DO YOU SEE WHAT I SEE?

EXPLORING PRESCHOOL TEACHERS’ SCIENCE PRACTICES

A graduate thesis submitted in partial fulfillment of the requirements

For the degree of Master of Art in Education,

Educational Psychology

By

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DEDICATION

This thesis is dedicated to my incredibly supportive and encouraging circle of family and friends.

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ABSTRACT

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Master of Arts in Education

Educational Psychology

Despite a recent spike in interest due to STEM (science, technology, engineering, math) research, preschool science remains a vitally important yet underdeveloped and often avoided domain within early childhood education (Roehrig, Dubosarsky, Mason, Carlson, & Murphy, 2011). Using a convenience sample, eight preschool teachers from four different schools were observed to gain a better understanding of teachers’ recognition of science experiences in early childhood education programs. The ways in which science was implemented, teachers’ own self-efficacy in teaching science, and an assessment of each classroom’s science environment was explored. Data sources included a curriculum categorization form, demographic questionnaire, a classroom science materials checklist, a science perception and self-efficacy questionnaire, and classroom observations. A prominent theme that emerged from both the literature and current study’s observations was the significant impact that self-efficacy appeared to have on teaching science in preschool. Additionally, a correlation between a lack of self-efficacy in teaching science and a reliance on executing pre-planned, teacher-centered science lessons was discovered. Teachers’ lack of recognition for science stood out as a possible explanation for the deficiency observed in extended scientific investigations and
teacher/child scientific inquiry. Perhaps most interesting, it appears that spontaneous science will emerge regardless of teacher recognition and/or support or availability of science materials especially if the children have adequate access to the outdoor environments.
CHAPTER ONE

INTRODUCTION

“Ideal teachers are those who use themselves as bridges over which they invite their students to cross, then having facilitated their crossing, joyfully collapse, encouraging them to create bridges of their own.”

(Nikos Kazantzakis)

Children are natural born scientists. Beginning in infancy, an innate curiosity compels children to continually observe, investigate, and spontaneously engage in scientific investigation as they examine the world around them. Current brain research suggests that the ideal time to support and enhance children’s scientific thinking is during their preschool years. It is during this critical period, referred to as “windows of opportunity” (Eshach & Fried, 2005, p. 334), in which learning “essential science skills such as logic and mathematics” (Eshach & Fried, 2005, p. 334) occurs most efficiently and rapidly. However, these “windows” begin to close around the age of 10 and once they close, the brain will “never again have the ability to master new skills so readily” (Eshach & Fried, 2005, p. 334) because during this time, the brain begins to “ruthlessly destroy its weakest synapses, preserving only those that have been transformed by experience” (Nash, 1997, p. 48). Therefore, the value of early science experiences on young children’s developing brains is no longer simply anecdotal but becoming increasingly quantifiable because neuroscientists “can now see the results under a microscope or in a PET scan” (Nash, 1997, p. 48).

While many states have developed preschool science learning standards, instructional practices, and curricula expectations, research has shown that among
developmental scores from children entering kindergarten, “science was the only domain that was significantly different (lower) than all the other seven domains (Physical Health, Approaches to Learning, Creative Arts, Motor Development, Early Math, Language & Literacy, and Social & Emotional)” (Greenfield et al., 2009, p. 246). This problem is even greater within low-income, minority communities where science is oftentimes identified with the “culture of power” (Roehrig, Dubosarsky, Mason, Carlson, & Murphy, 2011, p. 566). Moreover, current research on instructional practices suggested that “neither planned nor unplanned science activities were likely to occur in preschool classrooms” (Greenfield et al., 2009, p. 247). In fact, research focused on teachers’ activities and locations during free choice time showed that preschool teachers spent most of their time in the art and dramatic play areas and less than 10% of the activities engaged in were science related (Tu, 2006).

Recently, the California Department of Education created the California Preschool Learning Foundations Volume 3 (2012), focused on History-Social Science and Science. Within this volume, the importance of science experiences during the preschool years was highlighted: “Science fosters skills that are recognized as critical for success in work and in life in the twenty-first century: critical thinking, problem solving, creativity, collaboration, and communication” (p. 49). Moreover, research by Nayfeld, Brenneman, and Gelman (2011) revealed that when science is comprehensively integrated into the preschool curriculum, children achieve significant gains across all learning domains and this implementation “does not require neglecting the development of math, language, and other critical skills” (p. 984).

With so much compelling research supporting the importance of science in the
preschool classroom, why are science activities frequently excluded from early childhood education settings? According to Roehrig et al. (2011), the reasons science has been avoided in the preschool classroom included teachers’ feelings of “science anxiety, low self-efficacy with respect to teaching science, lack of experience participating in science activities as students, or the notion that literacy and language are more important during the early years” (p. 566).

**Statement of Need**

Although there has been a recent surge in interest due to STEM (Science, Technology, Engineering, and Math) research, science in the preschool classroom remains “an important but under researched school readiness domain” (Greenfield et al., 2009, p. 238). Furthermore, as noted by Greenfield et al. (2009), comprehensive research on the role of science in the preschool classroom is “still in its infancy” (p. 238). Therefore, the current study builds on the foundational research by investigating what, if any, science activities are taking place in typical preschool environments, how they are implemented and expanded, if teachers recognize science unfolding within their classrooms, and their perception of science and feelings of self-efficacy in teaching science. Finally, effective strategies to support and increase inquiry based science instruction within early childhood environments will be explored.

**Purpose of Study**

In order to better understand the prevalence and significance of science in early childhood education programs, the purpose of this exploratory research study is to observe the frequency of and process by which preschool teachers present, implement, expand, and categorize science-related activities within their classrooms. Additionally,
the goal is to better understand if, when, and how often teachers recognize science unfolding within the classroom (both planned and spontaneous) as well as their own self-efficacy in teaching science.

Eight preschool teachers from four different preschools will be individually observed while class is in session. The study uses a mixed-methods design with five different data sources. The first data source are observational field-notes by the researcher that include both the activity of the teacher and her conversations with children targeted to science-related topics. At the end of each observation, the teacher will be asked to categorize the day’s activities into one or more of the following domains: math, science, language and literacy, and art. The researcher’s observational notes and recordings will be compared to the teacher’s self-reported categorization of activities. A demographic survey will provide background information on each teacher and may uncover if there is a correlation between a teacher’s personal characteristics such as age, years of teaching experience, educational level, and cultural background and the amount of science activities and scientific inquiry found within their classroom environment. In addition, the environment (both indoor and out) will be assessed. Specifically, a science materials checklist will be completed for each classroom to determine whether or not science-related materials are available and accessible to the children. Finally, a science questionnaire completed by the teachers at the end of the observation will provide insight into their knowledge and perception of science in the preschool environment and their own self-efficacy in teaching science. The results of the science questionnaire will then be compared to the researcher’s observation notes to see if the results were reflected in the classroom.
Significance of Study

The results of this study will show if and how often science-related activities are offered at the selected sample preschools, if the scientific inquiry is encouraged, and whether or not teachers recognize both planned and spontaneous science taking place within their classrooms. These results may show that more science-related activities are taking place within early childhood education programs than the teachers themselves had perceived. For example, teachers may set up a water table outdoors “because children like to play with water” but they may be unaware that this experience also teaches children about qualities of liquids, evaporation, that water has weight, properties of buoyancy, etc. The current study will provide evidence of what science-related activities are being offered to children by providing insight into the curricular focus found in typical preschool classrooms.

The results from the surveys and demographic data will describe the background characteristics of the teachers, their feelings of self-efficacy in teaching science, why and how often science is intentionally input into their curriculum, and whether or not scientific inquiry is encouraged. Additionally, the current research provides a unique perspective on teachers’ implementation and understanding of their own curricular practices by comparing their categorization of daily activities to the observational notes taken by the researcher. This will be accomplished by observing eight diverse preschool teachers with differing backgrounds (e.g. varying ages and cultural backgrounds, those with no formal child development training to those with mater’s degrees, those with many years of teaching experience to those with only a few years of experience) from
four diverse schools (those serving very high income families to a state funded program that serves low income families).

Ultimately, this study is a pilot for a more in-depth training in the future. If observations and conversations seem insightful for teachers, this model may be used for a larger scale professional development training study. Possibly, by observing, encouraging, and highlighting when teachers engage in scientific thinking and/or specific science-related activities, their own perception of science and self-efficacy may improve thereby possibly enlarging the scope of science in the curriculum.

Terminology

The focus of this study is to examine the amount of *science inquiry* found in many preschool classrooms coupled with preschool teachers’ *attitudes* and *beliefs* about teaching science. The following terms are defined to provide a basis of understanding for the thesis:

- **Attitude:** “A learned summary evaluation of an object (e.g., science teaching; science as a content area) portrayed by attitude dimensions like good-bad, harmful-beneficial, or pleasant-unpleasant” (Maier, Greenfield, & Bulotsky-Shearer, 2013, p. 367); or simply a feeling one has about an object.

- **Beliefs:** “Statements a person considers to be true, regardless of whether they are, in fact, accurate” (Maier et al., 2013, p. 367).

- **Culture of Power:** “Represents a set of values, beliefs, and actions that unfairly and unevenly elevate groups of people. In the case of science, traditional and positivist visions of science, Western Science, are promoted as the single way of
knowing the world at the expense of native ways of knowing in science” (Roehrig et al., 2011, p. 566).

- **Earth Sciences**: “The study of the earth, includes topics related to properties of earth materials (soils, rocks, and minerals), the ocean, weather, and forces that shape the earth. Major components of earth sciences are geology and oceanography” (California Department of Education, 2012, p. 95).

- **First 5 LA**: “First 5 was established in 1998 after California voters approved Proposition 10, an effort to fund health, safety, and early education programs for children prenatal to age 5 through revenue from tax on tobacco products” (First 5 LA, 2012).

- **Life Sciences**: “The study of living things, including plants and animals, their characteristics, life cycles, habitats, and their interrelationships with each other and the environment. The three major branches of life sciences are biology, physiology, and ecology” (California Department of Education, 2012, p. 95).

- **Los Angeles Universal Preschool (LAUP)**: “Los Angeles Universal Preschool is a non-profit organization whose mission is to provide access to high-quality preschool education to the children of Los Angeles County at free or low-cost, regardless of income. LAUP is funded primarily by First 5 LA.” (First 5 LA, 2012).

- **Physical Sciences**: “The study of nonliving matter and energy. It deals with physical properties and transformations of substances, the nature of motion, force and energy (e.g., mechanical energy, heat, sound, light, electricity). The two major branches of physical sciences are physics and chemistry” (California

- **Science**: “Science is the study of the natural world, including the laws of nature associated with physics, chemistry, and biology and the treatment or application of facts, principles, concepts, or conventions associated with these disciplines” (California Department of Education, 2013).

- **Scientific Inquiry**: “The diverse ways in which scientists explore and develop knowledge and understanding of scientific ideas: making observations, posing questions, planning investigations, using tools to gather information, making predictions, recording information, and communicating findings and explanations” (California Department of Education, 2012, p. 96).

- **STEM**: Acronym for science, technology, engineering, and math.

**Preview of Thesis**

The next four chapters include an examination of the current state of science in early childhood education programs. Chapter Two will discuss empirical studies on the topics of early childhood classroom science environments, teachers’ attitudes, beliefs, and involvement in science activities, children’s interest in and use of science materials during free choice time, the connection between the lack of science instruction found within preschool environments with in-service preschool teacher’s feelings of low self-efficacy, and the design of two professional development programs. Chapter Three will provide a description of the sample, demographics, procedure, and instruments used in this study. Chapter Four will present the findings from all five instruments used with special emphasis on direct quotes from the teachers observed. At the end of Chapter Four, the findings across the instruments will be organized into two categories (teachers
and schools) to see prevalent themes that emerge when looking at all four schools as a whole and all eight teachers as a whole. Finally, Chapter Five will begin with an overall summary. The themes uncovered in the findings, implications for future research, and recommendations for improving science instruction within early childhood education environments are also presented.
CHAPTER TWO

LITERATURE REVIEW

Introduction

In this Literature Review, research related to the longitudinal benefits, prevalence, and quality of science in early childhood education as well as preschool teachers’ self-efficacy and perception of science will be presented. The chapter will begin with Sackes, Trundle, Bell, and O’Connell’s (2010) longitudinal research study focused on the influence of kindergarten science experiences on immediate and later science achievement. Next, studies by Tu (2006) and Nayfeld et al. (2011) that examined early childhood classroom science environments, teacher involvement in science activities, and children’s interest in and use of science materials during free choice time will be discussed. This is followed by a study by Maier et al. (2013) that discussed the development of a rating scale created to measure preschool teachers’ attitudes and beliefs toward teaching science. Next, a three-part study by Greenfield et al. (2009) outlined the creation of a professional development program in response to the connection discovered between the lack of science instruction found within preschool environments with in-service preschool teacher’s feelings of low self-efficacy. Finally, a study by Roehrig et al. (2011) measured the impact that a 3-year professional development program had on teachers’ inquiry-based and culturally-relevant science teaching practices over a 1 and 2 year period. To conclude, a review of the literature will synthesize the findings and provide justification for the current research.
Quality of Instruction Positively Impacts Immediate and Later Science Achievement

Hypothesis

A study by Sackes, Trundle, Bell, and O’Connell (2010) examined the longitudinal impact that children’s kindergarten science experiences had on their science achievement at the end of third grade. Sackes et al. (2010) hypothesized that within the kindergarten classroom, the main predictors of immediate and later science achievement were students’ socio-economic status and gender followed by the availability of science materials, the amount of instructional time allocated to teaching science, prior knowledge or exposure to science, and intrinsic motivation. Sackes et al. (2010) further hypothesized that these predictors would influence children’s “opportunities to learn science, their willingness and capacity to benefit from science learning opportunities, as well as their immediate and later science achievement scores” (p. 220).

Subjects

Data was obtained from the Early Childhood Longitudinal Study-Kindergarten cohort (ECLS-K) that employed a multistage probability sample design “that included stratification, clustering, and oversampling of certain subpopulations” (Sackes et al., 2010, p. 221). Base year sample was taken in 1998-1999 and included a data set of 8,642 first-time kindergartners that remained in the same school across the duration of the study. This data set included 4,281 boys and 4,361 girls from both private and public schools; 61% Caucasian, 11% African American, 16.5 % Hispanic, 5.5% Asian, and 5.8% other. Sackes et al. (2010) noted that “parents’ education and income variables were used to create a composite socio-economic status (SES) variable” (p. 221) that was calculated as “the unweighted sum of the z scores from the income and educational level
variables” (p. 223). Data were collected by trained ECLS evaluators who assessed children (including one-on-one assessments) in their schools and collected information from parents over the telephone. In addition, school administrators and teachers were asked to complete questionnaires.

**Method**

Participating teachers completed the kindergarten teacher questionnaire in spring of 1999. Teacher responses to six science-related questions were extracted from the database: (1) availability of sand/water table, (2) availability of other science equipment in the classroom, (3) frequency of science teaching, (4) duration of science teaching, (5) children’s involvement in science activities, and (6) children’s involvement in cooking activities (Sackes et al. 2010, p. 222).

Children were assessed using the general knowledge test at the beginning of the kindergarten year (fall 1998) to rate prior knowledge and again at the end of kindergarten (spring 1999). For this study, two competencies from the general knowledge test were evaluated: “(1) conceptual understanding of earth and space science, life science, and physical science concepts; and (2) scientific process skills such as asking questions, deriving conclusions, and making predictions” (Sackes et al., 2010, p. 222). Reliability coefficient of the observed scores were $\alpha = 0.88$ (spring) and $\alpha = 0.89$ (fall) (Sackes et al., 2010, p. 222). Additionally, approaches to learning scores (a subscale of the Social Skills Rating System), were used to measure children’s motivation (e.g. persistence, attentiveness, learning independence, flexibility).

In third grade, the children were assessed using the third grade science achievement test. For this study, the researchers focused on scores from two
competencies: conceptual understandings (factual knowledge of scientific phenomena) and scientific investigations (process skills such as questioning and communicating results) (Sackes et al., 2010, p. 223).

Results

As hypothesized by Sackes et al. (2010), children with higher SES had higher mean scores on prior knowledge, end of kindergarten assessments (26.90 and 31.95 respectively), and on third grade science achievement tests (52.31) than their peers. Additionally, kindergarten SES was a statistically significant predictor ($p < 0.01$) of the availability of science and nature areas, sand and water tables, engagement in science equipment activities, prior knowledge ($p < 0.001$), and end of kindergarten approach to learning scores ($p < 0.001$). However, the relationship between SES and the frequency and duration of science teaching was statistically significant but “in a negative direction” (Sackes et al., 2010, p. 226). Additionally, children’s prior knowledge and approach to learning were both significant predictors of their end of kindergarten scores and third grade scores ($p < 0.001$).

Boys scored marginally higher than girls on prior knowledge, end of kindergarten scores, and third grade science achievement test scores yet girls scored higher on approaches to learning. While gender was not a statistically significant predictor of science learning opportunities ($p > 0.05$), it was a significant predictor of children’s end of year kindergarten assessment ($p < 0.001$) and science achievement in third grade (Sackes et al., 2010, p. 226).

Analysis showed that 47.8% of teachers reported having water and sand tables in the classroom yet this was not a statistically significant predictor of frequency or duration
of science teaching (Sackes et al., 2010, p. 228). However, those with a science or nature area at school (63%), were more likely to teach science for longer periods of time which was positively related to children’s use of science equipment. Forty-seven percent of the teachers stated that they taught science one or two times a week with the majority (75.8%) reporting lessons lasting 1 to 30 minutes. Additionally, the majority of teachers reported that their students used science equipment two or three times a month with 16% reporting daily use while 6% reported never using science equipment in learning activities. Frequency and duration of science activities had a “statistically significant effect on children’s science activities ($p < 0.01$)” (Sackes et al., 2010, p. 228) yet not on end of year kindergarten scores.

