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ABSTRACT

This report describes a program for improving scientific literacy at the primary level. The target population consisted of pre-kindergarten and second grade students in an expanding suburban Midwestern community. An intervention which included the identification of scientific skills and their integration into the curriculum, student exposure to scientific properties through hands-on and real-life experiences, and explicit teaching of the processes of science is described. Findings indicate that students' scientific literacy increased as a result of the intervention. (Contains 36 references.) (WRM)

IMPROVEMENT OF SCIENTIFIC LITERACY AT THE PRIMARY LEVEL

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ABSTRACT

This report describes a program for improving scientific literacy at the primary level. The targeted population consisted of pre-kindergarten and second grade students in an expanding suburban community, located in the mid-west. Surveys conducted within district indicated that the targeted population was lacking in scientific literacy skills.

Literature research indicated that scientific literacy within the nation and state were below acceptable levels. Site based probable cause indicated district mandated curriculum had not been integrated with the newly adopted science textbook. Tests and observations showed that students' lacked observational skills, the ability to make logical predictions, and had difficulty forming explanations and conclusions.

Research literature combined with analysis resulted in the development of a three-step intervention. First, the scientific skills were identified and integrated into mandated curriculum. Second, students' exposure to scientific properties was expanded through hands-on and real life experiences. Third, the scientific process was taught and students were guided on how to relate this to other aspects in the real world.

Post intervention data indicated an increased development in the targeted scientific skills. The skills were observation, questioning, predicting, explaining and forming conclusions, application, and integration of all previous skills. Through the utilization of these skills, students increased their scientific literacy.

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CHAPTER 1

IMPROVEMENT OF SCIENTIFIC LITERACY AT THE PRIMARY LEVEL

General Statement of the Problem

The scientific literacy of primary students is inadequately developed. Tests and observations show that student's lack observational skills, the ability to make logical predictions, and have difficulty forming explanations and conclusions.

Immediate Problem Context

The subject facilities are located in a Midwest suburban unit district. Both sites have been school buildings that were closed and now reopened to satisfy growing student population needs.

Site A

Site A was built in 1972 as an open-concept school to house kindergarten through fifth grade students. This mid-sized facility was closed in 1992 due to a decrease in district student population. As a result of later district growth, the facility was reopened with a modified floor plan in 1994 as a pre-kindergarten through grade three building with consecutive yearly grade level expansions through the sixth grade. To achieve the district's goal of technology-enhanced classrooms throughout the district, the addition of interior walls was necessary to provide for access and hook-up of required computer hardware. As district growth continued to increase, the district reorganized all the elementary schools in 1997 to house grades first through sixth.

All district kindergarten and pre-school programs were moved to a reopened building. Now, the facility is comprised of five double and ten single classrooms which house an average of twenty-five students per room. Overall, the building is in sound structural shape and its size remains adequate for the present student population.

Site A currently houses first through sixth grade and the total population stands at 498 students. This population is comprised of: 92.2% White, 3.4% Hispanic, 2.4% Asian/Pacific Islander, 1.8% Black, and .4% Native American. None of these students has been identified as Limited-English-Proficient. Low-income families account for 16.1% of the total school population. The attendance patterns indicate a rate of 95.9% compliance with a student mobility rate of 14.8%. Two chronically truant students make for a chronic truancy rate of .6% (School Report Card, 1996b).

The academic team consists of: one principal, two district coordinators, three first grade teachers, three second grade teachers, three third grade teachers, three fourth grade teachers, three fifth grade teachers, and three sixth grade teachers. Support staff in the building include: one full time Early Literacy Specialist, one half-time Early Literacy Specialist, one half-time special education resource teacher, one half-time speech and language clinician, one half-time nurse, one part-time social worker, one part-time psychologist, and one part-time physical therapist. Additional support staff consists of: two part-time physical education teachers, two part-time art teachers, two part-time music teachers, and one full time learning center director. The teaching experience of the academic staff ranges from one year to twenty-seven years with eight of the twenty-five staff members holding a master's degree. The office staff consists of: one secretary, two part-time office aides, and five part-time general program aides who assist in teacher material preparation.

A team-teaching approach is used to cover the core subjects in technology-enhanced classrooms. Time devoted to each core subject on a weekly basis is as follows: reading/language arts, twelve and three-quarter hours; math, three and three-quarter hours; social studies, one hour; science, one hour. Curriculum integration allows for incorporation of commercially purchased programs, such as the self-esteem program know as Positive Action. These are used to complement the stated mission of the school:

> The mission of (facility) in unity with its families and communities is to recognize and challenge individual differences and to provide opportunities for growth and exploration within a safe, nurturing, non-competitive environment to foster life-long learning. (School Improvement Plan, 1996, preface)

Site B

Site B was built in 1954 as a traditional first through sixth grade building. Due to the decrease in district population, Site B was closed in 1979. Later enrollment growth forced the district to reconsider the most efficient use of building spaces available. Site B was reopened in 1997 to house the district's entire pre-school and kindergarten population. The building was completely remodeled to accommodate three to six year old children. Now the facility is comprised of 15 single classrooms each having access to an adjoining kitchenette and specially adapted restrooms. Each classroom houses an average of twenty-five students. Overall, the building is in excellent structural shape and room remains for additional growth as necessary.

The population of 615 students range in ages from three to six years old. The building presently contains 21 half-day kindergarten classes with four half-day pre-school programs. The population is comprised of: 96% White, 1% Hispanic, 1% Asian/Pacific Islander, 1% Black, and 1% Native American. Only 6% of these students have been identified as Limited-English-Proficient. Low-income families account for 13% of the total school population (Housing Report, 1997).

The academic team consists of: one principal, one district coordinator, two pre-kindergarten teachers, and 10 full time kindergarten teachers and one half-time kindergarten teacher. Support staff in the building include: one half-time nurse, one full time speech and language clinician, one full time Early Literacy Specialist, one half-time parent resource person, one half-time learning center director, and one full time parent educator. Additional support staff consists of: one art and one music teacher which services the building one day every other week, and two part time physical education teachers. The teaching experience of the academic staff ranges from one year to twenty-seven years with five staff members holding a master's degree. The office staff consists of: one secretary, one full time general program aide, four part-time general program aides, and two paraprofessionals who assist in teacher material preparation.

A project approach emphasizing developmentally appropriate curriculum integration is used to cover the mandated guidelines. The entire two hours and forty-five minutes of the student's school day is devoted to the exploration of developmental learning. Student progress is recorded through the non-graded assessments consisting of: student portfolios, observational checklists, and narrative summary reports. The facility stresses the home/school connection with parental involvement supported by the parent resource center and available parent workshops. The mission statement of the facility encompasses the philosophy of the staff for a successful beginning school experience for their students:

> The mission of the (facility) is to provide a safe, nurturing environment for children, families, and community members, which fosters meaningful experiences and active learning. The (facility) recognizes individuality and empowers all to reach their full potential as life-long learners. (School/Parent Handbook, 1997, preface)

The Surrounding Community

The school district currently serves an expanding suburban community of 33,700 residents and is located 15 miles south of the state line and 90 miles northwest of the third largest city in the nation. Two cities make up the district's 20 square attendance miles. Households without children account for 51.1% of the population. Married couples with children under 18 years of age comprise 41.3% of the total households with single-parent families standing at 6.2%. The median family income within the district is $36,076 (District Demographic Report, 1993).

The majority of residents 25 years of age and older have graduated from high school, yet a significant 23.8% do not have a diploma. Thirty point eight percent of the residents have either some college education or have earned a post high school degree (District Demographic Report, 1993).

The work force in the community is predominately blue collar with an employment rate of 94.8%. This work force is categorized as: 32.2% technical/sales/administration, 20.5% operators/fabricator/laborers, 18.4% managerial/professional, 15.9% precision production workers, 12% service workers, and .9% farming/forestry/fishing (District Demographic Report, 1993).

The district serves the needs of 6,636 students that range in age from three to twenty-one (School Report Card, 1996c). Students living more than one and one-half miles from their neighborhood school are eligible for district provided transportation. Special education services are available to mentally impaired, hearing impaired, visually impaired, physically impaired, speech and language impaired, and learning disabled students. Additional intervention services available are Early Literacy Services, Chapter One, Children At Risk Educationally, and transitional programs. A magnet school housing an academic academy is offered to elementary students who excel in academics and fine arts. The recent addition of a hands-on technical academy is also available for junior high and high school students. Start up funds for this academy was a collaboration of local business and the school district. Continued funding and staffing of the academy became the sole responsibility of the district.

The district strives to prepare graduates for vocational careers within the community with a focus to provide students with additional information and services regarding educational preparation for careers. In 1996, an effort was made to promote greater participation in the Advanced Placement Testing Program. The district's student scores were the highest out of the past ten years surpassing the state levels in English, reading, and science. In addition, twenty-three students took forty-one Advanced Placement exams compared to ten students who took sixteen exams in 1995. Out of these students 79% of them scored three to five on the exam allowing them to receive college course credit at participating colleges and universities. High school diplomas were earned by 74.6% of the 1995-96 seniors (School Report Card, 1996a).

Growth within the district has brought about the reopening of schools and relocation of the district pre-kindergarten and kindergarten programs. Some of this growth may be attributed to the district's proximity to a large metropolitan school district that is currently experiencing an on-going discrimination lawsuit. This lawsuit has resulted in flight from the adjacent district into the subject district.

The educational needs of the subject district are overseen by the central office administration. The administration consists of a superintendent, an assistant superintendent for business services, and an assistant superintendent for human resources. An elected school board meets twice monthly to address issues pertaining to budget, staffing, discipline, facilities, and curriculum.

National Context of the Problem

The results of international assessments in science have shown that American schools consistently rank at the bottom of all those from advanced nations (Goodstein, 1993). Five international studies conducted between the late 1960's and ending in 1991 revealed that United States students typically score well below students of similar age and grade level in industrialized nations. When compared with other industrialized countries, United States students are outscored in science subtest by margins of a high of 55% by Japanese students to a low of 3 % by German students. (Jaeger, 1992).

