequencies of question categories asked by the teachers. The focus was the teachers' question categories during the use of moving frames or still frames of videodisc science instruction. Determinations of question categories and the type of frame used were obtained from videotapes of the teachers in their classrooms during science class using videodisc instruction. Data were recorded on an instrument designed for this study (Appendix A).

Two types of data were examined. Type I was the use of moving or still frames of videodisc instruction. Type II data were the categories of questions utilized during moving or still frames of videodisc instruction.

Sample

A science education center at a land-grant institution in the Midwest and Optical Data Corporation, New Jersey, formed a partnership in 1992. This partnership involved a competitive program for participating schools to receive courseware valued up to $25,000. All 532 school systems in the institution's state were sent a personal invitation to attend one of two sessions where the courseware could be examined and where the proposal guidelines could be reviewed. A total of 97 school representatives attended the sessions.

The partnership team formulated the proposal's evaluative criteria by modifying existing criteria used in corporate partnerships with various state departments of education. A total of 37 proposals were submitted and reviewed. The participating school district in this study submitted the proposal that most closely matched the evaluative criteria.

The courseware was awarded to that school district. As part of the district's proposal, research involving implementation and use of videodisc instruction occurred. Administrators from the school district selected the sample for this research. Sample selection was based upon three criteria: a teacher included in the sample must have been in the district long enough to establish longitudinal student test score data; must have an acceptable level of competence and confidence with hands-on science education; and must have been instructed by Optical Data trainers to use videodisc science instruction. The acceptable level of competence and confidence with hands-on science education was determined by the administrators. That specific level and the method of determination were not provided for this study.

The subjects for this study were 12 elementary teachers -- six female and six male -- from the selected school district. The teachers represented six elementary school buildings with two teachers from each building. The sample was composed of two kindergarten, two first-grade, two second-grade, two third-grade, two fourth-grade, and two fifth-grade teachers. No teacher from the same building taught the same grade level. The school district's student population is 84% African American. However, only 50% of the participating teachers were African American .

Instrumentation

There are numerous question classification instruments used in education. Many of the instruments are based upon Bloom's Taxonomy (1956) in which questions are placed into one of six categories. Those categories are knowledge, comprehension, application, analysis, synthesis, and evaluation questions. Other question classification systems utilize terms such as narrow (Rosenshine, 1976), probing, (Riley, 1981) dynamic (i.e. closed and open-ended) (Hunkins, 1976), and inquisition (Rowe, 1974, 1978). However, Gall (1970, 1984) recommended that the most usual data analysis of questioning systems was to classify questions into two categories. Those two categories are narrow or closed-ended questions and broad or open-ended questions. This finding from Gall relates to Blosser's QCSS (1973) in that the questions are categorized as open-ended or closed-ended questions. In addition, the QCSS provides for other categories of questions that a teacher utilizes within a class. Those questions include rhetorical and managerial classifications.

The QCSS coding system allows for coding of questions into three levels of classifications. Those classifications are: Level I -- category of question, Level II -- questions by types of thinking, and Level III - the type of thinking operation the question requires.

The QCSS provides a framework for analyzing teacher questions. The first level is involved with the categorization of questions that the teacher asks, while the remaining levels of the QCSS deal with evaluation of the types of responses the student make to the level of questions. For purposes of this study, teacher questioning categories reflected the use of Level I classifications. Level II and Level III classification of the QCSS were not utilized in this study of teacher questioning categories.

The frequencies of the categories of questions that teachers asked during moving and still frames of videodisc instruction in elementary science classrooms were examined. Only the teacher question categories were analyzed while using the technology. Therefore, the first level of categorizing teacher questions of Blosser's QCSS was adapted for this study. In addition, the researcher-designed instrument allowed for coding of still and moving frames of videodisc instruction.

Reliability of the instrument was established by a inter-rater reliability test. A panel of three experts in the areas of elementary education and classroom questioning techniques were trained using a prepared manual (Appendix B). The training manual contained the operational definitions of the four categories of questions along with examples of each category of question. There were 200 questions representing 11% of the study's transcribed questions for the three experts to code. Training consisted of each panel member reading the training manual. Time was allowed for each member to ask for clarification of the question definitions.