**Discussion**

While this study showed that “science learning opportunities provided in kindergarten made a negligible contribution to children’s immediate and later science achievement” (Sackes et al., 2011, p. 230), SES and prior knowledge were both statistically significant predictors. Assuming that children with prior science knowledge and higher SES attended high quality preschools, perhaps a connection can be made between preschool exposure to science and later science achievement scores. Therefore, because SES and prior knowledge were both strong predictors of kindergarten children’s immediate and later science achievement, is it possible that exposure to inquiry based science activities within the preschool years will positively impact overall science achievement? If so, what are the characteristics of a quality science environment in a typical preschool classroom?
The Preschool Science Environment

Hypothesis

A study by Tu (2006) investigated science environments found in typical preschool classrooms, specifically the availability and type of science-related materials within the classroom as well as the amount of science activities provided by teachers. Tu (2006) was interested in whether the growing amount of research supporting science instruction in early childhood education was accurately reflected within the preschool classroom.

Subjects

Twenty ($N = 20$) lead teachers from 13 Midwestern childcare centers participated in this study. All participants were Caucasian and female, 60% had bachelor’s degree, 15% attended junior college, and 25% had high school diploma (Tu, 2006, p. 247). Out of the 20 participating teachers, 35% had 1 to 3 years of teaching experience, 40% had 4 to 10 years of experience, and 25% had more than 10 years of experience (Tu, 2006, p. 247). All participants taught children between the ages of 3- to 5-years old (Tu, 2006, p. 247).

Methods

Three instruments were developed for this study: The Preschool Classroom Science Materials Checklist, created to record the presence of science materials, equipment, natural materials, and “other” in the preschool classroom; The Preschool Classroom Science Activities Checklist, designed to identify the presence of five activity centers (science, cooking, sand box, water table, and sorting table); and The Preschool Teacher Classroom/Sciencing Coding Form to identify teacher child interactions and
science activities available to children within the nine classroom areas (art, blocks, computer, manipulative, science, dramatic play, language and reading, and sensory) (Tu, 2006, p. 247). Interobserver reliability was independently established at 95.83% for The Preschool Teacher Classroom Coding and 100% for the Preschool Teacher Sciencing Coding (Tu, 2006, p. 247).

Directors from 13 childcare centers were contacted by phone to seek and confirm participation in the study and to schedule a meeting with the director and one or two teachers nominated by the director for participation. Following verbal consent, a letter of consent and information about the study were distributed to directors, lead teachers, assistant teachers, and parents (Tu, 2006, p. 248). Teachers were videotaped for 60 minutes over a consecutive, two-day period during morning free time (Tu, 2006, p. 248). The Preschool Teacher Classroom/Sciencing Form was used to analyze the video. The remaining two checklists were conducted following the first day of taping.

**Results**

Results from the Preschool Classroom Science Materials Checklist showed that the most common science-related materials in the classrooms were vinyl animals (80%), plants (70%), sensory table (65%), posters/charts (60%), and magnets (50%). The most common nature science materials were plants (70%) and seashells (35%) (Tu, 2006, p. 248). Some of the classrooms provided science equipment such as prisms (35%), timers (25%), flower pots (25%), and binoculars (20%), and 20% had outdoor gardens (Tu, 2006, p. 248).

Results from the Preschool Science Classroom Activities Checklist showed that “half of the preschool classrooms had a science area; most of these were located by a
classroom window” (Tu, 2006, p. 250). Six classrooms (30%) provided indoor sand box activities (containing sensory items such as flour and bird seed with measuring cups and funnels). Five classrooms (25%) offered indoor water table activities containing seashells, vinyl animals, scoops and Legos. According to Tu (2006), there were no cooking activities or “sorting objects available in the classrooms” (p. 250).

Analysis of the Preschool Teacher Classroom/Sciencing Coding Form data showed that “the majority of activities in which the preschool teachers engaged were not science-related activities (86.8%)” (Tu, 2006, p. 250) and only 4.5% were related to “formal sciencing” (making play dough) (Tu, 2006, p. 250). The remaining 8.8% were informal science-related activities (water table and sand box exploration). Additionally, the research revealed that the teachers interacted most often with children “in the art area, followed by the sensory area, and least often in the science area” (Tu, 2006, p. 250).

**Discussion**

Although this study showed that science materials were available and easily accessible to children in their preschool classrooms, neither the children nor the teachers engaged with the materials. Is it possible that the student’s lack of interest in the science area was related to the overall lack of attention given to science by their teachers? Moreover, can teachers’ interest in science inspire their students and influence positive outcomes?

**Autonomous Exploration Versus Teacher Led Instruction**

**Hypothesis**

In this study, Nayfeld, Brenneman, and Gelman (2011) explored the role of science in the preschool classroom by investigating children’s use of science
materials/instruments during their autonomous, free choice time. Researchers were interested in exploring children’s spontaneous interaction with science materials in the science area, assessing whether an intervention involving a scientific tool (balance scale) would increase interest in the science area, and if the intervention would result in increased interaction with and lasting knowledge about the balance scale. Nayfeld et al. (2011) hypothesized that even if high quality science instruments and discovery areas were present and accessible to preschool children, without an intervention, teachers and children would often neglect them because “science activities are rarely observed” (p. 973).

**Subjects**

A total of 84 children between the ages of 3- and 5-years-old from six urban preschool classrooms in New Jersey participated in the study. Ninety percent of the students were English language learners from minority, low-income families whose children attended free of charge. There were three experimental groups (total of 42 students, 22 girls, 20 boys) and three control groups (total of 42 students, 24 girls, 18 boys) (Nayfeld et al., 2011, p. 974). All 84 students from the six classrooms participated in the circle time activity and were observed during free choice time. Because the researchers individually interviewed the children as part of the study, only children 4 years of age and older participated because of the “cognitive and linguistic demands of the interview procedure” (Nayfeld et al., 2011, p. 974).

**Method**

To analyze the children’s presence in the science area, the researchers used a measure called “child-minutes” (Nayfeld et al., 2011, p. 980) which were calculated by
documenting the number of children in the science area during each minute of occupation. For example, according to Nayfeld et al. (2011),

If the area was observed for 3 min and there were two children in the science center during the first minute, one during the second, and two during the third, the total number of child-minutes for that time interval would be 5. (p. 980)

Child-minutes were calculated for both the experimental and control groups.

Researchers collected complete pre and posttest interview data from 34 children randomly assigned to four groups. The control condition (two groups) contained 19 children total, 14 girls and 5 boys (mean age=55 months, range = 49-64 months). The experimental condition (two groups) contained 15 children, 12 girls and 3 boys (mean age = 57 months, range 48-66 months) (Nayfeld et al., 2011, p. 974). According to Nayfeld et al. (2011), interview data were analyzed from two control and two experimental classrooms “because of the relatively small numbers of eligible 4- and 5-year-olds in the remaining two classrooms and because of time constraints on data collection” (p. 974). The overrepresentation of girls within both groups was due to “parental permission and complete datasets, not selection bias” (Nayfeld et al., 2011, p. 974). In addition, because the overrepresentation occurred in both groups “true gender related differences, say in interest in science or knowledge about the tools of science, would be expected to influence both in similar ways” (Nayfeld et al., 2011, p. 974).

Materials used during the intervention (experimental group) included “a balance bucket scale (already present in all classrooms), standard weights for the scale, countable items commonly found in a classroom science area (e.g., acorns, shells, rocks), and other small countable items (e.g., blocks, plastic toy animals, crayons)” (Nayfeld et al., 2011, p.
Materials utilized in the control classroom’s circle time lessons included “color photographs of unusual objects (marmoset, persimmon, statue, robot dog)” (Nayfeld et al., 2011, p. 975).

Procedure

The study was conducted in three phases. Phase I included observations and interviews. To establish a “preintervention measure” (Nayfeld et al., 2011, p. 974) of knowledge about the balance scale, baseline observations of the children’s attendance in the science area during free choice time were recorded. Observations occurred over “several days for over 120 minutes in each classroom” (Nayfeld et al., 2011, p. 975). Using a time sampling method, researchers recorded the number of teachers and/or children in the science area, as well as their activity, at 60-second intervals. Special attention was given to any attention shown to the balance scale. Once the observations were completed, participating children were invited into the science area for individual interviews. According to Nayfeld et al. (2011), each child was asked three questions to gain a baseline measure of their knowledge of the balance scale, “What is this called? Which side is heavier? Can you make the two sides even/equal? Show me” (p. 976). Answers were scored as either correct (1) or incorrect (0).

Phase II included the intervention. Each class participated in two circle time lessons that were all conducted by the same adult. The experimental classroom’s two circle times focused on the balance scale, how it can be used, and the information it provided relating to weight. The first day’s lesson introduced the class to the scale and its function and the children participated in an interactive activity where they “used their muscles to find out which of two objects was heavier” (Nayfeld et al., 2011, p. 976).
They then used the balance scale to assess their predictions. After the lesson, the balance scale was returned to the science area and the area was observed during free choice time (60 to 80 minutes) (Nayfeld et al., 2011, p. 976).

The second day’s circle time lesson reinforced and extended the previous balance scale lesson. Children were asked to place an item on one side of the scale and predict how many items they would need to add to make one side go down or to balance the scale (equal sides). After the lesson, the balance scale was returned to the science area and the area was observed for 60 to 80 minutes (Nayfeld et al., 2011, p. 974).

The comparison classroom’s two circle time lessons focused on photographs of “unusual animate and inanimate objects” (Nayfeld et al., 2011, p. 977). The children were shown the photos and asked to describe the items and to predict, “what was on the inside of each object” (Nayfeld et al., 2011, p. 977). According to Nayfeld et al. (2011), this activity was chosen because “it is science related but does not advertise the science area or any materials found there” (p. 977).

Phase III included post intervention observations and interviews. After each of the four circle time lessons, observations lasting 60 to 80 minutes followed (during free choice time) with researchers time sampling adult and child presence and activity within the science area every 60 seconds (Nayfeld et al., 2011, p. 978). Additionally, children who participated in the initial interviews and had attended at least one of the circle time lessons were interviewed 20 to 25 days after the first group lesson to determine “whether children in the balance scale interventions classrooms showed increased and durable knowledge about the balance scale compared to children in the control condition” (Nayfeld et al., 2011, p. 978). The same three questions from Phase I were asked again.
Results

Results from Phase I (preintervention observations) revealed that the “science area was empty 77.6% of the time sampled across all six classrooms” (Nayfeld et al., 2011, p. 978). Without a teacher present, children spent a total of four minutes in the science area. After Phase II’s intervention, the number of minutes in which one or more children were present in the science area increased from 47 to 333 (76 to 638 child-minutes) in the experimental classrooms and decreased from 114 to 38 minutes (224 to 67 child-minutes) in the control classrooms. According to Nayfeld et al. (2011), “Children’s presence in the science area increased so dramatically in the balance scale intervention classrooms that there were times when the area was filled beyond capacity” (p. 978). Because of the interest shown, teachers increased the amount of children allowed in the science area and added an additional balance scale and table. Interaction with the balance scale increased from 0 to 386 child-minutes in the experimental groups and remained at 0 for the control groups (Nayfeld et al., 2011, p. 980). Overall time spent in the science area (not including balance scale interactions) “remained higher for intervention classrooms (252 child-minutes) than for comparison classrooms (67 child-minutes)” (Nayfeld et al., 2011, p. 980).

Total balance scale pre and posttest scores (out of 3 possible points) for the intervention group improved “by an average of 1.13 points (SE=0.24)” (Nayfeld et al., 2011, p. 981) while scores in control group decreased (mean change= −0.05, SE=0.19). According to Nayfeld et al. (2011):

A repeated measures analysis of variance was conducted to assess the effects of the intervention on balance scale scores, with time (preintervention vs. post
Intervention) as a within-subjects factor and type (experimental vs. comparison) as a between subjects factor. A significant main effect was found for time, $F(1, 32) = 12.693, p < .001$; and type, $F(1, 32) = 6.327, p < .05$. The interaction of time and type was also significant, $F(1, 32) = 15.286, p = .001$. (p. 982)

Individual scores were consistent with group scores. Intervention group scores increased while control group decreased, $X^2(1, N = 34) = 12.08, p < .001$ (Nayfeld et al., 2011, p. 982).

Discussion

As Nayfeld et al. (2011) illustrated, striking a balance between children’s autonomous exploration and teacher led instruction resulted in a statistically significant increase in children’s interest in and interaction with science materials. If simple interventions result in positive outcomes, why do some preschool teachers continue to avoid engaging in science-related activities? As Nayfeld et al. (2011) discovered, preschool teachers often feel more comfortable participating in art and literacy activities and less comfortable engaging in science-related activities. Therefore, the ability to assess preschool teachers’ attitudes and beliefs about teaching and engaging in science appears to be an important next step.

Preschool Teacher Attitudes and Beliefs Toward Science (P-TABS) Assessment Tool

Hypothesis

Maier, Greenfield, and Bulotsky-Shearer (2013) created and validated a rating scale, the Preschool Teacher Attitudes and Beliefs toward Science Teaching self-report questionnaire (P-TABS), to measure preschool teachers’ attitudes and beliefs towards teaching science. The researchers developed the P-TABS in response to a lack of
available “empirically validated measures” (Maier et al., 2013, p. 366) that specifically assessed teacher attitudes and beliefs towards science. Because the researchers hypothesized that teacher attitudes and beliefs were the strongest indicator of the quality and quantity of science instruction in the preschool classroom, the purpose of this research was to “contribute a new measurement tool to the field of preschool science” (Maier et al., 2013, p. 375).

According to Maier et al. (2013), the definition of attitude is “a learned summary evaluation of an object (e.g., science teaching; science as a content area) portrayed by attitude dimensions like good-bad, harmful-beneficial, or pleasant-unpleasant” (p. 367); or simply a feeling one has about an object. In contrast, the researchers defined beliefs as “statements a person considers to be true, regardless of whether they are, in fact, accurate” (Maier et al., 2013, p. 367). Because attitudes and beliefs influence one another, “what an individual believes to be true about an object (belief) determines how she feels about that object (attitude)” (Maier et al., 2013, p. 367).

Subjects

Study packets were sent to directors at 18 Head Start programs to be given to 851 lead teachers throughout Florida. A total of 507 Head Start teachers consented and completed the questionnaire. Ninety-eight percent of the sample (N=507) were female, 34% were Caucasian, 34% African American, 26% Hispanic, 5% other ethnicities, and 1% did not respond to the question (Maier et al., 2013, p. 368). Fifty-one percent of the participants reported that they had completed a CDA or other associate’s degree, 38% a bachelor’s degree, and 10% a masters or doctoral degree (Maier et al., 2013, p. 368). Ninety one percent of the respondents reported a range of 0 months to 42 years of
preschool teaching experience (M=11.77, SD=8.71). Forty-five percent of the teachers reported participation in “special projects that impacted their classroom instruction” (Maier et al., 2013, p. 368); of these, 36% “mentioned a science-related project (which is 16% of the entire sample)” (p. 368).

Additionally, a validity subsample of “30 teachers from the larger sample were from a local Head Start program and were participating in a larger, quasi-experimental project evaluating a preschool science curriculum” (Maier et al., 2013, p. 368). Of these 30 teachers, 20 were participating in science curriculum training while 10 were “comparison teachers” (Maier et al., 2013, p. 368) that were not participating in the training. All participants in the subsample were female; 19 Hispanic, 8 African American, 1 Caucasian, 1 Asian, and one did not report race. Eleven completed a CDA or other associate’s degree, 15 a bachelor’s degree, and three a master’s degree. Years of preschool teaching experience ranged from 0 months to 30 years (M=12.39, SD=8.54) (Maier et al., 2013, p. 368).

Method

The P-TABS was developed in three steps: (a) in-depth content review, (b) development of a pool of 70 items along with 16 items from the Early Childhood Teachers’ Attitudes towards Teaching Science Scale (2003) and two items from ECEASS (1992), and (c) each item was reviewed by an “expert panel of seven early childhood teachers from a local preschool program” (Maier et al., 2013, p. 369). Once approved by the university’s Institutional Review Board (IRB), study packets (informational letter, teacher and director consent forms, the P-TABS, and a demographic questionnaire) were mailed to 18 Head Start programs throughout Florida. Within a month of receiving
packets, teachers returned sealed packets to their director (whether they participated or not). Directors signed a consent form and mailed the packets back to the researchers. No incentives were given to the directors or teachers.

For the subsample, four trained observers collected additional information at the beginning, middle, and end of the school year. Using the Preschool Teacher Science Classroom Observation Tool (PreSCOT), observations of teacher’s science-related practices and “curriculum fidelity for the 20 teachers implementing the science curriculum” (Maier et al., 2013, p. 369) were recorded in addition to pre-intervention and post-intervention scores on P-TABS.