The science scores from the State show a mid-range of science aptitude. On a scale of 0 to 500, the (State's) Goal Assessment Program (IGAP) shows a statewide score of 250 in 1996 for students in grade four, which is the lowest level tested. This equates to a rate of 47% of students that meet but do not exceed the State required goals and 14% that are not meeting those required goals (School Improvement Plan, 1996-97).

When the State is compared to the nation on its science achievement it scores above the national average of 25% in the techniques of science: i.e. the process, techniques, methods, equipment, and available technology of science. At the same time, the score averages fall below the nation's in science concepts and vocabulary, implications of technology, and principles of research (School Improvement Plan, 1996-97).

With a small minority of three to four percent engaged in careers involving science, citizens wonder why it is necessary to learn science (Hoffman & Stage, 1993). Support for the sciences has dwindled as the economy has moved from manufacturing to service industries such as banking and insurance. These types of industries in turn do not support much scientific research (Goodstein, 1993). One of the few items of discretionary spending in the national budget is that of scientific research. With a country that is 4 trillion dollars in debt, discretionary items tend to be the first ones cut (Goodstein, 1993).

John Rigden, the director of development for the National Committee on Science Standards believes that science needs to be looked upon as reading, writing, and arithmetic. School administrators and teachers need to come together and decide what students should know about science and what they should be able to do (Hopkin, 1992).

Most elementary school teachers have been poorly prepared in the area of science. Elementary education is the only college major in many institutions that does not require a single science course. Many have chosen that major precisely for that reason (Goodstein, 1993). When science courses are taught at the college level they are usually taught by those with no personal experience with scientific research or no experience with the realities of elementary school (Swartz, 1991). Teachers come into the elementary situation not only ignorant of science, but they are 'preselected' for their aversion to science. This undoubtedly is passed along to their pupils (Goodstein, 1993). The elementary curriculum depends largely on the interest of the teacher. When questioned, only one quarter of teachers feel 'well qualified' to teach science (Hoffman & Stage, 1993). The majority of elementary students reveal an interest in science, and yet by high school science enrollments drop by more than one half each year (Hoffman & Stage, 1993). Teachers cite several reasons for failing to incorporate more science instruction into their day. These reasons range from inadequate training and limited access to appropriate materials, to a lack of strategies necessary to integrate science into their overcrowded days (Greene, 1991).

Bruce Alberts, president of the National Academy of Sciences, and Richard Kausner, chairman of a standards committee issue a "Call to action" to all those involved in raising the level of scientific literacy in the United States:

> All of us have a stake, as individuals and as a society, in scientific literacy. An understanding of science makes it possible for everyone to share in the richness and excitement of comprehending the natural world. Scientific literacy enables people to use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society. A sound grounding in science strengthens many of the skills that people use every day, like solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively and valuing life-long learning. And the economic productivity of our society is tightly linked to the scientific and technological skills of our work force. (Goodwin, 1996, p. 49)

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

As pointed out in Chapter 1, the science literacy of pre-kindergarten and primary age children is inadequately developed. In order to document this lack of knowledge teacher surveys, observations checklists, intervention checklists, and classroom observations were used over a three-week period.

Teacher surveys (Appendix A) were distributed to nineteen teachers. Of these nineteen teachers, fifteen teachers returned the surveys. The percentages reflect teachers' views of their students' scientific abilities upon grade level entry. Asked to evaluate pertinent scientific skills specific to their grade level, the majority of respondents felt that students exhibited "Partial" to "Adequate Knowledge" in the skills. The skills evaluated were: exploration, awareness, identification, recognition, comparison, association, and verbalization of conclusions. The "Knowledge Not Evident" rating of student skills indicates limited previous exposure to scientific skills. The low "Proficient" rating validates the need for increased scientific literacy at the primary level. The results are summarized on the following graph.

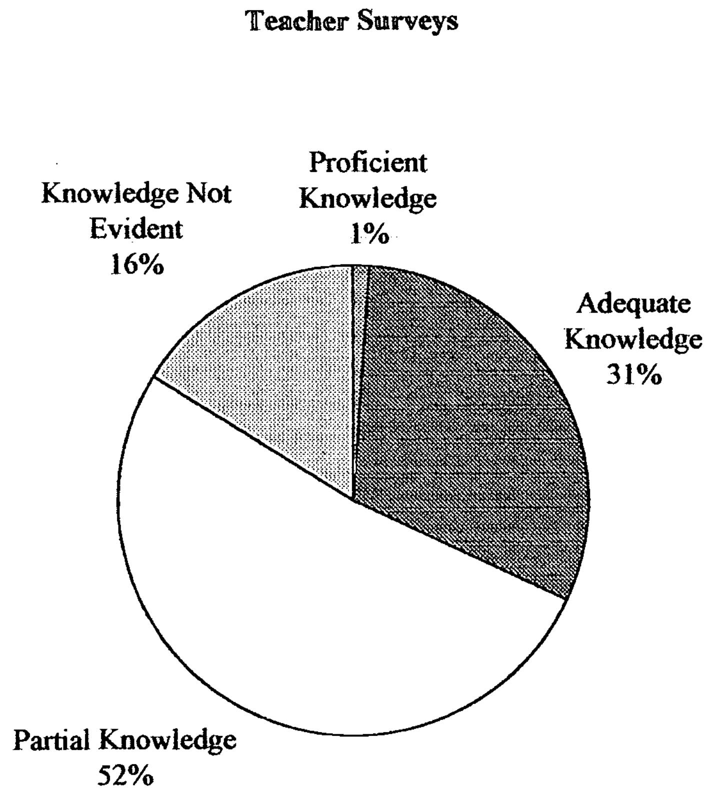

Figure 1. Teacher Survey Graph

Skill checklists were used with four classes. These classes were comprised of 95 students, one pre-kindergarten and three second grades. The checklists used are found in Appendix B. A summary of the skills addressed is presented in the three succeeding graphs.

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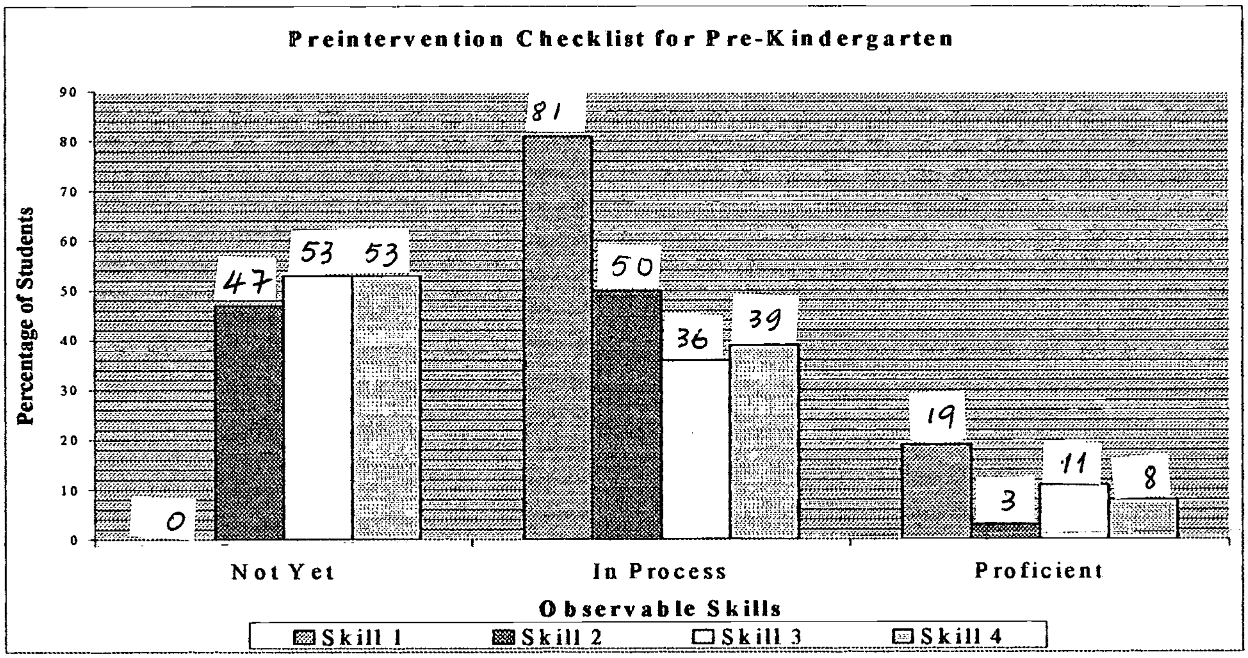


- Skill 1 - Uses senses to experience exploration with classroom materials and natural phenomenon
- Skill 2 - Uses tools for investigation to focus on an object and specific aspects of an object
- Skill 3 - Makes comparisons among objects that have been observed with adult prompts
- Skill 4 - Verbalizes observations about the natural world

