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ABSTRACT

This practicum endeavored to improve science laboratory instruction for elementary students. The major goal of the practicum was to facilitate laboratory use so that teachers would incorporate laboratory experiences as an integral component in science instruction. To improve the instructional significance of the science laboratory, the writer developed and initiated a MAPS change process model (Motivation, Alternatives, Planning, Sharing) in collaboration with representative teachers. The committee acted in a leadership capacity to develop goal commitment, formulate strategic actions plans, communicate a shared vision, resolve implementation obstacles and monitor progress. Implementation included inservice training in effective science teaching strategies, coordination of community volunteer participation and documentation of worthwhile hands-on science laboratory activities. Outcomes of this practicum illustrated that improvement in science laboratory instruction is contingent upon teacher empowerment, community involvement and participation, facilitative leadership styles, an understanding of the change process and goal commitment. As a result of this practicum, achievement in science increased in daily grades and on standardized tests, student and teacher attitudes about science improved, materials for science activities were obtained and the community became involved in promoting excellence in science education. (Author)

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IMPROVING THE EFFECTIVENESS
OF SCIENCE LABORATORY INSTRUCTION
FOR ELEMENTARY STUDENTS
THROUGH THE USE OF A PROCESS APPROACH FOR CHANGE

BY

WANDA S. VORSINO

STUART, FL

CLUSTER # 34

A Practicum II Report presented to the Ed. D. Program in Child and Youth Studies in Partial Fulfillment of the Requirements for the Degree of Doctor of Education

NOVA UNIVERSITY

1992

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PRACTICUM APPROVAL SHEET

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This practicum report was submitted by Wanda S. Vorsino under the direction of the adviser listed below. It was submitted to the Ed.D. Program in Child and Youth Studies and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova University.

Approved:

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Dr. Georgianna Lowen, Adviser

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ABSTRACT

Improving the Effectiveness of Science Laboratory Instruction for Elementary Students Through the Use of a Process Approach for Change. Vorsino, Wanda., 1992: Practicum II Report, Nova University, Ed.D. Program in Child and Youth Studies. Descriptors: Teacher Improvement/Instructional Improvement/Elementary School Science/Science Experiments/Laboratory-based Instruction/ Elementary Education/Science Education/Hands-on Activities/ Leadership/Implementation Processes/Change Process/ Interdisciplinary Instruction/Curriculum Improvement

This practicum endeavored to improve science laboratory instruction for elementary students. The major goal of the practicum was to facilitate laboratory use so that teachers would incorporate laboratory experiences as an integral component in science instruction.

To improve the instructional significance of the science laboratory, the writer developed and initiated a MAPS change process model (Motivation, Alternatives, Planning, Sharing) in collaboration with representative teachers. The committee acted in a leadership capacity to develop goal commitment, formulate strategic action plans, communicate a shared vision, resolve implementation obstacles and monitor progress. Implementation included inservice training in effective science teaching strategies, coordination of community volunteer participation and documentation of worthwhile hands-on science laboratory activities.

Outcomes of this practicum illustrated that improvement in science laboratory instruction is contingent upon teacher empowerment, community involvement and participation, facilitative leadership styles, an understanding of the change process and goal commitment. As a result of this practicum, achievement in science increased in daily grades and on standardized tests, student and teacher attitudes about science improved, materials for science activities were obtained and the community became involved in promoting excellence in science education.

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TABLE OF CONTENTS

ERIC

LIST OF TABLES

Table

LIST OF FIGURES

Figure

ERIC

CHAPTER I

INTRODUCTION

Description of Community

The target school is located in a southern multi-ethnic, low income, urban community. The population stability and socio-economic structure of the community which the school serves has changed dramatically over the past few years. Hispanic immigrants, migrant workers and northern transplants have caused the community structure to become more diverse. In addition, families have become more transient. In 1990, approximately twenty-five percent of the community's families relocated either into or out of the area as compared with ten percent in 1987.

In 1988, rezoning significantly changed the socioeconomic structure of the school's clientele. Previously, the target school had serviced students from the surrounding area which is primarily a low-income neighborhood heavily populated by racial minorities. Rezoning resulted in a change of the school population. Not only did the target school now service students from the lower socio-economic immediate neighborhood but also serve students in areas of much higher economic structure. The backgrounds, incomes, education and careers of the families from the two areas were--and continue to be--at opposite ends of a socio-cultural continuum.

As a result of the dissension caused by rezoning, the target school has been under close scrutiny by the community. Questions from parents on the quality of education at the target school were presented at school board meetings and to the superintendent. Because of the pressure placed on the school board by parents, the administration of the target school was changed.

Although the district and school administration have cooperatively planned for educational improvements at the target school and continue to promote positive community/school relations, parents from the various neighborhoods were disproportionately represented in volunteer programs or at school functions. Families from the lower socio-economic neighborhood adjacent to the school were hesitant to become actively involved in school activities, do not attend scheduled parent/teacher conferences and rarely respond to teacher or school communications.

Description of Work Setting

The school facility is composed of six clusters of podular classrooms, five portables, four large buildings, a covered play area and a large area for outdoor activities. Each podular cluster consists of six self-contained classrooms which are grouped around an outdoor atrium and connected by external sidewalks. Two of the large buildings house a total of fifteen individual classrooms. A third large building serves as the school's cafetorium and the fourth houses the administrative offices, a music room and a multipurpose room. The portables are used for Chapter I classes and as class-rooms for students with emotional handicaps.

Although the school was designed for self-contained instruction, some intermediate teachers team-teach for reading, math, social studies, and science. Cross teacher cooperation minimizes the number of ability groups and subjects for each teacher and facilitates individualized instruction.

The faculty consists of twenty-four regular classroom teachers, eight exceptional education teachers, three Chapter I instructors, and two teachers of students who have limited or nonexistent English proficiency. Of these teachers, nineteen have taught at the target school for over five years, twenty-seven have continuing contracts, and eleven hold master's degrees.

Student enrollment slightly exceeds 700 children. The student-teacher ratio in the primary grades averages 25:1. In the intermediate grades, the ratio averages 27:1.

Community and parental involvement is exemplified by a supportive Parent-Teacher Association (PTA), an active volunteer program, a strong School Advisory Council (SAC) and a responsive business partner relationship. This participation in school activities by parents and community volunteers facilitates positive communication between the school and the public, provides enriching educational opportunities for the students and establishes a community commitment to quality education.

The organizational climate of the target school encourages staff professionalism and promotes high task orientation. Formal communication channels between the administration and the staff members are maintained through daily bulletins, faculty meetings, and grade level planning sessions.

The school maintains a high goal focus as a result of extensive self-study and needs assessments incorporated in a school improvement plan. Innovation in implementation of school objectives to improve the learning conditions of students is supported by the administration in order to meet established standards of excellence.

Recent developments in school funds have led to increasing tension between teachers and the administration throughout the district. Two shortfalls in the 1990-91 and 1991-92 fiscal year allocations have prompted the school board to make unpopular decisions in an effort to balance the district school budget. Incremental pay increases and negotiatied raises for all school board employees were rescinded, school field trip and professional travel allowances were reduced and funds for instructional materials, supplies, and substitutes have been reduced from 33% to 50%. In addition, the school board has proposed a 3% across the board reduction in pay for all school board employees. The budget crisis has had a detrimental effect on staff morale.

Writer's Work Setting and Role

This was the writer's second year as the assistant principal of the target school and her seventeenth year in education. Her experience includes seven years with various stateside public schools and eight years with Department of Defense Overseas Schools in Germany.

As assistant principal, the writer was responsible for facilitating educational excellence for all students. Her duties include, but are not limited to, assisting instructional personnel in improving educational practices and experiences for students, organizing and/or communicating opportunities for staff development, organizing and maintaining community-school partnership programs, monitoring student discipline concerns, verifying data for computer-managed information services, presiding over exceptional student education conferences, scheduling educational programs and events, and chairing various school and district organizational committees. As a supervisor, it is the writer's responsibility to provide psychological and technical support in curriculum development and evaluate personnel performance, educational outcomes and curriculum goals. The writer also serves as a liason between the district and the school to insure adherence to district policies in pupil progression and basic skills instruction.

CHAPTER 2

STUDY OF THE PROBLEM

Problem Description

In the spring of 1990, several parents persuaded prominent community business leaders to donate a portable classroom to house a science laboratory. Later that same year, the school applied for and received a grant to purchase equipment, supplies and materials for the science laboratory. In addition, the administration of the target school provided inservice opportunities for teachers, scheduled regular laboratory sessions, and supplied instructional materials and laboratory resource guides. However, the explanations that follow demonstrate that the science laboratory was not effectively used to provide hands-on experiences in science for elementary students.

Although each class was scheduled for a laboratory session, teachers did not use the laboratory on a regular basis. Before the science lab was opened, teachers were concerned about being able to find time to fit science lab instruction into an already tightly scheduled day. As a result of this concern, time allotments for science lab sessions were decided upon collaboratively in order to assure teacher participation. Upon implementation of the science laboratory program schedule, class attendance in the science lab ranged from abstinence to sporadic use. This behavior denied students regular opportunities for science laboratory experiences.

In addition, there was a discrepancy between what teachers believed about strategies for science instruction and what they actually did. Prior to the opening of the science lab, teachers at the target school agreed that science was most effectively taught through hands-on activities connected with a core curriculum. In practice, science lab instruction consisted of demonstrations with discussion and worksheets. Often, lab activities were randomly selected for reasons other than concept enhancement and teaching strategies followed textbook patterns which stressed reading comprehension, lower-order cognitive skills and rote memorization of glossary terms.