According to Maier et al. (2013), “means, standard deviations, skewness, and kurtosis were examined for each item” (p. 369) and eleven negatively worded items were relevanced to examine the scale’s overall internal consistency. To examine the underlying factor structure, “a series of exploratory latent structure analyses were conducted using squared multiple correlations as initial commonality estimates” (Maier, et al., 2013, p. 369). The final factor structure was established using “oblique, multiple-group principal components cluster analysis in SAS and confirmatory factor analysis in Mplus Version 6.11” (Maier et al., 2013, p. 369). To verify generalizability, “structural invariance was examined by repeating common factor analysis” (Maier et al., 2013, p. 370) across teacher ethnicity, education, and experience. Using independent samples t-tests, P-TABS concurrent validity was tested by assessing whether the factor scores collected showed differences between teachers who did and did not report participating in a science-related special project within the last 3 years (16% of entire sample) (Maier et al., 2013, p. 370).
For the subsample \((n = 30)\), validity was examined by comparing P-TABS scores and observational scores. For the 20 teachers implementing the science curriculum, correlations were examined between their P-TABS scores and fidelity to curriculum scores (Maier et al., 2013, p. 370). Finally, using a paired sample \(t\)-test, pre-training and post-training P-TABS scores were examined.

**Results**

The final version of the P-TABS questionnaire had 35 items (11 negatively worded), grouped into three Factors (Factor 1: Teacher Comfort [14 items], Factor 2: Child Benefit [10 items], and Factor 3: Challenges [7 items]) and rated using a 5 point Likert Scale (strongly disagree to strongly agree) (Maier et al., 2013, p. 370). According to Maier et al. (2013), the overall internal consistency of the P-TABS was “excellent (Cronbach’s alpha= .91)” (p. 370) in addition to high internal consistency across Factor’s 1 and 2 (alpha .89 and alpha .85 respectively). Because low internal consistency was found across subgroups within Factor 3, it was dropped from subsequent analysis. According to Maier et al. (2013), the final “two Factor model fit was good, \(\chi^2(237)=574.19, p < .001, \text{CFI}=.93, \text{RMSEA}=.05, \text{SRMR}=.05\)” (p. 372). Finally, the P-TABS “factor structure was found to be generalizable and invariant across different subgroups (ethnicity, education level, and experience level)” (Maier et al., 2013, p. 373).

Concurrent validity in the full sample (independent \(t\)-tests) indicated significant differences between teachers who did and did not report participation in a science-related special project within the last 3 years: Teachers reporting involvement had higher mean scores on the Teacher Comfort Factor and Child Benefit Factor in comparison to teachers who had not reported involvement \((t(147.7) = -2.33, p =. 021\) and \(t(505) = -2.75, p=.006\).
respectively) (Maier et al., 2013, p. 373). Concurrent and predictive validity in the subsample showed significant improvement in end of year scores from the teachers that implemented the science curriculum (and attended trainings), “beginning of year: $t(18) = -3.72, p = .002$ and end of year $t(18) = -3.68, p = .002$” (Maier et al., 2012, p. 373).

Results from the P-TABS showed that on average, teachers reported feeling comfortable conducting science-related activities in the classroom and believed that science in preschool was important. However, teachers reported feeling less comfortable planning and engaging in physical and energy related science activities. Finally, responses indicated that teachers tended to plan curriculum in isolation “suggesting that preschool teachers typically do not use one another as resources when teaching science” (Maier et al., 2013, p. 374).

**Discussion**

Maier et al. (2013) noted that results from the full sample “indicated that teachers currently involved in science activities tended to have more comfort with teaching science and more positive perceptions of the benefit of science for children” (p. 374). Moreover, within the subsample, teachers that implemented the science curriculum “reported significantly higher Comfort and Child Benefit scores at the end of the year (post curriculum training) as compared to the beginning of the year” (Maier et al., 2013, p. 374). These results supported the hypothesis that teacher attitudes and beliefs were the strongest indicator of the quality and quantity of science instruction in the preschool classroom. Therefore, is professional development the most effective way to develop and support both pre-service and in-service teacher self-efficacy and comfort with teaching science?
Intervention to Support Pre-Kindergarten Classroom Science

Hypothesis

Greenfield, Jirout, Dominguez, Greenberg, Maier, and Fuccillo (2009) presented three studies that provided preliminary investigative research on the current state of science in the preschool classroom. This research was part of a larger, ongoing “university-community research partnership focused on preschool science (Head Start Association’s Research Committee)” (Greenfield et al., 2009, p. 242). The purpose of this multi-faceted approach was to show that incoming kindergarten science readiness scores were significantly lower than what was found in other developmental domains, to identify why these scores were low, and to implement a program that showed promising results in reversing this trend.

**Study 1.** Using Florida’s Head Start school readiness statewide database, the purpose of Study 1 was to compare incoming kindergartner’s science readiness scores to their scores in the other seven readiness domains (Approaches to Learning, Creative Arts, Early Math, Language and Literacy, Motor Development, Physical Health, Social and Emotional) (Greenfield et al., 2009). Greenfield et al. (2009) hypothesized that “science knowledge and skills would not only be low at the beginning of the [kindergarten] school year but also show smaller gains across the school year compared to gains in the other seven Head Start readiness domains” (p. 244). The researchers concluded that the low science readiness scores showed that there was a lack of exposure to hands-on, inquiry based science activities offered to children in preschool.

**Study 2.** The purpose of Study 2 was to uncover why children’s science readiness scores were significantly lower than their readiness scores on other domains by
investigating the amount and quality of science activities offered to children in preschool. Greenfield et al. (2009) tested two hypotheses with this study; “We were interested to see if they [the teachers] self-generated time management issues and low self-efficacy in teaching science during these discussions” (p. 257).

**Study 3.** According to Greenfield et al. (2009), the findings from Study 1 and Study 2 provided “both the rationale and guidelines for Study 3” (p. 250). Therefore, the purpose of Study 3 was to create a program that integrated the other seven Head Start school readiness domains around a set of science activities. Greenfield et al. (2009) hypothesized that “science activities that integrate other readiness domains will improve school readiness not only in science but also in these other domains” (p. 243).

**Subjects**

**Study 1.** Statewide data from Florida’s 2002-2003 and 2003-2004 Head Start school year database were used. Included in each database year were children that would be entering kindergarten the following fall. For the 2002-2003 cohort, “this was defined as Head Start children who had turned 4 years of age prior to September 1, 2002” (Greenfield et al., 2009, p. 244). For the 2003-2004 cohort, children had to be 4 years of age by September 1, 2003. According to Greenfield et al. (2009), each child was required to “have both a fall and a spring data collection point for all eight readiness domains” (p. 245).

The 2002-2003 sample included 2,032 children (955 females and 1,077 males). Because including children’s ethnicity into the database was optional (yet was requested), ethnicity was only available for 1,472 of the children in the study. Of this group, “829 were African American, 461 Hispanic, 93 Caucasian, 73 Haitian, 9 multiracial, and 7
Asian” (Greenfield et al., 2009, p. 245). The 2003-2004 sample included 2,927 children (1,376 females and 1,551 males). Ethnicity data was received for 1,995 of the children sampled that included, “1,088 African American, 577 Hispanic, 171 Caucasian, 67 Haitians, 18 multiracial, 16 Asian, and 58 ‘other’” (Greenfield et al., 2009, p. 245).

**Study 2.** For this study, a group of Head Start teachers participated in a series of informal focus group meetings. The meetings were facilitated by a local Head Start partner and included “twelve different large and small Head Start centers from different parts of the country, and each meeting had approximately 4 to 10 teachers present” (Greenfield et al., 2009, p. 248). In order to guarantee anonymity and to ensure a safe environment that fostered free and open discussions, attendance was not taken at these meetings and “no information is available on teacher characteristics or the exact number of teachers that were involved in these focus group meetings” (Greenfield et al., 2009, p. 248).

**Study 3.** Teachers from local Head Start programs in Florida were asked to participate in this study on a voluntary basis. Participant teachers were from 18 Head Start classrooms at 9 different centers. Six of the centers each included two classrooms (one control and one treatment per center), one center included four classrooms (two control, two treatment), and two nearby centers included one classroom each (a treatment classroom at one center and a control at the other center) (Greenfield et al., 2009). Each of the 18 classrooms contained 15 to 20 children. According to Greenfield et al. (2009), participants included:

168 children (84 female) ranging in age from 36 to 58 months ($M = 48.0, SD = 6.7$) in nine treatment classrooms, and 160 children (82 female) ranging in age
from 36 to 59 months ($M = 46.3$, $SD = 6.4$) in nine control classrooms. In
treatment classrooms there were 107 African American children, 35 Hispanic, 14
Haitian, 1 Caucasian, 1 Asian, and 10 “other.” In control classrooms there were
122 African American children, 23 Hispanic, 1 Caucasian, 1 Asian, and 13
“other.” (p. 251)

**Methods**

**Study 1.** In Study 1, Greenfield et al. (2009) analyzed a large, ethnically diverse,
statewide Head Start school readiness database from Florida to compare children’s
readiness scores in science to all other measured domains (Approaches to Learning,
Creative Arts, Early Math, Language and Literacy, Motor Development, Physical Health,
Social and Emotional) (Greenfield et al., 2009). The database was created using the
Galileo web-based system. The Galileo system “contains between 28 and 71 ($M = 48$)
binary skills in each federally mandated Head Start school readiness domain” (Greenfield
et al., 2009, p. 245). According to the researchers, the developers of the Galileo system
have reported that the measure has “high levels of internal consistency for the eight scales
ranging from .92 to .97” (Greenfield et al., 2009, p. 246).

Throughout the year, teachers observed and recorded children’s attainment of
specific skills within the eight domains of development. Each entry was date and time
stamped, “longitudinally tracking each child’s accumulation of skills in all domains”
(Greenfield et al., 2009, p. 245). According to the researchers, these eight domains were
divided into sub-skills (e.g., in the science domain, classifying in the natural
environment). Within each sub-skill were a set of skills that were either “learned/not
learned” (Greenfield et al., 2009, p. 245) and ordered from easiest to most difficult “(e.g.
an easy item for classifying was ‘distinguishing plants from animals;’ a more difficult item was ‘classifies animals into groups by the way they move’)’ (p. 245). Teachers deemed a skill “learned” once the child demonstrated it at least three times.

In addition to the age criteria, “October 31 was used as the final cutoff date for fall data and May 1 as the earliest beginning date for spring data” (Greenfield et al., 2009, p. 245). For each child in the analysis, the first fall and last spring data points were used. Those that did not have fall and spring data points were excluded from the analysis. This criteria created a data set of children that would enter kindergarten the following fall and had early fall and late spring data points for all eight school readiness domains. According to Greenfield et al. (2009), these guidelines created a more competent sample “because these children were enrolled in the program a minimum of 7 months and had conscientious teachers who completed assessments on all eight readiness domains” (p. 245).

**Study 2.** Study 2 was conducted informally; the researchers used qualitative notes to collect data. Twelve focus group meetings occurred at each of the participating Head Start centers, lasted 45 minutes, and occurred during children’s nap times. Head Start directors and supervisory staff were not present at these meetings. According to Greenfield et al. (2009), the university research director attended all 12 meetings and began each meeting by sharing “the statewide Galileo data from Study 1, highlighting the concern about low science scores” (p. 249). The researchers explained to the teachers that the committee was interested in “developing classroom-based programs to improve children’s science learning” (Greenfield et al., 2009, p. 249).
After the presentation, teachers were encouraged to work together and openly discuss their experiences teaching science including any barriers they encountered. During this discussion, the researchers collected notes to define main themes and issues but did not offer discussion prompts or questions. The goal of the discussion was to “see if the teachers self-generated the two themes of self-efficacy and time management” as reasons why they avoided teaching science (Greenfield et al., 2009, p. 249). Upon completion of the focus groups, the two main themes that emerged, self-efficacy and time management, “were cross-referenced with the 12 participating centers to determine in how many centers each of the two themes were discussed” (Greenfield et al., 2009, p. 249).

**Study 3.** Because the researchers felt that implementing a new and unfamiliar curriculum would be ineffective, the team partnered with the Museum of Science to develop a program that could be implemented into the existing curriculum. The Early Childhood Hands-On Science program (ECHOS) was a hybrid curriculum that combined direct instruction with inquiry-based science exploration (Greenfield et al., 2009). The program was field tested with a small group of Head Start teachers from December to May of the 2004-2005 school year. The goal of this new program was to “provide the resources needed for teachers to increase their confidence about teaching science and to help them adjust their classroom schedules to teach science through the integration of multiple school readiness domains within science activities” (Greenfield et al., 2009, p. 251). School readiness outcomes from the intervention group were compared to those in the control group.
The ECHOS program was introduced in December of 2004 to the participating teachers over a 2-day meeting in a classroom at the Museum of Science (Greenfield et al., 2009). Teachers worked in small groups while rotating to seven separate stations where various hands-on science units were introduced. Participants were asked to manipulate and discuss the activities at each station. Teachers were asked to present a lesson on Shells (one of the units presented) to their Head Start class and report back to the research team. The lessons included “Shells, The Beach, The Ocean, and Home for Hermit Crab” (Greenfield et al., 2009, p. 252). For the remainder of the year’s meetings, the Shells lesson would be the focus of discussions and classroom science activities.

At the second meeting, teachers were asked to integrate the Shells lesson into one additional Head Start readiness domain and implement this into their classroom (e.g. incorporate language and literacy into this science unit) (Greenfield et al., 2009). Once implemented, the teachers were asked provide presentations for the following group meetings on both successes and challenges they encountered. The participating teachers and researchers met once a month at the Museum of Science for the “remainder of the spring term” (Greenfield et al., 2009, p. 252).

Galileo fall and spring data were used to compare the treatment group (ECHOS) and the control group using MANOVA. According to Greenfield et al. (2009), “The first MANOVA score compared developmental scores on the eight school readiness domains between the two groups at the beginning of the school year and at the end of the school year” (p. 252). A second MANOVA compared scores from fall to spring.
Results

Study 1. After comparing all developmental scores beginning with “initial ability, end of year ability and equated interval level gain” (Greenfield et al., 2009, p. 246), within the eight Head Start school readiness domains, six showed consistent, yearly gains of more than 100 points. According to Greenfield et al. (2009), “Science was the only domain that was significantly different (lower) than all the other seven domains at the end of the school year in both the 2002-2003 cohort and the 2003-2004 cohort (83.4 and 90.7 respectively, all p < .0001)” (p. 246).

Study 2. Three themes emerged from the teachers participating in the 12 focus group sessions: low self-efficacy in teaching science, not having enough time in an already full day to teach science (because of the pressure put upon them to focus on language and literacy skills), and an absence of science activities listed within Head Start’s “Program Education Guide” (Greenfield et al., 2009, p. 249).

Study 3. The MANOVA showed significant differences between the treatment and control group scores at the beginning of the year, “Wilks’s $\Lambda = .90, F = 4.29, p < .001, \eta^2 = .10$” (Greenfield et al., 2009, p. 253). However, this pattern of statistical significance was not replicated between treatment and control children for “any one of the eight domains when analyzed individually” (Greenfield et al., 2009, p. 253). This was confirmed with follow up ANOVA analyses. There was statistical significance between the developmental scores of the treatment and control groups at the end of the school year, “Wilks’s $\Lambda = .79, F = 10.25, p < .001, \eta^2 = .21$” (Greenfield et al., 2009, p. 253). The children in the control group scored much lower than those in the treatment group across all eight domains at the end of the school year and showed a significant
difference from the fall data point to the spring data point across all domains and conditions, “Wilks’s Λ = .75, F = 12.90, p < .001, η² = .25” (Greenfield et al., 2009, p. 253). According to Greenfield et al. (2009), the children in the control group “were found to demonstrate less improvement than treatment children in all eight school readiness domains” (p. 253).

Discussion

The differences found between the control and experimental group scores supported the hypothesis that professional development may have a positive impact on classroom practices. Moreover, these statistically significant scores were the result of a very general and brief program that lasted only a few months. Would a sustained, long-term professional development program that integrated culturally relevant science practices and activities produce stronger, more lasting results?

Impact of Sustained Professional Development on Science Teaching Practices

Hypothesis

A study by Roehrig, Dubosarsky, Mason, Carlson, and Murphy (2011) measured the impact that Ah Neen Dush, a 3-year professional development partnership between the University of Minnesota and the White Earth Reservation Head Start program, had on teacher’s inquiry based and culturally-relevant science teaching practices over a 1 and 2 year period. The researchers were interested in the lack of science in minority communities where science is oftentimes associated with the “culture of power” (Roehrig et al., 2011, p. 566). The researchers hypothesized that offering teachers sustained, long-term professional development that integrated science with cultural relevance would reverse this trend and benefit the overall early childhood program (Roehrig et al., 2011).
Subjects

Six Head Start centers with a total of nine classrooms and 37 teachers participated in this study. All of the centers were located on a rural, Native American Reservation in the Midwestern United States serving a majority of Native students and a few non-Native students that were enrolled in centers located near the reservation’s border. Approximately half of the all female teaching staff were Native and “differed in age, level of education, years of experience, knowledge of traditional culture, and ethnicity” (Roehrig et al., 2011, p. 570). Each class had a lead and assistant teacher.

Methods

Quantitative data was derived from measuring teachers’ interactions with students over a two-year period using the CLASS (Classroom Assessment Scoring System) observation/assessment tool (Roehrig et al., 2011). A baseline score was obtained before implementing the program followed by a new score obtained one year after implementation. The final CLASS score was documented two years after the program’s implementation. Although the CLASS system does not score cultural sensitivity, “cultural relevance was specifically looked for during classroom observations” (Roehrig et al., 2011, p. 571). Five observers were trained to use the CLASS system and all observations were conducted once a semester at each of the 6 Head Start centers over a 2-year period. Each formal observation followed CLASS guidelines, “occurring for at least 2 hours with observations occurring in at least four intervals of 20 min, and summarizing the observation on a chart” (Roehrig et al., 2011, p. 571).