After coding was completed for each of the 200 questions, the percentage of agreement among all coders was computed (Good & Brophy, 1987). Agreement for question category was computed at 97.8%. The lack of agreement was noted for 13 individual questions. Those 13 questions were isolated and presented to the raters to discuss the reasons each rater utilized when coding the question category. After discussion among the raters and the researcher, re-coding of the thirteen questions occurred. Agreement of the coding of the question category was recalculated at 100%. The use of still or moving frames was determined by the researcher while viewing the videotapes of the science lessons.

Data Collection Process

The data for this study were collected during the 1993-1994 school year. Videotapes were made of the 12 teachers using Windows on Science™, videodisc instruction in their classrooms during October, November, December, January, February, March, and April. Video tapes from November, February, and March were analyzed for this study. The tapes from October were not included for this study to allow for acclimation to videodisc technology. December and January tapes were not analyzed for this study due to shortened class time in the elementary classroom. April videotapes were not included in this study due to sporadic use of videodisc instruction and lack of videotapes from the teachers.

The videotapes were prepared using school equipment with elementary school volunteers operating the video equipment. The volunteers were trained in videotaping procedures by the district's media specialist. The teachers and the videotaping volunteers were aware that the purpose of the taping was to observe what was happening in their classrooms while using videodisc instruction. The science lessons that were taped were self-selected by each teacher.

The science lessons reflected an array of teaching strategies. The strategies included teaching with videodisc technology, discussion, lecturing, using hands-on manipulative materials, chalkboard diagrams, computer assisted instruction, and reading from science text and trade books. The strategies for each science lesson were self-selected by each teacher. Only those questions using videodisc technology instruction, regardless of the teaching strategies, were analyzed in this study.

In addition, a daily log sheet was given to each teacher to record videodisc start and stop numbers, minutes of science instruction, hands-on science, and use of the Optical Data's Windows on Science ™ materials (Appendix C). The videotapes and the daily logs were given to the researcher on a monthly basis.

Data Analysis

Analysis of the data includes frequencies and percentages of closed-ended questions, open-ended questions, managerial questions, and rhetorical questions asked by teachers utilizing still and moving frames of videodisc science instruction. The data in this study consisted of frequencies in discrete categories (open-ended, closed-ended, managerial and rhetorical questions) for two independent groups (moving frames and still frames of videodisc use). To determine the statistical significance of any differences in the categories of questions between these two groups the Chi-square test for two independent samples was used. In this analysis, the hypothesis was tested by comparing the two groups with respect to the proportion of cases found in the various categories. Expected frequencies in each cell were calculated by multiplying the two marginal totals that are common to that cell. The product was then divided by the total number of cases (Siegel, 1956). The statistical procedure was a 2 x 4 Chi-square analysis of the frequencies of the question category and moving and still frames of videodisc usage. Data was analyzed using SAS (1985).

Results and Discussion

The data provided by the teacher logs (Appendix C), associated with the specific months of the study, reflected the teachers' self-reported use of videodisc technology at 63% of the total science lessons. Analyzing the percentages of use time of questions during videodisc lessons and the self-reported use of videodisc instruction by the 12 participating teachers, it was determined that approximately in one-half of time of the study's science instruction was found to involved videodisc instruction. Also, within that science instruction approximately one-half of the total questions asked were during videodisc instruction. This suggests that the questions that teachers asked were somewhat uniform regardless of videodisc technology use and the unit of study (Table 1).

Table 1.

Teacher Self-reported Use of Hands-on Science Instruction and Videodisc Technology

	Hands-on Science Instruction	Videodisc Technology Use	
Month	Days	Days	Percentage
November	81	42	58.85
February	81	52	64.20
March	97	64	65.98
Total	259	158	63.01

The frequencies of open-ended, managerial, and rhetorical questions asked by elementary teachers during moving and still frames of videodisc instruction were tabulated. Question categories asked by the teachers while using Optical Data's Windows on Science™ videodisc presentations were determined by viewing the teacher selected videotaped lessons and transcribing their actual questions. Analysis of each question and the use of moving frames or still frames of the videodisc presentation was determined by coding each question and the use of moving frames or still frames of videodisc presentation. Frequencies of the question categories during moving frames and still frames of videodisc instruction were determined by computing frequencies and percentages. Questions that did not reflect the use of videodisc presentation were excluded from analysis.

A total of 1729 questions was contained in the teacher selected videotaped science lessons. Questions that were asked while using videodisc presentation totaled 829. This represented 47.95% of the questions asked were during videodisc presentation, while the remaining 900 questions or 52.05% of the questions that were asked during the videotaped science lessons did not occur during videodisc use.

