Influence of teaching in an outdoor classroom on kindergarten children's comprehension and recall of a science lesson

Kari Anne Dietz
Louisiana State University and Agricultural and Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_theses

Part of the Education Commons

Recommended Citation
Dietz, Kari Anne, "Influence of teaching in an outdoor classroom on kindergarten children's comprehension and recall of a science lesson" (2002). LSU Master's Theses. 222.
https://digitalcommons.lsu.edu/gradschool_theses/222

This Thesis is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Master's Theses by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
INFLUENCE OF TEACHING IN AN OUTDOOR CLASSROOM ON KINDERGARTEN CHILDREN’S COMPREHENSION AND RECALL OF A SCIENCE LESSON

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College

in partial fulfillment of the requirements for the degree of Master of Arts

in

The Department of Curriculum and Instruction

by

Kari A. Dietz

B.A., University of Louisiana Lafayette, 1999

August, 2002
ACKNOWLEDGEMENTS

My sincerest and deepest thanks are extended to many people who were instrumental in my study. First to Dr. Hegsted, I probably never would have decided to do a thesis had it not been for the research class. Once I got underway, Dr. Buchanan, Dr. Burts, and Dr. Benedict guided me through the process. I am also indebted to Dr. Wandersee and Dr. Hamblen for the invaluable advice and support. The study would not have taken place without the kindness shown to me by Principal Regina Thomas and Superintendent Robert Clouatre, and their willingness to allow me to conduct my study in their school system. I am also grateful for the generosity of Nancy Braud, Brenda Hughes, Julie Laborde, and Donna Singleton, the kindergarten teachers, for their interest and patience in allowing me to interrupt their routine. Of course my heart goes out to each and every child who participated in my study, including my assistant who kept up with me on the nature trail. I am indebted to Dr. Steve Buco who was so very altruistic in sharing his resources and expertise in helping me analyze my results, and Tess who saved me through the rigors of the Graduate School’s formatting requirements.

Finally, my words of gratitude just don’t seem like enough for all of the love and support from my family, especially Mom and Dad who gave very many selfless hours of their lives in helping me through the process. I certainly could not have done it without both of you.
# TABLE OF CONTENTS

**ACKNOWLEDGEMENTS** ............................................................................................................ ii

**ABSTRACT** ................................................................................................................................... v

**CHAPTER 1 – INTRODUCTION** ............................................................................................ 1
  - Rationale............................................................................................................................. 1
  - Purpose of the Study ....................................................................................................... 3
  - Variables........................................................................................................................... 3
  - Hypothesis......................................................................................................................... 4
  - Limitations ....................................................................................................................... 4
  - Assumptions ..................................................................................................................... 4
  - Definitions of Terms ....................................................................................................... 4

**CHAPTER 2- REVIEW OF LITERATURE** ............................................................................... 7
  - Introduction .................................................................................................................... 7
  - Perspectives ................................................................................................................... 8
    - John Dewey .................................................................................................................. 8
    - Jean Piaget ................................................................................................................... 9
    - Lev Vygotsky ............................................................................................................... 12
  - Brain Research .............................................................................................................. 13
    - Child Behaviors Linked to Brain Research .............................................................. 18
  - Teaching and Learning Science .................................................................................... 20
  - Outdoor Science .......................................................................................................... 20
  - Research ........................................................................................................................ 21
  - Influences on Learning Science .................................................................................. 23
    - Teacher Attitudes and Behaviors .............................................................................. 23
    - Methods of Teaching Science ................................................................................... 26
      - Description of Programs and Research ................................................................. 26
      - Comparison of Programs ....................................................................................... 32
    - Outdoor Education ..................................................................................................... 35
  - Artistic Representations ............................................................................................... 38
  - Summary ........................................................................................................................... 40

**CHAPTER 3- METHODS** .................................................................................................. 42
  - Introduction ................................................................................................................... 42
  - Sample ............................................................................................................................ 42
  - Design ............................................................................................................................. 43
  - Instruments ..................................................................................................................... 44
  - Procedure ....................................................................................................................... 46
<table>
<thead>
<tr>
<th>CHAPTER 4- RESULTS</th>
<th>56</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER 5- DISCUSSION</td>
<td>68</td>
</tr>
<tr>
<td>Objective</td>
<td>68</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>68</td>
</tr>
<tr>
<td>Emergent Patterns</td>
<td>69</td>
</tr>
<tr>
<td>Reflection</td>
<td>69</td>
</tr>
<tr>
<td>Implications for Practice</td>
<td>76</td>
</tr>
<tr>
<td>Implications for Research</td>
<td>76</td>
</tr>
<tr>
<td>Limitations</td>
<td>77</td>
</tr>
<tr>
<td>Conclusion</td>
<td>79</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>82</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>87</td>
</tr>
<tr>
<td>A: NATIONAL SCIENCE STANDARDS AND LOUISIANA BENCHMARKS</td>
<td>88</td>
</tr>
<tr>
<td>B: RUBRIC</td>
<td>90</td>
</tr>
<tr>
<td>C: EXAMPLES</td>
<td>92</td>
</tr>
<tr>
<td>D: OBSERVATION SHEET</td>
<td>113</td>
</tr>
<tr>
<td>E: LSU INSTITUTIONIONAL REVIEW BOARD</td>
<td>115</td>
</tr>
<tr>
<td>F: LETTER OF PERMISSION</td>
<td>120</td>
</tr>
<tr>
<td>G: PARENT CONSENT FORM</td>
<td>122</td>
</tr>
<tr>
<td>H: CHILD ASSENT FORM</td>
<td>124</td>
</tr>
<tr>
<td>VITA</td>
<td>126</td>
</tr>
</tbody>
</table>
ABSTRACT

Kindergarten children learn through hands-on interaction with materials. Additionally, the environment contributes to their learning. Therefore, if children are learning about concepts that naturally occur outside, they need to learn these concepts through active exploration, using as many senses as possible. This thesis examines the influence that an outdoor environment may have on children’s abilities to comprehend and recall concepts in a science lesson. The sample for this study came from four kindergarten classrooms from a semi-rural school in Louisiana. Three treatment groups received a lesson on trees. The control group was not given a lesson. Two groups participated in the lesson indoors, interacting with either pictures only or pictures and concrete objects. The lessons presented concepts about trees (height, width, roots, leaves, and bark). Children in the fourth group explored each concept as it naturally occurred outdoors in a lesson. Children’s initial understanding of concepts and subsequent learning were measured by pre-and post-test drawings. The author found an influence by the outdoor environment on kindergarten children’s comprehension and recall of the science concepts. Children taught outdoors demonstrated more accurate understandings of the overall concept of “tree” and of the “leaf” concept.
CHAPTER 1

INTRODUCTION

Rationale

It is important for children to be given the opportunity to connect with and learn in an outdoor environment. Every area of the curriculum can be enhanced by the many experiences that an outdoor classroom has to offer. These benefits are especially seen in the area of science. According to Charlesworth and Lind, (1999) children apply science concepts when they explore the outdoors. When outside, children have many opportunities to investigate, test, and change objects. Children construct knowledge through meaningful experiences (Charlesworth & Lind, 1999). According to Piaget, children need to be actively engaged with the environment to learn about the world around them (Charlesworth & Lind, 1999).

Young children do not have the ability to think about the world in an abstract way; they need concrete examples of what is being taught (Charlesworth & Lind, 1999). In light of the knowledge that we have about the way children learn, it is important that they are not limited to learning science within the confines of a classroom (Charlesworth & Lind 1999). According to Charlesworth and Lind (1999), children function as concrete-operational thinkers who learn to understand the world through active exploration. Although children are just as likely to have concrete experiences indoors as they are outside, the “real world” experience is lost. The indoor classroom environment often lacks an element of authenticity that can be found in the dynamic interactions of the outdoor classroom. Children can learn much in an outdoor classroom, experiencing the natural world first-hand and constructing knowledge about the way science works.
With recent, new knowledge about how the brain functions, it has been established that creativity, emotions, and images are processed in the right hemisphere of the brain (Harlan, 1988). This is one of the reasons it is advantageous to be outdoors, because the right hemisphere is likely to be stimulated through the curiosity and creativity elicited with new things to discover outdoors. According to Raina (1984), educational institutions have made inadequate use of natural curiosity and creativity. Learning experiences should enable children to translate their curiosity into action. Therefore, an important strategy for cultivating the use of the right brain is to have children use their perceptions in actual contact with phenomena about which they are learning. Furthermore, according to Harlan (1988), the right brain can take in whole masses of detail at once as images, then recombine the content and create new ideas. This is the second reason why it is important to enhance science by using the outdoor classroom. When educators teach science concepts indoors that are best taught outdoors, the concept is isolated from its natural context, thereby limiting the full use and potential of a child's brain. Children who are allowed to learn concepts outdoors are more likely to amass the total picture into a complete and accurate idea of the concepts. Harlan (1988) also stated that the potential of the brain may be maximized when the processes of both the right and left brain are engaged. This implies that traditional learning activities that only tap the linear, logical functions of the left hemisphere may limit learning potential. The outdoor classroom is the perfect environment for young children to learn, using both sides of their brain actively.

Most educational research focuses on children’s construction of knowledge in the indoor classroom environment; there is very little research on the influence of the outdoor classroom on children’s ability to construct knowledge about science. Children who are able to use their
senses and explore the concepts being taught not only in the classroom but also outside, especially when the experience allows them to observe naturally occurring examples of science concepts in an authentic context, may better construct meaning and develop a better understanding than children who are only taught indoors.

**Purpose of the Study**

The purpose of this study was to discover if teaching science in an outdoor classroom has an influence on the ability of kindergarten children to recall the information being taught better than if these science concepts are only presented indoors. The objective of this study was to determine if children’s concept of trees was learned better in an outdoor classroom relative to the comparison groups who were only taught inside.

**Variables**

The independent variable was the use of an outdoor classroom by teachers for the purpose of teaching science to kindergarten children.

The dependent variables were recalled by kindergarten children after a lesson about trees in an outdoor classroom. The acquisition of these concepts was evidenced by the changes on the posttest drawing relative to the pre-test drawing.

These concepts included:

1. Tall versus short trees
2. Long skinny needles versus long fat leaves
3. Smooth bark versus rough bark
4. Wide versus narrow trunk
5. Visible roots versus hidden roots
Hypothesis

There is a difference between the students’ comprehension and recall of the science lesson for students taught in an outdoor classroom and students taught in an indoor classroom.

Limitations

The limitations of the study were:

1. The sample was limited to four classes of children five to seven years old attending kindergarten at one public school in Ascension Parish.
2. The sample was taken from a school in a somewhat rural area so the results may not be generalized to all public schools in urban areas.
3. The sample size was limited to seventy-two children.
4. The child’s ability to draw may be a limitation.

Assumptions

The following were assumed to be true and fundamental to the study:

1. The sample used was representative of five to seven year old children attending kindergarten in public schools in Ascension Parish, Louisiana.
2. Learning in an outdoor classroom was conducive to each child’s learning style.
3. A child’s concept knowledge was accurately represented by their drawing.

Definition of Terms

Terms used in this study are defined as follows:

Bark (child’s drawing)

A child’s drawing shows evidence of tree bark, artistically represented by intentional marks, in addition to those strokes (up/down or side to side) for the purpose of color.
**Branches** (child’s drawing)

A child’s drawings will show evidence of tree branches by artistically representing branches with intentional marks extending from the trunk of the tree.

**Ground line**

A ground line in the children’s drawings is the ground upon which an object(s) is assumed to be standing.

**Individual leaves** (child’s drawing)

The children’s drawings will show evidence of individual leaves, artistically represented by intentional marks in addition to those strokes (up/down or side to side) made for the purpose of color.

**Nature Trail**

The nature trail is a structured natural environment that follows the recommendations and standardizations set forth by organizations such as the National Wildlife Federation that certifies schools as Schoolyard Habitats, and Project Learning Tree that certifies schools with state certification as a Project Learning Tree site. The sites usually include learning stations centered on certain concepts such as an animal tracking station, a butterfly/hummingbird garden, a weather station, and garden plots.

**Proportion** (Child’s drawing)

In the children’s drawings, proportion is the artistic representation by the student that illustrates accurate size of self relative to the tree.

**Three-dimensional**

In the children’s drawings, a three-dimensional picture is a picture drawn to give the impression of having depth.
Outdoor Classroom

An outdoor classroom is any outside environment that is in a natural setting and away from man-made structures, if possible. This area should at least include grass and some other plant life.

Roots (Child’s drawing)

The children’s drawings will show evidence of roots with intentional marks, artistically represented, coming from the base of the tree (Watson, 1990).

Trunk (Child’s drawing)

The children’s drawings will show evidence of a trunk artistically represented by the student.
CHAPTER 2
REVIEW OF LITERATURE

Introduction

According to Orion and Hofstein (1994), “Science education is conducted predominantly in three types of learning environments: the classroom, the laboratory, and outdoors. The outdoor environment is the most neglected by teachers, curriculum developers, and researchers” (p.1097). This is unfortunate because all outdoors is science. This is where children can become part of the natural world. Whether educators use the outdoor environment to extend and enhance science lessons in the classroom or design lessons that focus on available outdoor resources, students will benefit from the experience of interacting with science concepts in a natural environment. According to Lind (1991), children will be excited about exploring the world around them. Any strip of land can be an area for outdoor learning. The important thing is to get students outdoors and engage them in challenging learning (Lind, 1991).

L.B. Sharp was the author of Outside the Classroom and was an historical figure in outdoor education. The dictum of Sharp can be easily applied to education in general, including science. He said, "That which can be best taught inside the school rooms should there be taught, and that which can be best learned through experience dealing directly with native materials and life situations outside the school should there be learned" (Richardson & Simmons, 1996, p 3). This statement supports the idea that objects occurring in nature, such as trees, are best learned in the outside environment, rather than as isolated fragments of information brought inside.

According to Charlesworth and Lind (1999), children in the primary grades continue to be active learners. Unfortunately, opportunities for students to be actively engaged in outdoor
explorations are not often provided in the curriculum for primary-aged children. This practice hinders children’s learning of science because primary-aged children are still concrete-operational thinkers who construct an understanding of the world around them through actively engaging in explorations (Charlesworth and Lind, 1999). The following chapter will explore the possible benefits of teaching kindergarten-aged children science in an outdoor learning environment as opposed to the traditional approach of learning indoors only. Furthermore, the chapter will present literature relating to learning in an outside environment and all that this concept entails. It will include these sections: (1) Perspectives; (2) Brain Research; (3) Teaching and Learning Science; (4) Outdoor Science; (5) Influences on Learning Science; (6) Artistic Representation, and (7) Summary.

**Perspectives**

**John Dewey**

John Dewey (1963) said that educational experiences must have continuity and quality. Experiences should be linked cumulatively to one another and inspire a sense of curiosity. The aspect of “quality of experience” that Dewey referred to could logically extend to include an outdoor learning lab because it allows children to experience natural phenomena in an authentic environment. Furthermore, the opportunity for children to observe a lesson outside on a regular basis may elicit curiosity not elicited in an indoor setting (Dewey, 1963). Dewey emphasized that a primary responsibility of educators is not only to shape children’s experiences through authentic learning environments, but also to recognize how these environments are conducive to concrete experiences that lead to growth (Dewey, 1963). According to Dewey (1963), educators, above all, should understand how to utilize the learning environments that exist so they may employ all of the resources that these environments have to contribute to relevant experiences.
This is important so that the experiences that children have are as meaningful and authentic as possible because the educator is employing all of the resources available in the surroundings.