CLASS domain and sub-scale scores were “averaged across classrooms for the baseline, end of year 1 and end of year 2 data” (Roehrig et al., 2011, p. 571). Statistical
comparisons were made using the baseline score and the scores after year 1 and year 2 of development (Roehrig et al., 2011). *T* tests were used to highlight growth within the individual domains and sub-scales over time and “qualitative observation notes were used to look for specific examples of growth within individual classrooms” (Roehrig et al., 2011, p. 571).

In addition to scoring, between year 1 and 2, each CLASS observer gathered qualitative data by noting behaviors, interactions, and activities occurring during observations, evaluating surveys completed after each professional development session, and group interviews (Roehrig et al., 2011). Finally, all conversations between teachers, Head Start administrators, and the researchers were supportive and touched on teachers expectations, struggles, and concerns.

The first year of the Ah Neen Dush program focused on “building a foundation for implementing inquiry-based science pedagogies” (Roehrig et al., 2011, p. 571). To insure that the program was culturally relevant, during the first year the researchers implemented “The Young Scientist: Discovering Nature with Young Children Curriculum” (Roehrig et al., 2011, p. 571). This constructivist curriculum focused on nature-based science and math skills and aided in the development of critical thinking skills such as investigating, questioning, and formulating theory based on emergent peer/peer and teacher/student discussions (Roehrig et al., 2011).

The program’s second year introduced the participants to a new curriculum titled “Young Scientist: Exploring Water with Young Children” (Roehrig et al., 2011, p. 571). This new curriculum focused on the teacher’s place in an inquiry based classroom. Workshops focused on educating teachers on how to encourage student inquiry using
open-ended questions, creating a patient environment that gives children time to develop answers and theories, and recording observations. Constructivist teaching practices were reinforced “through modeling and formative observations in teachers’ classrooms” (Roehrig et al., 2011, p. 571).

In addition to the new curriculum, monthly workshops became more collaborative, allowing each center to present an interesting science activity that integrated culture. Each meeting was led by one of the Head Start centers and included a presentation (including photos and documentation) followed by a group discussion.

Results

After the first year, CLASS Instructional Support scores remained low (3.02) and became “a constant discussion and concern for the program staff” (Roehrig et al., 2011, p. 575). Researchers discovered that while teachers were introducing new science activities, most were teacher driven and not student centered, inquiry based science activities. To address this deficit, Roehrig et al. (2011), introduced a new component to the program, “the use of model lessons in the classroom” (p. 575). Individualized model lessons were taught in the classrooms by a team member and based on a science topic chosen by the lead teacher in each classroom (Roehrig et al., 2011).

While CLASS scores after year one increased, it was not enough to be statistically significant. The small increases were attributed to teachers changing their instructional approach, integrating science and culture, and implementing new science practices. For example, the Young Scientist curriculum’s nature theme “allowed for ‘weaving in’ a variety of cultural themes” (Roehrig et al., 2011, p. 574). However, these changes remained “superficial when looking at the instructional support and the quality of
conversations and questioning around science concepts” (Roehrig et al., 2011, p. 577). Moreover, while there were increases to the Emotional Support domain (Baseline 5.39 to 1 year 5.56) and Instructional Support domain (2.28 to 3.02), the Classroom Organization domain decreased (4.78 to 4.20) which was attributed to “teachers learning their new roles in an inquiry-focused lesson” (Roehrig et al., 2011, p. 574).

After two years, the continued increase in CLASS scores became statistically significant. Overall, Emotional Support increased from a baseline score of 5.39 to 6.07, Classroom Organization increased from a baseline of 4.78 to 5.67, and Instructional Support increased from a baseline of 2.28 to 3.46 (Roehrig et al., 2011). These longitudinal results showed that an additional year of instruction further supported teacher’s attitudes and thinking about science and resulted in an overall increase in CLASS scores across the board.

**Synthesis of the Review of the Research**

**How Research Supports Current Study**

Each of the six studies discussed in this chapter demonstrated that science is vital to the development of the whole child. However, as the research presented has shown, science remains a neglected and oftentimes completely avoided domain within early childhood education (Greenfield et al., 2009; Maier et al., 2013, Nayfeld et al., 2011; Tu, 2006). This is due, in part, to preschool teachers feelings of low self-efficacy and lack of science and pedagogical content knowledge (Greenfield et al., 2009; Maier et al., 2013; Roehrig et al., 2011). While the research by Tu (2006) showed that most preschools have science areas and/or materials within the classroom, merely providing science-related materials does not appear to inspire student exploration or learning. According to
Nayfeld et al. (2011), this is because most young children need to have unfamiliar materials placed into a context that they will understand. As their research revealed, when science materials and instruments (such as a balance scale) were put into context through adult-guided introductions and interventions, children’s interests in science were sparked (Nayfeld et al., 2011). As Nayfeld et al. (2011) discovered, “learning is supported more effectively if autonomous exploration is preceded by teacher-led instruction” (p. 986).

Therefore, a teacher’s understanding of and comfort with science appears to be the strongest predictor of the success or failure of preschool science programs. As the research by Roehrig et al. (2011) discussed, establishing a culturally relevant, collaborative learning environment that utilizes scientific inquiry (scientific method) benefits both the children and the teachers. Within this environment, teachers play an active role in each child’s scientific journey as a co-researcher, explaining the function and purpose of new materials while providing provocations that deepen and extend learning (Greenfield et al., 2009; Maier et al., 2013; Nayfeld, et al., 2011; Roehrig et al., 2011).

The Next Step

While the research presented in this chapter established the importance of early science exposure, what, if any, planned and spontaneous science activities are actually taking place in typical preschool classrooms? Moreover, is it possible that teachers often do not recognize and/or miscategorize spontaneous and emergent science unfolding within their classrooms thereby thwarting their ability to expand and extend the learning? While Greenfield et al. (2009) interviewed preschool teachers to better understand their
feelings about science, Nayfeld et al. (2011) documented the amount of time teachers spent in their classroom’s science area, and Roehrig et al. (2011) gathered CLASS scores to measure teacher/child interactions, none observed the type or amount of science activities actually occurring in the classrooms, whether or not teachers recognized science unfolding throughout the day, and if their self reported perception of and self-efficacy in teaching science is reflected in the classroom. The current study’s design builds on the existing foundational research by providing a unique perspective into each teacher’s perception, implementation, and recognition of science in their preschool classrooms. The participants and design of the study are presented next, in Chapter Three.
CHAPTER THREE

METHODOLOGY

Introduction

The current study explores how teachers present, implement, expand, and categorize science activities within the preschool classroom by observing preschool teachers working with 3- to 5-year-old children. Due to the current lack of research on science practices within preschools directly, the goal was to explore what, if any, science practices were taking place in typical preschool classrooms and whether or not teachers recognized both planned and spontaneous science taking place within their classrooms. Additionally, teachers own perception of science in preschool and their self-efficacy in teaching science were investigated. Finally, a science materials checklist was created to assess the quantity and quality of each classroom’s indoor and outdoor science environments.

Participants

The participants of this study were at least 18 years of age or older and were employed as a lead (or co-lead) preschool teacher from local preschools in Los Angeles, California. Assistant teachers were excluded from the study. Eight female teachers ($N = 8$) from four different preschools ($N = 4$) participated in the study. All teachers ($N = 8$) served in the capacity of lead teacher and ranged in age from 27- to 55-years-old ($M = 36.625$). Table 3.1 describes the characteristics of each teacher. Overall, all teachers were well experienced, with their professional lives in early childhood ranging from 5 to 22 years ($M = 10.25$). The majority of the teachers ($n = 7$) had earned bachelor’s degrees but in a wide range of fields, such as journalism and acting, while one teacher was
working towards a Master’s Degree in Early Childhood Education. All eight teachers (N = 8) provided consent (Appendix A), were observed over the course of 1 or 2 days, and completed a demographic questionnaire (Appendix B), a science questionnaire (Appendix C) and a categorization forms (Appendix D).

Table 3.1

*Teacher Characteristics*

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Age</th>
<th>Level of Education &amp; Date of Completion</th>
<th>Years of Teaching Experience</th>
<th>Child Development Units/Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne</td>
<td>28</td>
<td>BA/BS 5 1982</td>
<td>5</td>
<td>California Community College CD courses: 1, 2, 3, 4, 10, 42, 38, 39</td>
</tr>
<tr>
<td>Angelina</td>
<td>29</td>
<td>Child &amp; Adolescent Development 2009</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Brenda</td>
<td>41-55</td>
<td>Liberal Studies 1982</td>
<td>22</td>
<td>CA Elementary School Credential</td>
</tr>
<tr>
<td>Bobbi</td>
<td>32</td>
<td>Family Consumer Science 2005</td>
<td>6</td>
<td>California Child Development Master Teacher Permit</td>
</tr>
<tr>
<td>Cathy</td>
<td>41-55</td>
<td>Media &amp; Educational Technology 1993</td>
<td>10</td>
<td>UCLA ECE Certificate (up to Director level)</td>
</tr>
<tr>
<td>Carrie</td>
<td>41-55</td>
<td>Education 1990</td>
<td>15</td>
<td>ECE classes up to Director level</td>
</tr>
<tr>
<td>Dot</td>
<td>26-40</td>
<td>Acting 1999</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Debbie</td>
<td>27</td>
<td>Journalism 2008</td>
<td>6</td>
<td>Child Development Certificate A, Associate Teacher, private preschool</td>
</tr>
</tbody>
</table>

Table 3.2

*Preschool Class Characteristics*

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Classroom</th>
<th>Class size</th>
<th>Age of Children in Years</th>
<th>Half or Full Day</th>
<th>Family SES/Cultural Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne</td>
<td>Apple Seed</td>
<td>20</td>
<td>2.5 to 4</td>
<td>Full</td>
<td>Low to high/Varied</td>
</tr>
<tr>
<td>Angelina</td>
<td>Apple Stem</td>
<td>24</td>
<td>4 to 5</td>
<td>Half</td>
<td>Low/Hispanic, Haitian, South African, Chinese, Filipino, Armenian, Caucasian</td>
</tr>
<tr>
<td>Brenda and Bobbi</td>
<td>Banana Peel</td>
<td>20</td>
<td>2.9 to 5</td>
<td>Both</td>
<td>Middle to high/Caucasian, African American, Asian, Hispanic</td>
</tr>
<tr>
<td>Cathy and Carrie</td>
<td>Coconut Milk</td>
<td>19</td>
<td>2.9 to 5</td>
<td>Both</td>
<td>Middle/Varied</td>
</tr>
<tr>
<td>Dot and Debbie</td>
<td>Dragon Fruit</td>
<td>13</td>
<td>3 to 4</td>
<td>Both</td>
<td>High to very high/Caucasian</td>
</tr>
</tbody>
</table>
Recruitment

Teachers were identified through a sample of convenience consisting of the researcher’s associates or acquaintances of personal contacts. A total of eight teachers participated in the study \(N = 8\). Initial recruitment began with local preschool directors from both state/federally funded and private preschools in the Los Angeles area. Prior to contacting participants, initial contact via phone and email was made with the director at each school to request permission to conduct the study at their center and for participant recommendations. Once approved, each director was emailed a California State University Northridge (CSUN) Off-Campus Institutional Approval letter (Appendix F) to sign and return. Once all letters were signed and returned to the researcher, days to visit each center to meet the teachers were scheduled.

On the day of the first visit, each teacher \(N = 8\) was asked to read and sign a consent form (Appendix A) describing the purpose of the study, procedures, time requirements, confidentiality, and right to withdraw. Once consent forms were signed, observations were scheduled. All teachers received a $10 gift card to Starbucks as a sign of appreciation for their contribution to the study.

Human Subjects

The protocol for the current study was submitted to the Standing Committee for the Protection of Human Subjects at California State University, Northridge on October 1, 2013. The researcher received notice of committee approval on December 23, 2013 (Appendix G).
This following section will begin with a description of each school \((N = 4)\) followed by a description of each classroom \((N = 5)\) with emphasis on each teacher that was observed \((N = 8)\).

**School Characteristics**

**Apple School:** Apple School is a non-profit preschool that has a state funded LAUP (Los Angeles Universal Preschool)\(^1\) classroom. The center serves children from birth up to 5-years-old. The school is located on the grounds of a city courthouse in a large facility with a small outdoor area. The school offers a full day program however, the LAUP class is only half day (3.5 hours). Two classes were observed, a 3- to 4-year old class that had 20 children in attendance and a LAUP class that had 24 4- to 5-year-old children enrolled.

**Banana School:** Banana School is a private, Catholic preschool serving children between the ages of 3- to 5-years-old. The preschool is located on the grounds of a private Catholic elementary school and encompasses one classroom and a small outdoor area. It is a mixed age program that offers both half and full day schedules and serves middle- to high-income families. There are 35 children currently enrolled with mixed backgrounds (Caucasian, African American, Asian, Hispanic).

**Coconut School:** Coconut School is private, developmental preschool that supports a play-based curriculum and serves children between the ages of 2.9- to 5-years-old. The preschool is located in a residential neighborhood in a single family style house with a large outdoor area. The program offers half and full day options and serves

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\(^1\) Los Angeles Universal Preschool is a non-profit organization whose mission is to provide access to high-quality preschool education to the children of Los Angeles County at free or low cost, regardless of income.
middle-income families from various cultural backgrounds. Currently, there are 19 children enrolled.

**Dragon Fruit School:** Dragon Fruit School is a private, developmental preschool and Kindergarten serving children between the ages of 2- to 6-years-old. The preschool is located in a residential neighborhood in a single family style house with an expansive outdoor area. The program offers four classes: toddler, preschool, pre-kindergarten, Kindergarten. The preschool is a half-day program with a full-day option while the Kindergarten program is full day and serves high- to very high-income families. The class observed contained thirteen 4-year-old children from mainly Caucasian backgrounds.

**Teacher Characteristics**

**Anne (Apple School):** Anne identified as a Hispanic, 28-year-old female with “some college.” She has been a preschool teacher for 5 years, worked at The Apple School for 7 years, and speaks Spanish and English. She completed eight child development courses (California community college child development courses 1, 2, 3, 4, 10, 42, 38, and 39). Anne currently works with 2- to 4-year-olds in a mixed-age class as a teacher in a full day program.

**Angelina (Apple School):** Angelina identified as a Hispanic, 29-year-old female with a Bachelor of Arts Degree in Child and Adolescent Development that was completed in 2009. She has been a preschool teacher for 2 years and has worked at The Apple School for 5 years. She currently works with 4- to 5-year-olds in a LAUP classroom (Los Angeles Universal Preschool) as a teacher in the morning and afternoon programs.
**Brenda (Banana School):** Brenda identified as a Caucasian female between the age of 41- to 55-years-old with a Bachelor of Arts Degree in Liberal Studies that was completed in 1982. She also has a California Elementary Teaching Credential. She has been a preschool teacher for 22 years and has worked at The Banana School for 22 years. Brenda currently works with 3- to 5-year-olds in a mixed age class as a lead teacher in the morning program.

**Bobbi (Banana School):** Bobbi identified as a 32-year-old Caucasian and Chilean female with a Bachelor’s Degree in Family Science that was completed in 2005. She is currently working towards her Master’s Degree in Early Childhood Education and has a California Child Development Master Teacher Permit. She has been a preschool teacher for 6 years and has worked at The Banana School for 6 years. Bobbi currently works with 3- to 5-year-olds in a mixed age class as a co-teacher in the morning and as the lead teacher during the afternoon session (11:30 am to 3:00 pm).

**Cathy (Coconut School):** Cathy identified herself Caucasian female between the age of 41- to 55-years-old with a Master’s Degree in Media and Educational Technology that was completed in 1993. She has been a preschool teacher for 10 years and has worked at The Coconut School for 7 years. She has completed the UCLA Early

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2 “A Child Development Master Teacher Permit authorizes the holder to provide service in the care, development, and instruction of children in a child care and development program, and supervise a CDP Teacher, CDP Associate Teacher, CDP Assistant, and an aide. The permit also authorizes the holder to serve as a coordinator of curriculum and staff development in a child care and development program” (California Commission on Teacher Credentialing, 2013).
Childhood Education Certificate up to the Director Level. She currently works with 3- to 5-year-olds in a mixed age class as a co-teacher in the morning and afternoon programs.

**Carrie (Coconut School):** Carrie identified as a Caucasian female between the ages of 41- to 55-years-old with a Master’s Degree in Education that was completed in 1991. She has been a preschool teacher for 15 years and has worked at The Coconut School for 7 years. She has completed all Child Development classes needed to become a Director. Carrie currently works with 3- to 5-year-olds in a mixed age class as a co-teacher in the morning and in the afternoon program.

**Dot (Dragon Fruit School):** Dot identified as a Caucasian female between the ages of 26- to 40-years-old with a Bachelor of Fine Arts Degree in Acting that was completed in 1999. She has not taken any Child Development Classes. She has been a preschool teacher for 13 years and has worked at The Dragon Fruit School for 13 years. Dot currently works with 3- to 4-year-olds as a co-teacher in the morning program.

**Debbie (Dragon Fruit School):** Debbie identified as a 27-year-old Caucasian female with a Bachelor of Arts Degree in Journalism that was completed in 2008. Additionally, she completed Los Angeles Valley Community College’s Child Development Certificate A, (Associate Teacher, private preschool). She has been a preschool teacher for 6 years and has worked at The Dragon Fruit School for 6 years. Debbie currently works with 3- to 4-year-olds as a co-teacher in the morning program.