As stated previously, the science laboratory was a project initiated outside of the target school faculty. The teachers at the school felt that the science laboratory and the curriculum implications which followed were imposed upon them by individuals outside the realm of education. This belief fostered negative teacher attitudes toward the science lab and laboratory activities.

In conclusion, the problem was that laboratory instruction for K-5 elementary students at the target school was approached negatively, ineffectively managed and randomly organized.

Problem Documentation

Documented evidence supported the deficiencies in science laboratory instruction. In accordance with district policy, the target school is required to assess needs in curriculum, student achievement and community relations in order to develop goals and strategies which would address demonstrated deficiences. A priority for the 1990-91 improvement plan was to increase academic achievement in science. Success was evaluated on percentage increases in standardized test scores of students in grades 3-5 and on participation in the science fair. Neither goal was met. Building level scores on the California Achievement Test administered in the spring of 1991 dropped five points in third grade, six points in fourth grade and five points in fifth grade. A total of 89 students participated in the target school science fair in 1991 which equates to less than 10% of the target school population.

Because the criteria for success was not met, this goal continued to be a priority for school improvement for the 1991-92 school year.

Also in the 1990-91 school year, it was the responsibility of the writer to develop a science laboratory schedule. She formed a committee of teachers (one per grade level) to preview a proposed schedule, gather input from the other teachers in their grade level, and to make necessary revisions. The final draft of the lab schedule was accepted unanimously by the faculty. However, as demonstrated in Table 1, out of five classes scheduled for laboratory activities daily, an average of two classes used their scheduled laboratory sessions over a four-week time period.

Table 1

Daily Log of Laboratory Sessions

	Daily Laboratory Sessions Scheduled/Daily Sessions Conducted				
Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	5/0	5/1	5/3	5/0	5/1
2	5/1	5/2	5/0	5/1	5/3
3	5/1	5/3	5/4	5/3	5/5
4	5/3	5/2	5/1	5/2	5/2

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One of the responsibilities of the writer is curriculum development. Since it was apparent that teachers were not using the science laboratory at the regularly scheduled times, the writer investigated the district science curriculum for some direction in laboratory use and/or suggested activities. She found that the district K-5 science curriculum that was developed in 1981 consisted of a listing of minumum performance skills and one example of a hands-on activity for each elementary grade level. There were no guidelines for laboratory instruction or activities neither were there specific evaluation techniques or instruments to assess concept mastery.

In order to evaluate instructional strategies used by teachers in science lab activities, the writer observed regular classroom teachers during their lab sessions. During the observation, she marked each strategy used during the lab activity. As demonstrated by Table 2, teaching strategies consisted primarily of discussion in conjunction with teacher demonstration and independently completed worksheets. Therefore, there was evidence that the teachers at the target school did not practice laboratory management procedures, avoided scientific methodology and depended on textbook activities for laboratory experiences.

Table 2

Instructional Strategies Used by K-5 Teachers During a Laboratory Lesson

Strategy	Number of Teachers
Cooperative Learning	3
Discussion	24
Demonstration	21
Students use manipulatives	4
Students use laboratory equipment	3
Students work independently	21
Students interaction encouraged	3
Students allowed to explore	0
Students complete worksheets	22
Use of scientific method	2

Note: Strategies taken from Science and Technology Education for the Elementary Years: Frameworks for Curriculum and Instruction by R.W. Bybee, C.E. Buchwald, S. Crissman, D.R. Heil, P.J. Kuerbis, C. Matsumoto and J.D. McInerney, 1989, Colorado Springs: The National Center For Improving Science Education.

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Teachers also noted deficiencies in the science lab program. At the conclusion of each school year, teachers are asked to complete a survey to evaluate specific programs and practices. The survey formalizes feedback which will guide revisions in curriculum/program practices for the following school year. The writer developed a second survey following the same format to gather information on teachers' perceptions about the science lab program (See Appendix A). Twenty-five of the twenty-eight teachers who responded commented on the need for assistance from volunteers in the science lab and the importance of soliciting help from individuals in the community with science-related backgrounds.

Causative Analysis

The problems associated with science laboratory instruction may have been caused by a combination of district policies, financial limitations, laboratory facility layout, negative attitudes toward science and insufficient teacher training. District policies specifically address academic achievement in reading and math for elementary students by monitoring standardized test scores and by requirements for promotion based on progress in reading and math.

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Standardized test scores in reading and math are used for placement in remedial programs. Mastery of skills is evaluated by established testing instruments developed by the district and documented on student profile cards in math and reading. In science, the district has made few provisions for evaluation of student performance and curriculum guidelines. Minimum performance skills are state mandated. According to state and district procedures, documentation that science is taught is found in teacher lesson plans. Evaluation of mastery of skills is left to the discretion of the teacher and documentation of mastery consists of a checklist of skills for third and fifth grade classes completed by the teacher. The district emphasis on reading and math achievement and progress has become justification for many teachers for not including science in their daily curriculum.

Budget limitations also compound problems in science lab instruction. The district maintains that funds are not available to develop improved standards, to establish consistent evaluation procedures and to provide inservice training to teachers. Although grant funds allowed the school to purchase basic equipment and materials to set up the lab facility, there are no provisions for teacher reimbursement for consummable items. In addition, the school budget does not allocate categorical funds to maintain, repair

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or replenish science laboratory equipment, materials or supplies. However, one must also remember that the budget directly reflects district and school policies, priorities and preferences.

Another cause for the deficiencies in science instruction has been the discomfort teachers experience with the subject (Shymansky, 1989). This discomfort is a result of the lack of preservice and inservice training. Many teachers have insufficient backgrounds in scientific content, instructional methods, laboratory management practices and few experiences with elementary science activities. Therefore, teachers not only avoid teaching science but convey negative attitudes related to science to their students.

Some teachers have cited the location, the layout of the facility and the facility itself as impediments to laboratory instruction. The laboratory is located at one end of the campus. Some believe the travel time detracts from the instructional benefits of a science lab. The facility itself may have been a barrier to effective use. The newness of the laboratory and the unfamiliarity which it exudes may have caused teachers to avoid using it. A final cause may have been the fact that the lab is a portable facility which sends an underlying message that the science lab is temporary and, therefore, the instructional value is decreased.

Relationship of the Problem to the Literature

Practitioners, business professionals, researchers and the news media are realizing that American education is not providing the scientific and technological skills which develop scientific literacy, environmental awareness and future employment skills. According to Leon Lederman, a Nobel Prize winning physicist, American schools have succeeded in "beating" the natural curiosity out of our elementary students (as cited in Begley, Springen, Hager, Barrett, and Joseph, 1990, p.55). His statement is supported by research which indicates that the number of students interested in science decreases as they progress through school. By third grade, 50% of third grade students consider science their least favorite subject. When students reach eighth grade, only 20% elect to continue taking science courses, and 93% of all high school graduates are not prepared to take college level science courses (Cowley, Springen, Barrett, and Hager, 1990). There is further evidence that, upon reaching adulthood, 90% of all children taught will have little or no interest in science (Yager and Penick, 1986). Pizzini (as cited in Cowley et al., 1990) explains that students do not pursue science-related subjects because of unsuccessful experiences with the subject, the stigma attached to those who enjoy science and/or the attractiveness of other subjects.

Understanding that American students have lost interest in science, it is not surprising that scores on standardized tests of science achievement are lower for American students then in other countries. On tests given to high school students in thirteen countries, American students ranked eleventh in chemistry, ninth in physics and thirteenth in biology (Cowley et al., 1990). According to Voelker (1982), American students tend to retain approximately 25% of what is taught.

Using these figures as a basis on which to evaluate American science instuction, education-as it is today-is failing to promote the scientific, technological and intellectual skills needed for the future (Kyle, Bonstetter, and Gadsen, 1988). The crisis in science education has been linked to an emphisis on basic skills instruction, deficient preservice and inservice teacher training, negative teacher attitudes toward science, inadequate facilities, the absence of sound implementation procedures and inappropriate teaching techniques.

Historically, reading and math have been priorities in elementary school curriculum. According to James and Hord (1988), reports of school effectiveness do not include measurement of science achievement, therefore, the tendency is to ignore what is not measured.

Some proponents of science education point to teaching techniques as the cause of existing problems. In 1989, a study conducted with the schools of the Richardson Independent School District, found that the majority of teachers approached science instruction using strategies identical to those used in language arts classes and that instruction concentrated on low level cognitive skills (Kyle, Bonstetter & Gadsen, 1988). Through observations of many science lessons, Goodlad (1984) concluded that teaching strategies used for science instruction are generally limited to lecture with the occasional discussion.

Other studies indicate that problems may stem not only by how students are taught but also what they are taught. Documented studies of science instruction content suggest that 90% of all teachers stress factual information that is directed toward further study, is textbook based, and is disconnected from direct experiences and concept development (Yager & Penick, 1986; Bybee, Buchwald, Crissman, Heil, Kurebis, Matsumoto & McInerney, 1989).

Interestingly, additional research has shown that there is a discrepancy in elementary education practitioners' beliefs and what they practice in their schools and classrooms. In a survey of elementary schools across the country, Weiss (1987), found that although 76% of elementary principals and 66% of elementary teachers consider laboratory-based science instruction and hands-on experiences the most effective instructional strategies, only 51% of the K-6 teachers in those same schools involved students in those types of learning activities.