Jean Piaget

Educators who are basing their teaching on Piaget’s theory of constructivism “…place emphasis on individual children as intellectual explorers, making their own discoveries and constructing knowledge” (Hart, Burts, & Charlesworth, 1997-1998, p.78). Constructivism is a theory that proposes that students construct their own knowledge from personal experiences. The process of constructing knowledge is an active one.

According to Piaget, (1973), the power of children's observations should not be underestimated by teachers because the perceptions of children ages four to five are approximate, incomplete, and distorted by preconceived ideas of the subject. Therefore, it seems reasonable to suggest that the likelihood of misconceptions is decreased if children see a subject in its natural environment. The opportunity for incomplete or distorted ideas is greater if children are only able to see components of a subject removed from the context. For example, if children are learning about the concept of bark on trees, simply bringing bark into the classroom is too abstract; children need to go outside and see how bark is only one component of the whole tree. This is supported by the notion that in Piaget’s view, the environment nourishes, stimulates, and challenges children, but it is the responsibility of the children themselves to build cognitive structures, called schemata, based on these observations. As children interact with engaging situations in the environment, they encounter events that do not quite correspond to past experiences, creating conflict (Crain, 1992).
This concept of conflict within the child arose from a model of developmental change Piaget called equilibration. There is the potential that the outdoor environment would, therefore, be the embodiment of the nourishing and stimulating environment mentioned above because “Experiences that promote cognitive development, in addition, are not only interesting, but usually place the child in a state of conflict” (Crain, 1992, p 123). This state of disequilibrium would arise if the information that the child is observing in the environment is not congruent with the child’s prior knowledge.

There are three basic components involved in acquiring knowledge: adaptation, assimilation, and accommodation. Essentially, knowledge in any form, including perceptual knowledge, is not simply a copy of reality because it always involves a process of assimilation into previous schemes (Piaget, 1971). Adaptation is the end result of the assimilation and accommodation processes. These are not two separate functions, but two functional poles set in opposition to each other, which is inherent for any final adaptation in acquiring knowledge (Piaget, 1971). Adaptation may be defined as a state of equilibrium between the forces of assimilation and accommodation, and assimilation will not result in adaptation without a corresponding accommodation of the incoming information.

According to Piaget (1971), the primary function of knowing is that it involves assimilation, or interaction, between the subject and the object. The nature of this interaction is such that the process involves a simultaneous accommodation of the most extensive characteristics of the object and an equally extensive incorporation into preexisting schemata. In the course of this assimilation process, the subject accommodates their schemata to the object, but in doing so, never abandons or changes the nature of the schemata. The object is simply included or comprehended.
The constructivist view has become one of the foremost theoretical positions in education and has become a powerful driving force in science (Treagust, Duit, & Fraser, 1996). The constructivist view is appealing because it provides a functional framework for understanding and interpreting experiences of teaching and learning. When used this way, constructivism provides a powerful theoretical foundation for building a classroom that maximizes students’ learning for several reasons. First, this framework encourages educators to reflect on the appropriateness of their teaching with regard to the way children learn. The other reason this framework maximizes learning is that elementary school teachers became aware that their students require many concrete experiences in which they are able to interact with concepts being presented. This includes scientific concepts that need to be connected to real-life experiences (Caine & Caine 1994). Concrete science experiences are especially important in the kindergarten through sixth grade levels because these experiences provide the foundation for later abstract learning at the high school and university levels (Caine & Caine 1994).

According to Robertson (1994), “Jean Piaget's classic study of children's conceptions of the world have influenced educators to respect the learner as one who actively constructs a coherent world-view and who seeks persistently to integrate formal and informal learning experiences” (p. 23). Piaget described the reasoning of those under twelve as influenced by concrete, observable phenomena. The idea that individuals construct their own meanings for events and phenomena leads to a constructivist model of science learning in which concept change is seen as the product of interaction between existing conceptions and new experiences (Millar, 1989). It is also possible for existing conceptions that children hold to be inaccurate, which is why it is crucial to expose children to subject matter in the context that it occurs as much as possible to aid accurate concept formation.
Lev Vygotsky

Vygotsky contributed a view of cognitive development that recognized both developmental and environmental forces (Charlesworth & Lind, 1999). While Piaget viewed development as if it arose mainly from the child alone as a product of the child’s internal maturation and spontaneous discoveries, Vygotsky, on the other hand, believed this was true only until about age two. He believed that internal and external forces interacted to produce new thoughts (Charlesworth & Lind, 1999). According to Vygotsky’s theory on concept formation, a concept is not simply a collection of associations involving connections that are learned with the aid of memory. According to Vygotsky, “Concepts do not lie along side one another, or on top of one another with no connections or relationships” (1987, p 224). Generalization as a result of immediate perception of reality can only occur if complex connections and relationships are established between the objects being represented in the concepts and the rest of reality (Vygotsky, 1987). Unlike some concepts that arise spontaneously, a child’s scientific concepts undergo a true process of development; these are actual concepts that are formed before our eyes. Learning a system of scientific concepts occurs through mediation between a child’s conceptual system and the world of objects.

According to Vygotsky, the weakness of the scientific concept lies in its verbalism; in other words, an insufficient saturation with the concrete (Vygotsky, 1987). Learning in an outdoor environment is an eloquent illumination of Vygotsky’s philosophy of learning scientific concepts because presenting scientific concepts in the absence of their authentic context denies the child an opportunity for making complex connections and forming relationships about the concept to its environment so that generalization may occur. Not only did Vygotsky
acknowledge the importance of the environment in concept formation, but also the role of interpersonal relationships.

Vygotsky put more emphasis on the roles that adults and more mature peers have on influencing children’s mental development than Piaget. While Piaget placed an emphasis on children as intellectual explorers and making their own discoveries, therefore constructing knowledge independently, Vygotsky emphasized his concept of the Zone of Proximal Development (ZPD). The ZPD is the area between where the child is currently operating independently in mental development and where that child might go as a result of assistance from an adult or more mature child. Based on Vygotsky’s research we know that children can do more in collaboration than spontaneously (Vygotsky, 1962). This is why the outdoor environment is an optimal environment to learn in because there are many concepts that can be learned through cooperative learning with peers. According to Vygotsky (Vygotsky, 1962), “Teachers will know that they have hit upon the right zone because children will respond with enthusiasm, curiosity, and active involvement” (p.9) which would most likely be seen in children who are actively engaged with observing and learning concepts in the outdoor classroom.

**Brain Research**

Humans have shown an interest in the mysteries of how our species' brain functions for centuries. Unfortunately, until recent breakthroughs in technology, we have been limited to postmortem studies. Nobel prize recipient Roger Sperry furthered our understanding of brain functioning immensely (Raina, 1984). He was responsible for coining the split-brain theory, based on his work with seizure patients. In order to stop people from having seizures, brain surgery was done to sever the corpus callosum, the connection between the hemispheres of the cerebral cortex. As a result it was discovered that each hemisphere had distinct functions (Raina,
Sperry decided to investigate further, and according to Raina’s evaluation of Sperry’s studies, he was able to demonstrate that the right hemisphere could perform spatial tasks, but had almost no language capability. On the other hand, the left hemisphere controlled speech but could not perform spatial tasks (Raina, 1984).

Technological innovations such as the EEG (electroencephalogram) and the tachistoscopic technique have allowed some insight into the functioning of the brain in living humans. Spatial ability in the right hemisphere and language in the left, as shown by Sperry, is not the only hemispheric specialization. In 1976, Kraft conducted a study using six to eight year old children. He found that the children engaged in Piagetian tasks that were using both hemispheres (according to an EEG reading) performed better throughout all tasks on nonverbal (right hemisphere) and verbal (left hemisphere) activities. When the non-verbal right hemisphere was used to process the verbal tasks in conjunction with the left hemisphere, performance on this task was better for those who used only their left hemisphere on verbal tasks. Additionally, according to Raina, studies using a tachistoscopic technique have validated specialization of the cerebral hemispheres. The left hemisphere is used for linguistic tasks, and the right hemisphere is superior for processing spatial (visual) tasks (Raina, 1984). Spatial and language abilities are only a few of the functions of the right and left hemisphere. Each hemisphere is capable of functioning differently from the other. For most people, the left hemisphere treats stimuli one at a time (serially), where the right hemisphere processes stimuli many at a time (gestalt).

According to Raina (1984), Zelniker and Jeffrey conducted a study where they related cognitive style to a model of cognitive processes in the brain. They hypothesized that reflective children (those above the mean on accuracy and latency of response) differ from impulsive
children (those who are below the mean on accuracy and latency of response) in their information-processing strategies. Upon analyzing the results, they found that the reflective children used a left hemisphere analytic-cognitive style and the impulsive children used a right hemisphere, global-cognitive style. An important educational implication of this study is that impulsive children are not necessarily inferior to reflective children in problem-solving ability when a global strategy may be used in solving a problem. This is important to educators because this finding implies that learning will be difficult for a student when there is a mismatch between a child’s global-cognitive strategy and the analytic organization of many lessons and instructional tasks.

The left hemisphere is better at analytical reasoning, math, speaking, and reading. The right hemisphere is considered spatial, holistic, and simultaneous in nature and has a greater capacity to deal with informational complexity. The left hemisphere is superior in tasks requiring fixation upon a single cognitive task. Even though each hemisphere of the brain processes aspects of meaning from the same experience, connections between the two hemispheres integrate to two processing styles and synthesize the information simultaneously (Raina, 1984). According to Rubenzer (1982), the need to integrate both convergent (left hemisphere) and divergent (right hemisphere) modes in learning experiences is well supported by research. The potential of the brain is maximized when both left and right hemisphere processes are engaged.

Many educators have assumed that learning occurs primarily through memorizing facts and specific skills. Educators neglect the fact that the brain has an innate predisposition to search for how things make sense and for meaning and experiences. It is a matter of discovering how what is being learned relates to what students already know and how experiences connect (Caine & Caine, 1994). This line of thinking is supported by the philosophy of Piaget that a
child’s prior experiences influence the construction of meaning. Our function as educators is to
provide students with many experiences that enable them to perceive patterns that connect.
Brain research establishes and confirms that many complex and concrete experiences are vital
for meaningful learning and teaching because active learning is experiential.

What we learn depends on the global experience, not just on the manner of presentation. It is important that we offer an education for the whole brain to enable students in understanding
the complex nature of the world and themselves (Raina, 1984). The most common practice of
education is biased towards left cerebral functioning and in the process leave the other side less
developed (Raina, 1984). Given a curriculum that is composed so largely of learning facts, we
impoverish the students’ experiences and foster a shallow form of competence. The right brain
appears to deal with perception and retention of complex, nonverbal auditory and spatial
relationships. Furthermore, the right hemisphere tends to combine similar ideas and mix images,
experiences, emotions, and other mental functions in a way that encourages invention;
knowledge is achieved not only through words but also through images. The right brain can take
in whole masses of detail at once as images and then recombine the content and create new ideas.
This has been confirmed by the fact that the interpretation of complex visual patterns has been
found by several investigators to be predominantly the right hemisphere function (Raina, 1984). The right brain processes information in a non-linear fashion and creates meaning out of many
kinds of information simultaneously.

The over-analytical models so often presented to children in their textbooks emphasize
linear thought processes. Traditional teaching only taps the linear functions of the left
hemisphere and actually limits learning potential (Harlan, 1992). It stifles children’s natural
need to explore and make meaning out of the world around them. The potential of the brain is brought to its maximum potential when both the right and left hemisphere processes are used.

Targeting the right brain has influenced the way educators present information which in turn has an affect on the children. One of these effects, highlighted by Rubenzer (1982), is that stimulation of right hemisphere processing increases measured intelligence. Rennel’s (1976) research found that sixty percent of the abilities that IQ tests measure were found to involve right hemisphere processes.

Our knowledge of brain functioning also influences how children should be educated. Our evolving knowledge of how the brain works is showing educators that they need to move away from the traditional teaching of the left hemisphere to a more holistic inclusion of the whole brain in teaching. When educators practice brain-based education that focuses on the right hemisphere of the cerebrum, children may gain enriched experiences. The right hemisphere makes an important contribution to human performance. It is the underlying neural basis for our ability to take in fragmentary sensory information and from it, construct a deeper comprehension of the outside world.

All complex events embed information into the brain and link what is being learned to the pre-existing experiences of the learner. The primary focus for teachers should be to expand the volume and quality of ways in which a student is exposed to content and context. This can be accomplished by ensuring that the student is engaged in the activities of talking, listening, reading, observing, exploring, discovering, acting, and valuing. Brain-based teaching employs methods that are complex, lifelike, and incorporate the use of natural environments. An important strategy to cultivating the right brain is by actively guiding the student by having them employ their perceptions through increased direct contact with phenomena about which they are
learning (Raina, 1984). According to Harlan (1992), it has been shown in past research that learning is facilitated when ideas are presented to young children in a variety of contexts. Raina stated, “The world outside the school walls, the larger environment, is therefore important material for study“ (Raina, 1984, p. 60).

**Child Behaviors Linked to Brain Research**

The reason the outside environment is developmentally and physiologically appropriate for the way in which children learn is based on the information that has been gained through brain research and research into children’s motivation, curiosity, exploration, and interest. There are three different motivational states: intrinsic, extrinsic, and amotivated. Intrinsic motivation is the most valued in education because the reward is an inseparable part of the spontaneous feelings and thoughts. Some of the behaviors demonstrated by intrinsically motivated children are curiosity and exploration. According to Deci and Ryan (1982), "The self-directed learning of little children is paradigmatic of intrinsically motivated behavior; it is active, involving, open minded; it includes surprise and wonder; it leads children towards mastery to their environments and provides them with the tools to be more self-determining” (p. 4).

In experiential learning, motivation is usually intrinsic because the learner is personally involved in the act of discovering. Motivation is seldom a problem with experiential learning, while teachers often see it as the major problem with learning in the classroom (Phipps, 1988).

According to Jenkins (1969), who studied curiosity in children, intrinsic motivation encourages non-linear (right brain) learning through curiosity. Students experience non-linear learning when they satisfy their curiosity. One way to stimulate curiosity is to enable students to experience the thrill of discovery. This can be achieved through bringing children outside into a natural environment and allowing them to construct meaning about what they are learning.
through exploration. Children, by nature, observe and explore their surroundings, driven by their natural curiosity which is one of the most valuable attitudes that can be possessed and is a basic component of science. Unfortunately, years of formalized experiences in traditional education allow little time for exploration and can crush this valuable trait.

Exploration is usually a concentrated activity and involves investigation and manipulation. There is a difference in body function that can be measured in children who are exploring. When a child is exploring, the blood flow to certain parts of the brain increases (Raina, 1984). There is evidence for example, that exploratory behavior can be encouraged through instructional techniques. The results from the Science Curriculum Improvement Study (SCIS), which will be discussed in the Methods of Teaching Science section, reveals that the SCIS children not only exhibited significantly more exploratory behavior than non-SCIS children, but also outperformed these children in exploration (Allen, 1970).