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3 “This certificate meets the educational requirements (12 units) for a Preschool Teacher as defined in Title 22. This certificate prepares the student to teach preschool in the private sector” (Los Angeles Valley College, 2014).
Procedure

Observations

The original design called for eight preschool teachers (two teachers from each preschool) to be observed over the course of 2 days (4 hours a day/8 hours total). However, due to illness, three participants \((n = 3)\) were only available for 1 day/4 hours of observation. Therefore, to account for this inconsistency, the research presented will only focus on 1 day (4 hours total) of observations per teacher. Seven participants \((n = 7)\) were observed during the morning session (8:30 am to 12:30 pm) while one participant \((n = 1)\) was observed during an afternoon session (11:00 am to 3:00 pm). During each observation, the researcher maintained a running record of classroom activities and discussions while teachers went on with their day as normal. During circle/meeting times and science activities and/or discussions, the teacher’s interactions were audiotaped using the researcher’s cellular phone. All participants \((N = 8)\) agreed to be audiotaped.

On the first day of each observation, the researcher arrived 30 minutes prior to the beginning of the school day to assess the indoor and outdoor environments using a science materials checklist (Appendix E). The checklist included items such as a science center, magnifying glasses, sand and water tables, and natural items such as seashells and feathers, etc. During the observation, the researcher remained within audible range of the teacher and documented the day’s activities and discussions using a running record of notes and audio recorder during meeting times and science-related activities.

At the end of each day of observations, each participant was given a demographic questionnaire (Appendix B) and a teacher categorization form (Appendix D) to be completed that day. The demographic questionnaire included information such as gender.
and age as well as educational level and professional background. The teacher categorization form included four columns (math, art, science, language and literacy) for the participant to catalog the day’s classroom activities into one (or more) of the four categories. In order to provide each teacher with enough time to complete each survey, the demographic questionnaire and categorization form were collected the following morning (day 2) and each teacher was then given a science questionnaire (Appendix C). The science questionnaire included questions regarding knowledge and perception of science and typical science activities offered to the children. The science questionnaire was collected the following morning (day 3). All surveys were explained to the participants and any questions they had were answered.

STUDY PROCEDURE DAILY SUMMARY (days were sequential per teacher):

DAY 1:
1. Researcher observed and completed detailed field notes for 4 hours and science materials checklist (Appendix E).
2. At end of observation, teacher was asked to complete the teacher categorization (Appendix D) form and demographic questionnaire (Appendix B).

DAY 2:
1. Researcher returned to school to collect completed surveys from Day 1.
2. Teacher was asked to complete science questionnaire (Appendix C).

DAY 3:
1. Researcher collected completed survey from Day 2.

4 The science questionnaire was given to each teacher after observations were complete (day 2) to ensure the teachers did not have prior knowledge that science was the focus of the research.
Table 3.3

Instrument Descriptions

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
<th>Examples of Content</th>
<th>Author</th>
<th>Appendix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>Written running record and audio recordings of teacher interactions for 4 consecutive hours per teacher</td>
<td>Circle time discussions Curricular activities Science activities</td>
<td>Researcher</td>
<td>N/A</td>
</tr>
<tr>
<td>Demographic Questionnaire</td>
<td>Demographic information</td>
<td>Age, ethnicity, experience, education</td>
<td>Teachers ($N = 8$)</td>
<td>B</td>
</tr>
<tr>
<td>Science Questionnaire</td>
<td>Questions related to perception of science and self-efficacy in teaching science</td>
<td>12 question Likert scale and short answers</td>
<td>Teachers ($N = 8$)</td>
<td>C</td>
</tr>
<tr>
<td>Teacher Categorization Form</td>
<td>Categorize day’s activities</td>
<td>Categories: Math, science, language/literacy, art</td>
<td>Teachers ($N = 8$)</td>
<td>D</td>
</tr>
<tr>
<td>Science Materials Checklist</td>
<td>Checklist of science materials accessible to children</td>
<td>Science center Seashells Outdoor garden Balance Scale Test tubes</td>
<td>Researcher</td>
<td>E</td>
</tr>
</tbody>
</table>

All identifiable information that was collected (such as teacher’s names) was removed and replaced with a two-digit letter/number code (e.g. A1, A2, B1, B2, C1, C2, D1, D2) to represent each participant and their place of employment (A1 and A2 worked at School A, B1 and B2 worked at School B, etc.). Subject confidentiality was maintained by storing the paper consent forms (identifiable data) in a locked file cabinet drawer in the researcher’s home office. All paper questionnaires and surveys were stored in a locked desk drawer in the researcher’s home office. In addition, the audio recordings and the linking list (identifiable data) were stored on a password protected external hard drive in the researcher’s home office. Transcripts of audio recordings and written analysis (de-identifiable data) were stored on researcher’s password protected laptop in the researcher’s home office. Only the researcher and her faculty advisors (thesis committee)
had access to the identifiable data. All collected data will be maintained for 1 year after the conclusion of the study and then destroyed by the researcher.

**Instruments**

As noted in the procedure, five different instruments were used (see Table 3.3):

- **Researcher observation notes**: Written notes tracking teacher interactions and activities occurring in the classroom during the day in addition to audio recordings of circle/meeting times and science-related activities and discussions.
- **Demographic Survey (Appendix B)**: To collect information on the teacher’s educational and professional background.
- **Science Questionnaire (Appendix C)**: Specific questions regarding teacher’s knowledge and perception of science, efficacy in teaching science, and typical science activities offered within the classroom.
- **Teacher Categorization Form (Appendix D)**: Teachers were asked to categorize curricular activities that their class participated in on the day of the observations.
- **Science Materials Checklist (Appendix E)**: Checklist containing items typically used in science activities (completed by researcher).

**Demographic Questionnaire**

To better understand the background of each teacher, the demographic questionnaire (Appendix B) included questions regarding the teacher’s age range (25 or younger, 26-40, 41-55, 56+, and exact age), gender (male or female), cultural background, first language, and other languages spoken. To gain insight into their educational and professional experience, additional questions focused on the teachers’ educational and professional backgrounds and included:
1. What is the highest level of education you have completed? High School, Some College, Bachelor’s Degree, Master’s Degree.
   a. If you have a BA, what was your major and year of graduation?
   b. If you have a MA, what was your focus of study and year of graduation?
2. What child development/early childhood education classes have you completed?
3. How long have you been a preschool teacher?
4. How long have you been employed at your current center?
5. What age are you currently working with?
6. What other age groups have you worked with in the past?

Finally, to better understand each teacher’s classroom population, questions were included that focused on the demographics of the population of children and families in their classrooms and included:

1. What age group are you currently working with?
   a. Please list the ages, class size, and background of the children.
2. Is this a full day or half-day program?
3. How would you characterize the families of your children?
   a. Poverty or below, low income, middle income, high to very high income

**Teacher Categorization Form**

The teacher categorization form (Appendix D) was provided to better understand how teachers categorize classroom activities and discussions and whether or not science was being overlooked or miscategorized. Instructions listed along the top of the chart stated:
Looking back at the morning… What activities engaged the children? Please write down each of the activities your class participated in today in one or more curricular categories. For example, if the class did an art project, note that specific project in the ‘ART’ column (e.g. ‘Painted with watercolors on paper.’).

Directly underneath the instructions were four columns titled: Math, Art, Science, and Language and Literacy.

**Science Questionnaire**

In order to uncover the teachers’ knowledge and perception of science in preschool in addition to their own self-efficacy in teaching science, the science questionnaire (Appendix C) included a five-level Likert Scale (strongly disagree, mildly disagree, neutral, mildly agree, strongly agree) and six short answer questions.

Instructions listed above the Likert Scale stated, “Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters.” The 12 statements listed on the Likert Scale are as follows:

1. I am comfortable planning and explaining science-related activities to my preschool class.
2. Science should be taught in preschool.
3. It is important for my preschool class to have a science center that the children can freely explore.
4. There is not enough time to teach science because I have to focus on other areas such as language and literacy and math.
5. Preparing science activities takes too much time.
6. It is not age appropriate for science to be introduced in preschool.
7. I do not have enough education in science to teach science.

8. I get ideas for science activities from the Internet.

9. Science only occurs in the science center.

10. I am worried that the children will ask me a question about science that I cannot answer.

11. I do not have enough science materials in my classroom.

12. Science activities require too many materials.

In order to better understand the participant’s process of developing and incorporating science curriculum in their classrooms as well as any professional development experience they may have had, six questions and sub questions were listed in the short answer section of the questionnaire and included:

1. Reflecting on the Child Development classes you have taken, please answer the following questions:
   a. Do you remember learning about science in preschool from your Child Development classes? If so, what class and can you share a few things you learned?
   b. Were you given strategies to help implement science activities in your preschool classroom? If so, what were some of the ideas discussed?

2. How often are science-related activities offered to the children in your classroom?


4. How important do you feel preschool science activities are for preschoolers? Why?
5. To what extent do you initiate the science learning in your class? To what extent do the children initiate the science learning?

6. Do you participate in professional development opportunities (e.g. workshops, trainings)? If so, will you please list a few workshops that you have attended within the last year?
   a. What do you find the most useful as a workshop participant?

Science Materials Checklist

To gage the indoor and outdoor classroom science environments, a science materials checklist (Appendix E) was created and included the following items: science center, tools for observation and measurement (goggles, test tubes, eyedroppers, funnels, magnets, balance scale, magnifying glass, mirrors, binoculars, tweezers, prisms, 3-D shapes, rulers, measuring tape, thermometer, tactile items [sand/flour/goop], tools to investigate [spoons/scoops/funnels/forks/tongs], measuring cups, cookie sheets, muffin tins/egg cartons), natural items (organic materials such as shells, pinecones, rocks, feathers, leaves, fossils, plants, animals, water/sand table, outdoor garden), and reference materials (clipboards, paper, pencils/pens, science-related books and magazines, maps, globes).

Data Management

All audio recordings taken during the observations were replayed and transcribed by the researcher one by one. In addition, all questionnaires were reviewed and coded by the researcher and reviewed by the chair of this MA thesis committee. All observational

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5 Only items out in the open and accessible to the children were included on the checklist. Any science-related items that were behind closed cabinets or in closed closets were not included.
notes and audio transcriptions along with the checklist and questionnaires were studied to
uncover any prevalent themes within each of the participant’s answers separately and
within the teachers as a group and schools as a group. In Chapter Four, each theme will
be described within each group of participants as it relates to the study’s purpose.
Chapter Five will then discuss the overall findings and interpretations of the data.
CHAPTER FOUR

RESULTS

Introduction

The proposed study sought to explore the current state of science-based learning, activities, and materials found in typical preschool classrooms by considering the following four questions:

1. What is the prevalence and quality of science activities offered in typical preschool classrooms?

2. Do teachers recognize planned and spontaneous science unfolding within their classrooms?

3. What are teachers’ perceptions of science in preschool and what are their feelings of efficacy in teaching science? Are these self-reported responses reflected in the classroom?

4. Does the classroom have a science center and/or science materials available and accessible to the children?

Eight preschool teachers ($N = 8$) from four different preschools participated in this study. While the study was designed to observe two participants from each preschool for 2 days (4 hours per day/8 hours total), due to illness, three participants ($n = 3$) were only available for 1 day of observations (4 hours total). Therefore, for consistency, only the first day of observations for each teacher will be included in the study.

While all aspects of the day were observed and data was collected on all activities (e.g. art, language and literacy, math, science) through observational notes, audio recordings, and teacher categorization forms, data related to science activities are the
primary focus of the results. As noted in Chapter Three, there were five different
instruments used:

- Researcher observation notes
- Demographic Survey (Appendix B) – To collect information on the subject’s
  educational and professional background.
- Science Questionnaire (Appendix C) – Specific questions regarding subject’s
  knowledge and perception of science, their self-efficacy in teaching science, and
  typical science activities offered within the classroom.
- Teacher Categorization Form (Appendix D) – Each teacher categorized the
  curricular activities that their class participated in on the day of the observations.
- Science Materials Checklist (Appendix E) – Checklist containing items typically
  used in science activities and found in science centers/areas.

This chapter will begin with a description of each school (\(N = 4\)) followed by a
description of each classroom observed (\(N = 5\)) with emphasis on each teacher that was
observed (\(N = 8\)). Each teacher’s science-related conversations and activities that
occurred during the observation were transcribed and documented (following the
chronological flow of the day). The results of the researcher’s observations compared to
each teacher’s categorization form will provide insight into the curricular focus of the
class, the presence, amount, and depth of the science activities provided, whether or not
each teacher recognized planned and spontaneous science unfolding throughout the day,
and if scientific inquiry was encouraged. The results of the science questionnaire will
reveal each teacher’s perception of science in preschool and their self-efficacy in teaching
science and will be compared to the researcher’s observation notes to uncover whether or not these ideas were reflected within the classroom.

**Apple School**

The Apple School is a non-profit preschool that serves children from birth to 5-years-old and has one LAUP (Los Angeles Universal Preschool) classroom. The school is located on the grounds of a city courthouse in a large facility with a small outdoor area. The school offers a full day program, however, the LAUP classroom is only half day (3.5 hours). Two classes were observed, a 3- to 4-year old class that had 20 children in attendance and the LAUP class that had 24 4- to 5-year-old children enrolled.

**Apple Seed Classroom**

The Apple Seed class is full day program (8:00 am to 5:00 pm) and serves 3- to 4-year-old children. On the day of observation, there were 20 children in attendance from varying cultural and socioeconomic backgrounds with one lead and two assistant teachers in the classroom.

**Environment.** Results of the science materials checklist (Appendix E) showed that the classroom had a designated science center (one 3-level bookshelf with a posted sign “Science/Math Center”) that included the following items from the Tools for Observation and Measurement category: A balance scale, sorting games, bingo games, puzzles, and plastic bins filled with various manipulatives (magnets [ABC and paddle shaped]), small plastic cubes, plastic small spiders, plastic fence shaped pieces, plastic farm animals, various plastic play dough tools (rolling pins, cookie cutters, utensils), and plastic lacing letters. On the back of a bookshelf facing the science center was an “All About Igloos!” handmade poster that included photos of igloos with small captions
including: “Definition of Igloo,” “Inuit Homes,” “The Inuit,” and “How Does An Igloo Stay Warm?” (Figure 4.1). Additionally, in the middle of the classroom was a large structure resembling an igloo made from plastic milk bottles that were provided by the families in the program (Figure 4.2). The “igloo” was large enough for the children to crawl into and had a few pillows inside for the children to sit on. According to Anne (the lead teacher), the teachers assembled the igloo. From the Reference Materials category, there were various science-related books in the classroom library.

Under the Natural Items category from the science materials checklist (Appendix E), the classroom had one plant in the children’s bathroom, a small Ziploc of seashells on top of a napkin holder next to the in-classroom sink, and a goldfish in an aquarium. Outside, was a sandbox with shovels, buckets, and molds that was large enough to hold many children (Figure 4.3). Additionally, there were flower beds/planters around the perimeter of half of the outside yard yet the majority of the outdoor area was cement and rubber.
Apple Seed Teacher – Anne

Anne identified herself as a Hispanic, 28-year-old female that has completed “some college.” She has been a preschool teacher for 5 years, has been employed at this center for 7 years, and speaks Spanish and English. She completed eight Child Development classes but does not have a bachelor’s degree. Anne currently works with 2- to 4-year-olds in a mixed age class as a teacher in a full day program alongside two assistant teachers.

Observation. The theme of the month was “Dr. Seuss” and the theme of day was “crazy hat day” so the teachers and children wore different types of hats. Breakfast was followed by a 20 minute long circle time that included a good morning song, updating the calendar, and weather. Circle time was followed by 30 minutes of outside free choice time and 30 minutes of inside free choice time that included story time, an art project, a table with tile magnets and sorting bears, and a table with animal figures and fencing.
The children returned to the outside yard for a second free choice time that included a table with pipe shaped manipulatives, access to the sandbox, and an additional story time.

*Circle time.* To determine the weather, Anne asked one of the assistant teachers to explain the day’s weather. The assistant answered, “It’s foggy, you will need to wear your sweaters.”

*Outside free choice time.* The teachers placed interlocking manipulatives on one table and crayons and paper on another table. The outdoor sandbox was covered with a tarp thereby rendering it inaccessible to the children. The teachers also provided large, plastic rectangular blocks for the children to use. The “Addams Family” soundtrack was playing on the outdoor CD player.

The majority of the children worked with the large, plastic blocks and lined them up to surround the perimeter of a small outdoor carpet. The children and Anne pretended to have a dance party inside the perimeter of blocks. Two children sat at the art table and colored with crayons while none of the children played with the manipulatives.

Following outside free choice time, the children returned to the classroom.

*Inside free choice time.* After returning to the classroom, a parent was waiting to read the children a book. While the parent read the book, the teachers set up the following activities at tables throughout the room:

Table 1: Shredded tissue paper, glue, pipe cleaners, and sheets of green paper.

Table 2: A pile of plastic farm animals and fence shaped manipulatives.

Table 3: Tile magnets (colored transparent plastic, geometric shaped magnets) and small plastic bears.
Table 3: Tile magnets and bears (Figure 4.4). Three boys and one girl were building a 3-D square shaped structure with the tile magnets:

Anne: “Are you building a castle? Will you sing “Let It Go?””

One boy left the table while the remaining children continued to build.

Anne: “What are you building? Mary made a square with two triangles. That’s a great idea.”

Anne showed the children at the table how to make a square using two triangles.

Anne: “Can someone build a house for my little yellow bear?”

The children began to sort the bears according to color with Anne.

Anne: “Let’s put red bears over here.”

Child 1: “In a line?”

Anne: “Okay in a line.”

Child 2: “Let’s make a big line!”

Anne: “A big line? Starting here?”

Anne added bears to the line the children created. Two other children at the table made 3-D structures (such as rectangles and squares) with the magnets while the other children lined up the bears. Anne noticed one child using triangle shaped magnets to create a large circle:

Anne: “Can I have a slice of pizza? What did you put on your pizza?”