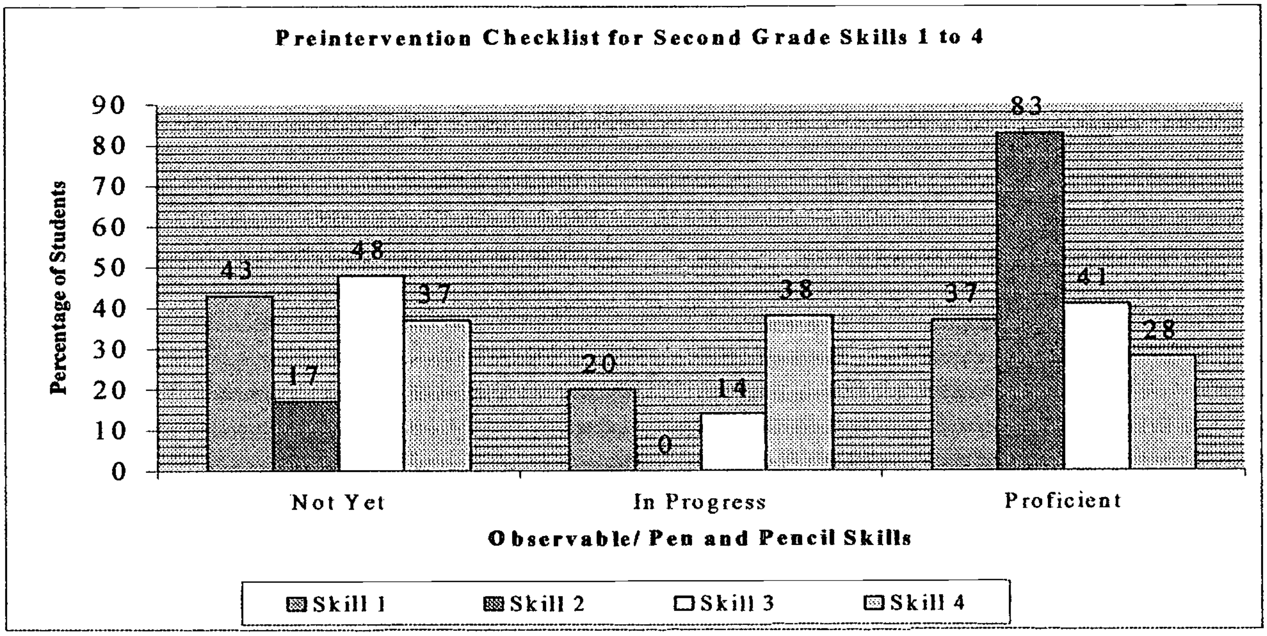
Figure 2. Preintervention Checklist for Pre-Kindergarten

Skill 1 - Inherent curiosity is evident in the percentages of " In Process" and "Proficient" students. Those in the higher range may have received more encouragement or freedom to explore the world around them.

Skill 2 - A close split in percentage scores exists between the" Not Yet" and "In Process" categories. This may be a result of prior experiences with similar tools and lead to a basic familiarity or lack of proper tool usage. While many students appear to have a basic knowledge of tools and their use, very few were proficient enough to adapt tool usage to fit a given need.

Skill 3 - The majority of children had difficulty visualizing or comprehending comparisons among various objects. Even with adult prompts, the comparisons were not apparent to the majority of children. This again could lie within the realm of prior knowledge or exposure to various materials.

Skill 4 - While inherently curious, many children at this age have difficulty verbalizing their observations. Lack of appropriate vocabulary or unfamiliarity of specific phenomenon lead to a high "Not Yet" rating.



- Skill 1 - Uses senses to notice details by careful observation
- Skill 2 - Can verbalize how scientific tools are used and why it helps them with their investigations
- Skill 3 - Classifies objects based on observation, as well as, on prior knowledge and experience
- Skill 4 - Seeks to answer questions using simple tests and application of prior knowledge

Figure 3. Preintervention Checklist for Second Grade – Skills 1 to 4

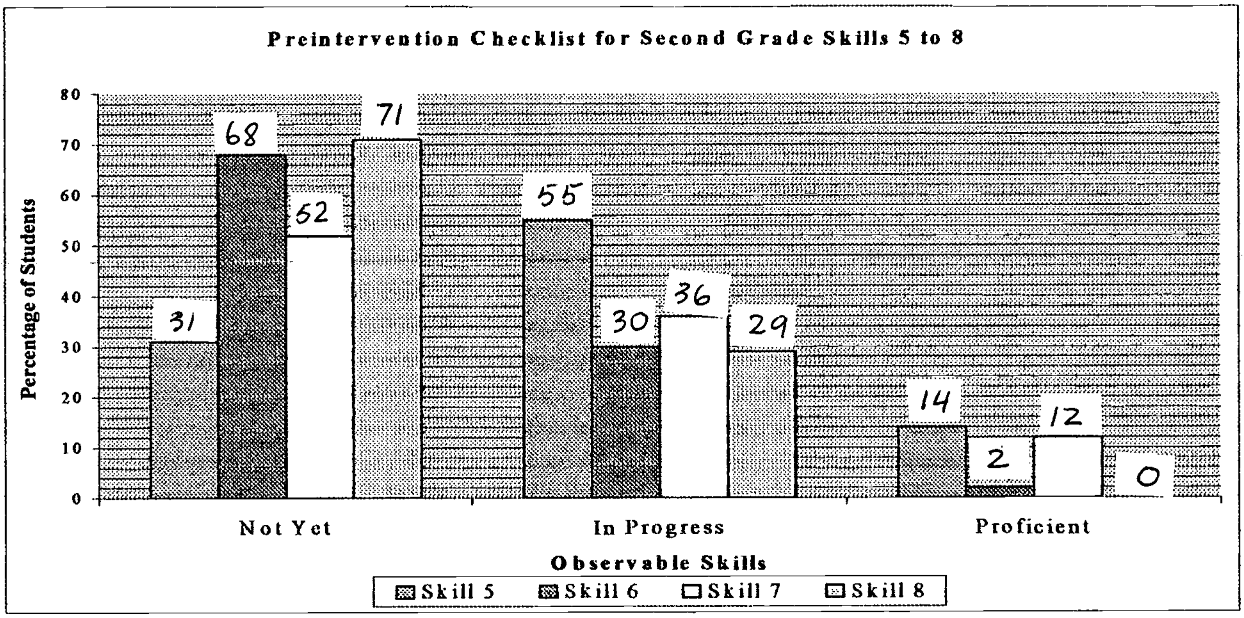
Preintervention percentages are derived from scores obtained from core concept tests for each chapter in the science series (Appendix C). Hands-on science centers, which illustrated thematic concepts, were also used. The skill graphs were a combination of teacher observations, standardized tests, and student written/drawn interpretations of specific core concepts. Results were tallied and percentages were based on the second grade population of Site A. Analysis of skills based on the graph is narrated in the following summaries. The skills of graph two were those most easily measured in a concrete form in conjuction with direct observation rather than a total reliance on direct observation.

Skill 1 - The slight difference between "Proficient" and "Not Yet" percentages lead to the possible conclusion that if the natural curiosity of a student had been nurtured up to this point he or she had a grasp of which senses to use during science investigation. If the child did not have such previous experiences he or she fell into the "Not Yet" range, not quite knowing which senses to rely on during any given point in the investigation.

Skill 2 - The largest percentage of students appeared well versed in the use of tools and when to use them. The "Not Yet" category of percentages reflects difficulty with new tools unfamiliar to some students, such as a child's basic microscope or the inability of the student to use it correctly when given the opportunity.

Skill 3 - As with skill 1, the break down of percentages and the relative closeness of "Not Yet" and "Proficient" scores suggest that where a child ranked relied on prior knowledge and experience.

Skill 4 - Percentages were very close for the "Not Yet" and "In Process" categories. Since much in this category is based on prior knowledge, the percentage of "Not Yet" students can be viewed as those with limited experience and without understanding of how to obtain an answer using the information and the tools given. Those falling within the "In Process" range have a grasp of how to make use of prior knowledge and various tools available, but need to refine their information gathering skills and correct usage of appropriate tools. Inconsistent use of said skill lead to many being categorized as "In Process".



- Skill 5 - Asks questions leading to possible investigation about the natural and physical world
- Skill 6 - Can reflect on their reasonable predictions
- Skill 7 - Can use observations and experimentation to develop reasonable explanations
- Skill 8 - Communicates scientific thinking through verbal and written forms

Figure 4. Preintervention Checklist for Second Grade – Skills 5 to 8

Percentage scores for this graph were based on direct observation along with minimal usage of written responses from the students.

Skill 5 - The majority of students appear to have an innate curiosity of the world around them and this is reflected in the percentages. While many students are curious, they lack the verbal skills, vocabulary, and prior knowledge necessary to phrase questions appropriately concerning the specific information they seek.

Skill 6 - The majority of the students could not reflect about their own thinking with any degree of success and regularity. While many could arrive at a reasonable answer or hypothesis, the reasoning behind their theories eluded them. Students lacked the vocabulary or proper prior knowledge to be able to explain, with any degree of certainty, why they felt the way they did about a subject or how they based or arrived at their conclusions.

Skill 7 - With the addition of hands-on opportunities, students seemed better able to reflect on why something occurred. While many still fell within the "Not Yet" range, the gap between it and "In Process" is less than it was for skill 6 when they were reflecting only on possible outcomes. The use of tools aided in the basic understanding of a phenomenon, yet verbal explanations were difficult for most.

Skill 8 - The high percentage in the "Not Yet" column represents the basic need to introduce and reinforce scientific thinking in both the oral and written forms. Students are very weak in written work, lacking the basic scientific vocabulary. There was not any cohesive follow-through of scientific processes evident. Students were unable to correctly verbalize and then write how to proceed from beginning to end of an experiment or observation.

Many of the shortcomings within the skills graphed appeared to be experienced based. While the natural curiosity of the children is evident in many of the instances, the lack of prior exposure leads to a shut down of the scientific process. Not knowing how to proceed with information gathered caused premature cessation within the skills. The children's full potential is not being tapped and prior knowledge bases have not been built upon satisfactorily. It is apparent that children need to become exposed to a variety of skills in order to enhance growth.

Probable Causes

Site based probable causes ranged from a lack of district support to teacher anxiety and avoidance of teaching science. A district funding of one dollar per pupil was allocated for the purchase of science related materials. This allocation was included in the budget of each building. While the building principal was to inform the science building facilitator of the exact dollar amount, the expenditure of funds was at the discretion of the science facilitator. At Site A, no additional funds were earmarked from the building budget by the principal. Site B was not placed within the district budget allocation. The lack of allocation in funds lead to teachers' use of personal funds to purchase necessary items required for the district-adopted textbook series.

An updated science series was adopted district wide in 1995. Additional funds were not budgeted for inservice training or materials needed to ease the implementation of the series adoption. Site A received the new replacement textbooks an entire year later at upper grade levels with primary grade levels to be purchased in future years as textbook funds allowed. Purchased textbooks were limited at second grade to one teacher support book and one class set for use with three different teachers and classrooms, while first grade and kindergarten received no textbooks or the accompanying teacher support books. The insufficient amount of textbooks and materials lead to limited implementation of the science series.