Another behavior related to children's learning, in addition to exploration, is interest. It is vital that educators involve children in an environment that cultivates this behavior. Although researchers have difficulty in defining interest so that it can be measured, Rennenger, Hidi and Krapp (1994) suggest there is a consensus that "...interest is a phenomenon that emerges from an individual's interaction with his or her environment and that a central research question concerns how interest affects learning" (320). Most researchers view interest as an independent variable and learning as a dependent variable. When we offer intriguing science experiences to young children, we nourish their natural capacity to know. If this is done with sensitivity to their interests, we enhance the affective component of knowing and learning. The outdoor environment is filled with new things to discover, and is an excellent place to capture and nurture children’s interest.
Teaching and Learning Science

The constructivist view of learning contrasts with the behaviorist view of teaching and learning which advocates a passive view of the mind where learners accumulate knowledge provided by the teacher. This view of teaching underlies the traditional approach to teaching. In traditional education, science can look to the learner like a body of knowledge that cannot be challenged, and whose learning leaves little opportunity for creative involvement.

In constructivist education, the teacher plays the role of a facilitator rather than a transmitter of knowledge. The teacher probes the students' understanding and helps them resolve conflicts between scientific concepts and their prior knowledge. Constructivism does not advocate that students discover everything for themselves. Rather, constructivist instruction focuses on relating new knowledge both to previously learned knowledge and to experiential phenomena so that students can build a consistent and accurate picture of the physical world.

According to Chrouser (1975), Busch suggests that children's learning environments should not be only indoors, but outdoors as well. Therefore, she urges that the children need the opportunity to explore their surroundings and to relate their scientific knowledge to all parts of their environment. Experiences on the school grounds are convenient and they can satisfy all of the following requirements: they can be continuous, qualitative if combined with classroom instruction, and extend through a student's entire school career (Harvey, 1989-1990).

Outdoor Science

According to Gonzalez-Mena (1998), children in the early years begin to learn about nature, “Nature is especially interesting because it too belongs to the real world. Nature is best learned by getting out and exploring it” (Gonzalez-Mena, 1998, p.353). It is also important that children learn a basic respect for nature (Gonzalez-Mena, 1998). As children actively construct
knowledge about areas such as biology and ecology, educators can teach the connections between nature and humans. They can teach that we are interdependent with nature, so that children are aware of the fragility of nature (Gonzalez-Mena, 1998). Gonzalez-Mena (1998) stated, “We want children to be gentle and respectful of nature, but we also want them to construct knowledge, which they need to do in a hands-on way” (p.368).

Outdoor classrooms can be used to extend science beyond the classroom walls. Outdoor classrooms can be as simple as an area of the school campus that has been specifically designated to allow children in urban settings to observe grass growing through the cement. An outdoor classroom can also be as elaborate as designed outdoor learning facilities that include nature trails, butterfly and hummingbird gardens, and amphitheaters. The outdoor classroom allows children the opportunity to observe natural phenomena first hand (Martin, 2000). The attitudes of educators make a significant difference in what children learn from their observations. According to Gonzalez-Mena (1998), “When an adult is an interested, curious, and respectful observer, children are more likely to approach observation the same way” (p 368).

The school grounds make an excellent environment for an outdoor classroom for all areas of the curriculum, not just science, and it is easily accessible on a daily basis. The school grounds are readily available, unlike field trips, which can be difficult to plan and coordinate. Opening the classroom door and stepping outside to the grounds surrounding the school can be just as effective of a learning tool as a field trip but with less idle time spent getting to the intended destination.

Research

The school grounds can be an important learning environment. Harvey (1989-1990) conducted a study using 845 children, equally divided by gender, with an age range between 8 to
11 years. These children were selected from 21 schools in England. The schools were selected because they had a maximum variability of vegetation on school grounds. The purpose of this study was to evaluate the impact of the school grounds on the students’ botanical knowledge. The general focus of the study was the relationship between children's experiences with vegetation and their environmental knowledge. Because all of the children’s experiences do not only occur on school grounds, past experience with vegetation was also measured.

Four specific aspects of the school landscape were examined. These aspects included the amount of vegetation, the diversity of vegetation, the complexity of environmental features, and the accessibility of vegetation. The hypothesis of this study was that the more extensive the children’s experience with vegetation, the more knowledgeable they would be about botany. Questionnaires were used to gather data from students and teachers. The results showed that the complexity of environmental features achieve the highest correlations with general botanical knowledge and the variety of past experiences of the students were positively associated with general botanical knowledge. The variety of experiences with vegetation seemed to be especially effective in improving students' knowledge base. This study provides evidence of a relationship between the school grounds and the cognitive development of children that supports the use of an outdoor classroom as an effective teaching resource.

Lisowski and Dissinger (1991) studied eighty-seven high school students' understandings of selected ecological phenomena while on a field trip to the Bahamas, Andros Island and the Grand Cayman Islands that lasted seven days. Also, they investigated the effects of the field instruction strategies on students' understanding and retention of targeted concepts. The study was conducted in two phases: the first phase was to design an instrument that was a means for obtaining information about students’ understandings of ecological concepts. The
second phase was to examine the influence of field strategies on deepening student understanding and retention of the targeted concepts. In this phase, students responded to the instrument prior to, at the conclusion of, and four weeks after the programs. Analysis of the results found that all groups exhibited statistically significant post-test gains.

The study provided support for the premise that field-based programs in the sciences are effective in helping the students understand and retain selected ecological concepts. Furthermore, this study demonstrated that the concepts targeted in this study were taught and learned effectively through the experiential field instruction programs. While it does show that students demonstrated gains in knowledge due to being outside, this is a very unrealistic field trip for most educators. The results of this study can be applied to the school grounds because it reveals the benefit of being exposed to concepts in an outdoor environment.

**Influences on Learning Science**

**Teacher Attitudes and Behaviors**

Children are our most important assets for the future, and few things are more important than young minds that are turned on to learning as an adventure and a process of discovery. When educators have a passion for opening their students up to the world around them, hopefully a door is being opened to a promising future where children continue to be active learners and construct meaning while exploring the natural environment. The environment outside can be just as exciting for teachers as it is for students.

The State Education and Environment Roundtable (SEER) Project on using the environment as an integrating context in education (Lieberman, 1998), suggests that a benefit to using the environment is the learning that reaches beyond students and encompasses teachers as well. This is important because it is likely that if teachers enjoy their work more, their
enthusiasm may cultivate enthusiasm in students. The results of this project show that ninety-five percent of teachers and administrators who responded to a teaching survey reported becoming more enthusiastic about their work after their school adopted SEER’s program, Using the Environment as an Integrating Curriculum (EIC) (Lieberman, 1998). The educational goal of having intrinsically motivated students is best achieved when the teachers themselves are intrinsically motivated. This means that they should be excited, involved, self-directed, and trying new things. Educators need to provide stimulating environments for the children to learn in.

One of the most critical stages of experiential education is the selection of the most appropriate environment to make sure that every child receives a quality experience with the corresponding quality education (Phipps, 1988). An exciting learning environment for children is the one outside that provides countless naturally existing experiences to discover. Unfortunately, according to Harvey (1989-1990), "In a nationally representative sample of American science teachers, Keown noted that sixteen percent of the teachers never used the outdoors for educational purposes, and that the majority of teachers used it fewer than three times a year" (p 10).

Recent curriculum development has focused on inquiry or discovery methods as an alternative to rote learning that has been prevalent in the schools (Novak, 1976). Teachers can be prepared to use the outdoors as a learning environment when given opportunities to analyze and reflect on the many ways in which students learn science and how to design and adapt strategies and materials for the purpose of accommodating different learning styles (Raizen, & Michelsohn, 1994). A study was done by Chrouser (1975) for the purpose of comparing two approaches to teaching biological science lab to pre-service elementary teachers. The two approaches were the
indoor lab and the outdoor lab. The sample size included 48 students. The subjects involved in this study were students (from sophomores through graduate students) who were enrolled in a biology course designed for prospective elementary teachers at the University of Northern Colorado. Each class was divided into an outdoor group and an indoor group. Every class received the same instruction during the lecture sessions, and the lab was held at the same time for each group. During the lab sessions, the indoor group performed exercises with no outdoor activity. The outdoor group, on the other hand, performed activities that were in the outdoors. The objectives taught were the same for each group.

The study found that the outdoor group showed greater satisfaction with school in general than the indoor group. Those in the outdoor group sensed a deeper understanding of the individual's role in the environment. The outdoor group was able to enjoy a natural object as a whole rather than something to take apart to study. They were also more curious about what something was, why it was there, and what effect it had on the local environment. The implications of this study are that learning in the outdoors seems to aid in the understanding of selected biological principles and interest in the subject matter. Furthermore, an individual's natural curiosity is stimulated when the lesson is presented in the outdoors in a learning situation. Curiosity is enhanced, which is important in the problem-solving approach to learning (Chrouser, 1975).

A sense of wonder and curiosity is just as important for teachers as it is for students, because educators will be more willing to adopt a discovery approach to teaching instead of a lecture format. In 1969, Lindberg studied the effects of two in-service instruction modes (lecture demonstration versus discovery) on elementary teachers' attitudes towards science. Students in a university extension service course were randomly assigned to two treatments. According to the
results of the study, ninety percent of the teachers taught by the discovery method reported
increased use of experiments and demonstrations in their own classes, whereas only sixty percent
of the teachers taught by the lecture demonstration method went on to use the experiment
method in their classes. Seventy-two percent of the teachers, including all of those taught by the
discovery method, preferred a discovery approach to in-service instruction. This study is
important because, by exposing prospective teachers to the benefits of discovery, they will be
more likely to employ this strategy in their own classrooms.

Methods of Teaching Science

The notion that learning is achieved by active construction of knowledge rather than
simple absorption or intake of information is a crucial concept. This concept is important for
teachers to grasp if they are to develop insight into the way children learn, which is that children
are active participants in the knowledge they gain. This is crucial if teachers are going to help
students succeed in learning. Children acquire science knowledge through direct observation
and exploration of familiar events (Hart, Burts, & Charlesworth, 1997). Concepts are best
understood when they are presented in a variety of ways that relate to other events in their world
(Hart, Burts, & Charlesworth, 1997). Hands-on and activity-based learning science is learning
from materials and processes of the natural world through direct observation and
experimentation. These direct experiences are sources for students’ learning about science and
are essential to learning (Hart, Burts, & Charlesworth, 1997).

Description of Programs and Research

There are many hands-on, activity-based curricula available to educators but for the
purposes of this paper I will be discussing SCIS, SAPA, SEER, and ESS because these are the
most widely used and most extensively researched programs. Furthermore, the National Science
Foundation sanctions these elementary science programs. These programs are non-traditional because they are activity-based and frequently use direct experience, experimentation, and observation as the sole sources of obtaining information about the natural world. They are process-oriented, placing as much emphasis on how to gain information and understand it, as on the information itself, and the children do not have textbooks.

Science Curriculum Improvement Study

The Science Curriculum Improvement Study (SCIS) is an elementary science program that was developed at the Lawrence Hall of Science at the University of California at Berkeley between 1962 and 1974. The general instructional pattern for SCIS is free exploration of new materials, introduction of a new concept, and application of the new concept in new situations. This program was developed with financial support from the National Science Foundation. The immediate goals of the program are to familiarize children with specific examples of objects and organisms, and to let these students investigate examples of natural phenomena and to help them develop skills in manipulating and recording data. The long-range goals of the program are to further the intellectual development of children and to increase the scientific literacy (the functional understanding of basic scientific concepts) of the school population.

Research studies by Allen (1970, 1972, 1973), were carried out to evaluate SCIS. The studies were experimental in design and were longitudinal over a six-year period. There were many variables that were considered at the dependent and independent level, and it was differential in that interactions between programs and students were examined.

The design and population of each study varied somewhat, therefore the details of each of the three studies will be discussed independently, but the general purpose of each study remained the same, to investigate whether participation in the SCIS Elementary Science Program (physical
science section) at grade level I, II and III (in independent studies) resulted in a performance superior to that of grades I, II and III non-participants (in independent studies).

While creating this study, the procedure of randomizing subjects, treatment groups and teachers was not possible. Therefore, a static group comparison design was used. For the SCIS grade I evaluation, according to Allen (1970) there were 150 children for the experimental (SCIS) group and 150 children for the control (non-SCIS) group. All populations were selected from the Honolulu school system. The non-SCIS children in all three studies spent a year with conventional hard cover commercial, elementary science textbooks. The instruction emphasized verbal interaction at the expense of manipulation of objects and organisms. The objectives in the study selected for examination at the grade I level were to describe an object by its properties, to group objects by material, to order objects serially by stating property, simple inference, grouping objects by other than visual means, and grouping objects by visual means. According to the results, the study found that SCIS children demonstrated significantly more exploratory behavior than non-SCIS children. The differences of successful item responses appear to be minimal. It is possible that superior exploratory behavior is all that can be realistically expected after only one year in the program.

The purpose of the SCIS study at grade level II is as stated above, but the design is different. After obtaining a complete list of grade I children participating in the SCIS program, a random sample of fifty subjects was drawn from the seven participating schools. These same children were used for the grade II evaluation, but because of attrition, the population was 213 from the original 300. There were 101 SCIS participants and 112 non-SCIS participants. For this study, the SCIS grade II physical science interaction unit was used. It taught the concepts of systems interaction and evidence of interaction. An analysis of the results found that the
Honolulu SCIS children are statistically superior to non-SCIS children in both the cognitive and the affective behavior categories. The motivational performance of the SCIS children did not appear to be any better than the non-SCIS children (Allen, 1972).

The purpose of the SCIS study at the grade III level is that which is stated above. This study used the same children who were in the first and second grade level evaluations. Again due to attrition the population was reduced from the original 300 to a population of 176. This study used the physical science unit that teaches the concepts of subsystems, variables, planned experiments, and controlled variables. An analysis of the results found that the grade III SCIS children were statistically superior to non-SCIS children in both cognitive and motivational (explanatory) behavior (Allen, 1973).

Werling (1979) compared the learning of SCIS content taught indoors, both with and without environmental lectures, to a modified SCIS approach in association with sight stewardship, the active involvement of the students in caring for land resources, in fourth and fifth grade students. He found that students learned that the outdoor (sight stewardship) groups gained significantly more environmental knowledge than either of the indoor groups.

**Elementary Science Study Program**

The Elementary Science Study Program (ESS) was developed at the Educational Development Center in Newton, Mass. from 1961 to 1971. Compared with SCIS and SAPA, ESS is the least structured. It has no specified sequence of objectives or detailed instructional procedures. Life and physical science units are included, along with several units including activities in spatial relations, logic, and perception. The activities are included for both their motivating quality and the opportunity for problem solving and understanding natural
phenomena. The activities begin with a presentation of a challenge followed by a period of exploration and concluding with a class discussion.