Twenty-one point nine percent of the 829 questions were asked during the use of moving frames of videodisc instruction. The remaining 78.05% were asked during the use of still frames. Analysis of the questions revealed that 45.06% of the moving frame associated questions were open-ended, as compared to 36.94% of the still frame associated questions. These questions made up 9.89% and 28.83% of the total number, respectively. Closed-ended questions comprised 35.16% of moving frame related questions and 46.52% of still frame related ones. These questions were 7.72% and 36.31% of the total number.

Managerial questions made up 10.99% of the questions associated with moving frames, and 46.52% of the questions associated with still frames were 2.41% and 6.88% of the total number. Eight point seventy-nine percent of the questions associated with moving frames were rhetorical in nature. The same was true for 7.73% for the questions associated with still frames. Rhetorical moving frame questions were 1.93% of the total number, while rhetorical still frame questions made up 6.03% (Table 2).

Table 2.

Teacher Question Categories During Moving and Still Frames of Videodisc Presentation

Question Level	n	%	Total %
Moving frames			
Open-ended	82	45.06	9.89
Closed-ended	64	35.16	7.72
Managerial	20	10.99	2.41
Rhetorical	16	8.79	1.93
Subtotal	182	100.00	
Still frames			
Open-ended	239	36.94	28.83
Closed-ended	301	46.52	36.31
Managerial	57	8.81	6.88
Rhetorical	50	7.73	6.03
Subtotal	647	100.00	
Total	829		100.00

The relationship between the variables coded by question category and by moving or still frames of videodisc instruction was analyzed using a 2 x 4 Chi-square statistical test. Analysis showed that the question categories asked by the teachers during moving and still frames of videodisc instruction computed Chi-square value was 7.504. The level of acceptance was 7.815 ($p \leq .05$). There were no significant statistical differences among open-ended, closed-ended, managerial, and rhetorical question categories asked by elementary teachers during moving frames and still frames of videodisc science instruction (Table 3).

Table 3.
Comparison of Observed and Expected Frequencies of Question Categories by Moving and Still Frames of Videodisc Usage

	Observed	Expected	O - E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Moving Frames					
Open-ended questions	82	70.473	11.527	132.872	1.885
Closed-ended questions	64	80.133	-16.133	260.274	3.248
Managerial questions	20	16.905	3.095	9.579	.567
Rhetorical questions	16	14.490	1.51	2.280	.157
Still Frames					
Open-ended questions	239	250.527	-11.527	132.872	.530
Closed-ended questions	301	284.867	16.133	260.274	.914
Rhetorical questions	57	60.095	-3.095	9.579	.159
Managerial questions	50	51.510	-1.51	2.280	.044
Total	829	829	0		$\chi^2 = 7.504$

$p \leq .05$ Accepted value: 7.815

Conclusions and Recommendations

Elementary science education is changing with the inclusion of videodisc technologies. Whether this inclusion will be perceived as an enhancement of the cognitive abilities of elementary students is yet to be documented. A logical beginning to document this new technology is begin to describe the questions that teachers ask when utilizing videodisc technology.

This study provided data in support of the use of moving and still frames of videodisc technology by analyzing the categories of questions that teachers ask during both formats as being not statistical different. If the question categories that teachers employ are statistical not different during the videodisc's unique format of moving or still frames, the conclusion becomes apparent that inclusion of videodisc technology using moving and still frames formats may provide evidence of underlying learning benefits from this new technology.

The results from this study do to some degree support earlier findings of Gall, Dunning, and Weathersby (1971) concerning percentages of questioning levels that teachers utilize. In their study, it was reported teachers utilize 60% of recall, or closed-ended questions; 20% of questions requiring students to think, or open-ended questions; and 20% of questions relating to procedures with in the classroom. It was determined while teachers use moving and still frames of videodisc instruction, 44.03% of the questions were closed-ended; 37.72% were open-ended; and a combination of rhetorical and managerial were 17.25% to the total questions utilized.

The questions the teachers utilized while using moving or still frames of videodisc instruction consisted of about 16% fewer closed-ended questions than reported in the Gall, Dunning, and Weathersby's study. In addition, the questions the teachers asked while using moving and still frames of videodisc instruction consisted of 17.72% more open-ended questions. Also, the use of rhetorical and managerial questions of the teachers using moving and still frames of videodisc instruction was 2.75% lower than the earlier study.

