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The Impact of a Commercially Prepared Science Program on Science Instruction and Scientific Literacy among Elementary Students

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ABSTRACT

The Illinois State Board of Education (ISBE) has provided funds through the Scientific Literacy Grant Program to improve curriculum and instruction in science, mathematics and technology. This summative evaluation describes some of the impact a commercially prepared science program, Windows on Science, had on science curriculum for K-6 students in fourteen elementary school buildings in east-central Illinois. The Grant was administered by Educational Service Center #15, Charleston, Illinois. The major elements of Windows on Science include Level 1 videodisc technology, supporting laboratory materials and an ancillary language laboratory. Results from surveys, interviews and observations indicate: i) teachers utilized the videodisc more than the other two major elements, ii) the program was used as a supplement to existing curricula rather than as the sole curriculum, iii) most teachers believe that science instruction is improved through implementation of the program.

Key Words: videodisc, scientific literacy, elementary science, technology

INTRODUCTION AND PURPOSE

Measures to improve science curriculum and instruction in elementary and secondary schools have continued since the flurry of activity during the 1960's to develop new science programs. Kyle, Shymansky and Alport (1982) report that during 1963 alone there were 412 federally funded in-service institutes earmarked for curriculum development in science and math. Only a few of these programs continue to be a part of science curriculum in elementary and secondary schools today. As the "economic sputnik" (Marcuccio, 1987) emerged in 1984 with the publication of A Nation at Risk: The Imperative for Educational Reform (The National Commission on Excellence in Education, 1983) new demands from private and public interest groups emerged. This new directive for science education has emphasized scientific literacy among students to enhance their ability to become functional, productive citizens in a technological society. Concurrently, the expanded use of technological advancements in instruction took place in

many schools. Advancements in videodisc technology, computer networking, and interfacing conventional laboratory equipment with computers began to find a niche among current methods and tools of instruction for science education in schools throughout the country.

To address the public and private demand for increased scientific literacy among students enrolled in elementary and secondary schools in Illinois, the Illinois State Board of Education (ISBE) began in 1989 the Scientific Literacy Grant program. Schools and government agencies submitted competitive grant proposals for money provided by the State Legislature. To date, recipients of these grants have used the funds "to support staff development projects for K-12 public school teachers to improve their literacy levels in science, mathematics and technology" (Illinois State Board of Education, 1995). As one of the annual recipients of these grants, Educational Service Center #15 (ESC 15), Charleston, Illinois, has provided programs designed to fulfill the mandates outlined by ISBE for elementary schools in its geographic area.

The purpose of this project was to evaluate how elementary teachers incorporated and utilized one particular program provided by ESC 15 to improve students' scientific literacy. This paper represents a portion of the evaluation report submitted to ESC 15 in August, 1995.

DESCRIPTION OF THE PROGRAM EVALUATED

The program evaluated during this project was Windows on Science (WOS) an elementary science program developed by Optical Data Corporation, Warren, New Jersey, in 1981. It is described as being a "complete curriculum resource that can be used throughout the year, either alone or to supplement an existing program" (Optical Data Corporation, 1994). The program features a videodisc with each of the 11 volumes of instruction and is organized in four titles: i) Primary Science, 3 Volumes, ii) Earth Science, 3 Volumes, iii) Life Science, 2 Volumes, iv) Physical Science, 3 Volumes. The three volumes of Primary Science are suggested for use by primary (first, second and third) grades. The Earth, Life and Physical Science volumes are intended to be used by intermediate (fourth, fifth and sixth) grades. Each volume contains three major elements for instruction, i) a 12 inch double-sided videodisc, ii) equipment and supplies for supportive laboratory activities, iii) an ancillary Language Laboratory.

Teacher Resources Booklets and Videodiscs

Teacher Resources Booklets are written for each unit of instruction. Each booklet provides the following information: i) instructions for first time videodisc users, ii) timelines for lesson and activity presentations, iii) content and process skills associated with each lesson, iv) articulation suggestions for other curricular arenas, v) student assessment, vi) barcodes and lesson notes for the videodisc, vii) equipment and supply lists, viii) procedures for activities, ix) ideas for critical thinking and enrichment exercises. Each volume contains a videodisc validated for Level 1 use i.e., the videodisc player is used without an external computer and is driven by remote control (Peterson, Hofmeister, Lubke, 1988). The videodisc can store up to 54,000 unique analog still images, film or videotape segments or computer generated graphics. Narrations for videotape segments, if present, are in English and Spanish.