From a broader perspective, some experts believe the problems which have developed with science instruction may be due to unsuccessful implementation procedures. In the 1960's, three elementary science curriculum programs were developed to promote excellence in science instruction; the Science Curriculum Improvement Study (SCIS); Science: A Process Approach (SAPA); and, the Elementary Science Study (ESS). The programs were noted for their accuracy in research-based content, attention to developmentally appropriate teaching strategies, and their emphasis on inquiry techniques, hands-on activities, and "discovery" learning. However, even with the support of the National Science Foundation (NSF), these programs failed to affect methods of science instruction (James & Hord, 1988).

Research has provided evidence that the failure of these programs was due to ineffective methods of implementation (James

& Hord, 1988). Factors which contributed to failure included the low priority ranking of science in comparison to other school subjects; teachers with limited backgrounds in science content and teaching methods; the lack of standardized testing in science; minimal to non-existent time allocations; inappropriate facilities and equipment; the lack of district and administrative support with respect to financial allocations; teacher preparation and instructional supervision; and, inadequate preservice instruction in scientific processes and concepts (James & Hord, 1988).

Results of other studies concur with these conclusions. Findings in a report by the Florida Department Of Education (FDOE) and the Florida Chamber of Commerce (FCC) (1989) concluded that college students majoring in elementary education take no higher level science courses in their junior or senior year. Kyle, Bonnstetter, and Gadsen (1988) found that the majority of teachers hold negatives attitudes about science to the extent that they consider science their least favorite subject. It has also been suggested that most elementary classrooms lack furnishings basic to science instruction; such as, sinks with running water, accessible electrical outlets and storage in addition to equipment which is unavailable, in disrepair, or misplaced (James & Hord, 1988). It is evident that although elementary educators may be aware of the unique strategies in science education, they have not been given the tools and the direction necessary for improvement. The stagnancy in elementary science education is the result of inadequate training, negative experiences, lack of administrative support, superficial content knowledge, and science textbook programs.

The problems related to deficiencies in science instuction have broad sociological, economic, political, and technological implications. The crisis in science education comes at a time when society is becoming increasingly dependent upon the ability to understand science-related social issues (Koballa & Rice, 1985).

Because many teachers lack fundamental science background, science has been taught by those not certified and/or unprepared. As a result, high school graduates are poorly prepared for informed citizenship, general scientific knowledge in the United States is below that of many other countries and scientific literacy for most Americans is insufficient to make informed decisions about issues of personal health, the environment, and energy use (Lapointe, Mead, & Phillip, 1989; Loucks-Horsley, Carlson, Brink, Horwitz, Pratt, Roy, & Worth, 1989; Engler, 1988).

Studies predict shortages in the workplace of qualified, professional, technical employees will increase as jobs requiring technical skills expand (FDOE & FCC, 1989). Other shortages will

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occur in doctoral level scientists in the U.S. unless something is done to attract students-particularly minorities and females-in science-related fields of study.

In conclusion, without a basic foundation in science, many children will be unprepared to become contributing members of society. To defray this "crisis", educators must endeavor to change their own attitudes about science and the way they teach it. Science is the "door" to understanding the world we live in, but, that "door" must be opened first.

CHAPTER III

ANTICIPATED OUTCOMES

AND

EVALUATION INSTRUMENTS

Goals and Expectations

The anticipated outcome of this proposal was increased teacher use of the science laboratory and improved methods in laboratory instruction for K-5 students. In general, the goal of the writer has been to facilitate laboratory use so that teachers would incorporate laboratory experiences into their science curriculum.

Behavioral Objectives

The following goals and objectives were projected for this practicum:

1. During implementation, each K-5 class will participate in a laboratory session twice a month as documented on a calendar schedule, lesson plans and by laboratory reports.
2. By the end of the implementation period, one teacher per grade level (K-5) will have completed six hours of inservice

training in science as recorded on an attendance log.

3. At the conclusion of implementation, each grade level will have a collection of 16 descriptions of laboratory activities which have been positively evaluated with respect to instructional effectiveness.

4. During implementation, a minimum of ten community volunteers will contribute a total of 160 hours of volunteer service in science laboratory activities as indicated on a volunteer sign-in log and registration forms.

Measurement of Objectives

The writer views assessment as a continuous monitoring process used to shape proposal implementation and to evaluate the progress of a specific plan. Therefore, assessment was to be both formative and summative throughtout the implementation process. Formative assessment was to be used to improve instructional strategies through teacher observations, to gather input on program implementation and to monitor participation. Summative assessment was to be used to determine the achievement of each objective.

The writer planned to use a variety of methods to evaluate the proposed objectives. To determine participation in scheduled laboratory sessions (Objective #1) teachers were to be required to document attendance on a lab schedule calendar which was posted in the science laboratory. The calendar was to serve a multiple purpose. It would allow the writer to evaluate the implementation of the objective on a regular basis, to recognize teachers who did conduct science laboratory sessions and to assist those who did not participate.

Documentation of attendance also was to include a record of science lab activities in teacher lesson plans and copies of science lab activities given to the writer. The teacher would have the option of describing the activity, identifying the source of the lab lesson or providing a copy of the laboratory experience.

Since the writer is a supervisor, she was also prepared to make regular visits to the science lab during scheduled laboratory sessions. Classroom observations would enable the writer to assess individual teacher's instructional methods, organization and use of materials, grouping procedures, evaluation techniques, lesson preparation and class management. Follow-up conferences were to provide an avenue for discussions on teaching and evaluation techniques, activities and cooperative learning methods.

Teacher participation in inservice training (Objective #2) was to be recorded at each workshop session. In addition to actual attendance at workshops, assignments to assess concept acquisition were to be given with specific amounts of time suggested. These time allotments for assignments were also considered as a part of or in addition to the workshops themselves. The classroom lesson component of training required teachers to practice concepts and teaching strategies presented at the workshops.

In order to develop a collection of science laboratory activities (Objective #3), the writer began with the copies or descriptions of the lab activities which were required for documentation of Objective #1. They were to be organized by grade level responding to teacher conerns about repeating lessons. The collection would provide a basis for a sequential guide to laboratory activites. Teachers were to be asked to rate laboratory activities on student interest in the activity, grade level appropriateness, activity organization, agreement with science curriculum, availability of materials, and specific strengths and weaknesses of the activities . Student interest was to be measured on the amount of active participation, the quality task orientation and attitude. Appropriateness was dependent upon the developmental and cognitive stages of children in relation to specific grade levels, achievement of concept mastery, selection of materials and meaningful lesson presentation. Activity organization referred to lesson flow and procedural clarity. Lessons were also to be rated on their congruency with student performance objectives in science and the ease and cost of obtaining materials. Although the writer realized the time element involved was extensive, the feedback on both sides far outweighed the time costs.

Assessment of volunteer participation and hours (Objective #4) were to be completed in conjunction with the volunteer coordinator following the procedures she had established to document the progress of the target school's volunteer program. Briefly, records were to be kept on each volunteer. These records included mailing information about volunteers, where they volunteered their time, arrival/departure times and time alloted for lesson preparation, laboratory organization, teacher assistance and/or lesson instruction. The writer would monitor the science volunteer program through monthly reports completed by the volunteer coordinator. A questionnaire (Appendix B) was to be used to evaluate the quality of the program.

The writer would keep a journal during the implementation of the practicum to record events which were not anticipated, yet, were direct results of planned interventions. The writer also planned to observe teachers during laboratory sessions, to encourage comments from her supervisor, photograph laboratory experiencies and discuss science laboratory activities with elementary students.

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CHAPTER IV

SOLUTION STRATEGY

Discussion and Evaluation of Solutions

A review of the literature suggested a variety of plausible solutions to the problems related to laboratory instruction which range from broad curriculum changes to implementation of specific classroom practices. Probable solutions were related to improving facilities and equipment, integrating science into other areas of the curriculum, addressing the negative attitudes of teachers, organizing a viable science laboratory curriculum and increasing inservice opportunities.

Appropriate facilities and equipment are essential for effective science laboratory instruction, in addition to provisions for consummable items used in science activities (James & Hord, 1988; Mechling, 1982). Higle (1991) suggests that the success of a science laboratory program depends upon the design of the lab facility, the equipment which is available for use and the identification of categorical bases for instruction. According to her own experience in setting up an elementary school science lab, student participation should be the central focus. That is, an elementary school science lab must be designed and equipped so that every student has the opportunity to be actively involved in a regularly scheduled, hands-on, laboratory experience.

The writer proposes that appropriateness is a measure of what is needed in a particular science program and may be specific to a school site. Facilities and equipment must facilitate instruction rather than become an impediment. This includes not only availability but also organization. Laboratory supplies and equipment must be easily accessible and identifiable.

Science laboratory instruction necessitates a hands-on instructional method. Proponents of this method advocate an emphasis on scientific processes and positive science experiences. Research suggests that students involved in inquiry-oriented, process approach science programs have higher scores on standardized tests of general science achievement, process skills, analytic skills, language arts and mathematics (Shymansky, Kyle, & Alport, 1983). However, Charles Anderson, a professor of teacher education at Michigan State University, premises his science methods classes with a warning that a "mindless hands-on science program is as possible as a mindless textbook program" (cited in Begley et al., 1990, p. 56).