**Science-A-Process Approach**

The Commission on Science Education of the American Association carried out the development of Science-A Process Approach (SAPA) for the Advancement of Science in Washington, D.C., from 1963 to 1974. This program “subscribes to the theory that science skills or processes taught through the use of meaningful classroom investigations and activities are more fundamental to effective science instruction than the memorization of facts or concepts. It has been proven to be one of the most popular of the new programs” (Davis, Raymond, Rawls, & Jordan, 1976, p. 205). Furthermore, the program is highly structured and focuses on teaching specific processes. The content is drawn from both the life and physical sciences and is selected because it presents a clear situation in which the process being taught can be applied. Because of the sequential nature of the objectives, evaluation at each step is provided. Individual students or whole classes can use this program.

The purpose of the study on SAPA was to compare the achievement and creativity of elementary students who were using project approach versus textbook programs. There was a sample size of 617 students from grades one through six. A random sample of 25 was drawn from each grade level at each school to assess creativity. This study compared two groups of students instructed with different science programs but who had participated in the standard reading and math elementary curriculum. The students were chosen according to scores on standardized tests assessing intelligence and achievement. Furthermore, the Metropolitan and SRA achievement tests were used as measures of achievement and science, reading and math. Students enrolled in the SAPA Program showed stronger verbal fluency, (the ability to produce a
large number of ideas and questions with words) and flexibility (the ability to produce a variety of ideas or questions on the Torrence Test of Creativity) than students at the fourth and sixth grade levels enrolled in a traditional textbook curriculum. Both components are necessary for divergent thinking and problem solving (Davis, Raymond, Rawls, & Jordan, 1976).

**State Education and Environment Roundtable**

Representatives of thirteen state education agencies created the State Education and Environment Roundtable (SEER). This group is interested in the potential of using environment-based education programs to improve student learning. They coined the term “EIC: Using the Environment as an Integrating Context for Learning”, which defines a framework for education. EIC-based learning...”is not primarily focused on learning about the environment, nor is it limited to developing environmental awareness. It is about using a school’s surroundings and community as a framework within which students can construct their own learning, guided by teachers and administrators using proven educational practices” (Lieberman & Hoody, 1998). EIC-based programs use the environment (outdoor classroom) as a comprehensive framework for learning in all areas.

There is relatively little research that presents the educational efficacy of environment-based education, and while there is a substantial amount of research on traditional environmental education that was primarily concerned with assessing only environmental skills, knowledge, and behavior, it provides little insight into overall educational experiences. Due to this fact, SEER designed this study for the purpose of evaluating the effects on learning and instruction by using the environment as an integrating context in kindergarten through twelfth grade schools. This study is primarily qualitative in design, using interviews and surveys, although as much quantitative data as possible was gathered. The sample size of this study included a total of 650
individuals, 400 students and 250 teachers and principals from 40 schools across the United States. Only those schools that had adopted the concepts and frameworks of EIC were used. These educators emphasized project and problem-based approaches to instruction that appealed to a variety of sensory processes and learning styles. These approaches combined hands-on, minds-on methods, taking advantage of students’ cognitive, kinesthetic, affective, and sensory abilities. Furthermore, EIC programs tend to employ learner-centered, constructivist teaching styles. The principal criteria for inclusion of these schools were the degree of integration of the environment throughout the curriculum, the students’ involvement in projects and problem solving, the extent of team-teaching, and program longevity. For the purpose of this paper, the results of this research will be discussed only as it pertains to the area of science. It was found that when compared with traditionally educated peers, not only did EIC-educated students more effectively master scientific knowledge and skills, but also achieved a deeper understanding of scientific concepts and processes. These students also performed better on standardized measures of science achievement and showed greater excitement and interest about learning science than students in regular curricula. When educators use the environment as an integrating context it is both highly motivating for students and effective in helping them develop higher-order thinking skills.

Comparison of Programs

Bredderman (1984) conducted a meta-analysis of the effectiveness of three major activity-based elementary science programs, Elementary Science Study (ESS), Science-A Process Approach (SAPA) and the Science curriculum Improvement Study (SCIS). There were several steps in the process of synthesizing the research. In the first phase, Bredderman synthesized research findings from the following sources: Dissertation Abstracts International,
ERIC, Journal of Research in Science Teaching, Science Education, The Annual Review of Research in Science Education, and Annual Meetings of the National Association for Research in Science Teaching. From a total of eighty reports, due to insufficient information, the total number of studies for this review was fifty-seven.

In order to assess the effectiveness of the programs on various outcomes, the fifty-seven studies on ESS, SAPA and SCIS were compared with other ways of teaching science and analyzed quantitatively. It is estimated that about thirteen thousand students from over nine hundred classrooms were tested in all the studies combined. Unfortunately, seventy-nine percent of the studies had static groups or non-equivalent control group designs. Using these fifty-seven studies, a total of four hundred comparisons were coded. Upon analyzing the overall effects of these activity-based programs, it was found that all outcome areas combined were clearly positive. Thirty-two percent of all four hundred comparisons favored the activity-based programs and were statistically significant whereas only six percent favored the non-activity based programs. The results indicate approximately a fourteen-percentile improvement for the average student as a result of being in the activity-based program group.

It was found that the effects of measures of science process, intelligence, and creativity are nearly twice as large as the effects on the outcome areas of affective, perception, logical development, language, science content and math. Furthermore, it is fairly certain that the use of activity-based programs promotes student achievement in all of the analyzed outcome areas that are science process, intelligence, creativity, affective, perception, language, science content, and mathematics with the exception of logical development.

According to Bredderman, several recent studies have contrasted the teaching of science content at the elementary level using certain features of activity-based approaches with more
traditional methods. Activity-based methods produced greater science content learning. The expectation was that an activity-based program with a problem-solving orientation and time for some free exploration would lead to increased creativity was investigated by researchers. Bredderman said the results generally confirm the above expectations. Furthermore, he concludes that performances on tests of science process, creativity, and possibly intelligence would show increases of ten to twenty percentile units. There is no basis in the present data to conclude that non-activity based students will outperform activity-based students on any educational outcome under any study conditions. Bredderman feels that the accumulating evidence in the science curriculum reform efforts from the past two or three decades suggests that activity-process-based teaching of science results in gains over traditional methods.

Almy (1970) conducted a study on logical thinking by second grade children who had received instructions based on SAPA and SCIS during kindergarten and first grade. More than one thousand children were studied in six districts of San Francisco, and New York. A control group, which did not receive instruction based on any of these programs, was also included. Assessment of logical thinking was achieved through interviews. The results of the study indicate that the children from the control group scored as well as the children who had received the treatment lessons in Kindergarten and first grade. However, it was found that children in these two groups scored better than children who had received only one year of instruction starting in the first grade (Anderson, 1972).

Oelrich's study in 1969 examined the effects of instructing a group of Kindergarten children to make observations as a way of learning about different plants and plant parts as opposed to having a set of scientific principles and laws explained to them by the teacher. The main purpose of the study was to determine whether the observation ability of Kindergarten
children can be improved with regard to plants included in the study as well as those not directly included. The children in the control group were not provided organized instruction in observation of plant specimens. The children in the experimental group were given a series of lessons. One lesson included viewing a video; the other involved the identification, description, and interpretation of plants such as a geranium, cactus, rose, violet and tulip. The children in both the treatment and control groups were pre- and post tested using an interview designed by the investigator. Both verbal and non-verbal responses were recorded. The treatment consisted of five lessons from the Iowa Television Science Education Program. It was found that the treatment groups improved on their performance on the tests as evidenced by greater notation of properties and more verbal responses.

**Outdoor Education**

Harvey (1989-1990) did an experimental study comparing indoor and outdoor environmental education and recommended a combination of classroom preparation with outdoor experiences. According to Howie (1974), this study determined the effect of an environmental education program as compared to one that was conducted completely indoors. The focus of this research was clearly on the cognitive facet of environmental education. The outdoor treatment was structured to provide the guided discovery of concepts presented to the group of fifth graders. The classroom materials were closely related to the activities of the outdoor group. There were four treatment groups: treatment one group was classroom-only activities, treatment two group was outdoor-only activities, treatment three group was indoor and outdoor activities, treatment four group (control) did not have environmental education activities. Results of the research suggest that use of an outdoor classroom needs to be an extension of the indoor class and not a spontaneous discovery approach to the lessons. In addition, according to
Backman and Crompton, (1985), the findings of Howie, Hosly and Goldsberry have concluded that “It is likely that environmental concepts may be learned effectively if students are oriented in the classroom with relevant concepts so that they have some sense of structure before going into the outdoor experiences” (p.11).

Outdoor education is an informal method of teaching and learning which can enrich, vitalize and compliment all content areas of school curriculum by means of first-hand observation and direct experience out of doors. Most schoolyards can provide learning opportunities about science concepts by observing nature. They provide first-hand experiences with natural phenomena while encouraging flexibility to incorporate all areas of learning to achieve the goals of education (Lee, 1984).

Crompton and Sellar's (1981) summary of research on outdoor educational experiences concluded that the out-of doors provides a stimulating environment for relevant fields of study. According to the researchers, any course that has as an objective, dealing with understanding the processes of science, should utilize the out-of-doors whenever possible. Outdoor experiences can achieve many educational objectives in subject areas.

According to Gallagher's (1972) summary of Davidoff's research, he studied the impact of out-of-school science experiences on sixth grade children's achievement in science and the interaction in learning situations between children from two different socio-cultural environments. The results showed that children provided with out of school experiences made greater gains on test achievement than a control group of students who did not participate in the program. The organizational patterns of elementary schools typically have fewer difficulties in arranging for out-of-school activities in comparison with secondary schools. The absence of
rigid time frames for instruction in specific subject areas makes it more feasible for the elementary teacher to arrange to leave the classroom and engage in outside adventure

According to Backman and Crompton (1985), it has been advocated that outdoor experiences are a superior vehicle for facilitating cognitive learning of general science. Furthermore, Smith suggests that "most of the science fields may be enriched and comprehension increased through carefully selected outdoor experiences” (Backman & Crompton, p. 7).

Elementary teachers are quick to identify and take advantage of learning situations that motivate students, such as bringing them outdoors to explore an expressed interest occurring in nature. Outside-the-classroom experiences can clearly provide such opportunities. Backman and Crompton (1985) evaluated a study by De Blanc where he used a pre- and post-test experimental design to examine how participation in an outdoor education program influenced science achievement of high school seniors. A total of four hundred seventy-nine students were involved. Two hundred fifty-eight were in the experimental group. The one hundred seventy-four students in the control group were from a different high school. The experimental group participated in twelve science short courses in a five-month period at an outdoor education center. Students in the control group did not take part in the program. The instrument used to evaluate the students in the study was the Metropolitan Achievement Test: Science Concepts and Understanding Science Information. Analysis of the results indicates that students in the experimental group achieved significantly higher score increases than the students in the control group.

Backman and Crompton (1985) did an evaluation of the study where Wise compared the effects of three different methods of science instruction. The methods of instruction included
direct experience in the outdoors, outdoor classroom instruction, and indoor classroom instruction. He measured three different dimensions of the cognitive domain. These included comprehension, acquisition of knowledge, and subsequent observations made by the students in an outdoor setting. The design of this study was a pre-test, post-test, and post-post-test; no control group was included. Two hundred sixty one subjects were used in this study and subjects and teachers were randomly assigned to treatment groups. These students were fifth graders that were randomly selected from three schools. The science content taught was in the area of soils, trees, and temperature. Pre-test scores revealed that no significant difference existed between groups prior to treatment. The analysis performed to determine the effects of the three treatments (knowledge/recall, comprehension and retention) showed that those subjected to the outdoor direct exposure treatment scored higher on both the post-test and the post-post-test. Furthermore, for both the knowledge/recall and comprehension parts of the test, the outdoor direct exposure group scored higher than the other two treatment groups.

According to Backman and Crompton's (1985) review of the literature, they suggest that the outdoors may be effective in stimulating critical thinking and increasing problem-solving skills. Furthermore, "the evaluative research reviewed for this paper offers qualified support to those who advocate the value of outdoor education in facilitating cognitive development in the areas of environmental education and general science” (p. 11)

Artistic Representations

According to Kellogg (1969), Read hypothesized that children follow the same graphic evolution in the process of discovering a mode of symbolization. Therefore the art of children can be a tool used in understanding mental development and the educational needs of children because there seems to be a universal sequence that children follow in the stages of their artistic
development. Kellogg (1969) investigated approximately one million drawings done by young children from toddlers up through age eight. These drawings were taken from thirty countries, including the United States. Based on studying the artwork, she was able to identify four successive stages that children progress through. These are patterns, shapes, designs, and pictorials that are achieved through the children’s individual perceptions and activities. From toddler through age two, children can be seen creating a variety of scribbles that have been identified as twenty different types. By around age two, children are in the pattern stage of development. In this stage, some of the children’s scribbings are put into definite placement patterns that show an effort to position the marking. As children approach age three, they enter into a transition stage of drawing emergent diagram shapes that precede actual diagrams that are typically drawn by children around three years old. Children will progress from emergent diagrams to more definite shapes that are drawn in outline form that is the shape stage. At ages three and four, children typically use a single type of scribble on paper. Between ages three and four, children will move from the shape stage into the design stage where they will elaborate the diagrams into line formations. Once the children have progressed through this stage of art development, they enter into the final stage that is pictorial work at around age four. According to Kellogg (1969), they draw “…representations of humans, animals, buildings, vegetation, and other subjects” (p.40). As children progress through artistic development they create new ways of making line formations but do not abandon earlier drawings, as evidenced by many of the same characteristics (Kellogg, 1969). Children beyond age four continue to refine their drawing skills. The typical vegetation seen in the drawings of young children are trees and flowers, with a prehistory clearly visible in their scribbles. A child’s first tree is very similar to an armless human but with the head containing extra markings not necessary for a face.
Another aspect of children’s artwork that may be examined is proportion. This may also give some insight into the level of children’s artistic and conceptual development. According to Runes & Schrickel (1946), proportion is customarily applied to the treatment of an artist’s subject matter. A work is said to exhibit proportion when the artist respects and adheres to the true worth and significance of different elements of the subject. The use of this term, therefore, involves an assumption about comparative values in the real world. Through the research that Kellogg (1969) conducted, she found that the trees drawn by children are not in sizes found in nature, but in sizes necessary to complete patterns or other aesthetic goals.

**Summary**

A review of the literature and research relating to science education in an outdoor setting reveals an emerging pattern of interest in researching this area of education followed by a void in information-gathering for a span of many years. Recent research has neglected the area of learning science in an outdoor environment, while there was a fair amount conducted between the 1960's and the 1970's. Given our recent strides in the impact of brain research in learning, and a rising trend in discovery, hands-on, and inquiry-based learning, the impact of introducing education in an outside setting may be seen with future research, which is already being addressed by organizations such as SEER. By encouraging and providing informal science experiences for all students, we can enhance lifelong science learning. Just as science is a process of discovery, so too is science teaching. Educators who are proficient build upon and stimulate students’ interests while motivating them to engage in challenging work. Science can be a very powerful subject in motivating students to be engaged by capturing their minds and bodies. Few learning environments are as complete in capturing students’ sense of wonder or as physically engaging as the world of nature outside. This study was designed to explore the
influence that learning science in an outdoor environment has on the ability of kindergarten children to comprehend and recall science concepts. The recall of these science concepts was in the form of an artistic representation by each child. It is not unrealistic to expect that kindergarten children would be within an age range that are able to represent concepts about trees in the form of drawings. This is supported by Kellogg’s analysis of what children are capable of drawing at this age.