The child did not respond. Anne switched her focus back to the children lining up bears.

Child 1: “Let’s make a train.”

Anne: “For bears?”

Child 2: “Yes.”
Anne: “Okay, show me how. I’ve never made a train. First we need to build the train.”

Child 3: “Sit them down and stand them up.”

The child tried to fit the bears into the structure they built (a 3-D square with an open top).

Anne: “How many do you think will fit in there? Let’s count.”

As they placed each bear in the structure, all the children counted out loud.

Children: “One, two, three, four, five, six, seven, eight.”

Anne: “Okay, eight will fit.”

Child: “Let’s put some like this.”

Anne: “Side to side?”

Child: “Yes.”

Anne: “Let’s connect the train to the boy’s castle.”

Two boys on other end of table made a 3-D square structure.

Anne: “How many [bears] fit into one square? Do you remember?”

Child: “Three.”

The child then showed Anne her 3-D triangle structure holding three bears. At that moment, another child smashed the castle.

Child: “Let’s make it even bigger! Touch the ceiling!”

Anne: “Do you think we have enough magnets?”

Child: “We do.”

Anne: “Look. Jack is already making it big. Wow, that’s going to be very tall.”

The children made a tower of 3-D squares stacked on top of one another and filled it
with the plastic bears. It eventually fell.

Anne: “Let’s build it first and then put bears in because the bears are too heavy and are breaking it.”

The children began rebuilding. Anne left the table and moved to Table 2 where three children were working with animal figures and fencing.

Figure 4.4. Apple Seed Classroom tile magnet and sorting bears activity on table in science area.

Table #2 – Animal figures and fencing. Three children were working at the table with Anne.

Anne: “Apes are very strong, so are chimpanzees.”
Child 1: “I was at a zoo and the chimps were chasing.”
Anne: “Was one scared or were they playing?”
Child 1: “They were screaming.”
Anne: “They were screaming? How did that sound?”
The child made a screaming sound to mimic the chimpanzee.
Anne: “Have you been to a zoo?”
Child 2: “No.”
Anne: “What about an aquarium?”

Child 2: “No.”

Anne added a set of plastic strawberries to the animal and fence figures.

Child 3: “I only eat ripe strawberries.”

Anne: “Oh, you only like ripe strawberries? That means they are ready to eat?”

The child did not respond. Anne picked up a polar bear figure.

Anne: “Let’s put the strawberries here so they come out to eat. Have you ever seen a polar bear?”

Children: “No.”

Anne: “They live out in the cold.”

A child noticed that the plastic polar bear had black marks on its body.

Child 1: “They need a bath.”

Anne: “How do we wash them? Who has soap?”

Child 2: “I do!”

Anne: “Okay I’ll pour water.”

A child left the table and walked to the sink to get water but Anne held up the strawberry basket and motioned for the child to return to the table.

Anne: “We have water here. We can use our imaginations. You can dry them.”

They played for approximately 2 more minutes and then it was clean up time.

*Outside free choice time.* During the second outside free choice time, the sandbox was open (see Figure 4.3). The assistant teachers placed a container of small, plastic, pipe shaped building manipulatives on an outside table. One child created a periscope out of the manipulatives and pretended to look through it while running around
the yard. Three other children worked in the sandbox. On the other side of the yard, Anne read a book to a group of children.

*Story time - dinosaur book.* Anne read a few pages of a book about dinosaurs to four children gathered on the steps of the climbing structure.

Anne: “What dinosaur was dangerous?”

Child 1: “T-Rex!”

Anne: “Let’s see if the T-Rex is the dangerous one on the next page. Nope, it was the Albertosaurus! There were other dangerous dinosaurs besides the T-Rex.”

Child 2: “Read another!”

Anne: “It’s time to clean up. We can read more about dinosaurs next time.”

Table 4.1

*Comparison of Researcher’s Observation Notes to Anne’s Categorization Form*

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Anne’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnets</td>
<td>Science</td>
</tr>
<tr>
<td>Plastic bears</td>
<td>Math</td>
</tr>
<tr>
<td>Animal Figures</td>
<td>Not listed</td>
</tr>
<tr>
<td>Dinosaur Book</td>
<td>Language and Literacy</td>
</tr>
<tr>
<td>Manipulatives (outside free choice time)</td>
<td>Not listed</td>
</tr>
<tr>
<td>Sandbox</td>
<td>Not listed</td>
</tr>
</tbody>
</table>
Science questionnaire results. Results from Anne’s science questionnaire (Appendix C) showed that she “strongly agreed” with the following statements:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.
- I get ideas for science activities from the Internet.
Anne “strongly disagreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- It is not age appropriate for science to be introduced in preschool.
- I do not have enough education in science to teach science.
- Science only occurs in the science center.

Anne selected “neutral” on the following two statements:

- I am worried that the children will ask me a question about science that I cannot answer.
- Science activities require too many materials.

Anne “strongly agreed” with:

- I do not have enough science materials in my classroom.

From the short answer portion of the science questionnaire, Anne reported that she learned about science in her child development classes with a focus on cooking and gardening. Strategies and/or ideas on implementing science gained from her classes included the use of books, nature, and cooking. Anne reported that she tries to offer a science activity at least once a day and gets ideas from books, conferences, the Internet, and other teachers.

Anne reported that science “is very important in preschool” because “children learn through exploration and science opens that avenue for young children.” She also noted that science crosses into other domains of learning such as “language, math, and social skills.”
Apple Stem Classroom

The Apple Stem class is a state funded LAUP (Los Angeles Universal Preschool) half-day (8:00 am to 12:00 pm) program and serves 4- to 5-year-old children. On the day of observation, there were 24 children in attendance from varying cultural and socioeconomic backgrounds with one lead and two assistant teachers in the classroom.

Results of the science materials checklist (Appendix E) showed that the classroom had a designated science center that included the following items from the Tools for Observation and Measurement category: Two balance scales, five small magnifying glasses, four 3-D cylinders containing colored liquid, a microscope (electronic, plastic with slides of small insects), a wall mounted thermometer, sorting trays, a color wheel, a large mold/set of teeth and gums, and a large toothbrush (Figure 4.6). On the walls surrounding the science center were an insect poster, a recycling poster, a four seasons poster, and a color-mixing poster made by the class (Figure 4.7). Mirrors and measuring tapes were found in the dramatic play area. From the Reference Materials category, there was a globe in the science area and various science-related books in the classroom library.

Figure 4.6. Apple Stem classroom science center.
A shelf on the perimeter of the science center held 36 plastic bins filled with various items including: wild animal figures, farm animal figures, insects and spider figures, ocean animals, sink and float items, magnetic fishing set, counting and linking beads, scoop and play fishing set, sea shell collection, magnetic wands, various small blocks, peg boards, and dominos (Figure 4.8).
Under the category of Natural Items from the science materials checklist (Appendix E), the classroom had one plant, one large seashell, and a fish tank with two goldfish in the science area. Outside, there was an in-ground sandbox with shovels, buckets, and molds that was large enough to hold many children (Figure 4.3). Additionally, there were flower beds/planters around the perimeter of half of the outside yard yet the majority of the outdoor area was cement and rubber.

**Apple Stem Teacher – Angelina**

Angelina is a 29-year-old female with a Bachelor of Arts Degree in Child and Adolescent Development that was completed in 2009. She has been a preschool teacher for 2 years and has been at this center for 5 years. Angelina is bilingual (Spanish/English speaking) and currently works with 4- to 5-year-olds in a LAUP classroom (Los Angeles Universal Preschool) as a teacher in the morning and afternoon programs.

**Observation.** The theme of the month was “Dr. Seuss” and the theme of the day was “crazy sock day” so the teachers and children wore different types of socks. Breakfast was followed by a 20 minute long circle time that included a good morning song, calendar, dancing to prerecorded music, and a discussion about the different types of socks the children and teachers wore to school. Circle was followed by a 1 hour and 40 minute long inside free choice time and then 40 minutes of outside free time.

**Circle time:** During circle time, the teachers and children discussed the different types of socks the children wore to school:

Angelina: “I see that all my friends have on their crazy socks today! I like the ones with patterns on them. These [referring to her own socks] have a pattern of purple and black.”
Child 1: “These are white!”
Child 2: “I have socks with patterns with little tiny circles!”
Angelina: “She has socks with little tiny circles! Why did you decide to wear pink socks?”
Child 3: “Because they don’t have a pattern.”
Angelina: [Speaking to another child] “Are your socks solid or do they have a pattern?”
Child 4: “Green, blue, green, blue.”
Angelina: “So they have a pattern?”
Child 4: “They have a pattern!”
Child 5: “I’m allergic to the sun.”
Angelina: “What?”
Child 5: “It burns my eyes.”
Angelina: “Do you think you are allergic or are your eyes sensitive to the sun?”
Child 5: “I want to stay inside because the sun is too bright for my eyes.”
Angelina: “Okay, you can stay inside.”

Inside free choice time. During inside free choice time, the children freely explored the various centers within the classroom (science, art, dramatic play, reading, block area). The following activities were set up for the children:

Art Center: Making “silly socks” which included precut paper sock shapes, stickers, jewels, markers, glitter glue, and spotty dotty paints.

Block Area: Various Lego pieces placed on the table.
Science Center: Sensory table with sand, two yellow plastic sifters, spatulas, and plastic shells with printed numbers (Figure 4.9).

Writing Center: Dry erase boards with stencils, markers, and erasers.

![Figure 4.9. Apple Stem classroom science center sensory table filled with sand, sifters, spatulas, and plastic numbered seashells.](image)

The majority of the children worked in the art area creating their socks. In the science area, four boys sifted sand and two boys chose to work with the Legos. There was one teacher in the art area, one in the reading area, and one in the writing center. Twenty-five minutes into free choice time, an assistant teacher moved into the science area/center because two boys began to argue over the sifters. The boys eventually left the science area leaving the center empty. Approximately 10 minutes later, a female student entered the science area and began to work.

Science center. While the child was working, she looked at the researcher and said, “I love science. I’m going to be a scientist!” The child then left the center to speak to Angelina who was in the art area.

Child 1: “I’m going to show her [researcher] that I’m a great scientist!”
Angelina: “You can do science in the art center also. But if you want to be a great scientist, you need to go to the science and math center.”

The child went back to the science area and the teacher remained in the art area. The child said to me, “I love science but nobody watches me do science. My mom and dad let me do experiments at home. Will you sit with me and watch me do science?” During this time, Angelina was in the art area, one assistant teacher was in the writing area, and the other assistant was sitting on the carpet while a few boys built a marble maze. After a few minutes, the child left the science center and moved to the art center to participate in the art project where Angelina was sitting.

Fifty minutes into free choice time, the Legos were put away and replaced with tile magnets and the sand table in the science area was closed and replaced with dominos. Two female students entered the science area to play with the dominos (Figure 4.10).

Angelina entered the science area shortly thereafter:

Angelina: “What are you going to do?”
Child 1: “Build something.”
Angelina: “What happens if you line them up? Sarah told me that I have to line them up but I want to make a pattern. Do you see my pattern? How do you know I’m making a pattern?”
Child 1: “Green, orange. I’m making a long one.”
Child 2: “Watch this teacher.”

The child set up a line of dominos and then hit one to knock the line down.

Angelina: “How did you do that?”
Child 2: “You push that at the end.”
Angelina:  “I’m trying to make a triangle. How do I make a triangle?”

Child 1:  “I made a square.”

Angelina:  “How many dominos did you need to make a square?”

Child 1 counted from one to twenty.

Angelina:  [Counts to fifteen] “It took 15 dominos to make a square.”

Angelina began to build a small structure with the dominos.

Angelina:  “First we need a foundation. Put them close together so others can be on top. Oh no, it fell! It’s time to clean up so that we can head outside to play!”

Figure 4.10. Dominos placed on table in Apple Stem classroom’s science center.

Outside free choice time. During outside free choice time, the sandbox was open and there were plastic, interlocking pipe shaped manipulatives placed on a table. Two girls were in the sandbox building volcanoes. The girls quietly worked together on the volcanoes, adding in sticks and leaves. Angelina and an assistant teacher were monitoring a group of boys that were running with the “guns” they had created from the
manipulatives. After 30 minutes, the children returned to the classroom for a final circle/music and movement time before leaving for the day.

Table 4.2

Comparison of Researcher’s Observation Notes to Angelina’s Categorization Form

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Angelina’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tile magnets</td>
<td>Math</td>
</tr>
<tr>
<td>Sock art project</td>
<td>Art and Science (color mixing)</td>
</tr>
<tr>
<td>Sock pattern discussion during circle time</td>
<td>Not listed</td>
</tr>
<tr>
<td>Dominos</td>
<td>Not listed</td>
</tr>
<tr>
<td>Sand table in science center</td>
<td>Not listed</td>
</tr>
<tr>
<td>Sandbox (outside)</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

Figure 4.11. Observation/categorization results. Angelina’s categorization of the day’s science-related activities.
**Science questionnaire.** Results from Angelina’s science questionnaire (Appendix C) showed that she “strongly agreed” with:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.
- I get ideas for science activities from the Internet.

Angelina “strongly disagreed” with the following statements:

- It is not age appropriate for science to be introduced in preschool.
- Science only occurs in the science center.
- I am worried that the children will ask me a question about science that I cannot answer.
- I do not have enough science materials in my classroom.
- Science activities require too many materials.

Angelina “mildly disagreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- I do not have enough education in science to teach science.

From the short answer portion of the science questionnaire (Appendix C), Angelina reported that she learned about science in her child development classes with a focus on cognitive development through “experiments and songs and games that are age
appropriate.” Strategies and/or ideas on implementing science gained from her classes included the importance of explaining materials to children and to “provide step by step directions.” She also noted that “science experiments are fun to do with preschool children [because] they learn about reactions when mixing different materials.” Angelina reported that she tries to offer a science-related activity two to three times per week and gets ideas from books, the Internet, collaborating with other teachers, conferences, and workshops.

Angelina reported that, “preschool science activities are very important because it gives children the opportunity to explore and think about what will happen in an experiment.” She also noted that some science activities are planned while others are “initiated by the children’s curiosity.”

**Banana School**

The Banana School is a private, co-op Catholic preschool that serves children between the ages of 3- to 5-years-old. The preschool is located on the grounds of a private Catholic elementary school and encompasses one classroom and a small outdoor area. The program is mixed age (all children are together in same class regardless of age), offers both half and full day schedules, and serves middle- to high-income families. There are 35 children currently enrolled from various backgrounds/ethnicities (Caucasian, African American, Asian, Hispanic). Both teachers observed work in the same classroom with a majority of the same children. Brenda is a lead in the morning (8:30 am to 11:30 am) and Bobbi is the lead teacher in the afternoon (11:30 am to 3:00 pm). While a few children are only there half of the day (either morning or afternoon), the majority of children stay the full day (8:30 am to 3:00 pm).
**Banana Peel Classroom**

The Banana Peel class is a half and full day (8:30 am to 12:00 pm and/or 12:00 pm to 3:00 pm) and serves 3- to 5-year-old children in one mixed age classroom. On the day of observation, there were 20 children in attendance from varying cultural and socioeconomic backgrounds with one lead teacher, one assistant teacher, and one parent volunteer in the classroom.

Results of the science materials checklist (Appendix E) showed that the classroom did not have a designated science center (there were no specific centers in this school). On a shelving unit within the classroom, there were open plastic bins holding different manipulatives including wood blocks (both colored and natural wood), square ABC blocks, Legos, and starbuilder blocks. However, many of the boxes were incorrectly marked; for example, one box was filled with starbuilder manipulatives yet the box was labeled as “interlocking squares” (with a photo of square blocks) while other bins had a mixture of blocks (e.g., a few Legos mixed in with wood blocks) (see Figure 4.12). None of the items listed in Tools for Observation and Measurement or category were noted.

![Figure 4.12. Banana Peel classroom’s block/manipulative shelf.](image)
Under the Natural Items category of the science materials checklist, the classroom had one plastic bin with seashells that was located on a large shelving unit (that was inaccessible to the children) and a vase with fresh flowers was placed next to the kitchen sink (see Figure 4.13). The outside area was small and fenced off from the rest of the elementary school’s playground. There were two sensory tables that were empty and a few potted plants near the entrance of the yard. Half of the outdoor area was grass and the other half was rubber (under a small outdoor structure and two plastic houses). From the Reference Materials category, there was a globe on the counter next to the sink and various science-related books in the classroom library.
**Banana Peel Teacher – Brenda (morning lead teacher)**

Brenda identified herself as a Caucasian female between the age of 41 to 55 with a Bachelor of Arts Degree in Liberal Studies that was completed in 1982. She has been a preschool teacher for 22 years and has been employed at this center for 22 years. She has a California Elementary Teaching Credential and reported taking “a lot” of child development classes but did not specify which classes she completed. Brenda currently works with 3- to 5-year-olds in a mixed age class as a lead teacher during the morning session (8:30 am to 11:30 am).

**Observation.** The day began with inside free choice time followed by circle time that included a discussion about snow and words that begin with the letter “S,” a review of each letter in the alphabet and words that begin with each letter, a review of classroom rules, a prayer, a few songs, and calendar. After circle time, the children participated in a paper snowman precut craft followed by snack, story time, and music and movement. The children then worked on letter “S” worksheets before heading outside. After 30 minutes outside, the children returned to the classroom for inside time. Total time inside: 3 hours; total time outside: 30 minutes.