A meta-analysis of the research on the effectiveness of hands-on, activity based science programs demonstrated that students performed better on measures of general achievement and problem solving skills (Shymansky, Hedges, Wordworth, & Berg, 1986). Based on these findings laboratory activities are a necessary component of science instruction, however, the strategy is not widely used because it requires detailed planning, teacher training and specific materials and equipment.

Early childhood experts believe that laboratory instruction for young children should relate to other areas of the curriculum (Zeimer, 1989). Practitioners have found that student interest is enhanced, achievement increased and positive attitudes are fostered in areas of study which are interdisciplinary (Main, 1984). Rather than science being an isolated experience, it should involve activities in areas of music, math and literature in what might be called a "holistic" approach. Advocates of this approach maintain that concepts are more easily acquired because they are whole, meaningful and functional (Cutting, 1988).

Research also shows that science experiences can be avenues for the development of basic language and reading skills (cited in Fehrenbach, Greer & Daniel, 1986). The Language Experience Approach (LEA) teaches beginning and remedial reading by combining students' experiences with their language patterns. According to Grabe (1981) LEA students can read, write, spell, and compose stories better than students in other reading programs.

The wholistic approach and LEA would intergrate subjects so that teachers would be able to effectively use a limited amount of time without sacrificing one subject for another. These approaches would also extend the laboratory experience outside the parameters of the lab facility making science lab activities an integral part of the curriculum rather than separate appendages. Although purchases of additional materials would be minimal, extensive planning is essential.

Yager and Penick (1986) endorse extending science lessons to include the community and advocate the use of problem solving methods when dealing with real environmental issues. They affirm that students learn more science from experiences unrelated to school science. Their research has found that building scientific knowledge by using actual experiences increases student achievement, interest and technological sophistication (Yager & Penick, 1986). To a limited extent this strategy may be applicable to elementary school, however, previous practical applications have been limited to secondary schools.

Inservice education on scientific methods and concepts enables teachers to design science instruction which motivates student interest, arouses curiosity and enhances positive attitudes (Kyle, Bonnstetter & Gadsen, 1988). Abel and Krueger (1991) propose that to improve instructional strategies in science education teachers must be trained by the same methods which they are to utilize in the science laboratory. By structuring training sessions in such a way that teachers experience the scientific processes they aspire to teach, participants increase their own process skills, develop a better understanding of science teaching methods, and feel more comfortable with teaching science. The authors found that teachers upon returning to their classrooms used the methods and concepts learned from the training sessions and made significant improvements in the quality of science laboratory instruction.

May (1989) describes a quite different scenario. He critically assessed a project undertaken by a group of small, rural schools who had formed a consortium in order to address educational probems. The Blue Mountain Small School Consortium (BMSSC) attempted to solve perceived weaknesses in elementary science education by offering summer inservice workshops on science kits, supplying appropriate curriculum materials, and facilitating training through videotaped lessons. May (1989) found that even though participation in the workshops was widespread and the training received excellent evaluations, the quality and/or quantity of science instruction did not improve when the teachers returned to their schools. These studies illustrate the importance of selecting appropriate avenues in implementing an elementary school's science lab program. One can infer that improvement in science must begin with teachers. Without their support and commitment the implementation of a science laboratory program for elementary students will be ineffective.

James and Hord (1988) describe a model for implementation which can be used as a tool for describing, introducing, and monitoring the introduction of an innovative science program. The key to the program is a facilitator who anticipates teachers' concerns, acts as a change agent, monitors activities, and makes revisions when necessary. This model is based on research on the change process conducted by Hord (1987) and includes an assessment of present practice, selection of a solution, initiation, implementation, and institutionalization. The model also addresses teachers' stages of concern and a taxonomy of interventions.

Doll (1986) describes three models for change: Research Utilizing Problem Solving Process (RUPS); Configurations, Linkages, Environments and Resources (CLER); and, Profile, Action, Response and Analysis (PARA). RUPS, developed by the Northwest Regional Educational Laboratory, is closely alligned with the five traditional steps in the change process; awareness, interest, evaluation, trial and adoption (Doll,1986). The CLER model although practical for assisting with program development and implementation in school situations, lacks the clarity necessary for lasting school improvements (Doll 1983). PARA is applicable to school improvement, however, the process focuses on individual profiles for goal setting and professional development (Cogan, 1973). A common element of all of the models examined is that teacher commitment is a prerequisite to the success of a newly introduced program and that innovation without a plan for change is doomed to failure.

Other areas in which the writer investigated possible solutions included the development of community resources to assist with science lab instruction (Feldman, 1987), using peer teachers as science laboratory instructors (Dunlevy, 1989) or hiring a science teacher for the science lab. Community resources remain largely untapped at the target school. As demonstrated by the active volunteer program and increased participation in the business partner program, the surrounding community is interested in promoting educational excellence. Peer teachers in the science lab is an interesting concept, however, teacher input suggests that teachers are not enthusiastic about that avenue for science instruction. Hiring a science teacher for the science lab would require additional funds to be appropriated and approval from the school board and the superintendent. With the reduction in force for this school year, this intervention is not feasible.

Description of Selected Solution

The writer chose to incorporate a change process model which included motivation, alternatives, planning and sharing (MAPS). Motivation concerns the identification of the need for change through analysis and assessment of the problem situation. Alternatives refer to the development of different scenarios for action. Planning involves the choice of a strategy and the formulation of an action plan. Sharing relates to communication among peers to adopt successful practices, note failures, routinize change effort procedures and revisit the initial step to identify revisions and/or other needs.

The change process model outlined strategies to ensure success in the implementation of science instructional techniques. The model also provided channels for constructive feedback and interventions which developed faculty commitment. Implementation of the model included inservice education in areas of effective teaching strategies, an introduction to the laboratory facility and equipment, exploration into interdisciplinary design and the development of community resources in an advisory and voluntary capacity.

Since the writer held an administrative position, she had to consider her role in the change process. According to James and Hord (1988), administrators should act as facilitators in the change process by encouraging adherence to the specified program, supporting teachers' efforts, assisting in problem resolution and supplying material requirements. Sergiovanni (1990) specifies the stages of leadership styles for school improvemment as bartering, building, bonding and banking. The stages refer to changes in leadership styles throughout the program improvement process. From her research, it is evident that the writer must fully understand the multiplicity of the administrative role during each stage of the change process.

Since teacher preparation was recognized as a barrier to effective science instruction, inservice training must be an essential part of any innovative program (James & Hord, 1988).

ERIC

Workshops presented strategies in science instruction, addressed specific concerns of teachers and developed positive attitudes toward science.

To analyze existing facilities and equipment, the writer prepared an inventory of materials in the science lab and assessed deficiencies and needed repairs. This process allowed the writer to "child-center" the lab facility in addition to making it "teacher friendly".

Interdisciplinary instruction is a wholistic approach which stresses linkages rather than delineations in concept areas. The writer felt that an integrated curriculum design would combat the fragmentation that has occurred in science lab instruction. Demonstration lessons in conjunction with inservice training helped to enhance and extend laboratory instruction by integrating classroom subjects with laboratory experiences.

Parental and community involvement promotes positive public relations, improves student attitudes, and increases student academic achievement. Using resources available in the community enriched the basic curriculum with experts in various fields and/or science-related organizations.

Report of Action Taken

The implementation of the practicum became a shared responsibility in order to foster goal commitment in improving science laboratory use and establishing the change process as an instrument to ameliorate overall school effectiveness. A committee had been established at the begining of the school year to enrich science education. Their established goal for the 1991-92 school year focused on improving science laboratory use. The writer worked collaboratively with this committee throughout the implementation process. The group was composed of representatives from grade levels, special programs and teacher assistants. The committee became a decision-making body with respect to science lab instruction, communication liasons for their represented groups, a leadership team which cooperatively solved problems associated with science lab instruction and monitored implementation progress. The writer became a member of the group rather than chair because of her involvement in the implementation.

The science committee met a total of fifteen times during the eight month implementation. Meetings were scheduled twice a month with the exception of the final month. The results are described according to the MAPS change process model.

Motivation

Activities in this stage clarified current practices to present documented evidence of a need for change. In addition, the target school faculty was made aware of avenues for change, current research trends and effective teaching strategies. Science laboratory problems and school (teachers' and students') attitudes toward laboratory instruction were identified through survey instruments designed by the committee (Appendix E). Results of the survey as demonstrated in Table 3 indicated that many students and teachers had negative attitudes toward science and that teachers lacked confidence or interest in teaching it.

The purpose of administering a learning style inventory was to reinforce teaching strategies which address style preferences and develop an awareness of one's own learning preference. Learning styles were assessed through the Gregorc Style Delineator. The instrument was administered and scored at a regularly scheduled grade level meeting. The results of the assessment were discussed with respect to teaching styles and accommodation for learning preferences.

A complete inventory of science laboratory equipment and materials was taken and a thorough inspection for "student-

Table 3

Pre-implementatin Student and Teacher Attitudes
Percent of Positive Responses

Item	Student N=694	Teacher N= 41
I like science:		
Best	24	0
All right	23	36
Least	45	64
Science is:		
Fun	26	7
Exciting	22	14
Interesting	16	25
Boring	76	33
During science lessons I feel:		
Successful	21	14
Uncomfortable	69	73
Curious	18	11
I would like more time for science lessons.	12	7
I would like more kinds of science activities.	58	12
I can use the science I've learned in everyday life.	21	57
I enjoy science lessons using:		
Discussion	10	53
Hands-on Activities	73	25
Worksheets	12	34
Book Activities	8	29

Note: Survey items selected and adapted from Preferences and Understandings-Teacher and Student Version, National Assessment of Educational Progress (NAEP) 1978.

friendly/teacher-friendly" use was conducted to assist the committee in evaluating deficiencies in materials and/or facility organization.