Speculation concerning the causes of these percentage differences can be related to the sample and methodology of this study. The subjects were volunteer teachers chosen by their building principals as being in the district long enough to establish longitudinal student test scores, each teacher had an acceptable level of competence and confidence with hands-on science, and each teacher had prior videodisc science instruction. These three selection criteria provided subjects who were experienced teachers, who had been trained using videodisc science materials, and who displayed confidence and competence in teaching science. All of the teachers volunteered for this study. Also, the teachers provided self-selected science lessons to be videotaped for analysis. Regarding the selection criteria and self-selection of videotaped science lessons by the teachers, a possible halo effect could have influenced the study's findings. This particular group of teachers may have represented an above average sample of the districts' teachers.

This study was completed in a mid-western, inner city school district. Also, the 12 teachers were chosen by their building principals, which may provide for a halo effect throughout this study. Further research studies need to be completed in other sized school districts in other geographical locations. In addition, a larger sample size, that was not determined by principals, may provide different possible findings.

This study provided no data concerning the effects of videodisc use on student and teacher attitudes in the elementary science classroom in this study. While viewing the videotapes, however, it appeared that there may have been a positive change in attitude during the use of moving and still frames of videodisc instruction by both the teachers and the students. A recommendation for further study would be to determine if student and teacher attitudes change during the use of moving or still frames of videodisc instruction. Also, further research should be completed to determine if the attitudes of the teachers and students using moving and still frames of videodisc instruction coincide.

Future research questions become a global concern. Can videodisc instruction, using moving and still frames of instruction, be a factor in other areas of education besides science? Other subject areas should be investigated at multiple levels, from primary to university levels. In addition, the use of multiple geographic areas may provide insight into this area of research.

Further investigations should focus upon the use of moving and still frames of videodisc instruction with other than questioning strategies. New strategies and teaching models could evolve from further research in this area. In addition, further research into the interactions of the students and the teachers using moving and still frames of videodisc instruction could provide innovative teaching models and strategies. Further investigations should focus on determining if moving or still formats of videodisc instruction could be more effective with students with different learning styles.

The use of videodisc technology in preservice science method classes has not been documented. One area for research would be to document if preservice teachers are presented with videodisc technology as method of teaching science. A logical next area of continued research would be to determine if the preservice teachers who were presented with this technology utilized it within their science teaching. A longitudinal study could focus on the usage of videodisc instruction by those teachers. This could be addressed by geographical region, size of district, and financial resources of the school district.

The technological training of both preservice and inservice teachers regarding videodisc materials has not been addressed in the literature. What types of technological training concerning videodisc materials should be provided to preservice and inservice teachers? Are there differences in the training time between the preservice and inservice teachers training for the use of videodisc materials?

The inclusion of videodisc technology is apparent in the elementary school. The cost of the materials has declined, videodisc materials have increased, and training in use of this technology is being provided to teachers. However, with any new technology in education, further research is needed to document effective teaching and learning. This research should include the inservice teacher and the preservice teacher.

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APPENDIX A

DATA COLLECTION AND CODING SHEET
OF QUESTION CATEGORIES

DATA COLLECTION AND CODING SHEET
OF QUESTION CATEGORIES

Data Collection Form

Question Level	Disc Used	Disc Format	Script
O-C-M-R	Y-N	M-S	Scr-Mod-T
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	2 3
1 2 3 4	1 2	1 2	3
1 2 3 4	1 2	1 2	3
1 2 3 4	1 2	1 2	2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 [illegible]	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3
1 2 3 4	1 2	1 2	1 2 3

Question Level Key:
- O = Open-ended questions
- C = Closed-ended questions
- M = Managerial questions
- R = Rhetorical questions

Disc Used Key:
- Y = Yes, Optical Data videodisc utilized
- N = No, videodisc not utilized

Disc Format Key:
- M = Moving frames of videodisc
- S = Still frame of videodisc

Script Key:
- Scr = Scripted by Optical Data
- Mod = Modified Optical Data
- T = Teacher non-associated question (context not in script)

APPENDIX B

TRAINING MANUAL FOR CODING OF QUESTIONING CATEGORIES AND MOVING AND STILL FRAME FORMATS

TRAINING MANUAL FOR CODING OF QUESTIONING LEVELS AND MOVING AND STILL FRAME FORMATS

INTRODUCTION

This instrument is designed as a research tool to collect data about the question levels, use of videodisc instruction, the videodisc format utilized, and the use of written script.