**Inside time.** The director of the program brought in a cooler with snow that she had formed into a small snowman. While the children worked at the various tables, the snowman was brought around for the children to see but they were not allowed to touch it. The snowman was only out of the cooler for a few minutes at a time because the director did not want it to melt. The following activities were set up for the children:

**Table 1:** I Spy preschool puzzles

**Table 2:** Crayons, scissors, shape tracers, glue sticks
Table 3: Lincoln logs

Table 2 (crayons, scissors, shape tracers, glue sticks). Five children worked at the table while Brenda watched.

Brenda: “We’re doing shapes at circle time.”
Child 1: “I made a rectangle.”
Brenda: “How many sides?”
Child 1: “Three.”
Brenda: “No, four. Write your name and print it as neatly as possible.”

The director approached the table with the small snowman on a Styrofoam plate. Water had pooled around the base of the snowman and collected on the plate.

Brenda: “Do you see snow? What’s he turning into?”
Child 1: “Water.”
Brenda: “This used to be snow, what is it now?”
Child 2: “Water.”
Brenda: “He’s melting! When it’s hot, we all start to melt in preschool. Did the snowman melt in Frozen [the movie]?”
Child 2: “Yes.”
Brenda: “Like Frosty the Snowman? Did he come back to life?”

None of the children answered Brenda’s question.

Brenda: “Line up everyone, it’s potty time.”

Circle time. The children sat on a rug in a circle and Brenda sat on a chair. A smart board was on the wall in front of the children. Brenda had the cooler next to her that housed the snowman. Circle time lasted 30 minutes.
Brenda: “Who can tell me what’s in this white box right here [pointing to the cooler]?”

Child 1: “Snow.”

Brenda: “It is snow. What did we, I mean Miss Bee [the director], make? A snowman! And what does snowman start with?”

Children: “S!”

Brenda: “What is this?”

Brenda held up a small Ziploc that contained water.

Children: “Water!”

Brenda: “What did this used to be?”

Child 2: “A lake?”

Brenda: “No, not a lake! How could I fit a lake in a bag?”

Child 3: “Water!”

Brenda: “Yes, we already said water. I asked what it was before it was water.”

There were no more answers given.

Brenda: “It was snow! It melted into water. Just like Olaf from Frozen melted. Why would the snowman start to melt?”

Child 2: “Because it’s summer.”

Brenda: “It’s not summer. It’s because it’s not cold enough here in our classroom.”

Brenda asked the children to come up with words that began with the letter s and she wrote the words they listed on the smart board:

Brenda: “What letter is this?”
Children: “S!”

Brenda: “Make the s sound. What is a word that begins with s? Raise your hand.”

Child 1: “Saturn!”

Brenda: “What is Saturn?”

Child 1: “A planet in space. And it has a lot of rings.”

Brenda: “What did we bring in today?”

Child 2: “Snowman.”

Brenda: “Right, Olaf [name of snowman in the movie Frozen]!”

Child 3: “Scorpion!”

Brenda: “A scorpion is a nasty spider. It’s very lethal.”

An assistant teacher entered the circle to read a story to the children. The circle time rug had many imprinted designs such as letters of the alphabet and numbers in a large circle in the middle, squares with pictures of various items such as shapes and animals along the border, and rulers on either side of the large center circle (Figure 4.14). While the assistant read, a child quietly counted the ticks on the ruler that were imprinted on the rug. Two boys next to her did the same and the children discussed numbers and measured their hands. Brenda noticed this and said, “What are you doing? Be quiet and listen to the story.” Brenda moved the children to different spaces on the rug.
Music and movement. After story time, Brenda played recorded music for the children to dance. Two boys were wearing paper crowns. While they were dancing, one of the boy’s crowns fell off and the crown disconnected/opened.

Child 1: “How did you do that?”

Child 2: “It’s broken.”

Child 1: “How did you do that?”

Child 2: “It’s a crocodile!”

The boy waved the opened paper crown around in the air mimicking a crocodile.

Brenda: “What are you doing? Put that away!”

Brenda took the crown from the boy and taped it back together to form a crown.
**Outside free play.** During outside free play, the children were given a light snack and allowed to play freely. Brenda and a child sat at one of the tables and noticed mud under the table.

Brenda: “It’s always muddy over here.”

Child 1: “We should get some seeds!”

Brenda: “Get some seeds?”

Brenda then walked away from the table.

After the children were finished with their snack, they placed their trash in an outside trashcan. On the trashcan, a line of ants crawled up the side and into the trashcan.

Brenda noticed a child who was watching the ants as they crawled.

Brenda: “See, that’s why we have ants. Spilled yogurt. We need to clean that up.”

Child 1: “What are the ants doing?”

Brenda: “They are crawling everywhere. Don’t touch them. Look up in the sky, do you see a blimp?”

The child looked away from the trashcan and up to the sky while a blimp passed overhead. Brenda walked away and the child resumed watching the ants until Brenda returned and removed the trashcan from the area. After outside time, the children returned to the classroom and waited for their parents to arrive.

Table 4.3

*Comparison of Researcher’s Observation Notes to Brenda’s Categorization Form*

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Brenda’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow and snowman</td>
<td>Science – “Snow, when it melts, water”</td>
</tr>
<tr>
<td>Saturn comment during circle time (s words)</td>
<td>Not listed</td>
</tr>
<tr>
<td>Snowman craft</td>
<td>Art and Science</td>
</tr>
<tr>
<td>Ants on trashcan</td>
<td>Not listed</td>
</tr>
<tr>
<td>Mud in yard</td>
<td>Not listed</td>
</tr>
</tbody>
</table>
Science questionnaire. Results of Brenda’s science questionnaire (Appendix C) showed that she “strongly agreed” with:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.

Brenda “mildly agreed” with the following statements:

- It is important for my preschool class to have a science center that the children can freely explore.
- Preparing science activities takes too much time.
• I get ideas for science activities from the Internet.

Brenda “strongly disagreed” with the following statements:

• There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
• It is not age appropriate for science to be introduced in preschool.
• I do not have enough science materials in my classroom.
• Science only occurs in the science center.
• I am worried that the children will ask me a question about science that I cannot answer.
• I do not have enough education in science to teach science.
• Science activities require too many materials.

From the short answer portion of the science questionnaire, Brenda reported that she did not recall learning about science in her child development classes. She noted that she tries to offer science-related activities “all the time – we try to incorporate science themes everyday in our classroom” and finds ideas for science activities from books, the Internet, and collaborating with other teachers.

Brenda reported that, “all subjects are important – but science activities introduced in preschool serves as the building blocks for future science activities as they age up. Sparks their interest, makes them comfortable with the subject.” She also noted that “Hands-on experiences work best, we try not to force learning on them, stick to topics they are interested in. We try to nurture the child’s sense of adventure and curiosity.”
Banana Peel Teacher – Bobbi (afternoon lead teacher)

Bobbi identified herself as a 32-year-old Caucasian and Chilean female with a Bachelor’s Degree in Family Science that was completed in 2005. She is currently working towards her Master’s Degree in Early Childhood Education and has a California Child Development Master Teacher Permit. She has been a preschool teacher for 6 years and has been employed at this center for 6 years. Brenda currently works with 3- to 5-year-olds in a mixed age class as a co-teacher in the morning and the lead teacher during the afternoon session (11:30 am to 3:00 pm).

Observation. The afternoon program began with inside free choice time followed by a 25 minute circle time that included stretching, work on the smart board (letter “S”), a 911 discussion (including a lesson on street addresses), and creating shapes with their bodies. After circle time, the children had lunch followed by art (strawberry crayon/watercolor resist), music and movement, worksheets (letter “S”), and outside free play. Total time inside: 3 hours; total outside time: 30 minutes.

Inside free choice time: Four tables were set up with the following activities:

Table 1: A random assortment of books
Table 2: Crayons and coloring pages
Table 3: Pattern blocks
Table 4: Sequencing cards

Pattern block table. Two children worked with the pattern blocks while Bobbi observed.

Bobbi: “What shape do you need?”
Child 1: “Three red ones. I need this kind of shape.”
The child pointed to an empty triangle shaped space.

Bobbi: “What kind of shape?”

Bobbi then turned around to talk to the assistant teacher.

Bobbi: “It’s circle time! Everybody head to your square on the carpet!”

*Circle time.* Towards the end of circle time, Bobbi asked the children to make shapes with their bodies. She gave them the terms circle, triangle, heart, and straight line.

Bobbi: “Let me see if you can make a circle. Now a triangle. A triangle has three edges.”

The children tried to create the shapes with their bodies.

Child 1: “Look at mine!”

Child 2: “I have a triangle!”

Bobbi: “Can you make a straight line, a slanty line?”

Child 2: “Straight line is easy, it’s like an attention stand!”

Bobbi: “Can you make a shape with your friends? How about a rectangle? Let’s all join hands and make a giant circle.”

Child 1: “Let’s hold hands!”

Bobbi: “Let’s stretch it and make an oval. Now let’s make it tiny tiny! Now let’s make a straight line!”

Child 2: “That’s easy!”

*Art (two tables).* Strawberry shaped pieces of white paper were given to each child. Black crayons and red watercolor were placed on each table. Bobbi had a plate of four trimmed strawberry halves (no leaves) that she showed each table. The children were not allowed to touch the strawberries and the plate was not placed on either table;
Bobbi held the plate for the duration of art time. The children were instructed to use the black crayons to make the seeds and then color over the paper with the red watercolor.

Following art time, the children had music and movement (to prerecorded music) and then worked on worksheets (letter “S” and a police car coloring sheet). After the worksheets were completed, the children went outside for 30 minutes of free play while waiting for their parents to pick them up.

Table 4.4

Comparison of Researcher’s Observation Notes to Bobbi’s Categorization Form

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Bobbi’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strawberry art project</td>
<td>Art and Science</td>
</tr>
<tr>
<td>Shapes with Bodies</td>
<td>Not listed</td>
</tr>
<tr>
<td>Pattern Blocks</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

Observation/Categorization Results:
Bobbi's Categorization of the Day's Science-Related Activities

Figure 4.16. Observation/categorization results. Bobbi’s categorization of the day’s science-related activities.
**Science questionnaire.** Results of Bobbi’s science questionnaire (Appendix C) showed that she “strongly agreed” with:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.

Bobbi “mildly agreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- I get ideas for science activities from the Internet.
- I do not have enough science materials in my classroom.

Bobbi “strongly disagreed” with the following statements:

- It is not age appropriate for science to be introduced in preschool.
- I do not have enough education in science to teach science.

Bobbi “mildly disagreed” with the following statements:

- Preparing science activities takes too much time.
- Science only occurs in the science center.
- I am worried that the children will ask me a question about science that I cannot answer.

Bobbi was “neutral” on the following statement:

- Science activities require too many materials.
On the short answer portion of the science questionnaire, Bobbi reported that she completed an early childhood education science curriculum class and that children learn science best when they can be “physically involved and hands-on.” Additionally, “it helps if it relates to their world and is in context with what is in their environment yet pushes just beyond what they can do (ZPD).”

Bobbi provided cooking and gardening as techniques to use to support science in the preschool classroom. Strategies and/or ideas on implementing science gained from her child development classes included:

1. Ask open-ended questions.
2. Make it meaningful.
3. Try experiments that may be a surprise to the teacher as well (e.g. “When will the seed sprout” versus “What kind of seed is this?”).
4. Relate it to their world.
5. It’s about the work in progress, not just the end result.

Bobbi reported that she tries to offer a science-related activity at least two times a week and “a true science experience once a month – for example a seed sprouts/garden we are in the middle of now.” She noted that she finds ideas for science activities from classes she has taken, books, the Internet “and mostly I build it around what the children are interested in.” Bobbi also reported:

Science is very important. It helps children build a mental map for later in life. If they know more about the world around them they can draw back on those experiences and generalize the information into other aspects of their life such as
math. Also science helps children think outside the box. It pushes them to think of more than one answer, which will help with problem solving.

Bobbi identified that 50% of the time, science in her classroom is teacher initiated and 50% of the time it is child initiated, “Sometimes I set out provocations for the children. For example, I set out seashells one day to see what they thought and/or knew about shells.”

**Coconut School**

The Coconut School is private, developmental preschool that supports a play-based curriculum and serves children between the ages of 2.9- to 5-years-old in a multi-aged environment. The preschool is located in a residential neighborhood in a single family style house with a large outdoor area. The program offers half and full day options (9:00 am to 12:00 pm or 9:00 am to 3:00 pm) and employs two lead teachers that co-teach the same group of multi-aged children. Therefore, both teachers observed work together in the same classroom with the same children. On Day 1, lead teacher Cathy was observed and on Day 2, lead teacher Carrie was observed.

**Coconut Milk Classroom**

The Coconut Milk class serves 19 children between the ages of 2.9-to 5-years-old with various cultural backgrounds from mainly middle-income families. Because the school’s building structure is a single-family house, each room houses a different center (blocks and dramatic play in one room, art in one room, library in one room, and science, math, and writing center in one room). On the first day of observations, there were 10 children in attendance and on the second day of observations, there were 13 children in attendance.
The outside area contained a climbing structure, a sand area with many sand toys (sifters, funnels, shovels, molds) and two sensory tables, an outdoor plastic structure and climbing blocks, a garden with raised planter boxes (which were empty on the days of observation), multiple trees, natural pathways, a grass area with various sized tree trunk logs, and numerous potted plants and bushes (Figure 4.17).

![Figure 4.17. Coconut School’s raised planter beds.](image)

Results of the science materials checklist (Appendix E) showed that the classroom had a designated science center (a 2-level bookshelf) that included the following items from the Tools for Observations and Measurement category: test tubes, a balance scale, magnifying glasses, mirrors, binoculars, bug catchers, various puzzles and cards (sequencing cards, five senses game, sea life puzzle), plastic sea creatures, and a few manipulatives (Figure 4.18, 4.19). From the Reference Materials category, there were science-related books and magazines and a globe on the shelf of the science center.
From the Natural Items category of the science materials checklist (Appendix E), hanging above the science center were real butterflies and insects pressed in glass (Figure 4.18). Additionally, within the science center there were seashells, a starfish, rocks, sticks, and a few caterpillars in a plastic container. The outside yard included a sand area filled with tree cookies and logs in different sizes, funnels, scoops, shovels, buckets, and molds, a sensory table, and many plants, flowers, and trees (Figure 4.20).
In the art center, 3-D diamond shaped glass figures and glass jars filled with black sand, rocks, leaves, and black pebbles were on a shelf that was accessible to the children (Figure 4.21). Additionally, the art center had many natural items such as seashells, leaves, dried flowers, and pinecones in baskets on shelves accessible to the children in addition to leaves pressed into contact paper on the windows of the art center and block center (Figure 4.21 and 4.22).
Figure 4.21. Coconut School’s art room with natural items (rocks, sand, seashells, pinecones, etc.).

Figure 4.22. Coconut School’s art room and block area windows with leaves pressed into contact paper.

Coconut Milk Teacher – Cathy

Cathy identified as a Caucasian female between 41- and 55-years-old with a Master’s Degree in Media and Educational Technology that was completed in 1993. She has been a preschool teacher for 10 years and has been at this center for 7 years and speaks English and Spanish. She completed the UCLA Early Childhood Education Certificate up to the Director Level. Cathy currently works with 3- to 5-year-olds in a mixed age class as a co-teacher in the morning and afternoon programs.
Observation. The day began with 1 hour and 30 minutes of outside free choice time while the children arrived. This was followed by a 20-minute circle time that included the days of the week song, updating the calendar, and a short book that the child of the day brought in to share with the class. Circle time was followed by snack and 45 minutes of inside free choice time.

Outside free choice time. After arriving at school, three boys and one girl found a caterpillar that they were watching in one of the planting beds. Cathy noticed the children’s observation:

Cathy: “Do you want to get the bug catchers?”
Child 1: “Yes, can I have one?”
Cathy: “Yes, there are two. You will have to share.”
Child 1: “Okay!”

One of the children ran inside to collect the bug catchers from the science center and returned to the other children outside.

Cathy: “This is how you open it. If you put a caterpillar in it be careful because you want to be gentle.”

The child gently picked up the caterpillar.

Child 1: “It’s spiny!”
Cathy: “It is spiny!”
Child 2: “It’s hurt!”
Cathy: “It’s not hurt. Be careful. Find another insect outside. Go see if you can catch one.”
Child 2: “There are pincher bugs!”
Cathy: “Maybe we should put them in it.”

The group of children observed and inspected the planter bed for approximately 10 minutes.

Child 3: “They are eating.”

Cathy: “How do you know the pincher bugs are eating the plants?”

Child 3: “I saw it.”

Child 2: “Can I see the caterpillar?”

Child 1: “See the spiny thing in there? It’s Mr. Caterpillar. We can’t touch him.”

Child 2: “Everybody come and look!”

Cathy: “Does anybody need a magnifying glass? Can you see it? Keep the bug catcher out of the sand.”

Child 1: “They don’t like sand.”

Cathy: “You think they don’t like sand? Then let’s decide to keep the bug catcher on the concrete.”

Child 1: “Guys come here! The caterpillar is making a cocoon!”

Child 2: “Wow!”

Child 3: “I think it’s eating.”

A group of six children gathered to look at the caterpillar in the bug catcher.

Child 1: “It has to find a strong and steady branch to build its cocoon.”

Child 2: “Or it is laying eggs.”

Child 1: “It’s not laying eggs.”

Cathy: “Where do you see it laying eggs?”

Another child with a second bug catcher approached Cathy and showed her that it was
Cathy: “Where do you think bugs will be?”

The child pointed to another planter and walked away with bug catcher. Cathy returned her attention to the children with the caterpillar.

Cathy: “Do you want to get new leaves for the caterpillar?”