Laboratory Equipment

Complementary to each volume is a set of materials, equipment and supplies for manipulative or hands-on activities. The original set of supplies from the manufacturer contains consumable as well as non-consumable materials. The initial quantity of lab equipment provided is such that activities can be performed by pairs of students or at least by small groups of 3 to 4 students. The laboratory supplies are designed to provide supportive hands-on activities associated with other elements of the program.

Language Laboratory

The Language Laboratory is a set of booklets with reading passages intended to provide supplemental reading material. In some cases, writing prompts and suggestions for activities are provided to be coordinated with other subjects, such as math or social studies. Pictures, diagrams and concept maps are a part of each booklet.

METHODS OF EVALUATION

Population

The population of interest was the self-contained and/or departmentalized kindergarten through sixth grade teachers from the fourteen buildings that participated in ESC 15's Scientific Literacy Grant for the last two years. Specifically faculty and staff who had or were utilizing WOS were included in the study.

Instrumentation

A survey was constructed to examine attitudes and reactions of faculty who used WOS. The survey consisted of two parts. Questions from the first part of the survey were used to determine: i) faculty demographics, ii) faculty definition of scientific literacy, iii) the role of WOS in addressing faculty's definition of scientific literacy, iv) which portion(s) of WOS were deemed important by the faculty, v) the extent to which the three major elements of the program were used, vi) the extent to which the program supports, supplements and/or replaces existing science curricula, vii) changes that have occurred in science education as a result of implementing WOS, and viii) how WOS compares with other science programs utilized. A 5-point Likert scale (Murphy and Likert, 1938) was used to rate opinions and attitudes. The scale included the following dimensions: 1=Strongly Disagree, 2=Disgaree, 3=Undecided, 4=Agree, 5=Strongly Agree. Written comments also were solicited. The second part of this survey was used to gather specific information regarding which primary and/or intermediate WOS units have been used by teachers for science lessons. This portion of the survey is not discussed in this report.

Data Analysis

Results of the survey were hand tallied. Statistical analysis was done using the Statistical Package for the Social Sciences (SAS). Frequencies, mean values, standard deviations, number of respondents, and percentages of category responses were data provided by this computer program. As WOS is divided into volumes for primary and intermediate grades, comparisons of results from primary (kindergarten through third grade) and intermediate (fourth through sixth grade) teachers were made for some questions. A Kruskal-Wallis test was used to determine if significant differences existed.

RESULTS

One hundred and five K-6 teachers have access to Windows on Science in their buildings and were asked to complete the survey. Eighty surveys were returned. All but one building returned at least one survey. At all grade levels, the majority of time devoted to science instruction takes place in the afternoon. Eighty-four percent of the K-3 teachers reported teaching science in the afternoon and eighty percent of 4-6 teachers reported the same.

Teachers were asked to rate statements that could be included as part of a definition for scientific literacy. Primary grade teachers rated "Correct use of lab tools" and "Ability to determine several ways of finding a solution to a problem" highest (Table 1). Intermediate teachers rated these statements along with "Ability to conduct simple research projects" as highest (Table 1). The history of science was least important for both groups (Table 1).

Teachers were asked to what extent WOS provided adequate instruction for their definition(s) of scientific literacy. The first choice for both groups was "Concepts and science vocabulary" (Table 2). Primary teachers rated "Relating science and technology" as second and intermediate teachers rated "Conducting simple research projects", "Use of lab tools" and "Role of science in society" as second (Table 2). Both groups of teachers rated WOS as providing the least adequate instruction in "History of science" and "How scientists work" (Table 2).

Teachers were asked how WOS was used in conjunction with current and/or previous curricula and textbooks. Primary teachers rated the program highest regarding use to supplement units they teach and secondarily as a supplement to their science text (Table 3). Intermediate teachers rated WOS highest as a supplement to units they teach (Table 3).

Teachers responded to which of the three major elements of the program were most important, the videodisc, the Language Laboratory or the laboratory materials (Table 4). The Kruskall-Wallis test revealed that K-3 teachers differed with respect to their rank of the three components ($H = 86.2$, $P<0.0004$); similarly 4-6 teachers' attitudes differed statistically ($H = 15.7$, $P<0.001$). Both groups rated the videodisc most important in for instruction followed by the laboratory equipment and the Language Laboratory.

Teachers were asked to indicate how often they used the three major elements of the program when science lessons were taught. Table 5 shows that primary and intermediate teachers used the videodisc most frequently. Intermediate teachers used the hands-on equipment the least while primary teachers used the Language Laboratory the least.