The concepts in this study revolved around the parts of trees and a comparison of the human form in relation to the tree. Proportion was not directly presented but dependent on the child’s observation skills. Proportion in this study applies to a comparison between the child’s artistic representation of a tree and a self-portrait standing next to the tree. This component of the study will be an interesting area to explore because Kellogg found that the proportion of trees drawn by children typically do not represent an accurate size of those found in nature. Therefore, it will be interesting to discover if the children in this study, learning in an outside environment, will have a more accurate representation between themselves and the trees in the post-test drawing.
CHAPTER 3
METHODS

Introduction

The purpose of this study was to discover if the environment in which children learn significantly influences their comprehension and recall of the science concepts being presented. This study examined concepts that related to trees that were both directly and indirectly presented by the researcher. There were five dependent variables in this study that were directly presented in the lesson; tall versus short trees, long skinny needles versus long fat leaves, smooth bark versus rough bark, wide versus narrow trunk, and visible roots versus hidden roots. There were also dependent variables that were measured but not directly presented in the lesson; total score, branches, dimension, proportion, and ground line.

Sample

A purposive sample of four pre-existing classes was employed. There were six kindergarten classes to choose from. One kindergarten class was excluded because of a strong teacher bias towards the use of the outdoor classroom for learning, and another was excluded due to the teacher’s physical limitations. The classes were randomly assigned to treatment groups. The classes contained a total of 88 children, but due to unreturned consent forms and absences, there were 72 participants in this study who ranged in age from 5 to 7 years of age. This total included 36 girls and 36 boys. There were four groups in this study. The Control (X₀) group had a total of 19 students; (10 boys) 53%, and (9 girls) 47%. The Inside-2D (X₁) group had a total of 16 students, (8 boys) 50%, and (8 girls), 50%. The Inside-3D (X₃) group had a total of 20 students, (10 boys) 50%, and (10 girls) 50%. The Outdoor (X₂) group had a total of 17 students,
(8 boys) 47%, and (9 girls) 52%. The subjects in this study were from Galvez Primary, which educates students from a four year old class through grade four. The school is located in a rural area of Ascension Parish near Gonzales, Louisiana. The criterion for choosing this school was that it has an outdoor classroom that has been certified both by the National Wildlife Federation as a Schoolyard Habitat, and by Project Learning Tree as a state-certified site.

**Design**

This study used an experimental design with a pre-and post-test in both the control group ($X_0$) and the treatment groups ($X_1$, $X_2$, $X_3$). All groups received the same pre-test assessment and post-test. This experiment was carried out over a four-day period. Three groups received the same concepts but presented in different ways and in two different environments, one group outside and two groups inside. The Control ($X_0$) group received a pre-test and post-test but no lesson.

The children in the experimental groups were given a chance to participate in first-hand experiences in different ways. The groups were also given opportunities to use a varied number of senses to learn. It was not that the outdoor group used the most senses, because the Inside-3D ($X_3$) group also used the visual, tactile and auditory senses. Every treatment group used the visual sense; therefore it was a combination of the senses and the Gestalt experience of seeing the concepts in context that distinguished the Outdoor ($X_2$) group from the other experimental groups.

Inside-2D ($X_1$) saw photographs and Inside-3D group ($X_3$) saw photographs and objects of the trees that the treatment group saw on the trail. After each experimental group received their lesson, the children were then given the post-test assessment indoors where they were asked to draw another picture of a tree to determine if there was a change in their concept of a tree and
their recall of detail. Once again they also drew themselves standing next to the tree to
determine if there had been a change in their concept of proportion. On the first day, both the
control group and the experimental groups did the pre-test drawing. On the second day, Inside 2-
D (X_1) participated in their lesson and completed their post-test, and the Control group (X_0)
completed their post-test. On the third day, the Outdoor group (X_2) participated in their lesson
and completed their post-test. On the fourth day, the Inside-3D group (X_3) participated in their
lesson and completed their post-test.

In order to minimize experimenter bias, two procedures were employed. The first
procedure, used in all four groups, was the use of a tape recorder. Recording began on the first
day while the pre-test was being administered in each of the groups. On the second through the
fourth day, the lesson of each treatment group, and the post-test that followed, was also recorded.
The Control group (X_0) post-test was also recorded. The second method used was a teacher
observation sheet designed by the researcher. This form included each of the concepts presented
in the lesson in the order that they occurred, with a space below each for notes. Each teacher
received their own observation sheet for the treatment group they were involved in. They were
expected to take notes on how each concept was presented. Each observation sheet also included
a space for the teacher to record the time the lesson began, duration of time the lesson was
taught, and the ending time (time the last child finished the post-test). There was also a line for
the teacher’s signature for authenticity. An example of the observation sheet can be seen in
APPENDIX D.

**Instruments**

A method of scoring was chosen to record and make note of any changes that occurred
from the pre-test assessment to the post-test assessment. A rubric was used to score the drawings
made by each child. The same rubric was used to score both the pre-test and the post-test drawings (see APPENDIX C). A three-point scoring system was used. Each of the following concepts was given a score of two points for a definite existence of the concept in the drawing, and one point if the concept was somewhat present, and zero points for absence of the concept in the drawing. The concepts included roots, trunk, bark, branches, individual leaves, proportion, and additional details that were anatomical to the tree but not included in the lesson. The other concept measured in this rubric was the proportion of the child relative to the tree. If the proportion was accurate, two points were awarded; if the proportion was somewhat accurate, one point was awarded, and if the proportion was inaccurate, zero points were given (see drawing, APPENDIX C). The maximum possible score was sixteen on the post-test. The minimum possible score was a base of two points because all the children had at least a trunk on their trees and drew themselves as part of the assignment. The reliability of the rubric was determined by use of the interrater reliability procedure. It was conducted with an unbiased person ignorant of the details regarding the study. In order to determine the accuracy of the concept definitions and their scoring, the drawings from the field test in May were used. Half of the pre-and post-test drawings were scored using the rubric and the corresponding concept definitions in isolation from the other rater. Afterwards, the same drawings were given to the second rater along with the corresponding definitions. She went through the same scoring procedure, also in isolation. It was determined that there was only 50% interrater reliability. The definitions were modified and the process was repeated with the second half of the drawings. The interrater reliability increased to 90%.
**Procedure**

The following concepts were presented to each treatment group regarding specific trees on the nature trail:

- Tall versus short trees (pine versus water oak)
- Long skinny needles versus long fat leaves (pine versus magnolia)
- Smooth bark versus rough bark (holly versus pine)
- Wide versus narrow trees (oak versus fringe tree)
- Visible roots versus hidden roots (oak versus pine)

**Control (X₀)**

On Day One at 11:00, the children in the Control group participated in a pre-test assessment that lasted approximately 30 minutes. The duration of the time spent for the pre-test depended on when the last child finished. The first fifteen minutes were spent arranging the children into a single file line sitting on the floor in the classroom. Each child had a clipboard with their own piece of blank paper with their name on the back. They also had their own crayons. The children were told not to start drawing until everyone was seated. I instructed all of the children to “Draw me a picture of a tree, not a Christmas tree, but a tree like you would see outside and draw yourself standing next to the tree.” Once the children began drawing, I walked around the room to observe the drawings. When a child announced they made a mistake, they were allowed to turn the paper over and begin again. When a child announced they had made a mistake on both sides, I gave them a new piece of paper with their name written on it. The mistakes were labeled as such and placed in a separate folder. As the children completed their picture, they were given another piece of paper to draw anything they wanted. These
pictures were not collected as part of the data and were not used as part of this study.

On Day Two, I returned to the Control \( (X_0) \) group and asked them to sit in the same arrangement as they had in the pretest, and I administered the post-test to the Control \( (X_0) \) group that lasted approximately 30 minutes. This group did not receive a lesson between the pre-test and the post-test. Their instructions for both tests were to draw a tree with themselves standing next to it.

**Inside –2D \( (X_1) \)**

On Day One at 9:30, I administered the pre-test to Inside-2D \( (X_1) \) that lasted approximately 30 minutes. The children were arranged in a single file line sitting on the floor. Due to the small size of the classroom the children sat in the hall, which remained distraction-free. Chairs were not used so to minimize looking I instructed the children that their drawing was a secret and that nobody else could see it. Each child had a clipboard with their own piece of blank paper with their name on the back. They also had their own crayons. The children were told not to start drawing until everyone was seated. I then instructed all of the children to “Draw me a picture of a tree, not a Christmas tree, but a tree like you would see outside, and draw yourself standing next to the tree.” Once the children began drawing, I walked around to observe the drawings. When a child announced they made a mistake, they were allowed to turn the paper over and begin again. As the children finished their drawings, they were not given an extra paper for fun, but went back into their classroom and resumed their assignments.

On Day Two at 9:00, the Inside-2D \( (X_1) \) group participated in their lesson that lasted approximately 30 minutes. First I gathered the children for group time, and once they were sitting I informed them that we would be learning some things about trees. I had a large brown sack beside me containing enlarged photographs of the exact concepts that the outdoor treatment
group was seeing. The first photograph demonstrated the variable “tall” and it showed a picture of the pine tree with a kindergarten student standing next to it. I pointed out the girl standing near the tree and asked the class to observe how big she was compared to the tree. I walked to the children individually and let them observe the photograph until they had a chance to focus on the concept. Then I returned to the front and allowed a brief discussion to take place if the children had any comments to make. After I had placed that picture out of sight, I pulled the next photograph out of the bag.

The same procedure was followed to introduce the photographs of the remaining variables. This was the order in which they were presented:

- A photograph of the same kindergarten student standing next to the short tree
- A photograph of a long, fat magnolia leaf on an adult arm for scale
- A photograph of long, skinny pine needles on the same arm for scale
- A photograph of a wide oak tree trunk, a photograph of a skinny fringe tree trunk
- A photograph of a piece of rough pine tree bark on an adult arm
- A photograph of a piece of smooth holly tree bark
- A photograph of visible oak tree root
- A photograph of hidden pine tree roots

At the conclusion of presenting all of the concepts I asked the children to sit down in the same arrangement as in the pre-test, and had them draw a post-test picture of a tree with themselves standing next to it that took approximately 20 minutes.

Outdoor (X₂)

On Day One at 10:15, I administered the pre-test to the Outdoor group (X₂), that lasted approximately 30 minutes. There was a substitute teacher who was unfamiliar with placing
children in the seating arrangement as seen in figure 3.1, so I allowed the children to choose their own place to sit, well separated from each other, and they were asked not to let anyone else see their pictures because it was a secret. Each child had a clipboard with their own piece of blank paper with their name on the back. They also had their own crayons. The children were told not to start drawing until everyone was seated. I instructed all of the children to “Draw me a picture of a tree, not a Christmas tree, but a tree like you would see outside and draw yourself standing next to the tree.” Once the children began drawing, I walked around the room to observe the drawings. When a child announced they made a mistake, they were allowed to turn the paper over and begin again. When a child announced they had made a mistake on both sides, I gave them a new piece of paper with their name written on it. The mistakes were labeled as such and placed in a separate folder. As the children completed their picture, they were given another piece of paper to draw anything they wanted, which was not part of the data. These pictures were not collected as part of the data and were not used as part of this study.

On Day Three at 9:00, the Outdoor group (X2) participated in a lesson about trees on the nature trail. Approximately 5 minutes was spent walking to the trail. The lesson took approximately 30 minutes. Rather than doing group time indoors, I informed the children that were going out to the nature trail. Upon arriving at the nature trail, I introduced the first concept. I had the children line up in a row side-by-side across the street from the pine tree demonstrating “tall”, exactly 75 feet away. I explained to the children that we are going to observe the size of the tree compared to one of their classmates. I had the student stand immediately beside the tree for scale and asked the children to observe the height difference. I then asked one other child to take her place so that the first student could make the same observation. We then turned our
attention to a water oak tree on the opposite side of the road that demonstrated “short”. I repeated the same procedure as for the concept of “tall”.

We then walked across the street to the magnolia tree used in the study. I explained to the children that they would be observing long, fat leaves and comparing it to the size of their hands. Next we walked to the pine tree with a limb on the ground for each child to observe. I presented the concept “long, skinny needle” by using the same procedure that was used to present the magnolia leaf. We then proceeded to the live oak tree for a lesson on “wide trunk”. I explained to the children we would be observing a tree with a wide trunk by exploring how many of them it would take to wrap around the tree holding hands.

I then led the class to the fringe tree to observe the concept of “skinny”. The same method was used as for the previous concepts. The next concept presented was “rough bark,” so I led the children to the specified pine. I explained that they would be observing the rough texture of bark. I had the children approach the tree a few at a time and feel the bark. After each child had a turn, we walked to the holly tree. I introduced the concept “smooth bark,” and repeated the same procedure as for the pine.

The final concepts dealt with roots. I brought the class back to the same live oak as before and told the class they would be observing roots above the ground. I had a few children go to the tree and find a root and stand on it. After each child had found a root I asked them to walk on it and follow it as far out as they could. I repeated this until each child had a chance. The last concept was “hidden roots,” and I lead the class to the pine tree. I explained that they would be observing a tree where the roots were not above ground but were hidden. I had a few children at a time approach the tree and try to find the roots; I repeated this until every child had a turn. The children were then led back inside, and they spent approximately thirty minutes
completing the post-test drawings of the tree with themselves standing next to it in the same arrangement they had while taking their pre-test.

**Inside - 3D (X3)**

On Day One, beginning promptly at 9:00 a.m., the Inside-3D (X3) received their pre-test. The first fifteen minutes were spent arranging the children with their chairs. The children sat on the floor with the seat of the chair facing each child as a table for drawing and the back of the chair acting as a barrier. The next child sat between the back of the chair behind them and facing their own chair seat. This arrangement was one of three methods used to minimize looking at each other’s pictures (see figure 3.1).

![Figure 3.1 Pre- and post-test seating arrangement](image)

Each child had a clipboard with their own piece of blank paper with their name on the back. They also had their own crayons. The children were told not to start drawing until everyone was seated.
I instructed all of the children to “Draw a picture of a tree, not a Christmas tree, but a tree like you would see outside, and draw yourself standing next to the tree.” Once the children began drawing, I walked around the room to observe the drawings. When a child announced they made a mistake, they were allowed to turn the paper over and begin again. When a child announced they made a mistake on both sides, I gave them a new piece of paper with their name written on it. The mistakes were labeled as such and placed in a separate folder. As the children completed their pictures, they were given another piece of paper to draw anything they wanted. These pictures were not collected as part of the data and were not used as part of this study.