The question levels are divided into four levels. The four levels of questions are open-ended, closed-ended, managerial and rhetorical. The operational definitions and examples are as follows:

Open-ended questions are questions that have a wide range of responses. Examples of open-ended questions are: "Why will water boil at a lower temperature at a high altitude than it will at sea level? When you change the microscope magnification from low to high power, what frequently appears to happen to the object you are viewing?" (Blosser, 1991, p.4).

Closed-ended questions are those questions that have a limited number of acceptable responses. Examples of closed questions are: "What is the chemical formula for water? What is the boiling point of water, at normal atmospheric pressure, on the centigrade scale? What are the names of the three classes of rocks? Who is credited with the formulating the germ theory of disease?" (Blosser, 1991, p. 4).

Managerial questions are questions that a teacher asked to facilitate classroom operations. Examples of managerial questions are: "Does everyone have the necessary equipment? Will you turn to page 15, please? Who needs more time to finish the experiment?" (Blosser, 1991, p. 4).

Rhetorical questions are questions that a teacher asked to reinforce a point and does not want or expect a response (Blosser, 1973). Examples of rhetorical questions are: "The green coloring matter in plants is called chlorophyll, right? Yesterday we said there are three major groups of rocks: igneous, sedimentary, and metamorphic, okay?" (Blosser, 1991, p. 4).

The use of videodisc instruction is composed of two possible responses. The responses are as follows: yes, the videodisc was utilized in the lesson or no, the videodisc was not utilized in the lesson.

The determination of the disc format is coded as either moving frames of videodisc, as in a moving sequence, or as a still frame as in a photograph.

The use of script is represented by three choices. The first choice is represented by use of Optical Data prepared script. For this choice, the teacher utilized the prepared text questions within the lesson. The second choice is the use of a teacher modified text questions within the lesson. The questions were modified while the overall contextual meaning remains the same as the written text by Optical Data. The third choice is the use of non-associated teacher questions. The teacher non-associated questions do not represent the written text or modified questions that were based upon Optical Data material.

For each of the questions, first determine the question level. Indicate your response on the coding sheet by circling the appropriate response. Circle 1 for open-ended, 2 for closed-ended, 3 for managerial, or 4 for a rhetorical question. Circle only one response for each question.

To determine if videodisc instruction was utilized locate the number of the question and compare it to the teacher's log of usage. Indicate if videodisc instruction was utilized by circling 1 for videodisc usage or 2 for non-usage of videodisc materials.

The disc format of moving or still frame will be determined by observation of the portions of the videotapes that contain the questions. Indicate the appropriate response by circling either 1 for moving frame or 2 for still frame usage.

The use of scripted, modified, or non-associated questions will be determined by comparing the transcribed teacher question to the Windows on Science ™ text of scripted questions. If alignment of the Windows on Science ™ scripted questions occurs with the teacher's question, circle 1 for scripted. If the content of the question from Windows on Science ™ and the teacher is similar, but not exact, circle 2 to indicate a modified question. If the Optical Data written script and the transcribed teacher question do not align, circle 3 for teacher non-associated question.

If you have any questions, feel free to ask before proceding to use the coding sheet.

APPENDIX C

TEACHER DAILY LOG

TEACHER DAILY LOG

NAME:________________

SCHOOL DISTRICT OF ___- HANDS-ON SCIENCE ACTIVITIES & VIDEODISC VIEWING EVALUATION

Monday	Tuesday	Wednesday	Thursday	Friday	Weekly Totals
1. Circle the dates you taught science. 2. For each date, circle the way (s) you taught science. 3. Indicate how well the lesson went by circling on the rating scale 1(LOW)- 5 (HIGH)					
4 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	5 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	6 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	7 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	8 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	MINUTES: COMMENTS:
11 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	12 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	13 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	14 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	15 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	MINUTES: COMMENTS:
18 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	19 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	20 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	21 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	22 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	MINUTES: COMMENTS:
25 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	26 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	27 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	28 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	29 HANDS ON VIDEODISC video start # ____ end # ____ Rating 1 2 3 4 5	Monthly Student Reactions to Hands-On Science Activities 1 2 3 4 5 6 7 Student Reactions to Videodiskc instruction 2 3 4 5 6 7