A problem inherent in Site A is the building design itself. As a semi-open space, noise remains a constant factor. This prohibited the use of noise producing activities. Many of the recommended hands-on science projects are just such activities (Sumrall, 1997).

Another contributing cause was the addition of technology within the district. This emphasis became a significant factor in time constraints in the teaching day. Use of technology leaned toward drill and practice rather than a technological expansion of the mandated curriculum. Time devoted to the introduction of technology-based skills, along with federal and states guidelines for core subject time allotments, lead to selective abandonment of the academic subjects teachers felt the least comfortable teaching. The most frequently dropped subject was science (Bracey, 1991).

Science instruction created anxiety, as teachers felt ill equipped and unsure of their own scientific knowledge. Teachers were overwhelmed with the combination of the new series, the lack of teacher inservice, the lack of materials, and time constraints in the teaching day. These factors contributed to the avoidance of exploring ways to incorporate science into the present curriculum. Instead, teachers chose only specific scientific areas that were of interest to them. The teacher-controlled curricula caused a lack of cohesiveness from year to year in science instruction. This leads to a weak scientific base for prospective growth within future grade levels.

The literature suggested several causes for the deficiency in scientific literacy of children. Although the probable causes were numerous and varied from author to author, an underlying thread appeared that linked researchers' thoughts into a spiral. This spiral began with the community, continued with the teacher and ended at the student.

This thread begins with the observation that Americans of all ages and types tend to be scientifically and technologically illiterate. It was noted that social conditions, which prevented academic achievement, also impeded improvement in learning science. The public's attitudes toward science tended to be non-existent or unsupportive (Fort, 1993).

These attitudes influenced the training of the Nation's teachers. As Linda Darling-Hammond (1990, p.291) stated, "The National Science Teachers Association estimates that roughly one-third of the total mathematics and science teaching force nationwide is not fully qualified to teach these subjects." The feelings of teachers were even more alarming as two-thirds of elementary teachers reported they felt unprepared to teach science (Fort, 1993). Teachers continued to say they did not have the training required to teach science, the access to appropriate materials, or strategies needed for integrating science into their over crowded day (Greene, 1991). Overall, it appeared that most elementary school teachers were poorly prepared to present even the simplest of lessons in scientific subjects (Goodstein, 1993). Teachers, feeling defeated by their initial lack of training, continued to compound this inadequacy as their teaching careers evolved. Support for this evolution was shown in Deborah Forts (1993, p.677) statement, "Most teachers took their last science class a long time ago. And since knowledge doubles every five years, there's a good chance that what teachers learned in college is no longer adequate."

The spiral of scientific illiteracy continued as the nation's teachers taught. The majority of children received only rudimentary instruction in elementary school, (Fort, 1993) due to inadequate teacher training. If students adopted a liking for science, they became ridiculed by their peers. Therefore, the attitudes toward science were being set at the elementary level (Estes, 1993). Nationally, these attitudes toward science lead to poor academic performance (Anderson and Lee, 1997). The cycle continued as high school graduates went on to college and found themselves unprepared for the science courses offered there (Fort, 1990).

Teacher training cannot fully be blamed for scientific illiteracy. Differences in curricula and teaching strategies across the nation were also a prominent factor (Rotberg, 1990). Curriculum development projects found students had not been adequately prepared even when meaningful science knowledge was included (Swartz, 1991). Scientific knowledge was often presented in ways that failed to connect with the student's own ideas about how the world works. Most science programs did not provide the students with opportunities to learn with understanding (Anderson and Lee, 1997). The typical scientific education does not fulfill a student's natural curiosity (Hagerott, 1997).

According to Goodstein (1993), our entire system of education was seen to be a leaky pipeline, badly in need of repairs. Together the literature and site causes pointed to three major areas of concern. First, there was a lack of support from the public, school district, and teachers. Secondly, the lack of sufficient training of teachers initially at the college level emphasized the public's attitudes of science and the students they teach. Thirdly, lack of curriculum support, insufficient materials, and on-going training inhibited the teacher's ability to meaningfully incorporate science into their students' daily schedules.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

Analysis of probable cause data suggested that a lack of science literacy could be attributed to inadequate support from local school officials and surrounding communities, insufficient teacher training, and a deficiency of support materials necessary to implement an adequate science program. Research regarding the need for increased public support showed the necessity to work from the top down. An increase in federal monies was needed to ease the financial burden on already strapped local districts (American Chemical Society, 1990). At the local level, each district had the responsibility to finance the education of its students. Sources of local funding determined a districts educational quality (Harris, 1992). District funding has been generated through a combination of property taxes and private sources. District funds were allocated per building based on pupil population. Any monetary shortages at the building level were then passed on to individual teachers. Out of necessity, teachers were forced to supply essential support materials, to elicit parental help in donating materials, and to apply for available grants.

Financial support should not stop at the funding of materials, but also needs to cover teacher training. Fullan (1991) recommended continued staff development to handle the ever-increasing accumulation of information. These inservices should occur at regular intervals, be aligned with national, state, and local standards and be compulsory (Down, 1997). The district offered forty separate inservices, three of which were science related and geared at introducing teachers to new ideas and honing their own scientific skills (District Staff Development Handbook, 1997). These inservices were designed to heighten teachers' scientific knowledge and to aid teachers in accurately imparting this knowledge to their students.

With the majority of teachers uncomfortable in the teaching of science, there existed a need for better teacher education. Misconceptions and anxieties must be addressed at the college level. College students had expressed the need for further courses dealing with science instruction (Gafney and Weiner, 1995). Recommendations by the American Chemical Society (1990) suggested at least three semesters of the sciences before teacher certification. Teachers who are thoroughly trained prove to be more effective and capable of adapting new programs into existing science curriculum. Change in education should come through the nation's supply of qualified, prepared teachers (Darling-Hammond, 1990).

Support should not stop after graduation. New teachers should be paired with a mentor-teacher (Down, 1997). Science resource specialists should be hired to aid the classroom teacher who has difficulty presenting science. Support must also incorporate those outside the school setting. Professionals and those involved in science education societies must be encouraged to take an active role in the communities' classrooms as mentors. Professionals and teachers need to work together to provide integration of science within all curricular areas (American Chemical Society, 1990).

Parents also provided an integral support system. Increased family involvement can be achieved through the use of newsletters, science nights, and parent-child science activities. These activities needed to be both in and out of school experiences where teachers provide the framework to extend classroom learning (Kepler, 1996).

The literature search for solution strategies found interest in science was highest within the early grades and diminished as the years progressed (Newport, 1990). Therefore, teaching methods and curriculum adaptations needed to begin at an earlier level. This change ultimately rested with the classroom teacher's ability to bridge the gap between true scientific knowledge and the student's often misguided perceptions (Woods, 1994).

Many choices regarding future fields of study can be decided upon even before a child reaches the secondary level. The curiosity and wonder showed by young learners about the natural world needed to be carefully nurtured. However, evidence suggested that science taught at the elementary level was more likely to douse curiosity and wonder than foster the pursuit of more scientific knowledge (American Chemical Society, 1990).

In a study conducted by Novak and Musonda, data was collected that suggested primary grade children had a capability of learning science concepts that went untouched in schools. Students in grade two demonstrated better understanding of scientific concepts than some twelfth grade students. This may be true in other areas as well. If, in the primary grades, only a small amount of quality science instruction could have such an effect on learning throughout the school years, it seemed that more meaningful learning potential remains undeveloped in our school children (Bracey, 1991).

An educator's job is to open the world of science to themselves, to their colleagues, and then to their students. In order to have change within the classroom a teacher must be able to interpret and carry out suggested reforms within a set curriculum (Woods, 1994). One way to approach the world of science and technology is through themes with clear significance to everyday life.

According to Clinchy (1995), "Children do not arrive at school with empty minds. As the philosopher of science, David Hawkins says, their minds 'are not empty at all; they are already full,' and educator's task is not to fill but 'enlarge' them." In order to enlarge a student's mind a teacher cannot simply implant concepts. For content to take hold, it must connect with the student's preconceived "naïve theories" (Anderson and Smith, 1987). Students and teachers will understand and grow in confidence in their knowledge of science and technology only when they actively experience these areas as they exist in real life situations rather than in educational settings (Fort, 1993). Ms. Fort (1990) also states that no one can discover an aptitude or a gift in science without having the opportunity to exercise it. Teachers must choose problems that are personally meaningful to the students. Through the children's use of observation, analysis, and forming hypotheses they will discover that these skills can be used in everyday life (Mitman, Mergendollar, Marchman, and Packer, 1987).

The key at any grade level is to focus on planning and problem solving at least once a day so that these strategies enter a student's repertoire and become automatic. An effective learner is a creative problem solver who is able to harness creativity through organization and careful planning (Casey and Tucker, 1994).

Fundamentally, teachers and students need time to investigate independently, to become science literate, and to learn a street sense about science and technology (Fort, 1993). According to Clinchy (1995):

> If only teachers were able to give just the right sort of direction at just the right moment so that an assignment would have a transformative effect on the student. These transformative experiences can occur only when teachers have time to attend to their students as individuals and when teachers and students have the freedom to depart from a

> "scripted curriculum." No standard scripted curriculum can ever engage the developing interests of a whole classroom – let alone a whole generation- of students. (p. 389)

Teachers and students will do much better when they approach a field of knowledge or investigation with the attitude that they can understand. If an individual cannot understand the concept, there may be something wrong with the approach or process. Knowing this is an essential first step in developing a science literate population (Fort, 1993).

Incorporating hands-on science into the curriculum will develop, with greater purpose, the skills needed in other subject areas. The students will see what they are learning and how it can be applied to other areas that matter to them. They will learn to observe, think, experiment, and validate their findings. Students will learn teamwork, communication skills, and experience first hand how the real world works (Kepler, 1996).

After review of the literature solutions, it is evident that the capability of changing school officials and surrounding communities' support and attitudes toward science literacy is a formidable task. It would take many people working together from the federal level down through the classroom teacher to bring about changes in funding and standards in science education that would ultimately affect science literacy nationwide. Teacher training and on-going inservices are also beyond a classroom teacher's immediate control to change. The district allows for teacher input on inservice subjects. The real key was to change teaching methods and curriculum adaptations. This change could be completed by the classroom teacher. It became the teacher's responsibility to integrate science skills into curricular units and replace preconceived ideas with true scientific knowledge in a way that the students could adapt to their everyday life.