The committee adopted the National Science Teachers' Association (NSTA) Position Statement on Laboratory Science (1991) to guide science laboratory improvement. The standards (Appendix F) were posted in the science lab, reviewed at grade level meetings and included in a parent newsletter.

Science committee members met with grade level/program teams to complete the science lab questionnaire (Appendix A). Information from the questionnaire was used in planning inservice training, identifying perceived problems and accommodating scheduling concerns.

Alternatives

Actions implemented in this stage were directed toward decisions on specific strategies to improve science laboratory use. The committee examined options in scheduling, volunteer and business partnership assistance, staff development, and resources to purchase supplies and equipment.

The science lab schedule from the previous year was reviewed to attempt to address the concerns of teachers regarding sufficient time for set-up/clean-up, behavior of kindergarten students, language arts blocks and open times for additional activities. Scenarios for scheduling included weekly 30 minute time slots for each class, bi-monthly 45 minute sessions and weekly 90 minute sessions for third, fourth and fifth grade classes only. The committee decided that sessions for students in English for Speakers of Other Languages (ESOL) would follow grade level equivalents.

According to the NSTA (1991) Laboratory Position Statement, parent and community participation is essential in the implementation of an effective science lab program. It was especially important considering that the lab project began as a result of the efforts of parents and community leaders. Options examined which provided opportunities for volunteer assistance and participation were donations of supplies, business professionals in science-related fields used an instructors, guest presentations and science lab assistants for laboratory preparation and maintenance.

Although the science committee agreed that staff development was a necessary component of the implementation process, they adamantly opposed additional meetings because of the numerous after school meetings required for the target school's improvement plan and the completion of the initial self-study for accreditation by the Southern Association of Colleges and Schools. Methods of inservice training were considered which eliminated the necessity for additional afternoon meetings. Options included training during regularly scheduled inservice days, workshops during designated grade level/team meetings, provisions for release time for training and demonstration lessons during laboratory sessions.

The science laboratory had been equipped the previous year with non-consummable materials. The problem for many teachers became the expense of purchasing consummable supplies required for many science laboratory activities. Suggestions made to address this problem were to charge students a small fee to cover science materials, request funds from the Parent Teacher Association (PTA) and/or community businesses, make petty cash available for immediate purchases and apply for local mini-grants to cover the cost of materials.

Members of the science committee expressed concern about science lab activities being duplicated throughout grade levels. It was proposed that either a curriculum guide for laboratory activities be developed by the committee or that descriptions of laboratory experiences conducted by teachers during the year would be organized by grade level.

Planning

A draft of the schedule was reviewed by each teacher and discussed at grade level/program meetings. Revisions for time slots were made and the schedule was accepted. The final science laboratory schedule (Appendix G) included 30 minute bi-monthly sessions for K-2 classes and hour bi-monthly sessions for 3-5 classes. Because of increased class size in kindergaten, location of kindergarten classrooms on campus and behavior problems encountered on the way to and from the science lab, kindergarten teachers conducted lab activities in their classrooms for the remainder of the first semester. First grade teachers requested laboratory sessions to be scheduled every week. Self-contained ESOL classes were scheduled for sessions according to the grade placement of the majority of their students. Open times were available for teachers to conduct special projects or additional activities. Copies of the schedule were posted weekly in the science lab and included in a faculty bulletin. Each teacher was requested to initial the weekly schedule which was posted in the lab when conducting a lab session in order to monitor laboratory use.

The science committee met with the volunteer coordinator to discuss plans for amassing a group of parents and/or business partners as lab assistants or guest instructors. In grades K-2, four parents from each grade level volunteered as lab assistants on a rotating basis. These parents would assist teachers in preparing the lab and organizing materials for specific experiences, helping students during the activity and cleaning up after the activity was completed. A third grade parent with an educational background volunteered to plan and conduct laboratory lessons for all third grade students. The community hospital offered to organize a group of lab professionals to conduct laboratory sessions for fourth grade students focusing on the body and the use of laboratory techniques in designing experiments. For fifth grade, one parent was interested in becoming a lab assistant for all fifth grade classes. It was decided that when a volunteer was unable to attend a scheduled time, that volunteer was responsible for finding a substitute and/or contacting the volunteer coordinator.

The writer worked closely with all volunteers to address concerns, coordinate curriculum, provide materials and give feedback from the teachers and students and to recognize volunteers for their contribution of time and effort. An orientation meeting introduced the volunteers to the lab facility, the materials request form (Appendix H) , the lab inventory and campus layout. Keys to the science lab were made available for check-out to the volunteers. The materials request form simplified laboratory set-up and ensured availibility of supplies. Five forms were given to each teacher and others were avialable from the office staff. Requests for materials were submitted one day prior to a scheduled lab session.

Since the science committee considered afternoon workshops a detriment to the implementation of an improvement plan, inservice training was planned during regular grade level/team meetings and district-wide inservice days. Workshops included an orientation to the lab facility, laboratory teaching strategies, sample activities, demonstration lessons, safety precautions and coordination of classroom lessons with laboratory experiences. Originally, the writer had planned to conduct three, two-hour workshops with participants from each grade level. The present method changed the configurations of the workshops.

Several avenues were developed through which consummable materials would be acquired. Each grade level was asked to formulate a list of supplies needed for science lab activities for each month. The list was distributed to parents in a monthly newsletter and to local business establishments. Teachers applied for mini-grants to cover materials expenditures and the principal established a petty cash fund, not to exceed $35 per teacher, to be used for science material purchases.

Teachers were requested to provide copies, descriptions or outlines of each lab lesson they conducted with an evaluation in order to develop a guide for science laboratory activities. The final collection would become a basis for laboratory experiences by grade level.

Sharing

Sharing was incorporated throughout the implementation process to monitor progress and identify areas which needed to be revised. As a stage in the change process, it was a review of what actually occurred during the process and a final analysis to determine the effectiveness of planned strategies to improve laboratory use.

Classes attended scheduled lab sessions according to designated times. Problems arose in arranging special assemblies or programs, however, sufficient open time slots were available to accommodate classes which had to be rescheduled. In the beginning, teachers neglected to initial the posted schedule in the science lab when lessons were conducted. Committee members shared on a rotating basis the responsibility of confirming and completing (if necessary) documentation through review of weekly schedules and teacher contact. Parent/business partner volunteers who functioned as lab assistants or instructors were scheduled for the remainder of the school year. The volunteer coordinator and the writer were

ERIC

responsible for confirming volunteer attendance and documentation of times. Volunteers/business partners became valuable, dependable components of the laboratory program. Instructors presented lessons which provided students hands-on situations using career-oriented, science experiences. Volunteer lab assistants demonstrated initiative and enthusiasm in setting up the lab for an activity and helping the teacher and student during the experience.

Opportunities to provide inservice training became available throughout the school year. Orientation sessions of the science lab were conducted during regularly scheduled grade level meetings and demonstration lessons were modeled for each teacher during lab sessions. The writer was able to reserve participant slots for a district science workshop, interest several teachers in attending business sponsored science workshops and recommend a teacher to attend a science methods class at no charge for inservice points and college credit. The writer also secured permission to provide substitutes for four committee members to visit an established elementary school science laboratory in another district.

Science committee members and the target school faculty were greatly concerned about supplying materials during a time of budget cuts and economic recession, however, the greatest problem connected with consummable supplies was not obtaining them but became storing them. The response to the listing of items needed to conduct science activities in the newsletter and distributed to community businesses was overwhelming. Boxes and bags filled with supplies were sent in daily. Parents and independent enterpreneurs were excited about donating the inexpensive but much needed materials. This allowed teachers to use the petty cash funds to purchase perishable materials for science activities.

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CHAPTER V

RESULTS, DISCUSSION AND RECOMMENDATIONS

Results

This practicum addressed deficiences in the implementation of a science laboratory program. Neither teachers nor students exhibited an interest in laboratory activities, scheduled laboratory sessions were not being utilized, there were no district curriculum guidelines to support laboratory instruction and instructional strategies for laboratory activities were ineffective, inappropriate and failed to motivate students' curiosity.

To improve the instructional significance of the science laboratory, the writer initiated a MAPS change process model in collaboration with a science committee. The committee assumed a leadership role in developing goal commitment, communicating a shared vision, resolving implementation obstacles, monitoring progress and strategic planning. Using the change process model, committee members identified deficiencies, specified problem

ERIC

areas, formulated alternative scenarios, delineated strategies for program improvement and synthesized implementation outcomes. During committee meetings, members communicated concerns of team/grade level teachers, gave detailed reports on implementation progress, planned strategies to be introduced, shared successful practices in laboratory instruction and made recommendations for inservice training. The implementation process was completed after eight months. A discussion of the success or failure of each objective follows.

Objective One stated that each K-5 class will participate in a laboratory session twice a month as documented on a calendar schedule, in lesson plans and by laboratory reports. Each teacher documented laboratory sessions on a monthly schedule posted in the lab. Lab instruction included guided hands-on activities, independent exploration experiences, demonstration lessons and controlled experiments. Documentation of laboratory instruction was supported by explanations in lesson plans and copies of laboratory activities. Table 4 illustrates a monthly average of the sessions scheduled as compared with the sessions conducted. Table 5 designates the total number of laboratory sessions attended by each teacher at each grade level.