On Day Four at 9:00, the Inside 3-D group (X3) participated in their lesson that lasted approximately 15 minutes. I gathered the children to the group time area and informed them they would be learning about trees. The children were given an opportunity to look at each photograph and object to analyze it, followed by a brief discussion of each picture. As with the other groups, I began with the “tall” concept and I introduced the concept and held up the same photograph as the Inside-2D (X1) group saw. I did the same method of presentation for the “tall” and “short” concepts as for the pictures-only group. The next concepts were dealing with leaves. I introduced the concept of “long fat leaf” and held a magnolia specimen for the children to see. I walked around to the children individually and allowed them to observe the size of the magnolia leaf and compare it to their hand. After each child had a chance to observe the leaf, I put it away and introduced the next concept. I explained that they would now observe “long skinny needles” and repeated the same process. The next concepts were on the trunk sizes. I presented these concepts of “wide oak tree” and “skinny fringe tree” by showing the same photographs that the Inside-2D (X1) group saw, letting them individually observe the photographs. For the concept “rough” and “smooth” bark, I had a pine and holly specimen to let
the children observe. I presented each concept separately and walked around to the children individually and let them feel the bark samples. The final concept was roots. I explained to the children that some trees have visible roots and I presented the same photograph as with the Inside-2D (X1) group and I walked around for each child to see. I repeated the same procedure with the picture of the pine tree demonstrating hidden roots. After the lesson, the children were asked to go back to their chairs that were placed in the same arrangement as the pretest, and draw another picture of a tree to see if there was any change in the children’s concept of a tree and recall of detail. They were also asked to draw a picture of themselves standing next to that tree to assess their concept of proportion. The post-test lasted 30 minutes.

On Day Four, all of the pre-tests and post-tests from each group were gathered. The drawings were randomized and scored using a blind scoring procedure. These data were statistically analysis.
Table 3.1
Lessons corresponding to concepts

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control (X₀)</th>
<th>Inside 2D (X₁)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hidden roots vs. visible roots</strong></td>
<td>Children were not given any lesson or exposed to any concepts for the study. They only received a pre-and post-test.</td>
<td>A discussion was held on visible roots while showing an 11 X 17 photograph of the tree roots the outdoor group saw. Afterwards, each child saw the photograph up close. The same procedure was repeated for hidden roots.</td>
</tr>
<tr>
<td>(pine/oak) <em>(concept A</em>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tall vs. short tree</strong> (pine/water oak)</td>
<td>Children were not given any lesson or exposed to any concepts for the study. They only received a pre-and post-test.</td>
<td>A discussion was held on tall trees while showing an 11 X 17 photograph of the tree the outdoor group saw. Afterwards, each child saw the photograph up close. The same procedure was repeated for the short tree.</td>
</tr>
<tr>
<td><em>(concept F</em>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Long skinny needles vs. long fat leaves</strong> (pine/magnolia) <em>(concept E</em>)</td>
<td>Children were not given any lesson or exposed to any concepts for the study. They only received a pre-and post-test.</td>
<td>A discussion was held on long, fat leaves while showing an 11 X 17 photograph of leaves from the tree the outdoor group saw. Afterwards, each child saw the photograph up close. The same procedure was repeated for long, skinny needles.</td>
</tr>
<tr>
<td><strong>Smooth bark vs. rough bark</strong> (holly/pine) <em>(concept C</em>)</td>
<td>Children were not given any lesson or exposed to any concepts for the study. They only received a pre-and post-test.</td>
<td>A discussion was held on rough bark while showing an 11 X 17 photograph of bark from the tree the outdoor group saw. Afterwards, each child saw the photograph up close. The same procedure was repeated for smooth bark.</td>
</tr>
<tr>
<td><strong>Wide vs. narrow trunk</strong> (oak/fringe tree) <em>(concept B)</em></td>
<td>Children were not given any lesson or exposed to any concepts for the study. They only received a pre-and post-test.</td>
<td>A discussion was held about a wide trunk while showing an 11 X 17 photograph of the same tree the outdoor group saw. Afterwards, each child saw the photograph up close. The same procedure was repeated for a narrow trunk.</td>
</tr>
</tbody>
</table>

* Indicates concepts correlated with the Rubric in APPENDIX B.  

(table cont.)
<table>
<thead>
<tr>
<th>Variables</th>
<th>Outdoor (X2)</th>
<th>Inside-3D (X3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible roots vs. hidden roots (oak vs. pine)</td>
<td>The students were led to the oak tree and each child was allowed to observe</td>
<td>A discussion was held on visible roots while showing an 11 X 17 photograph of</td>
</tr>
<tr>
<td>(concept A*)</td>
<td>the roots. Then the children were led to the pine tree and allowed to make</td>
<td>the tree roots the outdoor group saw. Afterwards, each child saw the</td>
</tr>
<tr>
<td></td>
<td>observations on the absence of roots.</td>
<td>photograph up close. The same procedure was repeated for hidden roots.</td>
</tr>
<tr>
<td>Tall vs. short tree (pine/water oak) (concept F*)</td>
<td>One child stood under the tree while the classmates stood at a distance</td>
<td>A discussion was held on tall trees while showing an 11 X 17 photograph of</td>
</tr>
<tr>
<td></td>
<td>of 75 ft and observed the tree size relative to the child. The same was</td>
<td>the tree the outdoor group saw. Afterwards, each child saw the photograph</td>
</tr>
<tr>
<td></td>
<td>done for the child under the tree. The process was repeated at the water</td>
<td>up close. The same procedure was repeated for the short tree.</td>
</tr>
<tr>
<td></td>
<td>oak.</td>
<td></td>
</tr>
<tr>
<td>Long skinny needles vs. long fat leaves (pine/magnolia) (concept E*)</td>
<td>Children from this group each hold a pine needle and a magnolia leaf to</td>
<td>A discussion was held on long fat leaves while showing a specimen from the</td>
</tr>
<tr>
<td></td>
<td>make comparisons of leaf width.</td>
<td>tree the outdoor group saw. Afterwards, each child held the specimen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The same procedure was repeated for long, skinny needles.</td>
</tr>
<tr>
<td>Rough bark vs. smooth bark (pine/holly) (concept C*)</td>
<td>Children were led to the pine tree and were given a chance to touch and</td>
<td>A discussion was held on rough bark while showing a specimen from the tree</td>
</tr>
<tr>
<td></td>
<td>and analyze the texture of the bark. They were then led to the holly and</td>
<td>the outdoor group saw. Afterwards, each child held the specimen. The same</td>
</tr>
<tr>
<td></td>
<td>were given the same opportunity to examine the bark.</td>
<td>procedure was repeated for smooth bark.</td>
</tr>
<tr>
<td>Wide vs. narrow trunk (oak/fringe) (concept B*)</td>
<td>Children were led to the oak tree and each child was given a chance to see</td>
<td>A discussion was held about a wide trunk while showing an 11 X 17 photograph</td>
</tr>
<tr>
<td></td>
<td>how many classmates it takes holding hands to measure the width of the tree.</td>
<td>of the same tree the outdoor group saw. Afterwards, each child saw the</td>
</tr>
<tr>
<td></td>
<td>The children were then led to the fringe tree and each child was allowed to</td>
<td>photograph up close. The same procedure was repeated for a narrow trunk.</td>
</tr>
<tr>
<td></td>
<td>hug the tree to experience the width of the tree in relation to his/her size.</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 4
RESULTS

The analysis of the data gathered from the study was computed at Statistical Resources, using Statistical Analysis System. Table 4.1 demonstrates that the genders of the subjects in this study were fairly evenly divided both within and between groups, two of which even had an equal distribution of males and females. The sample was not very representative of different racial/ethnic backgrounds. The majority of children were white, but there were African American and Native American races present in the sample. Among the white children, there was a fairly even gender division both between and within each group, with two groups having an exact equal distribution of male and female participants. The overall mean age for each group was fairly closely distributed between each group. The ages of the males and the females were also fairly evenly distributed within each group. The exception was the Outdoor (X2) group that had the widest separation in gender. Finally the table shows how many children in this study had been enrolled in a specific developmental kindergarten grade at the school the previous year. Each group had nearly half of its children in this particular grade the previous year.

The results were analyzed determine if the four research groups represented equivalent populations. The analysis was conducted with the assistance of Steven Buco, Sr., Ph.D., Master of Science in Applied Statistics, and President of Statistical Resources, Inc. He was an Assistant Professor at Louisiana State University from 1981 through 1987 in the Department of Experimental Statistics An initial analysis of variance was done on the pre-test (Table 4.2). The analysis indicated that there was no significant differences found in the scores of the pretests between the four groups, therefore an ANOVA was used to analyze the rest of the results.
Table 4.1
Post-test description of sample

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender Total</th>
<th>Race</th>
<th>Mean Age</th>
<th>Number in DK Year: 2000-2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (X₀)</td>
<td>M 10, F 9</td>
<td>1 0 9</td>
<td>5.8 5.5 5.6</td>
<td>7</td>
</tr>
<tr>
<td>Inside-2D (X₁)</td>
<td>M 8, F 8</td>
<td>0 0 8</td>
<td>5.8 5.8 5.8</td>
<td>6</td>
</tr>
<tr>
<td>Inside-3D (X₃)</td>
<td>M 10, F 10</td>
<td>0 0 10</td>
<td>6.0 6.1 6.0</td>
<td>8</td>
</tr>
<tr>
<td>Outdoor (X₂)</td>
<td>M 8, F 9</td>
<td>0 1 7</td>
<td>5.9 6.1 5.6</td>
<td>6</td>
</tr>
</tbody>
</table>

*NA means Native American  B means black (African American)
*DK means Developmental Kindergarten  W means White
Table 4.2
One Way, ANOVA, Pre- test Results of the Analysis of Variance

<table>
<thead>
<tr>
<th>Dependant Variable</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots</td>
<td>3</td>
<td>0.20</td>
<td>0.36</td>
<td>0.78</td>
</tr>
<tr>
<td>Trunk</td>
<td>3</td>
<td>0.11</td>
<td>0.50</td>
<td>0.68</td>
</tr>
<tr>
<td>Bark</td>
<td>3</td>
<td>0.04</td>
<td>0.30</td>
<td>0.83</td>
</tr>
<tr>
<td>Branch</td>
<td>3</td>
<td>0.32</td>
<td>0.51</td>
<td>0.68</td>
</tr>
<tr>
<td>Leaf</td>
<td>3</td>
<td>0.22</td>
<td>1.91</td>
<td>0.14</td>
</tr>
<tr>
<td>Proportion</td>
<td>3</td>
<td>0.26</td>
<td>0.73</td>
<td>0.54</td>
</tr>
<tr>
<td>Dimension</td>
<td>3</td>
<td>0.09</td>
<td>0.85</td>
<td>0.47</td>
</tr>
<tr>
<td>Ground</td>
<td>3</td>
<td>0.12</td>
<td>0.17</td>
<td>0.92</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>1.76</td>
<td>0.38</td>
<td>0.77</td>
</tr>
</tbody>
</table>
In order to examine the effects of the treatments, a one-way analysis of variance was constructed to examine the change scores between the pre-test and post-test of the four groups to discover if there was an influence of environment on the student’s recall of the eight concepts in the lesson. The change score was calculated by subtracting the pre-test from the post-test and was used as a dependent variable. The mean scores in Table 4.3 represent the means of the change scores as a function of group for the pre- and post-test. The influences of the teaching/learning environment were seen in the recall of the leaf variable $F(3, 64) = 2.79, p < 0.05$ and the total score $F(3, 64) = 4.50, p < 0.01$

Table 4.3
Means, standard deviation (SD), and group sizes of change scores as a function of group for pre- and post-test

<table>
<thead>
<tr>
<th>Var</th>
<th>Control</th>
<th>Inside-2</th>
<th>Inside-3</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>0.32±0.67</td>
<td>0.16±0.50</td>
<td>0.38±0.72</td>
<td>0.58±0.72</td>
</tr>
<tr>
<td>T</td>
<td>1.84±0.50</td>
<td>1.79±0.42</td>
<td>1.81±0.40</td>
<td>1.69±0.48</td>
</tr>
<tr>
<td>B</td>
<td>0.10±0.32</td>
<td>0.05±0.23</td>
<td>0.16±0.28</td>
<td>0.19±0.40</td>
</tr>
<tr>
<td>BR</td>
<td>0.47±0.84</td>
<td>0.74±0.80</td>
<td>0.62±0.88</td>
<td>0.50±0.82</td>
</tr>
<tr>
<td>L</td>
<td>0.10±0.32</td>
<td>0.21±0.54</td>
<td>0.32±0.48</td>
<td>0.19±0.40</td>
</tr>
<tr>
<td>P</td>
<td>0.32±0.48</td>
<td>0.26±0.56</td>
<td>0.31±0.60</td>
<td>0.31±0.60</td>
</tr>
<tr>
<td>D</td>
<td>0.16±0.37</td>
<td>0.05±0.23</td>
<td>0.06±0.25</td>
<td>0.00±0.40</td>
</tr>
<tr>
<td>G</td>
<td>0.47±0.84</td>
<td>0.42±0.84</td>
<td>0.62±0.88</td>
<td>0.81±0.98</td>
</tr>
<tr>
<td>TL</td>
<td>3.79±2.1</td>
<td>3.68±1.67</td>
<td>4.10±2.07</td>
<td>4.06±2.38</td>
</tr>
</tbody>
</table>

Note–Variable (Var) are Root (R), Trunk (T), Bark (BK), Branch (BR), Leaf (L), Perspective (P), Dimension (D), Ground (G), and Total Score (TL)
Figure 4.1 graphically displays the results for the total of all tree concept variables used for the pre-test and the post-test. The pretest baseline shows no statistical difference between groups. The gray bar represents the pre-test. According to the results, each group was entering into the study with similar representations of trees. Analysis of the results reveals that all of the post-test scores showed no statistical difference between each group except for the outdoor group. The black bar on the graph represents this information. Only the outdoor group showed a statistically significant difference in the post-test score from all other groups.

Figure 4.1
Total of the average scores of all plant variables used for the pre-test and posttest
The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
Further analysis showed the outdoor group was the only group in this study that had a total difference in average score that was above zero, approaching 2.5. Figure 4.2 shows the results of Duncan’s Multiple Test. The alphabetic letters A and B on the bars of the graph represent the results of this test. Those bars with different letters are significantly different. The Control (X₀), the Inside 2D (X₁) group, and Inside-3D (X₃) group all have the letter B, representing that they were not statistically different from each other. The outdoor group was the only one demonstrating statistically significantly differences.

Figure 4.2

Total difference in average score between the pre-test and posttest. Bars with different letters are significantly different by the Duncan’s Multiple Test, P < 0.05. The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
Figure 4.3 represents analysis on the leaf variable. The Outdoor group was statistically different from the other groups, according to the Duncan’s Multiple Test. The Control group and the Inside-3D (X₃) group were not significantly different from each other. The two groups that were significantly different from each other on the leaf variable, p < 0.05, were the Outdoor (X₂) and the Inside-2D (X₂).

Figure 4.3
Numerical difference in average score for the leaf variable between pre-test and post-test. Bars with different letters are significantly different by the Duncan’s Multiple Test, P < 0.05. The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
All of the following graphs, Figures 4.4 – 4.8, do not have statistically significant results, but were included because they revealed consistent, interesting trends. The Outdoor group showed a consistently higher average between the pre- and post-tests than any of the other groups in this study. These are the variables listed in decreasing average score for the Outdoor group: roots, branches, dimension, and bark.

While the ground variable for the test group source was not statistically significant, it is apparent that the average for the Outdoor group was still higher than the other groups, as shown in Figure 4.4.