Project Objectives and Processes

As a result of increased instructional emphasis on the sciences, during the period of August 21, 1997 to January 21, 1998, the pre-kindergarten and second grade students will increase their scientific literacy, as measured by teacher observation checklists, student skill posttests, and teacher journal entries.

In order to accomplish the project objective, the following processes are necessary:

1. Integration of science skills into curricular units.
2. Expand student's exposure to scientific properties through hands-on and real life experiences.
3. Teach scientific process and guide students on how to relate this to other aspects in the real world.

Project Action Plan

This project on increasing the scientific literacy with pre-kindergarten and second grade students will take place during the first semester of the 1997-1998 school year. All the skills and activities are to be science-based and integrated into existing classroom curriculum.

This action plan is presented in an outline form with the three processes occurring concurrently. The plan is broken down into curriculum setting, unit formats, and process-based activities.

The integration of science skills, expansion of science exposure, and the introduction into the scientific process will occur within four units. While duration of unit format remains constant, differences will be made for each age level in frequency and intensity of lessons as follow: pre-kindergarten for twenty minutes twice a week, second grade for thirty minutes, three times a week. The specific skills to be addressed and their anticipated duration are as follows:

- Investigating using observational skills-three weeks
- Questioning and predicting skills-three weeks

- Explaining and forming conclusions-four weeks
- Integration of all skills-four weeks

The skill units will incorporate aspects of all the processes, which will be noted in outline section C. Each skill will be broken down into learning stages with specific activities chosen to enhance skills and concurrent processes. At the end of the semester, all three processes will have been addressed within the four skill units.

I. Investigating using Observational Skills – 3 week duration
  A. Curriculum setting – Animal Groups
  B. Unit format
    1. Introduction – 1 week duration
    2. Practice – 1 week duration
    3. Transfer – 1 week duration
  C. Process Based Activities
    1. Activities for integration
      a. pet web/language arts
      b. pet graph/math
      c. animal attribute chart/social studies
    2. Activities for expansion
      a. petting zoo brought to school
      b. guest speaker – dog trainer for seeing eye dogs
    3. Activity for scientific process
      a. pet show
II. Questioning and Predicting Skills
  A. Curriculum setting – Family Groups
  B. Unit format
    1. Introduction – 1 week duration
    2. Practice – 1 week duration
    3. Transfer – 1 week duration
  C. Process Based Activities
    1. Activities for integration
      a. Prediction of future when they are grandparents/language arts
      b. graph of their family members/math
      c. web types of family units/social studies
    2. Activity for expansion
      a. Create own family tree
    3. Activity for scientific process
      a. family picnic
III. Explaining and Forming Conclusion Skills
  A. Curriculum setting – Plants
  B. Unit format

1. Introduction – 1 week duration
2. Practice – 2 week duration
3. Transfer – 1 week duration

C. Process Based Activities
   1. Activities for integration
      a. trade book sharing/language arts
      b. chart the needs of plants/language arts
      c. learning log of seed planting/language arts and math
   2. Activities for expansion
      a. planting of seeds
      b. seed travel game
   3. Activities for scientific process
      a. edible plant parts and plant usage
      b. taste testing plants with seeds in them and chart
      c. categorize seeds and glue on a chart
      d. how the sun helps the plants
      e. expansion circle of a seed

IV. Application and Integration of Previous Skills
   A. Curriculum setting – Solar System and Life Cycles
   B. Unit format
      1. Introduction – 1 week duration
      2. Practice – 2 week duration
      3. Transfer – 1 week duration
   C. Process Based Activities
      1. Activity for integration
         a. compare size of planets/math
      2. Activities for expansion
         a. planetarium visit
         b. experience revolution vs. rotation
      3. Activity for scientific process
         a. observe and chart moon phases
         b. predict constellations placement

Methods of Assessment

The data collection methods used to assess the effects of increasing science literacy through curriculum integration included teacher intervention checklists, student skill posttests, and teacher journal entries. The intervention checklists noted a running record of each student's skill progression throughout the project time. The student skill posttests assessed each student's knowledge growth within a specific scientific discipline. Compared to pretest scores, posttest results helped determine extent of knowledge growth. Teacher journal entries assisted subject teachers to gain insight as to success or failure of each science project completed within the units of study. Use of journal entries and informal observations aided in the preparation of upcoming units.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to increase the scientific literacy of pre-kindergarten and second grade students. The implementation of this project was activity-based to integrate science-processing skills within the existing curriculum.

The integration of science skills, expansion of science exposure, and the introduction of scientific processes occurred within four units. Frequency of lessons at the pre-kindergarten level was twenty minutes twice a week. As the units unfolded within the second grade classrooms, it was necessary to increase the frequency of lessons from thirty minutes three times a week, to thirty minutes four times a week. Duration of skills was modified to fit in school assemblies and calendar changes.

The scientific skills that were first introduced to the students were investigation and observation. The pre-kindergarten students began with the study of dogs. Students brought in items from home that pertained to their dog. Using these items, the teacher created activities that included listing facts, webbing, sketching, and manipulation. Further expansion of these skills led to the investigation of many different animals. The students used pictures to group animals by using their observational skills.

In second grade, these skills were presented within a unit on elephants. Students were asked to compare and contrast two types of elephants by the use of a Venn diagram. The students observed and compared the size of an elephant to a student. They used investigative skills to experience the elephant senses, food simulation, and habitat. The skills were then assimilated into the animal group curriculum. Practice and transfer of these skills were based in the activities of: Venn of pets and animals, pet webbing, pet graphing, animal attributing and animal classification charting. The expansion activity involved a guest speaker who trains Seeing Eye dogs. We were unable to proceed with the petting zoo due to the unavailability of the animals at the required time. Growth in the scientific processes of observation and investigation was demonstrated when the students organized a pet show. Each of the students either brought their pet, showed a picture of their pet, or shared a picture of a pet they would like to have. Further extension of skills presented itself when a museum tour of bats became available. Using the skills of investigation, students experienced a bat's senses and habitat and compared a bat's anatomy and family structure to their own. The observational skills were transferred into practice at the museum tour. This impromptu tour was used to blend a unit of investigation and observational skills into the questioning and predicting skills as taught through the upcoming family curricula.

The curriculum of family was introduced to the pre-kindergarten by observing physical differences in each other. Next, student discussions were transformed to class groups that represented similarities and differences among the students. Literature was used to further the discussion of individual differences to families. At this point questioning skills were practiced with the students. They examined who makes up their family and their placement in it. Many questions lead to discussions of cultural diversity and family differences. Students were able to share these diversities during special family days where the students were able to bring, show, and explain in their own way items that told about their family.

During the second grade introduction phase of the family curricula the students made predictions by creating a "What makes a family?" web. Students then practiced their questioning skills by interviewing classmates as to who resides at their address. Students transferred this skill by interviewing family members to create a family tree. The individual family "leaves" were arranged to create a classroom family tree. The final project was planning a mock family picnic, in which the students had to predict what elements are necessary to plan a family picnic successfully. A segment of this curriculum needed to be adapted as calendar changes for a school wide observation of Grandparent's Day was changed from the first quarter to the fourth quarter of the school year. Due to this change the family curricula was shortened, but the process skills were extended into the plant curricula that followed.

Pre-kindergarten students were introduced to explaining and forming conclusions by the use of sprouting beans in a baggie. They observed the beans and predicted the changes they would see happen. Throughout the sprouting process students tried to explain what was happening to the seeds. Further exploration came with the planting of a bulb in peat moss. Students were given the opportunity to compare and contrast plant growth of the seed and the bulb. An unexpected transfer of questioning and predicting skills occurred when some seeds were inadvertently placed into the sand table. Based on student questions, an impromptu experiment transpired which compared dirt and sand as growing mediums.

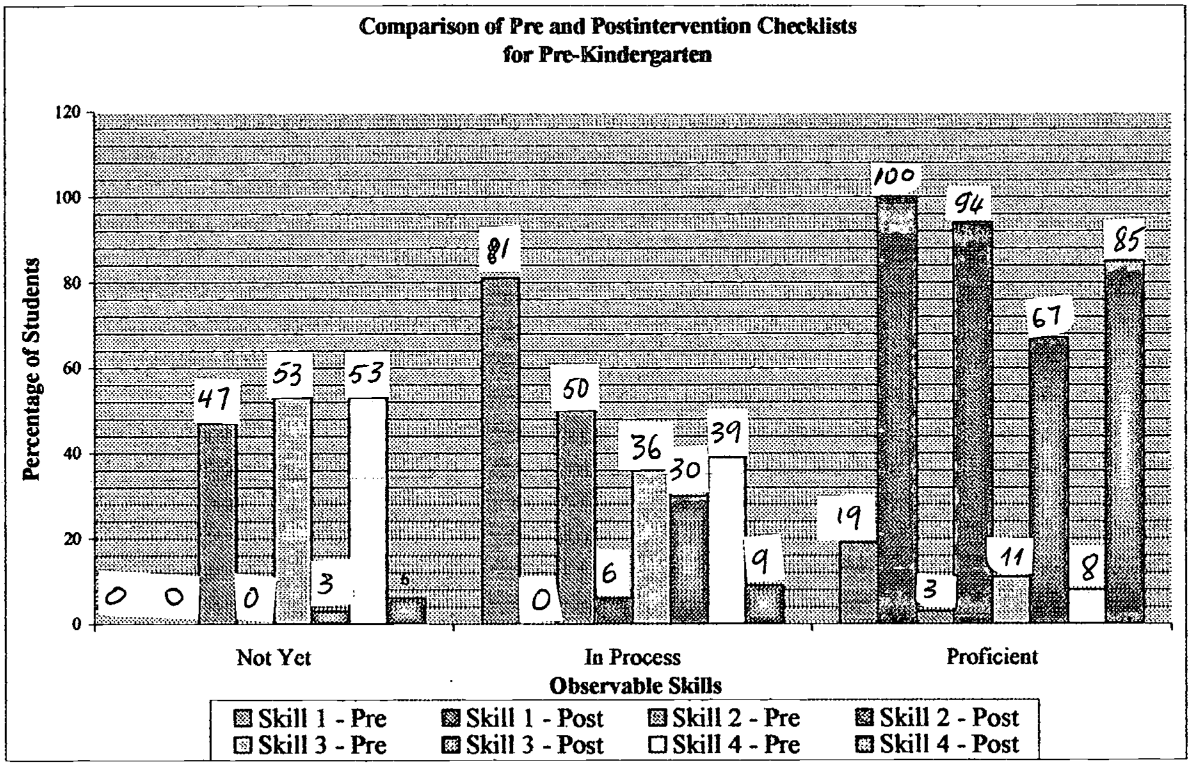
In the introduction of the second grade plant curricula, the questioning and predicting skills unit was integrated by the use of related children's literature and the KWL graphic organizer. The practice and transfer phase of this unit incorporated the explaining and forming of conclusion skills, which were to be addressed in this particular curriculum setting. Students were given various seeds to categorize. Students then planted the seeds and with the use of a learning log formed predictions, wrote explanations based on observations, and drew conclusions on plant phenomenon. The follow-up included the identification of plant parts, the purpose of each part and its probable usage. Taste testing of edible plant parts led to discussion on how plants reproduce, their survival needs, and the life cycle of a plant.