Table 4

Average Daily Log of Laboratory Sessions

Laboratory sessions scheduled/ Sessions conducted

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	4/4	6/6	3/3	4/4	2/2
2	3/3	3/4	3/3	4/4	2/2
3	4/4	6/7	3/3	4/4	2/3
4	3/5	3/3	3/3	3/3	2/3

Table 5

Total Laboratory Sessions by Teacher

Grade	Teacher				
	A	B	C	D	E
K	14	14	14	16	
1	18	16	18	19	*16
2	16	16	16	16	
3	18	17	17	18	
4	16	16	20	20	**18
5	18	18	20	20	***16

*ESOL Primary Class
**ESOL Intermediate Class
***Alternative Education Class

For Objective One to be successful each teacher must have conducted 14 science laboratory sessions. Note the number of kindergarten laboratory sessions even though they attended none during first semester. The teachers attended weekly sessions during second semester which compensated for the sessions not attended at the beginning of the year. As demonstrated by Table 7 the number of laboratory sessions satisfied and exceeded the number needed for this objective to be met.

According to Objective Two, one teacher per grade level will have completed six hours of inservice training. Training incorporated workshops during grade level/team meetings, district or business sponsored workshops, observation of demonstration lessons, follow-up assignments to science workshops, university sponsored training and visitations to model elementary science laboratories. Table 6 indicates hours of training for each grade level teacher.

Results far surpassed the hours specified in the objective. Unexpected developments during implementation provided opportunities for workshops, demonstrations of model lessons and classes sponsored by university and science-related organizations.

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Table 6

Hours of Inservice Training

Grade	Teacher				
	A	B	C	D	E
K	18	6	8	6	
1	62	62	62	18	*8
2	6	8	10	10	
3	122	14	16	18	
4	20	20	20	26	**20
5	8	10	8	18	***10

*ESOL Primary Teacher

**ESOL Intermediate Teacher

***Alternative Education Teacher

Objective Three stated that sixteen descriptions of laboratory activities which have been positively evaluated are required for each grade level. An activity which received an overall rating of 3 or above on the Laboratory Activity Evaluation Form (Appendix D) was considered positively evaluated. Thirty-two activities were collected for kindergarten, 19 for first grade, 32 for second, 18 for third, 24 for fourth and 20 for fifth grade. Using the evaluation criteria explained above, the writer eliminated activities falling below the "three" rating. The final collection was comprised of 24 kindergarten, 18 first grade, 28 second grade, 16 third grade, 20 fourth grade and 18 fifth grade activities. The number of activities exceeded the requirement specified in Objective Three.

In Objective Four, a minimum of ten community volunteers will contribute a total of 160 hours ofvolunteer service in science laboratory activities. Volunteer service encompassed laboratory instruction, lab preparation and maintenance, lab assistance during activities, lesson preparation time and guest presentations. Table 7 represents hours recorded for 30 volunteers for each month of implementation.

Table 7

Science Lab Volunteer Hours

Month	Hours				
	Instruction	Set-up/ Clean-up	Maintenance	Preparation	Assistance
NOV	15	6	6	4	6
DEC	16	6	2	11	24
JAN	27	4	2	9	24
FEB	24	3	3	10	26
MAR	30	2	1	10	12
APR	18	2	1	6	11
MAY	24	2	2	10	24
JUN	8	1	8	4	6
JUL	0	0	16	0	0
SUBTOTAL	162	26	41	64	143
		TOTAL	436		

Both the total number of volunteers and the hours which they donated was more than the amount specified in the objective.

Committee members were responsible for collecting copies of lab activities from teachers and ensuring that activity descriptions and evaluations were complete. Some grade level teachers planned activities on a rotating basis. One teacher would plan the activity and coordinate materials for all the classes at that grade level. However, each teacher would evaluate the activity separately. Committee members reviewed the lab activity guide and organized activities appropriate for each grade level.

A survey was administered to teachers to gather information about the practices which were implemented (Appendix I). To summarize, teachers stated that:

1. The laboratory schedule provided sufficient time for preparation, instruction and clean-up.
2. Volunteers were invaluable before, during and after laboratory sessions. Explore the possiblity of incorporating peer tutors to assist kindergarten and first grade students in the lab.
3. Science lessons conducted by professionals enhanced concept development and career education.
4. Knowlegeable volunteer instructors expertly

demonstrate scientific processes not only for students but also for teachers.

5. Demonstration lessons were effective in modeling teaching strategies. Request that the process be expanded.

6. Teachers assumed no expense for consummable materials for science activities.

7. The science laboratory is not centrally located. Consideration should be given to ciasses located at the opposite end of the campus.

A survey was sent to parents (Appendix C) to assess parental knowledge and involvement in the science laboratory program. One survey was set home for each family. Of the 457 surveys sent, 352 parents responded. Table 8 illustrates parents' positivity about science lab instruction as an important aspect of education. Comments included suggestions that children be allowed to go to the science lab more often, the development of an after-school science lab program, more professionals as instructors and a better classroom facility.

Table 8

Parent Survey: Science Laboratory Program

Item	Percentage of Positive Responses
My child goes to the science lab regularly.	74
My child enjoys going to the lab.	94
I have volunteered my time in the science lab.	45
I feel instruction in the science laboratory is important.	92
Science education is preparing students to be informed citizens.	91

Each volunteer lab assistant/.nstructor completed a questionnaire (Appendix B) to assist the committee in planning for continuation of the science volunteer program. Science volunteers were recognized at at luncheon sponsored by the target school faculty and staff. The community hospital volunteers were also recognized at a school board meeting and at a reception organized by the hospital administration and the target school.

Students and teachers completed an attitudinal survey (Appendix E). The results as seen in Table 9 demonstrate an increase in positive attitudes toward science. After implementation students and teachers enjoyed science more, felt better about being involved in science lessons, believed science concepts learned had practical applications in everyday living and acquired a different conception of effective science instructional strategies.

Table 9

Post-implementation Student and Teacher Attitudes
Percent of Positive Responses

Item	Student N=694	Teacher N= 41
I like science:	Pre/post	Pre/post
Best	24/74	0/52
All right	23/20	36/38
Least	45/6	64/10
Science is:		
Fun	26/82	7/68
Exciting	22/72	14/57
Interesting	16/78	25/92
Boring	76/19	33/6
During science lessons I feel:		
Successful	21/87	14/79
Uncomfortable	69/12	73/8
Curious	18/72	11/77
I would like more time for science lessons.	12/82	7/36
I would like more kinds of science activities.	58/83	12/57
I can use the science I've learned in everyday life.	21/86	57/93
I enjoy science lessons using:		
Discussion	10/6	53/21
Hands-on Activities	73/92	25/86
Worksheets	12/5	34/12
Book Activities	8/3	29/6

Note: Survey items selected and adapted from Preferences and Understandings-Teacher and Student Version, National Assessment of Educational Progress (NAEP) 1978.

Discussion

The objectives of this practicum addressed barriers which prevented an effective science laboratory program. However, the evaluative criteria for the objectives and end results were, in fact, indicators of dedicated utilization of a change process model. Through the participatory change process, teachers developed ownership of the laboratory program which had been lacking previously. The science laboratory lost its connotation as an imposition and became a vital instrument in science education.

Initially, teachers were unwilling to do more than complain. This school year district decisions created a climate of dissension. The resulting controversy negatively affected staff morale and cooperative attitudes. The teachers who volunteered as members of the science laboratory committee were sincerely commited to enhancing science education through laboratory instruction. The members of the committee assumed leadership responsibilities during the implementation. Research concludes that leadership roles in schools are not confined to those individuals in established positions of authority (Cox, Loucks-Horsley & French, 1987). As noted in an elementary science education report sponsored by the National Center for Improving Science Education, enduring improvements in educational practices require a variety of leader configurations (Loucks-Horsley et al., 1989). The science committee, being comprised of individuals from diverse levels and backgrounds, created an atmosphere for commitment, enthusiasm, cooperation and empowerment.

The majority of teachers agreed that the schedule from the preceding year was unrealistic. The major shortcoming was insufficient time alloted to allow for preparation and clean-up. Other concerns included grade level blocks in the science laboratory, longer but less frequent lab sessions and open slots for special projects. It became apparent that the aforesaid lab schedule was frustrating teachers and, therefore, they abstained from using the lab. The newly formulated schedule became a workable solution. Even though classes were not scheduled as often, each designated class time was attended--with some classes conducting additional sessions.

Another factor which discouraged teachers from using the laboratory was the time and effort spent in setting up activities. They were unfamilar with the lab, other concerns held greater priority and often the lab was not easily accessible. This was a pronounced concern especially among primary teachers. Younger students were unable to set up or clean up quickly after a lab activity. This problem also belied the deficiency in scheduling. The coordination of a group of parent volunteers to assist not only in lab preparation and organization but also with science activities, alleviated the burden of science lab mechanics for teachers, helped to maintain a smooth progression during laboratory adventures and offered parents a rewarding and enlightening experience in science education.

Inherent in the deficiencies in hands-on activities was an ignorance of stimulating science experiences, discomfort with experimental methods and/or prohibitive costs of materials. It became crucial that teachers be educated about resources, cooperative learning methods and teaching strategies involved in successful learning experiences in science. In addition, materials and/or funds to purchase materials had to be readily available. The learning style self-assessment initiated a renewed awareness of the variety of preferences for learning. Demonstration lessons and training established a reference for teaching methods and activities. Donations of materials and supply funds greatly reduced, if not eliminated, the cost teachers usually incurred to conduct science activities. Lab orientations, a professional science reference guide and a science laboratory inventory demystified the scientific domain of instruction.