Questions about changes in instruction show primary and intermediate teachers feel science instruction has changed since implementing WOS (Table 6). Both groups agreed that their instruction is better now than prior to using WOS. Both primary and intermediate teachers rated the impact of WOS on their science curriculum as positive (Table 6). Questions dealing with issues that define generally accepted improvement in science instruction had median values of 3.0 or better. These questions addressed the amount of time spent on science since using the program, the amount of time spent reading relative

to hands-on activities, and change in the units of science included in the curriculum. Sixty-five percent of all teachers disagreed or strongly disagreed that the videodisc player was a replacement for the textbook. Overall, primary teachers gave higher ratings to this set of questions than did intermediate teachers.

DISCUSSION

Survey responses revealed that teachers feel science education should involve an activity-based, hands-on approach. Concepts rated highest in teacher definitions of scientific literacy were: i) correct use of lab tools, ii) multiple solutions to problems, iii) conduct simple research, and iv) correct use of scientific terms. Survey results also demonstrated that definitions of scientific literacy by K-3 and 4-6 teachers did not differ remarkably. However teachers' definitions of scientific literacy (Table 1) differed from their views on how Windows on Science (WOS) addresses these definitions (Table 2). Rated by teachers in the top 50% of how well WOS addresses components of scientific literacy were: i) concepts and vocabulary, ii) relating science to technology, iii) role of science in society, and iv) use of lab tools. What teachers feel is important in scientific literacy is not necessarily what they feel is the best part of this program.

Responses show that teachers believe improvement in science instruction has taken place as a result of WOS. Table 6 shows that all faculty gave one of the highest ratings to "I think science instruction is better than prior to having WOS." Since no pre- and post-testing was conducted with regard to the impact of WOS on science instruction, transcriptions from interviews with teachers were examined for reasons why teachers believe science instruction is better now than before. References to the multitude of visuals that are now available to teachers through the videodisc are replete throughout the interviews. Similarly, teachers assert how much more interesting these visuals make their lessons and note that these visuals (including short video clips) appear to enhance student enjoyment of classroom presentations. With this in mind, improvements in scientific literacy and science instruction attributable to WOS may result from an increased capacity to illustrate biological, physical and environmental phenomena.

Though science textbooks are still available for student use in many classrooms and reading assignments from these texts remain a part of science instruction for some classes, faculty stated their students spend less time reading science and more time with hands-on activities since use of WOS began (Table 6). However, reports that students are spending more time with activities are contradicted by data in Table 5. Approximately 64% of K-3 faculty used the videodisc more than half of the time in science instruction. This is supported by results which show primary teachers rated the videodisc player as the most important part of the program followed by the laboratory equipment and Language Laboratory (Table 4). Hands-on activities were used by only 12% of K-3 teachers more than half of the time, and there is no record of any primary teacher using the Language Lab more than half of the time (Table 5). Intermediate teachers favored the videodisc, as 66% used it more than half of the time they taught science (Table 5). In contrast, the percentage of teachers who reported use of the other two elements more than half of the time for science instruction was relatively low (laboratory equipment: 20%, Language Laboratory: 13%). It is possible that students may be using materials from WOS along with activities from another text or curriculum guide, or from supplemental material

provided by the teacher. The survey did not discriminate between various sources for supporting activities. Additional interviews and review of total science curricula may reveal various sources of supportive hands-on activities.

Observations of science lessons in the participating schools confirm the extensive use of the videodisc player as reported in the results. As an example, still frames of graphs, charts or photographs along with video segments have provided background information enabling students to ask questions, formulate hypotheses from their questions, and test hypotheses by collecting information about natural phenomena. In turn these may stimulate students to analyze information collected from the visual display and draw conclusions. Without the teacher blatantly stating "today's lesson will be a method for scientific investigation", some of the frame and video sequences could be used to trace the steps of the scientific method. Accordingly the videodisc may be seen by teachers as a replacement for a traditional hands-on laboratory activity which was used to demonstrate the steps in the scientific method and it may be viewed as a way of simulating activities that require materials and equipment unavailable to the class. Consequently teachers may regard the videodisc as an alternative to presenting laboratory activities without students actually performing manipulations. Videodiscs may present students with opportunities to observe activities that normally cannot be conducted in an elementary science classroom. Teachers may equate use of the videodisc with actively engaging students in something other than traditional activities such as reading a text or writing answers to questions hence the perception of spending less time reading and more time engaged in alternative activities. This new tool for instruction may indeed be engaging students in activities heretofore unavailable.