The culminating curricular unit was the solar system and life cycles, which incorporated the application and integration of previous skills. At the pre-kindergarten level, the solar system was addressed in very basic terms. The concepts introduced included the sun, moon and stars and where and when they appear. Correlating literature was read which enhanced the primary concepts.

For the second grade students, new vocabulary was addressed during the introduction phase by the use of hands-on experiments. Investigation and observational skills were used in the comparison of planet sizes and constellation viewing in the sky. The use of the portable planetarium led to questioning and predicting of constellation placement based on the rotation of the earth. Specific legends and stories of current constellations assisted the students in creating and composing their own constellation and legend.

Presentation and Analysis of Results

In order to assess the effects of integrating scientific skills within the curriculum of pre-kindergarten and second grade students, checklists were used with the targeted population. The preintervention checklists (Appendix B) were reused to gather postintervention data. The population within the one pre-kindergarten and three-second grade classes decreased by seven students during the intervention period. A comparison of the scientific skills addressed is found in the following graphs and narratives.



- Skill 1 - Uses senses to experience exploration with classroom materials and natural phenomena
- Skill 2 - Uses tools for investigation to focus on an object and specific aspect of an object
- Skill 3 - Makes comparisons among objects that have been observed with adult prompts
- Skill 4 - Verbalizes observations about the natural world

Figure 5. Comparison of Pre and Postintervention Checklists for Pre-Kindergarten - Skills 1 to 4

Skill 1 - The emphasis on developmentally appropriate activities and freedom to manipulate objects as desired may have lead to the total population achieving a "Proficient" rating.

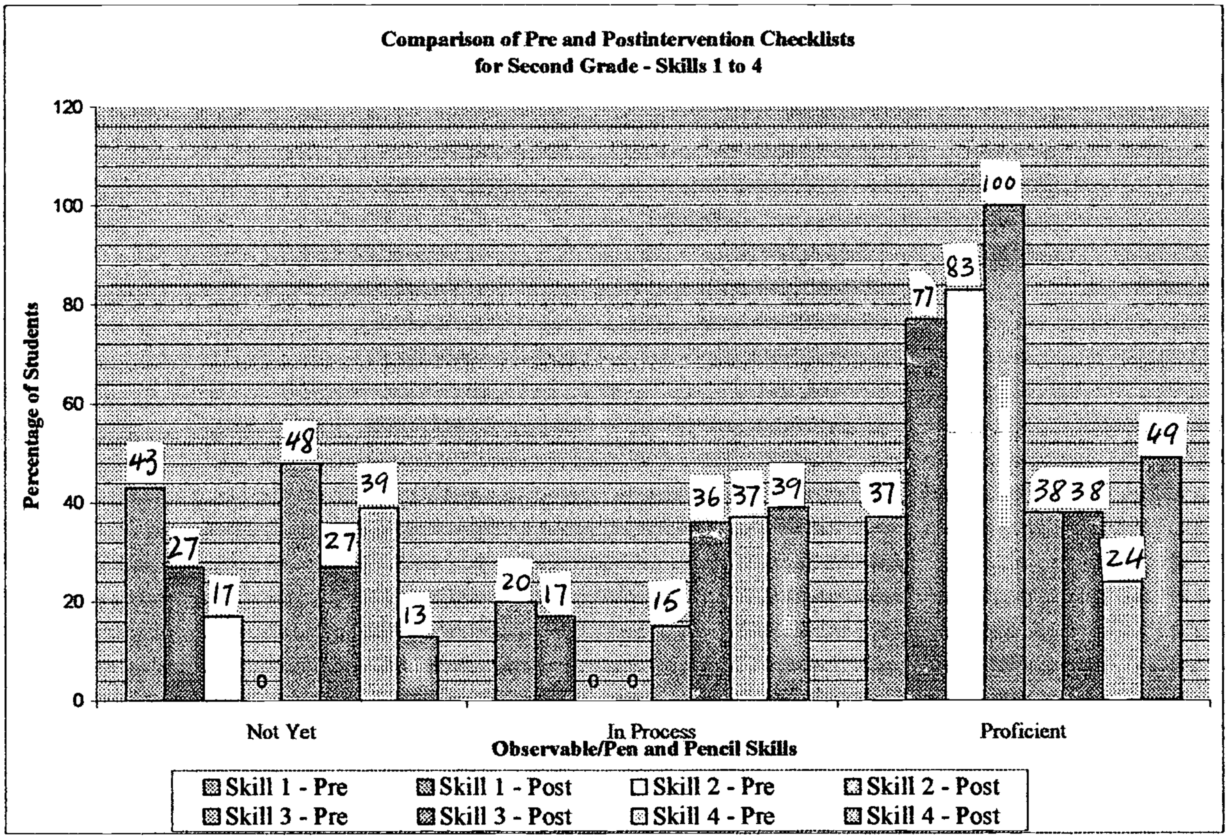
Skill 2 – Unlimited access to the investigative tools and instruction into their proper usage lead to a reduction in the "Not Yet" and "In Process" ratings. Continuous exposure and familiarity through their use influenced the increase in the "Proficient" rating.

Skill 3 – While the percentage of "In Process" remained the same, the reduction of "Not Yet" demonstrates that the prior knowledge base was expanded upon. The increase in the "Proficient" rating may indicate that higher level thinking has occurred.

Skill 4 – The dramatic increase in the "Proficient" rating attest that students were exposed to appropriate vocabulary by literature and teacher lead discussions. Students were also encouraged to verbalize their thoughts and observations throughout the intervention.

The overall improvement at the Pre-Kindergarten level showed students benefited from increased exposure, opportunities for free exploration, and activities geared to be developmentally appropriate.

Second grade pre and postintervention percentages were derived from scores obtained from core concept tests for chapters 1 through 8 and chapter 10 in the science series. Results were tallied and percentages were based on the Site A population. The graphs show a comparative record of the pre and posttest scores excluding chapter 9 core concept test scores as on previously shown graphs.



- Skill 1 - Uses senses to notice details by careful observation
- Skill 2 - Can verbalize how scientific tools are used and why it helps them with their investigation
- Skill 3 - Classifies objects based on observation, as well as, on prior knowledge and experience
- Skill 4 - Seeks to answer questions using simple tests and application of prior knowledge

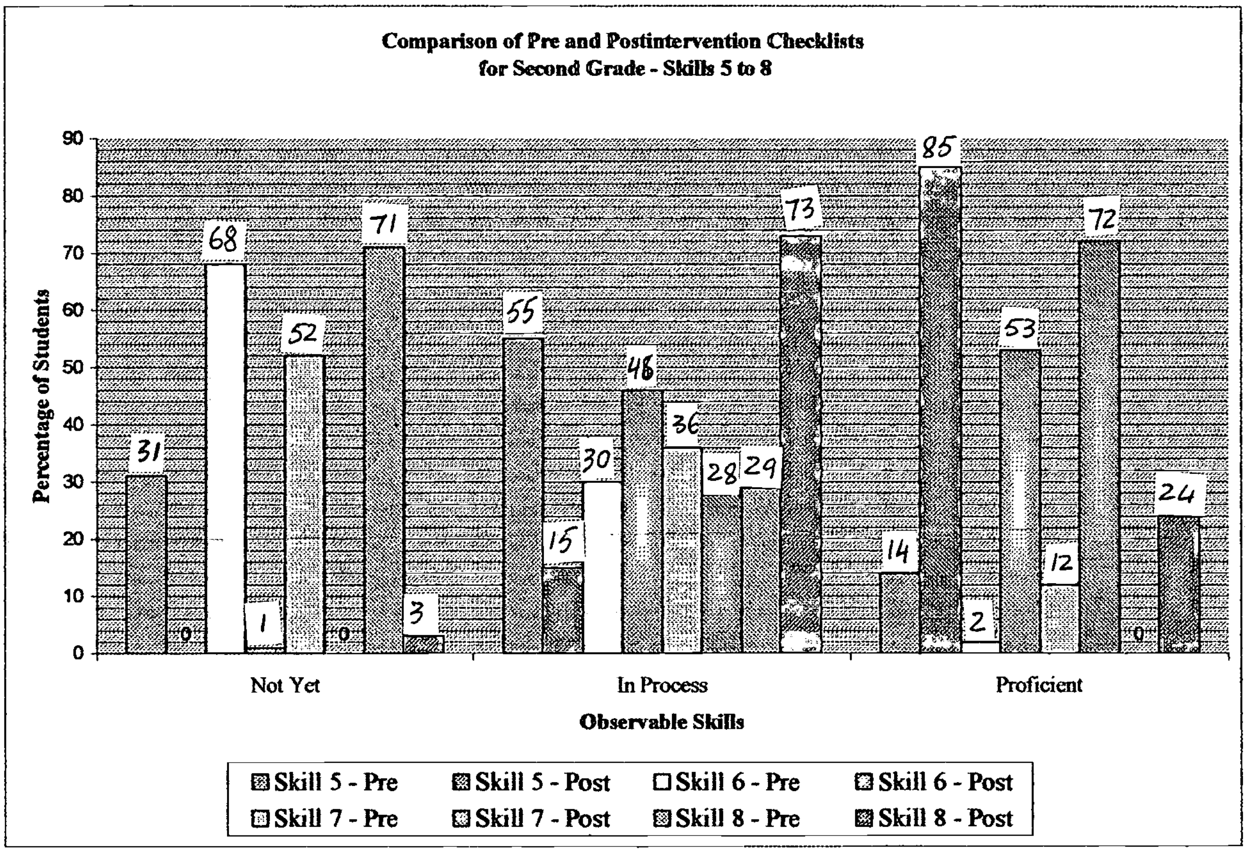
Figure 6. Comparison of Pre and Postintervention Checklists for Second Grade – Skills 1 to 4

Skill 1 - The largest percentage of increase occurred within the "Proficient" range. Due to the variety of learning experiences within the presented units, students were able to make observations by use of their senses.