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Initially, the introduction of professionals in science related fields conducting science lab lessons was not taken seriously. Teachers were thrilled with the proposition that a person trained in science would prepare and present lessons, but wary about the endurance and regular attendance of the volunteers. Because the volunteers were not educationally oriented the writer worked closely with them in lesson content, time frames, materials, objectives, cooperative grouping and the development of follow-up activities. To facilitate lesson flow and to model the cooperative group process, teachers were asked to have students divided into groups of three. Each student was assigned a title with a specific assignment: Director, Materials Manager and Recorder. Volunteer instructors provided each teacher an outline of the activity and suggestions for follow-up.

The volunter instructor program was a resounding success according to teachers, students and volunteers. Teachers became observers and facilitators of the scientific process. Students were enthralled with using laboratory equipmont and bombarded volunteers with amazingly detailed questions. Volunteers gained a true respect for teachers and a delightful sense of accomplishment.

The writer noted "spin-off" results of the emphasis placed on the improvement of science education. Students became more

ERIC

involved in science outside the regular classroom environment. An obvious measure of interest was science fair participation. In 1990, 45 kindergarten through fifth grade students submitted projects in the target school science fair, of which five were entered in the district science fair and none received placement. In 1992, 112 projects submitted by students in second through fifth grade were reviewed for placement in the district fair. Twenty were selected and 12 received honors. The target school was recognized for having the most points for awards in the district fair. In addition, 25% of the school's students participated in the three science camps offered by state parks and other agencies compared with 5% in 1991.

At the conclusion of the school year, the writer found that student achievement in science had increased both on report cards and on standardized tests. In grades three through five, 93% of students earned a grade of "C" or higher in science. The writer compared 1991 and 1992 standardized test scores in science. Only students who had taken the science section of the achievement test were tabulated. Therefore, a second grade student's score in 1991 would be compared to his/her score as a third grader in 1992. Figure 1 demonstrates the results of the comparison.

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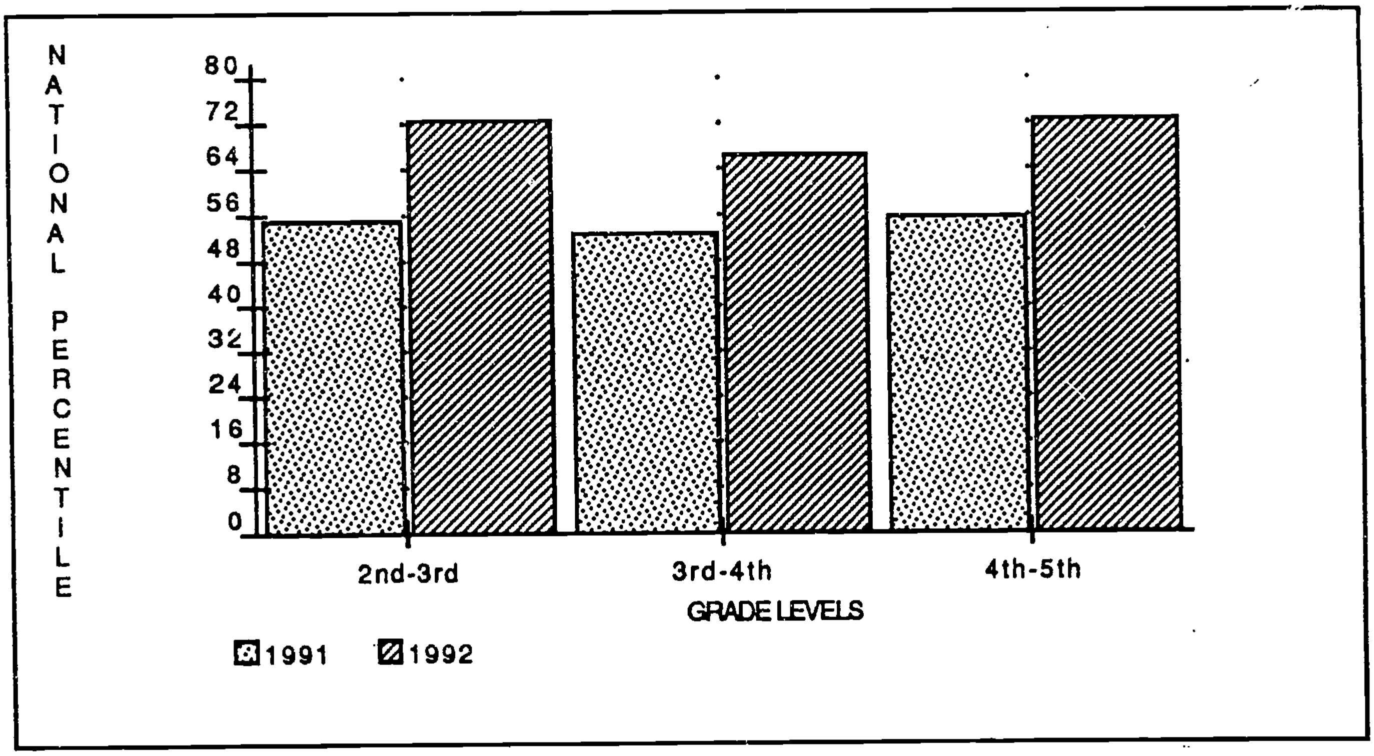
Figure 1

Comparison of 1991-1992 California Achievement Test Scores



During the sixth month of implementation the writer observed teachers to determine the extent of instructional improvement in teaching strategies. Table 10 demonstrates the change which was incurred.

Table 10

Instructional Strategies Used by K-5 Teachers During a Laboratory Lesson (Post-implementation)

Strategy	Number of Teachers	
	Pre	Post
Cooperative Learning	3	24
Discussion	24	8
Demonstration	21	10
Students use manipulatives	4	18
Students use laboratory equipment	3	24
Students work independently	21	0
Students interaction encouraged	3	24
Students allowed to explore	0	12
Students complete worksheets	22	12
Use of scientific method	2	16

Note: Strategies taken from Science and Technology Education for the Elementary Years: Frameworks for Curriculum and Instruction by R.W. Bybee, C.E. Buchwald, S. Crissman, D.R. Heil, P.J. Kuerbis, C. Matsumoto and J.D. McInerney, 1989, Colorado Springs: The National Center For Improving Science Education.

The documented results and corresponding effects of this practicum support the use of a participative strategy in a change model. The processes involved to accomplish stated goals is as, if not more, important than the goal itself. Just as an individual is not an island so cannot a goal be isolated from its content. By developing commitment, establishing a vision, initiating communication through collaboration, empowering teachers, maintaining administrative support and transposing problems into solutions, hindrances in the improvement plan became invitations for achievement.

In conclusion, improvement in science education can be accomplished through collaborative decision-making, adherence during implementation to the structure and flow of an appropriate change process model and practices in congruence with identified standards.

Recommendations

The writer submits the following recommendations for the continuation of improvement in science laboratory education at the target school:

1. Develop K-5 thematic units of science laboratory curriculum guide which integrate classroom experiences with laboratory techniques and processes.
2. Initiate an after-school science laboratory program

managed by volunteers.

3. Expand the use of volunteer instructors to all grade levels.
4. Develop methods to assess student progress during laboratory instruction.
5. Change the location of the lab facility by moving it to a better suited and/or centrally located building/room.
6. Continue the science committee as a resource to monitor laboratory use, provide curricular advise, augment curriculum and to maintain the momentum in promoting educational excellence in science.
7. Introduce technology into the science laboratory to expand techniques in exploration, documentation and robotics.

Dissemination

The results of this practicum were shared with the target school's faculty and administrator, district administrators and school board members, and parent/community volunteers. The faculty and staff were enthusiastic about student interest and motivation to learn science through laboratory activities. District administration and school board members commented on the improvement of achievement scores and the positivity in volunteer commitment to the program. Parent and community volunteers have already expressed their enthusiasm in working in the science lab for the next school year. The writer has also organized visits to the science lab and provided district and neighboring district schools with a summary of practicum implementation actions and results.

The writer intends to share practicum results with local and state science organizations and to develop lab activity resource packets to be shared with other schools. She plans to submit a summary of practicum outcomes and/or descriptions of specific components of the implementation to professional journals.

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APPENDIX F

A NSTA POSITION STATEMENT ON LABORATORY SCIENCE

APPENDIX F

A NSTA POSITION STATEMENT ON LABORATORY SCIENCE

Elementary science classes must include activity-based, hands-on experiences for all children. Activities should be selected that allow students to discover and construct science concepts; and, after the concept is labeled and developed, activities should allow for application of the concept to the real lives of students. Provisions also need to be included for inquiry activities in which students manipulate one variable while holding others constant and extablish experimental and control groups.

Children at all developmental levels benefit brom science experiences. Appropriate hands-on experiences must be provided for children with special needs who are unable to participate in classroom activities.

A minimum of 60 percent of the science instruction time should be devoted to hands-on activities, the type of activities where children are manipulating, observing, exploring, and thinking about science using concrete materials. Reading about science, computer programs, and teacher demonstrations are valuable, but should not be substituted for hands-on experiences.

Evaluation and assessment of student performance must reflect hands-on experience. The full range of student experience in science should be measured by the testing program.