![Figure 4.4](image)

Figure 4.4
Statistically not significant numerical difference in average score for the root variable between pre-test and post-test. The Control group is \((X_0)\), the Inside-2D group is \((X_1)\), the Inside-3D group is \((X_3)\), and the Outdoor group is \((X_2)\).
Figure 4.5
Statistically not significant numerical difference in average score for the roots variable between the pre-test and post-test. The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
Figure 4.6
Statistically not significant numerical difference in average score for the branch variable between
the pre-test and post-test. The Control group is ($X_0$), the Inside-2D group is ($X_1$), the Inside-3D
group is ($X_3$), and the Outdoor group is ($X_2$).
Figure 4.7
Statistically not significant numerical difference in average score for the dimension variable between the pre-test and post-test. The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
Figure 4.8
Statistically not significant numerical difference in average score for the bark variable between the pre-test and post-test. The Control group is (X₀), the Inside-2D group is (X₁), the Inside-3D group is (X₃), and the Outdoor group is (X₂).
CHAPTER 5

DISCUSSION

**Objective**

The objective for this study was to determine if the concept of tree was better taught in an outdoor classroom, relative to the concept of tree taught to the comparison groups who received the same lesson indoors. The analysis of data gathered in this study yielded interesting findings that were both statistically significant, and results that were statistically insignificant but that revealed an emerging pattern worth mentioning. There were eight dependent variables in this study that were concepts involved in a science lesson on trees. The ninth dependant variable was the total score for all concepts. Of these nine variables, two were statistically significant, which can be seen on Table 4.3 in chapter four. The two significant results will be discussed in the treatment group section. The second section is reserved for those findings that show an interesting pattern in the dependant variables that were not statistically significant. The final section ties the results of this study with findings from other studies.

**Treatment Group**

There were four groups involved in this study, three treatment groups and the Control (X₀) group that received no lesson and only a pre- and post-test. The Inside-2D (X₁) group received their lesson indoors and saw only pictures of the concepts. The other group was the Inside-3D (X₃). In this group, the subjects saw real examples of leaves and bark and saw photographs of the other concepts, all inside the classroom. The final group was the Outdoor (X₂) group that were taught the same concepts except they were outside seeing and actively exploring each concept on the trees as they were explained. The Outdoor (X₂) group was the
only one that yielded results that were statistically significant. In this study, being in an outdoor environment seemed to influence children’s recall of leaves, more so than sitting in a classroom and only seeing a picture of a leaf, or seeing one leaf from the tree. The children who were on the nature trail for their lesson also scored higher on their overall total score on all of the concepts than any of the other treatment groups.

**Emergent Patterns**

The total score and the leaf variable were not the only concepts being measured that were influenced by the learning environment. They were simply the only variables that were statistically significant. In analyzing the data and evaluating them graphically, a definite pattern emerged. The scores of the children who had their lesson outside scored higher than all of the test groups for the remaining variables. For the root variable, the Outdoor group was above 0.4 and all the other groups were at or below 0. For the branch variable, the Outdoor group was above 0.5, the inside groups fell below 0, and the Control group was above 0.2. For dimension, the Outdoor group was above 0.1 and all the other groups were either at or below 0. The bark variable for the Outdoor group was above 0.15, the Inside 3-D (X3) and the Control (X0) were at or below 0, and the Inside 2D (X1) was above 0.1.

**Reflection**

The results of this study reflect a convergence of many areas and theories in education that will be addressed. The study itself involved a science lesson about components of trees. There was a dynamic interaction between how that lesson was perceived, recalled, and expressed by the learner, the environment in which the lesson took place, and the modality with which lessons were presented, all of which will be discussed below. At the most basic level, this study revolved around presenting a science lesson. Within this basic level there were three
interconnected components: the learner, the environment, and the lesson. Each one of these components will be explored and connected with relevant results from this study and previous studies.

I was interested in discovering if teaching a science lesson in an outdoor environment would influence children’s ability to recall that lesson. The learners in this study were kindergarten children ranging in ages from five to seven years. There are very many factors that contribute to the process of learning, both external to and internal for the learner such as those processes highlighted in Vygotsky’s theory on concept formation (Charlesworth & Lind, 1999). For the kind of learning relevant to this study to occur, the learner must not only receive information from a source external to them, but internal processes must also take place. Internal processing of information involves taking information in from the world around them through the senses.

In this study it was found that the learning environment does have an influence on children’s retention and recall of the concepts presented in the science lesson. Specifically, children who were in the outdoor environment scored higher on their post-test drawings than any of the other groups in representing the leaf and total score variables.

There were several studies that supported the effectiveness of the outdoors as a learning environment. Wise (Backman & Crompton, 1985) also found that the method of conducting science instruction so that children had direct experiences outdoors resulted in the children having more comprehension, retention, and recall of the concepts that were taught. The three methods of science instruction Wise looked at with two hundred sixty fifth grade students were direct experience in the outdoors, outdoor instruction, and indoor instruction of science. Another study with similar findings was conducted by Harvey (1989-1990). He found that a variety of
experiences in the outdoor classroom were effective in improving the students’ knowledge base about plant life.

Not only does imagery aid in understanding the concepts that were seen, but also that perceiving information visually seems to be age appropriate. The focus of the current study was the recalling of the concepts in the lesson. In order for a learner to recall the concepts in this study, the lesson must first be presented and perceived. Imagery is a tool used to understand what is seen, and thus far the visual modality has been the primary method classroom teachers use in presenting the lessons in this study. Each of the groups in this study used varying levels of their senses to perceive the concepts in the lesson, except for the control group. The Inside-3D (X₃) group and the Outdoor (X₂) group both used auditory, visual and tactile senses to perceive the concepts. The Inside-2D (X₁) group relied on visual and auditory senses because of the way the concepts were presented.

Since images were consistently used by all three groups, including two dimensional pictures, three dimensional objects, and visual images generated from being outside, there must have been an additional factor involved to explain why the learners in the outdoor group were able to recall the concepts significantly more than the indoor groups. Montessori recognized that it was not only the images themselves, but also the environment from which they were derived that was important (Sheikh & Sheikh, 1983). According to Sheikh and Sheikh (1985), Montessori believed that “Intelligence is a function of the capacity for receiving impressions from the environment, elaborating images. It abstracts the dominant characteristics of things and thus succeeds in associating their images and keeping them in the foreground of consciousness” (p 23). This idea reinforces the idea of using images to further our understanding of information.
received from the environment and subsequent recall of that information. As mentioned before, it is through the use of imagery that the mind can explore and put into context what it sees. But the proper environment is required to put certain concepts into context. A learner may understand the concepts about a tree on a basic level if the lesson is presented indoors, but placing those concepts into their relationship with the whole tree is difficult without the environment. This may explain in part why the outdoor group scored highest in their recall of leaves and on their overall score.

Theory and research support the benefits of teaching in an outdoor environment. John Dewy (1963) recognized that children’s experiences may be shaped through the use of authentic environments by educators to nurture growth. Studies have shown that direct experience and exploration in this context influences learning (Harvey, 1989-1990; Backman & Crompton, 1985). The objective of the current study was the recall and representation of concepts in the science lesson. The lesson was more of a guided discovery than a teaching of concepts. I presented each variable to the children but the degree to which each child recalled and expressed those concepts was dependant on their observations. This was true for the indoor and outdoor groups. The outdoor group was presented with each variable upon arriving at each tree. I expected that there would be a recall of more than two out of eight dependant variables that were significant by this group. The concepts were presented without a prior lesson because I felt that a truer measurement of the influence by the environment would be reflected in the scores between the pre-and post-test. This absence of some prior teaching may be an explanation for the low recall.

This is substantiated by other research findings in the area. Harvey (1989-1990) did a study on the cognitive domain of environmental education. He suggested that use of an outdoor
classroom needs to be an extension of the indoor class and not a spontaneous discovery approach to the lessons. He believes there should be a combination of classroom preparation with outdoor experiences. In addition, Backman and Crompton (1985) reviewed the results of research done by Howie, Hosly, and Goldsberry. They concluded that “It is likely that environmental concepts may be learned effectively if students are oriented in the classroom with relevant concepts so that they have some sense of structure before going into the outdoor experiences” (p. 11).

The final component of the study at its basic level was the lesson itself. As mentioned previously, there is a lot of support for presenting information in a way that allows for visual perception resulting in imagery (Sheikh & Sheikh, 1985; Kraft, 1976). Research suggests that children benefit from this, especially given what we now know about brain specialization in learning (Sheikh & Sheikh, 1985). It has also been established that direct experiences in an authentic context are important in learning, which is why a lesson involving objects occurring in nature should take place in nature (Backman & Crompton, 1985; Gonzalez-Mena, 1998). Not only was the information in this study presented in a visual modality, but also the concepts recalled by the learner were expressed pictorially. The benefit is that drawing leaves a visible record that can be examined and understood (Egan & Nadaner, 1988). This is the reason I chose this medium for the children to express their knowledge, because it is a tangible representation of the prior knowledge and recall of the variables. The act of thinking requires more than simply forming and assigning concepts; it involves the unraveling of relations. According to McKim (1980), “Image-making serves to make sense of the world. Art then, approaches the means and ends of science very closely” (p 257). Since thinking involves images, and in turn these images contain thought, we can trace this visual thinking process by examining the images in art (McKim, 1980).
This study involved the measurement of the recall of information by the students through the examination and scoring of their drawings. Evidence of these concepts in the children’s art can be seen in the shapes and relations that characterize these concepts. If using this as an assessment, the presence or absence of the concepts “… are readily found in work done at early levels of mental development, for example, in the drawings of children” (McKim, 1980. p. 254). When I examined the posttest drawings of the children for evidence of recalling the concepts, I was essentially reviewing a statement neither written or verbal, but visual. According to McKim (1980), “This medium of expression demands direct experience because a picture is highly conceptual and it springs entirely from intense observation of the sensory world” (p 254). This is a reason for having the students represent the concepts from the current study artistically because it was a reflection of their observations.

Finally, the analysis of the data seemed to reveal that both of the indoor treatment groups produced negative change scores from their pre-test to their post-test. This may suggest that the group scored lower on certain concepts following the lesson. This perplexing finding has several possible explanations.

According to Piaget, mental images are involved in what he referred to as figurative knowledge (Piaget, 1977). The artistic representations of the concepts by the children in this study may be described as a result of mental images of the children. These mental images function only in the absence of the object, in this case the concepts about trees, as a result of internalized reproduction. The law of relative centrations governs visual field effects as a result of “…the immediate structuring of the perceptual field in figure-ground relationships” (Piaget, 1977, p.648). There are deforming relationships in perception. In judging the qualities of an
object, there are various comparisons that children can make. This is done by centering their attention on one or another aspect of it. This may be a partial explanation of why there seems to be a negative change between the pre-test and the post-test scores on certain concepts. This is seen in the apparent attention to one concept, for example roots on the pre-test drawing and then that same child, after the lesson, focused their attention on another concept, such as branches, with the absence of the first concept, such as roots, as seen in the previous drawing.

Another explanation for some of the groups producing negative change scores might be the use of only a single medium for the children to represent their comprehension and recall of the concepts in the lesson. Some of the children may have known the concept but were not able to demonstrate competence through that particular avenue or were at a point in their artistic development where they were focusing on particular aspects of the drawing from pre- to post-test. While children at this age are known to have a limited language capability, allowing them to describe the concepts in addition to the drawing may have increased their score. Also, kindergarten aged children have been found to be unreliable test takers since they do not understand the importance of the situation they are in (Gullo, 1994). There are several modifications that might be made to using only drawing. Document the children’s verbal descriptions about their artistic representations, use a variety of modalities for the children to express their concept comprehension, and repeat the study several times.

Additionally, the sample size and the reliability of the test may also have contributed to negative change scores. The sample size of this study was small, and the smaller the sample size, the higher the potential for error. Furthermore, even though the interrater reliability was good, there was no test-retest reliability performed in this study that is a weakness.
Implications for Practice

These results seem to support the hypothesis that the outdoor environment does have an influence on the recall of concepts in a science lesson. Although learning in the outdoor environment may be enhanced by presenting pertinent information about the concepts prior to going outside, there are many schools that have varying degrees of natural areas available on the school grounds; some may have none at all.

Each of the test groups may be compared to classes with different levels of resources available. The outdoor group can be likened to a school having access to a trail or natural area, and the indoor groups might reflect classes either having minimal or no natural resources. Each of these groups also has varying degrees of authenticity. The outdoor group is obviously the most authentic since the children were able to see the concepts firsthand in the environment. The Inside-3D (X3) group would be the next in authenticity with some of the real objects from the environment, and the Inside-2D (X1) group would be the least authentic with only photos.

Even though the indoor groups may not be ideal, as reflected in the results of the study, they do have qualities of the presentation that are conducive for the way children learn. Each test group involved visual perception of the concepts. There is evidence that even this level of perception will allow learning to occur because it is presented in a pictorial fashion which leads to image making, a key element in the cognitive process. Therefore, for those schools that have very little access to an outdoor environment, the proper presentation of concepts, including components of the concept or a picture only, will still result in learning.

Implications for Research

An area of interest that I believe could be investigated as a future study is to determine if presenting the concepts in the classroom prior to seeing them outdoors would result in a more
significant recall of the information. Because the outdoor group in the current study scored consistently higher than the other groups, further studies may reveal that presenting the lesson indoors and then extending the lesson outside for first-hand observation result in more recall by the students.

Post hoc analysis that was not part of the experimental design says there is some ancillary evidence gender influenced the perception, recall, expression, or a combination of the ground and trunk variables. What is perplexing about these results is that the influence of gender was not consistent on one variable versus the other. Females scored significantly higher than males on the ground line variable whereas males scored significantly higher than females on the trunk variable. In partial explanation, research has found some differences in gender. These findings strongly suggest that males are superior to females in visualization ability (Sheikh & Sheikh, 1985). These results do not support why females scored higher on one of the two variables in my study. Future studies might include gender in the design to further investigate this variable.

Finally, a replication of this study might be done that would allow the children to express their concept knowledge in more than one medium. A variety of modalities should be available for the children to demonstrate learning.

**Limitations**

There were several limitations that may have affected the results of the study. The teaching was conducted during the week immediately preceding Christmas. This influenced the children’s concept of tree, as evidenced by of the children’s drawings resembling the simple triangular form of a Christmas tree. The Outdoor \((X_2)\) group had a total of 28 children; .03% of those children drew triangular shaped trees on the pre-test and 0% on the post-test. The Control \((X_0)\) group drew .01% on the pre-test and 0% on the post-test. None of the children in the Inside
–2D (X₁) group drew triangle trees in the pre-test or post-test. .04% of the children in the Inside-3D group (X₃) drew triangle shaped trees on their pre-test and .03% of the children were drawing these trees on their post-test. Not only did some of the classrooms in the study have Christmas trees, but also the teacher of the outdoor group actually gave a lesson on how to draw a triangular Christmas tree that I was unaware of until after the study was over. This was a limitation for my study because I was teaching concepts to the children about trees in nature, not those that had been altered as a Christmas symbol. Furthermore, the children’s concept of tree had been altered by the prior experience of having been taught a lesson on how to draw and decorate a Christmas tree. Another aspect of this study was the children’s artistic ability. Children in this age group have a range of fine motor ability that has an impact on their ability to draw. This is a limit because, while the children with weak muscle coordination might remember the concepts, they may not be able to represent them artistically.