Skill 2 - The total population of Site A appeared better versed in the use of scientific tools as shown in the higher "Proficient" rating. With the introduction of scientific tools within each curricular unit, students were given the opportunity to manipulate, experiment, and explore the possible uses of each tool.

Skill 3 - While the overall "Proficient" rating remained the same the most notable change was shown in the "In Process" rating. The enhancement of student knowledge was through hands-on curricular experiences.

Skill 4 - Noticeable increase in the "Proficient" rating indicated an application of observational, investigation, and experiential skills leading to the improved ability in seeking answers.



- Skill 5 - Asks questions leading to possible investigation about the natural and physical world
- Skill 6 - Can reflect on their reasonable predictions
- Skill 7 - Can use observations and experimentation to develop reasonable explanations
- Skill 8 - Communicates scientific thinking through verbal and written forms

Figure 7. Comparison of Pre and Postintervention Checklists for Second Grade – Skills 5 to 8

The percentage scores from pre and postintervention were based on direct observation along with minimal usage of written responses from students.

Skill 5 - The introduction of appropriate vocabulary within the curriculum setting may have lead to the decrease in the "Not yet" rating. The "Proficient" rating may have increased throughout the intervention due to teacher-guided discussions and student inquiry discussions.

The frequency and open nature of these discussions were encouraged through familiarity of the students within the classroom. Refinements of the students questioning skills were improved with the teacher's expectations for appropriate and meaningful participation by students.

Skill 6 - During the intervention students repeatedly honed their metacognitive skills by using a variety of graphic organizers. The evidence of this skill practice was shown in the decrease of "Not Yet" rating. The "Proficient" increase might be linked to the students becoming better able to support their theories and predictions using accurate and appropriate vocabulary.

Skill 7 - The large decrease in "Not Yet" and increase in the "Proficient" ratings could be attributed to the continual exposure of students to hands-on activities that required observation and experimentation. Expansion of these skills included rationalization of student ideas using logic, inquiry, hypothesizing, and inferring.

Skill 8 - The gain from "Not Yet" to "In Process" can be attributed to the diverse teaching techniques used by the teacher to aid the students' ability to communicate their scientific thinking. Teacher use of think aloud, modeled KWL, numerous graphic organizers, journal entries, and data collection methods were several techniques incorporated into the curricular setting.

The intervention appeared to have a positive effect on targeted skills as based on the pre and postintervention graphic comparisons. Incorporation of the science textbook, curriculum integration, science skills, and replacement of pre-conceived ideas facilitated transfer into the students' everyday life. Student exposure was expanded using hands-on and real life experiences, thus increasing their scientific literacy.

Conclusions and Recommendations

Based on the presentation and analysis of the data on scientific skills, targeted population showed a marked improvement in the "Proficient" ratings. The additional use within second grade of a purchased primary level newspaper and the district mandated series enhanced the integrated activities planned during the intervention period. Students polished scientific skills learned on a continuous basis, both individually and in cooperative groups, throughout the entire intervention period. The various skills addressed during the intervention transferred from one curricular setting to another. Based on teacher observations, an increase in student generated questions in social studies and reading activities was noted.

While the intervention was successful, there may be a few modifications other researchers might want to consider. First, research the incoming population by interviewing its present teachers. This will help to verify student ability levels, project relevancy and appropriateness. Individual students may become the target population instead of using an entire class. Second, be flexible in strategies, activities, and timelines to accommodate calendar changes within the intervention period. Thirdly, be conscious of the limited intervention duration when planning strategies. It is easy to over plan.

Much researcher and subject learning occurred during the planning and execution of intervention strategies. The focus shifted from departmentalized instruction to an integrated curriculum with an emphasis on science. Additional exposure, preparation, and planning of intervention strategies increased teacher comfort levels in the area of science. Through this intervention, a by-product emerged. There was a desire to educate colleagues as to the ease with which science skills can be integrated into their existing curriculum.

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APPENDICES

Appendix A
Teacher Survey for Kindergarten Teachers

KINDERGARTEN SCIENTIFIC LITERACY SURVEY

Please reflect back on your students over the last three years and provide us with feedback on the general abilities of the majority of your students.

The majority of students entering kindergarten are able to...

SKILLS	KNOWLEDGE NOT EVIDENT	PARTIAL KNOWLEDGE	ADEQUATE KNOWLEDGE	PROFICIENT KNOWLEDGE
1. use senses to explore classroom materials and natural phenomena by focusing and organizing experiences into meaningful thought.				
2. use tools for investigation to begin drawing conclusions from observations.				
3. make same and different comparisons among objects observed.				
4. seek answers to questions through active exploration.				
5. verbalize observations and ask questions about the natural world.				

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Appendix A Continued
Teacher Survey for First Grade Teachers

Teacher Survey of Science Skills
Grade 1

Please reflect back on your students over the last three years and provide us with feedback on the general abilities of the ***majority*** of your students.

The majority of students *entering* First Grade are able to:

Skills	Knowledge Not Evident	Partial Knowledge	Adequate Knowledge	Proficient Knowledge
Identify living and non-living things				
Recognize and name common animals				
Associate common animals with the sounds they make and the places they live				
Be aware that plants grow from seeds				
Recognize and name common parts of the body				
Be aware of the five senses and their uses				
Recognize weather changes and seasonal changes				
Be aware of the seasons				
Be aware of how weather affects daily living				
Be aware of seasonal changes affecting the environment				
Be aware of pollution and its effects				

Appendix A Continued
Teacher Survey for Second Grade Teachers

Teacher Survey of Science Skills
Grade 2

Please reflect back on your students over the last three years and provide us with feedback on the general abilities of the ***majority*** of your students.

The majority of students *entering* Second Grade are able to:

Skills	Knowledge Not Evident	Partial Knowledge	Adequate Knowledge	Proficient Knowledge
Classify things as living or non-living				
Identify wild and domestic animals				
Identify the ways animals eat, change, move, and are born				
Be aware of what plants need for growth				
Be aware that plants have parts				
Identify and use the five senses				
Be aware of basic body needs				
To sort objects that are or are not attracted toward a magnet				
Be aware of what causes day and night				
Be aware of what causes shadows				

Appendix A Continued
Teacher Survey for Third Grade Teachers

Teacher Survey of Science Skills
Grade 3

Please reflect back on your students over the last three years and provide us with feedback on the general abilities of the ***majority*** of your students.

The majority of students *entering* Third Grade are able to:

Skills	Knowledge Not Evident	Partial Knowledge	Adequate Knowledge	Proficient Knowledge
Classify animals into categories				
Be aware of life cycle changes in some animals				
Name ways mankind uses animals				
Be aware of the growth stages of mankind				
Name the basic parts of a plant				
Recognize changes in growing plants				
Recognize changes in sound				
Make comparisons by measuring				
Recognize the properties of magnets				
Identify light energy				
Recognize heat energy				
Be aware of electricity				
Identify various kinds of weather changes				
Identify kinds of pollution and methods of control				
Recognize three states of water				
Recognize how water is used in each of the three states				

Appendix B
Intervention Checklist for 3-4 Year Olds

INTERVENTION CHECKLIST; 3-4 YEAR OLDS

Name of Child________________________________

SKILLS	NOT YET	IN PROCESS	PROFICIENT
1. Uses senses to experience exploration with classroom materials and natural phenomena.			
2. Uses tools for investigation to focus on an object and specific aspects of an object.			
3. Makes comparisons among objects that have been observed with adult prompts.			
4. Verbalizes observations about the natural world.			

Appendix B Continued
Intervention Checklist for Second Grade

INTERVENTION CHECKLIST; SECOND GRADE

Name of Child________________________________

SKILLS	NOT YET	IN PROCESS	PROFICIENT
1. Uses senses to notice details by careful observation.			
2. Can verbalize how scientific tools are used and why it helps them with their investigations.			
3. Classifies objects based on observation, as well as, on prior knowledge and experience.			
4. Seeks to answer questions using simple tests and application of prior knowledge.			
5. Asks questions leading to possible investigation about the natural and physical world.			
6. Can reflect on their reasonable predictions.			
7. Can use observations and experimentation to develop reasonable explanations.			
8. Communicates scientific thinking through verbal and written forms.			

Appendix C
Core Concept Test – Chapter 1

SCIENCE HORIZONS

Name ______________________ SCORE

Chapter 1 Core Concepts

Read each question. Circle the answer.