Hands-on activities should be revised and adapted to meet student needs and to enhance curricular goals and objectives. There should be ongoing dissemination of elementary science education research results and information about supplementary science curricula.

Hands-on activities must be supported with a yearly building science budget, including a petty cash fund for immediate materials purchase. Enough supplies, e. g., magnets, cells, hand lenses, etc., should be purchased, permitting each child to have hands-on experiences. Many science activities can also be taught using easily accessible, free and inexpensive materials.

Reasonable and prudent safety precautions should always be taken when teachers and students are interacting with manipulative materials.

Elementary science should be taught in a classroom with sufficient work space to include flat moveable desks or tables/chairs, equipment, and hands-on materials. Consideration should be made for purchase an storage of materials with convenient accessibility to water and electricity. Computers, software, and other electronic tools should be available for children's use as an integral part of science activities.

Parents, community resource people, and members of parent/teacher organizations should be enlisted to assist elementary teachers with science activities and experiences. For example, these individuals could act in the role of field trip chaperones, science fair assistants, material collectors, or science classroom aides.

The number of children assigned to each class should not exceed 24. Teachers and children must have immediate access to each other in order to provide a safe and effective learning environment.

NSTA Reports (1991, November/December). National Science Teachers Association, Washington, DC pp15-16.

APPENDIX G

SCIENCE LAB SCHEDULE

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APPENDIX G

SCIENCE LAB SCHEDULE

"A" WEEK

TIME	MON.	TUES.	WED.	THURS.	FRI.
8:15-8:45	OPEN	OPEN	OPEN	FOURTH-A	OPEN
8:50-9:20	OPEN	OPEN	OPEN	FOURTH-A	OPEN
9:25-9:55	OPEN	KNG-A	OPEN	OPEN	FIFTH-A
10:00-10:30	KNG-B	KNG-C	KNG-D	FOURTH-B	FIFTH-A
10:35-11:05	OPEN	OPEN	OPEN	FOURTH-B	FIFTH-B
11:10-11:40	OPEN	OPEN	OPEN	OPEN	FIFTH-B
11:45-12:15	FIRST-A	FIRST-B	THIRD-A	OPEN	OPEN
12:20-12:50	SND-A	SND-B	THIRD-A	ESOL-INT	OPEN
12:55-1:25	OPEN	OPEN	THIRD-B	ESOL-INT	OPEN
1:30-2:00	FIRST-C	FIRST-D	THIRD-B	OPEN	OPEN

SCIENCE LAB SCHEDULE

<u>"B" WEEK</u>

TIME	MON.	TUES.	WED.	THURS.	FRI.
8:15-8:45	OPEN	OPEN	OPEN	FOURTH-C	OPEN
8:50-9:20	OPEN	OPEN	OPEN	FOURTH-C	OPEN
9:25-9:55	OPEN	OPEN	OPEN	OPEN	FIFTH-C
10:00-10:30	OPEN	OPEN	OPEN	FOURTH-D	FIFTH-C
10:35-11:05	OPEN	OPEN	OPEN	FOURTH-D	FIFTH-D
11:10-11:40	OPEN	OPEN	OPEN	OPEN	FIFTH-D
11:45-12:15	FIRST-A	FIRST-B	THIRD-C	OPEN	OPEN
12:20-12:50	SND-C	SND-D	THIRD-C	ESOL-PRI	OPEN
12:55-1:25	OPEN	OPEN	THIRD-D	OPEN	ALT. ED.
1:30-2:00	FIRST-C	FIRST-D	THIRD-D	OPEN	ALT.ED.

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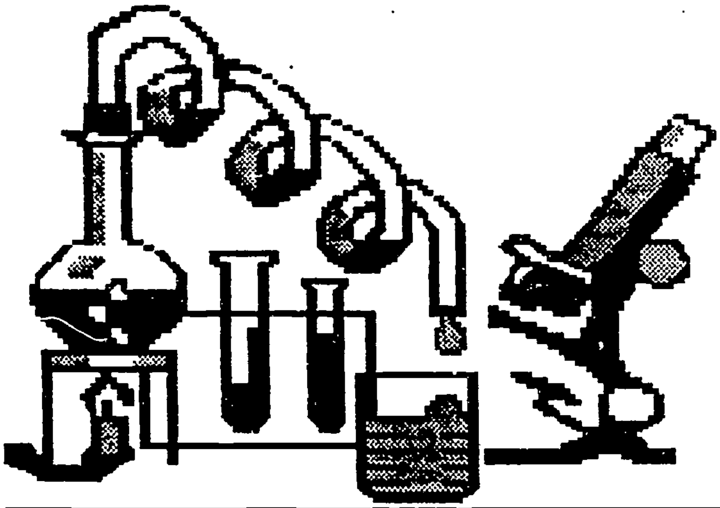
APPENDIX H

LABORATORY MATERIALS REQUEST FORM

ERIC



SCIENCE LAB

CLASS PLANNING GUIDE

TODAY'S DATE:___________ LAB DATE:___________ *

TEACHER:____________ GRADE:______

NUMBER OF STUDENTS:____________

MATERIALS TO BE USED:______________________________

____

____

____

____

____

____

SPECIAL INSTRUCTIONS:____________________

____

____

____

____

*PLEASE TURN IN THIS REQUEST BEFORE YOUR NEXT LAB TIME.

APPENDIX I

SCIENCE LABORATORY PROGRAM EVALUATION SURVEY

ERIC

DATE: September 9, 1992

TO: Dr. Mary Ellen Sapp
Director of Practicums
Programs in Child and Youth Studies
Nova University/CAE
3301 College Avenue
Fort Lauderdale, FL 33314

FROM: ERIC Clearinghouse on Elementary
and Early Childhood Education
University of Illinois
College of Education
805 W. Pennsylvania Avenue
Urbana, Illinois 61801-4897

RE: Practicum Report

Student: Wanda S. Vorsino

Cluster: 34

Title: Improving the Effectiveness of Science Laboratory Instruction for Elementary Students Through the Use of a Process Approach for Change

The report has ______ has not ______ been accepted for abstraction in ERIC.

____
Signed

Accession Number ____________________

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APPENDIX A

TEACHER SURVEY OF SCIENCE LABORATORY PROCEDURES AND PRACTICES

ERIC
Full Text Provided by ERIC

APPENDIX A

TEACHER SURVEY OF SCIENCE LABORATORY PROCEDURES AND PRACTICES

Please respond to each item as a grade level.

1. List any procedures or practices in the science lab which you would like continued.

2. List suggestions for scheduling of science lab sessions.

3. How do you feel science lab instruction could be improved?

4. General Comments

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APPENDIX B

VOLUNTEER LAB ASSISTANT QUESTIONNAIRE

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APPENDIX B

VOLUNTEER LAB ASSISTANT QUESTIONNAIRE

We appreciate the hours you have spent volunteering your time in the JOY OF DISCOVERY. In order to plan for future programs in the science lab, please complete this questionnaire.

1. In what areas did you enjoy volunteering?
   a. working with students
   b. set up--clean up
   c. inviting guest speakers
   d. caring for animals
   e. taking inventory
   f. caring for materials and supplies

2. Which one (or ones) of the above areas would you volunteer for next year?

   ____

   ____

3. What are some practices that you would like to see continue in the science lab?
   a.____
   b.____
   c.____

4. What would you like to see changed in the science lab?
   a.____
   b.____
   c.____

APPENDIX C

PARENT SURVEY: SCIENCE LAB PROGRAM

APPENDIX C

PARENT SURVEY: SCIENCE LAB PROGRAM

We are very proud of our science lab and want to ensure that it continues to provide th best possible laboratory program for our students. Please help us by completing this survey. Circle your response to each question or statement.

1.	My child goes to the science lab regularly.	Yes	No
2.	I feel instruction in the science laboratory is important.	Yes	No
3.	I have volunteered my time in the science lab.	Yes	No
4.	My child enjoys going to the science lab.	Yes	No
5.	Is our science education program preparing students to be informed citizens?	Yes	No

Please complete the following statements.

The science lab program could be improved by______________________________

I feel the science lab needs______________________________

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APPENDIX D

LABORATORY ACTIVITY EVALUATION

APPENDIX D

LABORATORY ACTIVITY EVALUATION

DIRECTIONS: Please rate the activity you conducted 1 being the lowest to 5, the highest.

1. Students were interested.	1 2 3 4 5
2. Activity was appropriate for grade level specified.	1 2 3 4 5
3. The activity was well organized.	1 2 3 4 5
4. The activity concept snhanced science curriculum.	1 2 3 4 5
5. Materials were available and easy to obtain.	1 2 3 4 5
OVERALL RATING	1 2 3 4 5

COMMENTS:

APPENDIX E

STUDENT AND TEACHER ATTITUDE SURVEY

ERIC

APPENDIX E

STUDENT AND TEACHER ATTITUDE SURVEY

DIRECTIONS: Circle a response for each survey item. For items 2, 3 and 7 more than one response may be chosen.

1. I like science:
   Best All right Least

2. Science is:
   Fun Exciting Interesting Boring

3. During science lessons I feel:
   Successful Uncomfortable Curious

4. I would like more time for science lessons. YES NO

5. I would like more kinds of science activities. YES NO

6. I can use the science I've learned in everyday life. YES NO

7. I enjoy science lessons using:
   Discussion Hands-on Activities
   Worksheets Book Activities

Note: Survey items selected and adapted from Preferences and Understandings-Teacher and Student Version, National Assessment of Educational Progress (NAEP) 1978.