Another limitation pertained to experimenter bias. The researcher taught the lessons in each group herself instead of training someone outside of the study to teach the lesson. The pre-and post-tests were also conducted and scored by the researcher, although the pre-and post-tests were randomized and blindly scored. Even though the researcher taught the lessons, the purity of the treatment was addressed. Discrepancies in the teaching of each lesson were monitored by requiring that the teachers kept a record of what was said while presenting the lessons. In addition, the administration of the lesson and post-test for every group was tape-recorded but not transcribed.

Finally, approximately half the children in all four groups had been enrolled in developmental kindergarten (DK) the year before. This is relevant because the children were in a grade that spent a great deal of time on the nature trail used in this study and therefore had prior
experience with at least one of the trees in the study. Since there were a limited number of kindergarten classes, it was unavoidable that any class would not have included any children from this DK grade.

One variable in this study that could have been controlled for involved the design. The delay time between when the children in the outdoor group, as compared to the indoor groups, were able to do their posttest drawings could have influenced the results. The children in the indoor groups had very little delay time relative to the outdoor group. The time between when they received the lesson and did their post-test was much briefer, essentially governed by the time it took to get the seating arrangement and materials set up. On the other hand, the outdoor group had a much longer wait from the time they received their lesson until the time the children were able to draw their post-test. This time was dictated by how long it took for the children to walk back from the trail until they were inside and set up to draw. The children indoors did not have to wait as long to recall the information, as did the children outside.

Conclusion

Humans have always had a connection with the world around them. From the time we are born we are learning from our environment through exploration. As educators, we should continue to encourage those explorations of our environment so that this connection is not lost because it still holds a lot for us to learn. The results of this study seem to reinforce and support the idea that the outdoor environment can be a very important tool for educators. The results suggest that children do seem to be influenced by the environment in which they are learning. The outdoor environment does appear to influence learning when the concepts being presented can be found in nature.
Some aspects of the results, though, were somewhat unexpected and even perplexing. For example, the outdoor group achieved statistically significant scores on only two dependent variables, the total score and leaves. In examining the results, though, an interesting pattern did emerge. The outdoor group did, in fact, consistently score higher than all of the other test groups; for other items it was just not to a statistically significant level. Therefore, there seem to have been factors that were discussed previously which acted upon the study and influenced the outcome. There were four variables that the children scored significantly higher on, but only two of them seem to be influenced by the outdoor environment.

A second surprising finding was the gender influence on the learning and recall of the concepts. Apparently in this study, gender influenced the perception, recall, expression, or a combination of the ground and trunk variables. What is perplexing about these results is that the influence of gender was not consistent on one variable versus the other. Females scored significantly higher than males on the ground line variable whereas males scored significantly higher than females on the trunk variable. In partial explanation, research has found some differences in gender. These findings strongly suggest that males are superior to females in visualization ability (Sheikh & Sheikh, 1985). These results do not support why females scored higher on one of the two variables in my study.

This study not only supports the importance of the environment in the education process, but also in the way children learn based on discoveries in brain research. We should approach teaching in a way that encourages children to use both hemispheres of their brain rather than one or the other. Whole-brain instructional methods have been suggested not only for art and music, but also biology and chemistry. Even outdoor education will be of benefit. According to Sheikh
& Sheikh (1985), “Outdoor education achieves its ultimate impact on an individual in experiences which are probably sensed and interpreted in the right hemisphere” (p 98).

Ideally, the natural environment on school grounds will become a second classroom that is no less important than the one inside because so many first-hand, authentic experiences are available to children outside, Sharp said, "That which can be best taught inside the school rooms should there be taught, and that which can be best learned through experience dealing directly with native materials and life situations outside the school should there be learned" (Richardson & Simmons, 1996, p3).


The following National Science Standards and corresponding Louisiana Science Benchmarks were addressed during the course of the lessons in the four treatment groups:

<table>
<thead>
<tr>
<th>National Science Standards</th>
<th>Louisiana Benchmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Science Standard C:</td>
<td>Life Science/Elementary:</td>
</tr>
<tr>
<td>As a result of activities in grades K-4,</td>
<td>-LS-E-A3: locating and</td>
</tr>
<tr>
<td>All children should develop understanding of:</td>
<td>comparing major plant or animal structures and their</td>
</tr>
<tr>
<td>-the characteristics of organisms</td>
<td>functions</td>
</tr>
<tr>
<td>-organisms and environments</td>
<td>LS-E-B2: observing, comparing and grouping plants and</td>
</tr>
<tr>
<td></td>
<td>animals according to likenesses and/or differences</td>
</tr>
</tbody>
</table>

Science as Inquiry: Standard A
As a result of activities in grades K-4.
All students should develop:
-abilities necessary to do science inquiry

Science as Inquiry:
-SI-E-A1: asking appropriate questions about organisms in the environment.
-DI-E-A3: communicating that observations are made with one’s senses.
-SI-E-A6: communicating observations and experiments in oral and written format.

Physical Science/Elementary:
-PS-E-A1: observing, describing, and Classifying objects by properties (size, weight, shape, color, texture)
APPENDIX B
RUBRIC
APPENDIX B

I. Concepts

A. Roots
B. Trunk
C. Bark
D. Branches
E. Individual leaves
F. Proportion

II. Artistic ability

A. Three-dimensional
B. Ground line

Total Score

Point System
(concepts and artistic ability)

0 = not at all
1 = somewhat
2 = definite
APPENDIX C
EXAMPLES OF SELECTED CONCEPTS
OUTDOOR GROUP (X₂)
PRE- AND POST-TEST DRAWINGS
APPENDIX C.1
EXAMPLE OF ROOTS IN PRE-TEST DRAWING
APPENDIX C.2
EXAMPLE OF ROOTS IN POST-TEST DRAWING
APPENDIX C.3
EXAMPLE OF BARK IN PRE-TEST DRAWING INSIDE-3D (X₃)
old things on tree
APPENDIX C.4
EXAMPLE OF BARK IN POST-TEST DRAWING INSIDE-3D ($X_3$)
APPENDIX C.5
EXAMPLE 1 OF BRANCHES IN PRE-TEST DRAWING
APPENDIX C.6
EXAMPLE 1 OF BRANCHES IN POST-TEST DRAWING
APPENDIX C.7
EXAMPLE 2 OF BRANCHES IN PRE-TEST DRAWING
APPENDIX C.8
EXAMPLE 2 OF BRANCHES IN POST-TEST DRAWING
APPENDIX C.9
EXAMPLE OF INDIVIDUAL LEAVES IN PRE-TEST DRAWING
APPENDIX C.10
EXAMPLE OF INDIVIDUAL LEAVES IN POST-TEST DRAWING
APPENDIX D
OBSERVATION SHEET
Concepts to be covered:

1. Tall tree (Pine)

2. Short tree (Oak)

3. Long fat leaves (Magnolia)

4. Long skinny needles (Pine)

5. Wide trunk (Oak)

6. Skinny trunk (Fringe tree)

7. Rough bark (Pine)

8. Smooth bark (Holly)

9. Visible roots (Oak)

10. Hidden roots (Pine)

Observer: ________________________________
LSU INSTITUTIONAL REVIEW BOARD (IRB)

IRB APPLICATION: APPROVAL OF PROJECTS WHICH USE HUMAN SUBJECTS

The IRB uses this form to obtain succinct answers to questions it must consider. If incomplete, your application will be returned! You can download this form and all other IRB documents from http://www.osp.lsu.edu/irb) & complete it with your word processor. Call Robert Mathews for assistance, 225-578-8692, or e-mail him at: irb@lsu.edu.

===============================================
(IRB Use: IRB# Review Type: Expedited Full)
===============================================

Part 1: General Information

1. Principal Investigator: Kari Dietz Rank: Graduate Student
   (PI Must be an LSU Faculty member)
   Dept.: Curriculum & Instruction Ph: 578-6867
   E-mail: kstewart@lsu.edu

2. Co-investigators:

   *Student? Y/N Y (Thesis) dissertation/class project? Y/N __
   Dept.: ___________________________ Ph: ___________________________ 
   E-mail: ___________________________

3. Project Title: Influence of Teaching in an Outdoor Classroom on Kindergarten's 
   Comprehension and Problem Solving of a Story

4. Proposed duration (months): 3 Start date: Fall

5. LSU Proposal #: 42

6. Number of subjects requested: 42

===============================================

A. ASSURANCE: PRINCIPAL INVESTIGATOR (named above)

I accept personal responsibility for the conduct of this study (including ensuring compliance of co-investigators/co-workers in accordance with the documents submitted herewith and the following guidelines for human subject protection: The Belmont Report, LSU's Assurance with OPRR, and 45 CFR 46 (Available from OSP or at http://www.osp.lsu.edu/irb/)

Signature of PI __________________________ Date 11/28/01

B. ASSURANCE OF STUDENT/PROJECT COORDINATOR named above

I agree to adhere to the terms of this document and am familiar with the documents referenced above.

Signature __________________________ Date __________________

Part 2: Project Abstract - provide a brief abstract of the project.

Part 3: Research Protocol

A. Describe study procedures

   Describe study procedures with emphasis on those procedures affecting subjects and safety measure. Also provide script for telephone surveys.

B. Answer each of the following questions.
Part 2: Project Abstract
The purpose of this study will be to discover if the environment in which children learn significantly influences their comprehension and retention of the concepts being presented. The study is seeking to establish if in fact there is a causal relationship between teaching science to kindergarten children in an outdoor classroom and the children's resulting performance on the post-test evaluation. This study will be examining concepts that relate to trees, and are being directly presented by the teacher. The limitations of this study are that the sample may not be representative of the general population because the subjects are from only one school in a rural setting that has access to a Nature Trail which may not be available to schools in an urban setting. A paired-t test will be used to analyze the results gathered from the study.

Part 3: Research Protocol
A component of this study includes the treatment group participating in the lesson on trees in the outdoor classroom on the nature trail. This lesson will require that the students move around on the grounds of the trail. Two areas of this trail have the potential for harm being caused to the students, one of which would be snakes coming from one of the two areas that have water. This safety issue will be addressed by the teacher and janitor going out before the experiment begins and doing a thorough search for snakes in the areas the children will be in. The janitor will remove any snakes found in the area. Due to the fact that there is a tree on the trail that is inhabited by a colony of honeybees, for the concerns of safety in this study, that portion of the trail will not be included in the study area.
1. The use of human subjects is necessary to demonstrate the influences of education in an outdoor setting on the comprehension and retention of kindergarten-aged children.

2. The data will be collected from two kindergarten classrooms at Galvez Primary.

5. The physical risks to subjects in this study include those risks inherent in any outdoor venture. These may include a broad range of allergic reactions to plants and insects and a host of other possible sources. The potential for being bitten by a snake exists since a bayou and a small wetlands area is near the school grounds. There are no foreseeable social or psychological risks involved in this study.

6. Two areas of this trail have the potential for harm being caused to the students, one of which would be snakes coming from one of the two areas that have water. This safety issue will be addressed by the teacher and janitor going out before the experiment begins and doing a thorough search for snakes in the areas the children will be in. The janitor will remove any snakes found in the area. Due to the fact that there is a tree on the trail that is inhabited by a colony of honeybees, for the concerns of safety in this study, that portion of the trail will not be included in the study area.

7. The pool from which subjects were chosen for the purposes of this study are from the community of Gonzales, Louisiana at Galvez Primary, including a group size of forty-two subjects, two of which are teachers. The criteria used to select the subjects for the study were the availability of two pre-existing kindergarten classrooms with established teachers.

8. The subjects in this study are within a vulnerable population due to the fact that they are under the age of eighteen. The age ranges of these children are from five to seven years.

9. Prior to the study being conducted, a letter will be sent to each family of the subjects in the study. Included in this letter will be a consent form detailing all of the necessary information about the study and a request for signature of the consent form along with the option of attending an optional informational meeting pertaining to the study whereby any questions and/or concerns may be addressed. The investigator's phone number will also be made available.

10. The confidentiality of the subjects in this study will be maintained through using the subjects' first name only in this study and the security of the data will be protected by keeping the drawings in a locked cabinet.
1. Why is the use of human subjects necessary? (v.s. animals/in vitro)

2. Specify sites of data collection.

3. If surgical or invasive procedures are used, give name, address, and telephone number of supervising physician and the qualifications of the person(s) performing the procedures. Comparable information when qualified participation or supervision is required or appropriate.

4. Provide the names, dosage, and actions of any drugs or other materials administered to the subjects and the qualifications of the person(s) administering the drugs.

5. Detail all the physical, psychological, and social risks to which the subjects may be exposed.

6. What steps will be taken to minimize risks to subjects?

7. Describe the recruitment pool (community, institution, group) and the criteria used to select and exclude subjects.

8. List any vulnerable population whose members are included in this project (e.g., children under the age of 18; mentally impaired persons; pregnant women; prisoners; the aged.)

9. Describe the process through which informed consent will be obtained. (Informed consent usually requires an oral explanation, discussion, and opportunity for questions before seeking consent form signature.)

10. (A) Is this study anonymous or confidential? (Anonymous means that the identity of the subjects is never linked to the data, directly, or indirectly through a code system.)
    (B) If a confidential study, detail how will the privacy of the subjects and security of their data will be protected.
APPENDIX F
LETTER OF PERMISSION
Ms. Kari Dietz  
4625 Mimosa Street  
Baton Rouge, LA 70808

Dear Ms. Dietz:

This letter grants permission for you to conduct a study at Galvez Primary School involving Science concepts.

Yours truly,

Robert J. Clouatre
Superintendent
Ascension Parish Schools

RJC/ksl
Cc: Ms. Regina Thomas, Principal

"An Equal Opportunity Employer"
APPENDIX G
PARENT CONSENT FORM
"I have been fully informed of the above-described procedure, its possible benefits and risks and I give my permission for participation of my child in the study."

Parent/guardian signature                                PRINT parent/guardian name                                date

Approved: Keefia G. Thomas, Principal
My name is Ms. Kari and I am a student at LSU. I am here in your class to ask if you would like to do something with me and your classmates. I am going to ask you to draw some pictures and I will be talking with you and your classmates about trees at your school. After we talk about trees, all of us will go outside and look at the trees we talked about. You do not have to do this with me and your classmates. Would you like to do this?

Yes ____  No____

(If Yes)

Once I start talking to you about trees, if you do not want to do it any more you may tell me at any time and I will let you stop.

Child’s Name ____________________________

Child’s Age ____________________________

[Signature]
Kari Dietz

Date ____________________________

These signatures acknowledge that the above statement has been read to the child by me, and the child has agreed to participate.

Witness ____________________________

Child’s signature ____________________________
VITA

Kari A. Dietz was born July 4, 1971 in San Francisco, California. She graduated from the University of Louisiana, Lafayette in 1999 with a Bachelor of Arts degree in Communicative Disorders. In the fall of 2001 she entered the College of Education at Louisiana State University to obtain graduate training in early childhood education.