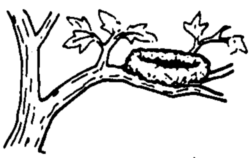
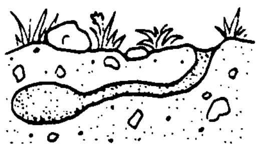
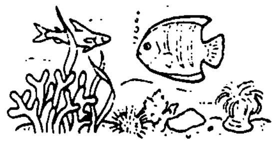
1. Which is a way scientists group animals?

by fur color   by egg size   by body covering

2. Which animal lays eggs?



3. Where do many birds lay their eggs?

4. Which group has animals that change from tadpoles to frogs?

amphibians   mollusks   reptiles

5. In which way are frogs and alligators alike?

how big they are   where they live   how their young form

Appendix C Continued
Core Concepts Test – Chapter 2

SCIENCE HORIZONS

Name

SCORE

Chapter 2 Core Concepts

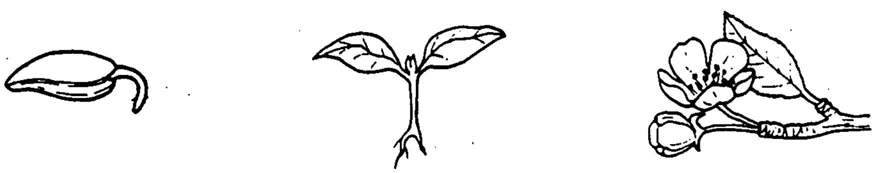
Read each question. Circle the answer.

1. When pollen reaches an egg, what forms?

2. Which of these do plants and seeds need to grow?

animals   water   wind

3. What happens first when an apple seed sprouts?



4. Which is a good place for new plants to grow?

5. What is formed inside a pine cone?

leaf   seed   flower

Appendix C Continued
Core Concept Test – Chapter 3

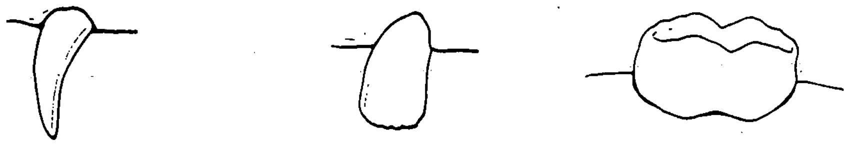
SCIENCE HORIZONS

Name ______________________ SCORE

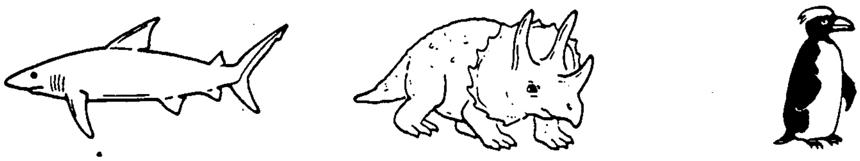
Chapter 3 Core Concepts

Read each question. Circle the answer.

1. Which tooth helped dinosaurs eat meat?



2. Which animal is a dinosaur?



3. Where are most fossils found?

in plants   in rocks   in water

Use this drawing for question 4.

4. Which animal made these footprints?

whooping crane   giraffe   dinosaur

Appendix C Continued
Core Concept Test – Chapter 4

SCIENCE HORIZONS

Name

SCORE

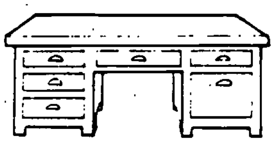
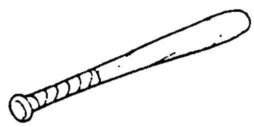
Chapter 4 Core Concepts

Read each question. Circle the answer.

1. Which is true of matter?

There is only one kind of matter. | Some matter does not take up space. | All objects are made of matter.

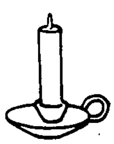
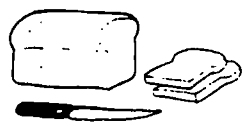
2. Which object takes up the most space?

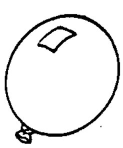
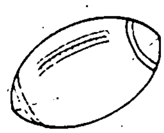
3. Which is true of a solid?

It has its own shape. | It spreads out in space. | It does not have a shape.

4. Which kind of matter is changing form?

5. Which has matter inside that you can see?

CHAPTER 4 CORE CONCEPTS

Appendix C Continued
Core Concept Test – Chapter 5

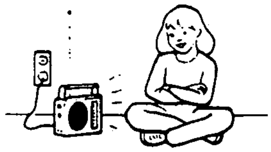
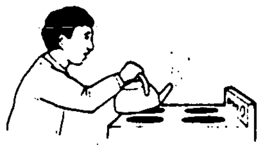
SCIENCE HORIZONS

Name _______________________ SCORE

Chapter 5 Core Concepts

Read each question. Circle the answer.

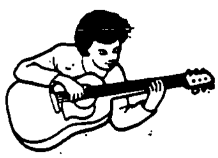
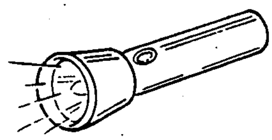
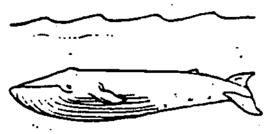
1. Which person is using electricity that is changed into heat energy?

2. What kind of energy moves fastest?

light electricity sound

3. Which shows air moved by sound energy?

4. Which kind of objects absorb sound energy?

big objects light objects soft objects

5. Which of these has the darkest shadow?

CHAPTER 5 CORE CONCEPTS

Appendix C Continued
Core Concept Test – Chapter 6

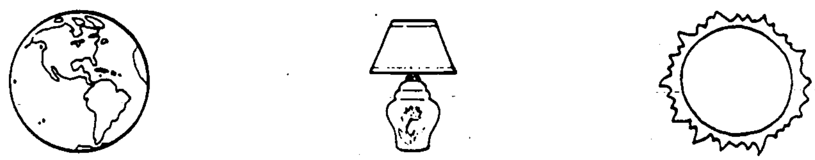
SCIENCE HORIZONS

Name ______________________ SCORE ____

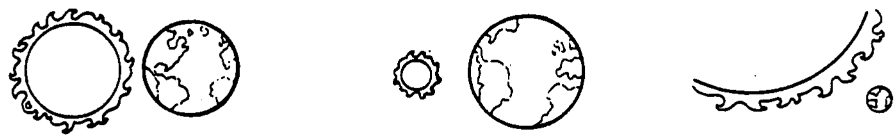
Chapter 6 Core Concepts

Read each question. Circle the answer.

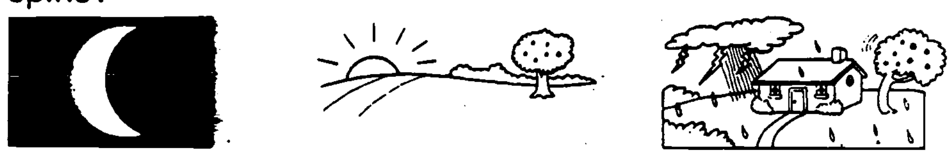
1. What makes light from burning gases?



2. Which shows how big the sun is?



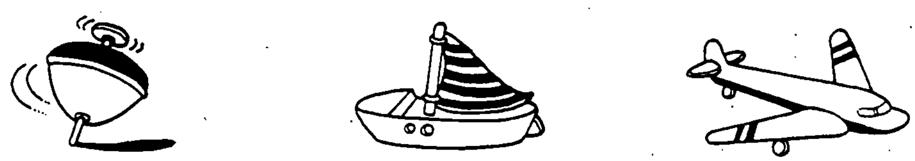
3. Which of these happens because the earth spins?



4. What does the earth do that causes day and night?

rotates   rises   sets

5. Which object moves like the earth?



Appendix C Continued
Core Concept Test – Chapter 7

SCIENCE HORIZONS

Name ______________________ SCORE

Chapter 7 Core Concepts

Read each question. Circle the answer.

1. Where do people get oxygen?

from water from air from animals

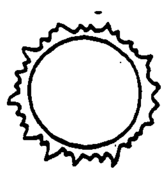
2. Where does a worm get air?

from soil from water from plants

3. What is inside the bubbles in water?

ice air salt

4. What is made of liquid water in the air?



5. Which kind of water do you drink?

salt water fresh water ocean water

CHAPTER 7 CORE CONCEPTS

Appendix C Continued
Core Concept Test – Chapter 8

SCIENCE HORIZONS

Name

SCORE

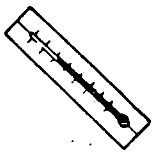
Chapter 8 Core Concepts

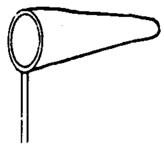
Read each question. Circle the answer.

1. What is the word for how hot or how cold something is?

   thermometer weather temperature

2. Which of these measures temperature?

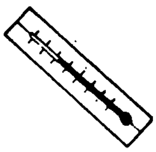




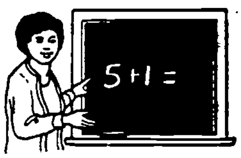
3. What is a short burst of strong wind called?

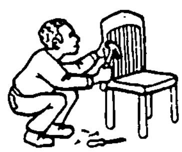
   breeze gust storm

4. Which shows where the wind is coming from?




5. Who cannot work when it rains?



CHAPTER 8 CORE CONCEPTS

Appendix C Continued
Core Concept Test – Chapter 9

SCIENCE HORIZONS

Name

SCORE

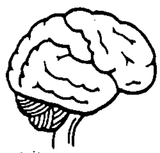
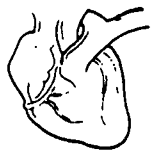
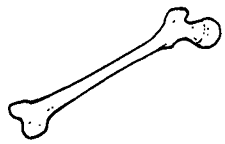
Chapter 9 Core Concepts

Read each question. Circle the answer.

1. Which body parts help you write?

heart and lungs | mouth and throat | eyes and hands

2. Which of these controls many parts of the body?

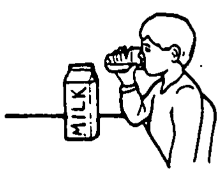
3. Which of these holds up your body and gives it shape?

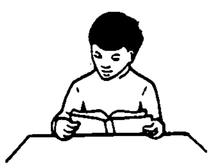
heart | skeleton | nerves

4. What does a muscle do to make a bone move?

It squeezes the bone. | It gets shorter. | It pumps blood.

5. Which child is helping his bones stay strong?






CHAPTER 9 CORE CONCEPTS

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