In summary, teachers perceive that Windows on Science enhances their instruction. Primary and intermediate teachers use the videodisc extensively and perhaps as a substitute for other hands-on activities. Apparently, WOS has resulted in somewhat of a redefinition of activity-based science instruction. What remain to be distinguished are teachers' perceptions of "activity- oriented" lessons for science. A more precise explanation of what constitutes activity-based or hands-on science is needed from elementary teachers. Additional observations of science lessons and interviews with teachers, staff and students could clarify their definition and provide further evidence of how a program such as Windows on Science is incorporated into instruction.

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Table 1. Primary (K-3) and intermediate (4-6) teacher definitions (Mean/Median) of scientific literacy.

	K-3	4-6
Correct use of lab tools	4.4/5.0	4.5/5.0
Multiple solutions to problems	4.4/4.0	4.5/5.0
Conduct simple research	4.2/4.0	4.5/5.0
Correct use of science terms	4.3/4.0	4.4/4.0
Relationship between science and technology	3.9/4.0	4.3/4.0
Role of science in society	3.8/4.0	4.2/4.0
How scientists work	4.0/4.0	4.1/4.0
Science history	3.5/4.0	3.6/4.0

Table 2. Survey response to the question "To what extent does Windows on Science (WOS) provide adequate instruction with respect to your definitions of scientific literacy?" Values are expressed as mean/median on a 5-point Likert Scale.

	K-3	4-6
Concepts and Vocabulary	4.1/4.0	4.5/4.0
Relating science and technology	3.9/4.0	3.5/4.0
Role of science in society	3.8/4.0	3.7/4.0
Use of lab tools	3.8/4.0	3.7/4.0
Science process skills	3.8/4.0	3.6/4.0
How scientists work	3.7/4.0	3.5/4.0
Conducting simple research projects	3.7/4.0	3.7/4.0
History of science	3.1/3.0	3.5/4.0

Table 3. Survey response to the question "How is Windows on Science (WOS) used in conjunction with existing curricula?" Values are expressed as mean-median on a 5-point Likert scale.

	K-3	4-6
WOS supplements units I teach	3.7/4.0	3.1/4.0
WOS supplements my science text	3.6/4.0	2.9/4.0
WOS is supplemented by my science text	3.3/4.0	2.9/2.5
WOS is thorough enough to stand alone	3.0/3.0	2.9/3.0

Table 4. Response to survey question "What elements of Windows on Science (WOS) are most important for science instruction?" Values are expressed as mean/median on a 5-point Likert scale.

	K-3	4-6
Videodisc player	4.4/5.0	4.2/4.0
Laboratory materials	3.3/3.0	3.5/4.0
Language laboratory	2.3/2.0	2.3/2.0

Table 5. Response to survey question "When teaching science how often (percent of time) do you use the videodisc, hands-on lab activities, and/or Language Lab with your instruction?" Values expressed as percentages.

		100%	75%	50%	25%	0%	
Videodisc	K-3	27.7	36.9	23.1	12.3	-	(n=65)
	4-6	33.3	33.3	20.0	13.3	-	(n=15)
Hands-On Lab	K-3	1.6	11.1	33.9	45.2	6.5	(n=62)
	4-6	-	20.0	20.0	46.7	13.3	(n=15)
Language Lab	K-3	0.0	0.0	4.8	35.5	59.7	(n=62)
	4-6	6.7	6.7	20.0	40.0	26.7	(n=15)

Table 6. What impact has Windows on Science (WOS) had on science instruction? (Mean/median)

	K-3	4-6
When I use a WOS unit, my students are involved in more hands-on activities than direct teacher instruction from me.	3.5/4.0	3.1/3.5
My class spends more time with hands-on activities since using WOS.	3.4/4.0	2.9/3.0
Overall I think science instruction is better than prior to having WOS.	4.0/4.0	3.5/3.0
More time is spent each week teaching science since using WOS.	3.4/4.0	3.0/3.0
I have included more units of science since using WOS.	3.3/4.0	2.7/2.0
My students spend less time reading and more time with activities since using WOS.	3.7/4.0	3.5/4.0
WOS gives me the chance to teach more about the effects of science and technology on society.	3.6/4.0	2.9/3.0
My students get more instruction on science “facts and figures” since using WOS.	3.3/3.0	3.2/3.0
WOS simply replaces the textbook with video and TV to teach science.	2.6/2.0	2.3/2.0
My science instruction has not changed since we acquired the WOS material.	1.7/2.0	2.2/2.0

Figure 1. a) A comparison of the importance of the three major elements of Windows on Science (WOS) for Primary (K-3) teachers. b) A comparison of the importance of the three major elements of Windows on Science (WOS) for Intermediate (4-6) teachers.