Child 1: “Yes!”

Cathy: “You can pick some fresh leaves for caterpillar.”

Child 1: “I think it’s liking them. Let’s ask Cathy if we can add some sticks. It needs to be a strong stick. You know why? Because it needs to make its cocoon.”

Three children worked together to put leaves and flowers in the bug catcher.

Child 2: “It needs steps to get up right?”

Child 3: “We need more flowers.”

Child 1: “No more flowers.”

Child 3: “Yes, we need more!”

Child 1: “It’s making a cocoon.”

Cathy: “Be careful not to shake it around. Why is he so spiky?”

Child 3: “I don’t know.”

Child 2: “Because it has swords?”

Child 1: “So it can protect itself.”

Child 2: “So it can protect itself and scare other animals away!”

Cathy: “Where can you find another caterpillar?”

Child 2: “I don’t know.”
The children walked away and searched for more caterpillars. Another child walked up to Cathy with a watering can filled with water.

Cathy: “Will you water the flowers?”

Child 2: “Yes! They look sick.”

Cathy: “They need water, yes they look sick. Let’s see what happens later today after you water them.”

The child poured some water on the flowers.

Child 2: “It doesn’t look different.”

Cathy: “I think we need to give it more time.”

Child 2: “Look!” [pointing to flowers]

Cathy: “The water has to go all the way to the bottom to get into the roots.”

Child 2: “This one’s getting wet.”

Cathy: “Because you are giving it water.”

The boys with the caterpillar in the bug catcher approached, picked up the watering can, and poured water into the bug catcher.

Cathy: “Don’t pour water on the caterpillar. Do you know where caterpillars get water? From leaves.”

Child 1: “Really?”

Cathy: “Yes. How do plants get water?”

Child 2: “From roots.”

Child 3: “Butterflies get water from flowers!”
Cathy: “That’s right! Let’s find something to put in Lee’s bug catcher. Maybe a cricket? A caterpillar? Lee, look through [the bush] from the other side. See if you can find one.”

Child 4: “Where’s my caterpillar?”

Cathy: “You have to look because they don’t want to be found.”

The six children looked into the bushes with magnifying glasses.

Child 1: “Look! It’s a stink bug on a leaf!”

Child 3: “Let’s find the other bug catcher!”

The children placed the bug into the second bug catcher. Shortly after this, Cathy announced that it was time to line up for circle time. After circle time, the children washed their hands and sat down for snack.

**Inside: Snack time.** The children were given string cheese and crackers for snack.

Cathy: “Don’t eat your string cheese so fast!”

Child 1: “I’m a rocket! I’m fast!”

Cathy: “Rockets burn fuel slowly, so eat slowly.”

Child 2: “Rockets go to space.”

Snack time was followed by 45 minutes of inside free choice time.

*Speed skating.* In the art room, the teachers set up a speed skating track (tape was placed on the wood floors to define lanes in an oval shape). The children were given fluffy socks to wear so that they were able to slide along the floor as speed skaters in the Olympics. Cathy used her cellular phone to show the children a video of speed skating.
Three children slid around the track, and they all fell many times. One child was in the middle of the track giving direction:

Child 1: "Go faster! Faster! Mary, don’t slide on Lila’s track!"

Cathy: "I think they need more instruction. What is a strategy they can use?"

Child 1: "Don’t fall down!"

Cathy: "That’s a good strategy!"

While all of the other centers were open during this 45-minute period, none of the children visited the science center. The majority of the children played in the block area and the dramatic play area while five children tried speed skating.

Table 4.5

Comparison of Researcher’s Observation Notes to Cathy’s Categorization Form

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Cathy’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect Search and Bug Catchers</td>
<td>Science</td>
</tr>
<tr>
<td>Caterpillar Discussion (water, food)</td>
<td>Science</td>
</tr>
<tr>
<td>Creating Habitat for Stink Bug</td>
<td>Science</td>
</tr>
<tr>
<td>Watering the “sick” flowers</td>
<td>Not listed</td>
</tr>
<tr>
<td>Speed skating</td>
<td>Language and literacy</td>
</tr>
<tr>
<td>Rocket discussion at snack time</td>
<td>Not listed</td>
</tr>
</tbody>
</table>
Observation/Categorization Results: Cathy's Categorization of the Day's Science-Related Activities

Science questionnaire. Results from Cathy’s science questionnaire (Appendix C) showed that she “strongly agreed” with the following statements:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.

Cathy “mildly agreed” with the following statement:

- I get ideas for science activities from the Internet.
Cathy “strongly disagreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- It is not age appropriate for science to be introduced in preschool.
- I do not have enough education in science to teach science.
- Science only occurs in the science center.
- I am worried that the children will ask me a question about science that I cannot answer.
- I do not have enough science materials in my classroom.
- Science activities require too many materials.

From the short answer portion of the science questionnaire, Cathy reported that science was not discussed in her child development classes because “the focus on all the classes was literacy and math.” She also noted that her child development classes did not provide any strategies to help implement science and that “all of our school’s science topics and materials have come from our experience and knowledge.” Cathy stated that science activities are provided daily and that the children have unlimited access to the classroom science center. She noted that the children are especially fond of bug catchers, balance scales, and magnifying glasses. Cathy and her co-teacher collaborate on the curriculum as a whole and noted that:

We plan themes for our curriculum and then find ways to incorporate all aspects of learning (i.e. physical play, language development, math, art, and motor skill
development) not just science. The “why” and the “how” of the order of things is also discussed.

Cathy reported that science is very important in preschool because “it is a fact of life and part of their daily experience; it is naturally connected to all other aspects of learning.” She noted that half of the time, science in her classroom is teacher initiated and the other half of the time it is child initiated: “We will present ideas and concepts to the children and we will experiment. The children are also frequent initiators (unbeknownst to them) of the science learning. Scientific exploration and discovery are a natural consequence of their daily play.”

**Coconut Milk Teacher – Carrie**

Carrie identified as a Caucasian female between the age of 41- and 55-years-old with a Master’s Degree in Education that was completed in 1991. In addition, she has completed preschool administration and director classes. She has been a preschool teacher for 15 years, has worked at this center for 7 years, and currently works with 2.9- to 5-years olds in a mixed age class as a co-teacher in the morning and afternoon programs.

**Observation.** The day began with 1 hour and 30 minutes of outside free choice time while the children arrived. This was followed by a 20-minute circle time that included the days of the week song, updating the calendar, and a short book that the child of the day brought in to share with the class. Circle time was followed by snack and 45 minutes of inside free choice time.
**Outside free choice time.** A child held a bug catcher in one hand and a stick in the other while pretending to fish in the sandbox. Next to him was another child with a stick:

Child 1: “I got a catfish! Now I got a shark!”
Child 2: “We’re in the ocean.”
Child 1: “We are trying to catch a bug! It walks in and the door shuts!”

The child bent down and scooped sand into the bug catcher. Carrie observed the interaction.

Child 1: “They need sand in the bottom.”
Carrie: “How can a bug fit if there is so much sand?”
Child 1: “It goes in there [points to a spot that did not have any sand].”

Five additional children gathered around the child with the bug catcher (a total of six boys and one girl).

Child 2: “I want to catch a worm.”
Child 1: “Let’s look in the bushes!”
Child 3: “We’re the animal catchers!”
Child 1: “Yes, go animal catchers!”
Children: “Go animal catchers! Go animal rescuers!”
Child 4: “Where’s that bug we found last time?”

The children added leaves to the bug catcher until it was completely filled with sand and leaves.

Carrie: “It doesn’t look like there is much room for bugs in the bug catcher. How can you get that sand out? What do you think?”
The child banged the bug catcher on the ground and shook his head.

Child 1: “No.”

Carrie: “It didn’t work?”

Child 1: “No.”

Another child gathered rocks in a colander and walked around the yard offering to sell them to his peers.

Carrie: “I see you have many rocks. You can put them inside to use again or would you like to paint them?”

Child 5: “I don’t want to paint them.”

Carrie: “You like to keep them natural?”

Child 5: “Yes.”

Carrie: “Okay. If you want to keep one of the rocks, make sure to put it in your cubby.”

*Shaving cream table*. An outside table was set up with plastic placemats and piles of shaving cream. Seven boys sat down at the table with Carrie:

Child 1: “It’s sticky!”

Child 2: “It’s soft!”

Child 3: “It’s cloudy!”

Child 4: “Maybe I was right. It’s sticky!”

One child used his forearms to pick up the shaving cream.

Child 1: “It’s sticky! Smell it!”

Child 3: “Eat it!”

Carrie: “Don’t eat it. Remember, this is not food.”
Child 4: “My hands are stuck!”

Child 2: “My hands are stuck too!”

Another child approached the table. It was his first day of school.

Carrie: “Hello! Would you like to sit down?”

Child 5: “Ok.”

The new child sat down and did not touch the shaving cream. He watched the other boys.

Carrie: “Do you hear the sound the shaving cream makes when it is squished?”

Child 5: “I can’t hear anything.”

Carrie: “When you squish the shaving cream, you can hear it. And when you smear it on the plastic, it slides under your fingers.”

Carrie squished her pile and moved her ear close to her hands. The child watched Carrie and then squished his pile of shaving cream.

Child 5: “I can hear it! It is bubbles popping!”

Carrie: “Yes.”

Child 5: “It’s sloppy. It’s soft!”

Immediately following outside free choice time, the children lined up to go inside for circle time.

**Circle time.** The child of the day brought a dinosaur book from home to share during circle time. Because it was a long book, Carrie asked him to pick his favorite page:

Carrie: “Wow, there are a lot of words. Do you all want to see? It says giant dinosaurs and there’s tons of words explaining what a dinosaur is. Would
“you like to share your favorite page? Maybe we can read [the rest of the book] later. It’s a very long book. Which one is your favorite?”

Child 1: “This one.”

Carrie: “Wow! Check this one out.”

Child 2: “It’s a Tyrannosaurus rex!”

Carrie: I thought it was but you know what it says? It says Giganotosaurus.

Giganotosaurus, what does that mean?

Child 3: “Giant!”

Child 4: “It’s bigger than a T-rex!”

Carrie: “He looks humongous to me! Let’s see what it says. Oh, he was from Argentina where you are from! Maybe that’s why he’s your favorite. This dinosaur was the biggest meat eater ever, even larger than the…”

Child 5: “The T-rex!”

Carrie: “The Tyrannosaurus rex.”

Child 1: “So he could eat the T-rex!”

Carrie: “It says he was more lightly built that the T-rex so they don’t actually know who was bigger or stronger. I’m scared of him.”

Child 6: “He looks bigger and stronger.”

Carrie: “He’s 10 feet tall. Hmmm. How big is 10 feet tall?”

Child 7: “As tall as you.”

Carrie: “Even taller.”

Child 3: “Maybe taller than an elephant?”

Carrie: “Even taller! He was 43 feet long.”
Child 7: “I saw a meteor on Valentine’s Day.”

Carrie: “You did?”

Child 7: “Yes, and it was saying go back to bed.”

Carrie: “The meteor said that?”

Child 7: “It told my mom and dad and they told me.”

Snack time. Immediately following circle time, the children sat down at a table to have a snack.

Child 7: “I saw a meteor on Valentine’s Day.”

Child 1: “What’s that?”

Child 7: “It’s a rock with yellow around it like the sun but you can’t look at the sun, only a meteor.”

Child 2: “Is the yellow part of the meteor ever going to come back?”

Child 7: “I don’t know. The sky knows when it comes. It’s yellow, made of a circle, it’s a shooting star or you can call it a meteor. But it comes out of a rock. My mom told me all about it. I was scared of it. And it said, ‘Go back to bed.’”

Carrie: “That was a good explanation.”

Second circle time. Carrie read a book about a zoologist to the class.

Carrie: “Watch them swing from tree to tree, what funny creatures do you see? Hmmm.”

Children: “Monkey!”

Child 1: “It’s a monkey! It’s so obvious!”
Carrie: “How did you know? How was it so obvious to you that it was a monkey?”

Child 2: “Because we saw the tail.”

Carrie: “What about if you didn’t see the tail? Would you still have known? You know what would have been a clue for me?”

Child 3: “The banana?”

Carrie: “Yes, the banana. I would have just guessed.”

Table 4.6

Comparison of Researcher’s Observation Notes to Carrie’s Categorization Form

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Carrie’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect search and bug catchers</td>
<td>Science</td>
</tr>
<tr>
<td>Dinosaur book discussion</td>
<td>Language and literacy</td>
</tr>
<tr>
<td>Zoologist book</td>
<td>Language and literacy</td>
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<tr>
<td>Meteor discussion</td>
<td>Not listed</td>
</tr>
<tr>
<td>Shaving cream activity</td>
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</table>
Science questionnaire. Results from Carrie’s science questionnaire (Appendix C) showed that she “strongly agreed” with the following statements:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.

Carrie was “neutral” on:

- I do not have enough science materials in my classroom.
Carrie “strongly disagreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- It is not age appropriate for science to be introduced in preschool.
- I do not have enough education in science to teach science.
- I get ideas for science activities from the Internet.
- Science only occurs in the science center.
- I am worried that the children will ask me a question about science that I cannot answer.
- Science activities require too many materials.

In the short answer section of the science questionnaire, Carrie reported that “there were no [child development] classes which discussed science even in a curricula way” and that “any science activities we [teachers in the preschool] just figured out ad hoc.” Carrie stated that within her classroom, science activities are most often initiated by the children and provided three to four times a week and that she “tries to have science activities through our whole program.” Carrie responded that she and her co-teacher collaborate on the school’s science curriculum and that many science activities are child initiated:

The children will show interest in a specific area (i.e. butterflies) and we will follow their lead. Maybe looking up pictures of caterpillars, talking about the life cycle, going on walks to see or look for butterflies, which then of course leads to other scientific observations.
Carrie reported that science is very important in preschool because

    It’s part of their world – such a huge integral part of what they do each day is
    based on nature. Therefore, they have hundreds of questions regarding their
    surroundings – all to do with discovery and curiosity – how, what, where, why?

    **Dragon Fruit School**

    The Dragon Fruit School is a private, developmental preschool and Kindergarten
    serving children between the ages of 2- to 6-years-old. The preschool is located in a
    residential neighborhood in a single family style house with an expansive outdoor area
    including a large sand area with swings, a multi-level chicken coop with five chickens, a
    stage, a grass area, and many small structures such as a child-sized wooden bus and a
    playhouse, teeter toddlers, slides, and monkey bars. The program offers four classes:
    toddler, preschool, pre-kindergarten, Kindergarten. The preschool is a half-day program
    with a full-day option while the Kindergarten program is full day and serves high- to very
    high-income families. The class observed contained thirteen 4-year-old children from
    mainly Caucasian backgrounds. Each classroom has two lead teachers that co-teach the
    same group of children. Therefore, both teachers observed work together in the same
    classroom with the same children. On Day 1, lead teacher Debbie was observed and on
    Day 2, lead teacher Dot was observed.

    **Dragon Fruit Classroom**

    The Dragon Fruit Classroom is a pre-k class that serves children between the ages
    of 4- to 5-years-old. On the first day of observation, there were 13 children in
    attendance from mainly high to very high income, upper middle class Caucasian families.
    There are two lead teachers in the classroom.
Results of the science materials checklist (Appendix E) showed that the class did not have a designated science center. A large shelving unit against the wall contained numerous Tupperware containers housing various manipulatives, blocks, and animal figures. In addition, the shelving unit held two Tupperware containers labeled as “science boxes,” one Tupperware labeled “magnets,” and the following items from the Tools for Observation and Measurement category: x-rays of sea life, sorting trays, tweezers, eyedroppers, photographs of animals, plastic spoons and bowls (Figure 4.25). Additionally, the school had a child sized, working kitchen where the children prepared and cooked food (Figure 4.26).
Figure 4.25. Dragon Fruit classroom’s shelving units.
From the Natural Items category of the science materials checklist, the “science boxes” contained seashells, snakeskins, insects in plastic cubes, and starfish. Outside was an expansive yard with three sensory tables; one held dried pasta tubes, paper towel tubes, and plastic scoops, the second table held cornmeal with dried pasta and three metal sifters, and the third held water and pitchers (Figure 4.27). An outdoor shelving unit held funnels, pitchers, sand toys (shovels, scoops, cups, bowls), PVC pipes, and animal figures (Figure 4.28).
The yard contained many mature trees, plants, and four raised vegetable garden beds filled with growing vegetables (Figure 4.29). In addition, the school had an outdoor, 3-level chicken coop with five chickens that was built next to the classroom window thereby creating a “chicken observation deck” inside the classroom (Figure 4.29 and 4.30). From the Reference Materials category, there were clipboards and pencils at the chicken observation deck/window, science-related books and magazines in the classroom library, and a large world map on the classroom wall.

Figure 4.27. Dragon Fruit School’s outdoor sensory tables.
Figure 4.28. Dragon Fruit School’s outdoor shelving unit with funnels, PVC pipes, pitchers, etc.

Figure 4.29. Dragon Fruit School’s outdoor chicken coop with planter beds filled with growing vegetables.
Figure 4.30. Dragon Fruit School’s chicken observation center (inside view of chicken coop from classroom).

**Dragon Fruit Teacher – Debbie**

Debbie identified as a 27-year-old Caucasian female with a Bachelor of Arts Degree in Journalism that was completed in 2008. Additionally, she completed Los Angeles Valley Community College’s Child Development Certificate A (Associate Teacher, private preschool). She has been a preschool teacher for 6 years and has worked at this center for 6 years. She currently works with 3- to 4-year-olds as a co-teacher in the morning program.

**Observation.** The theme of the month was space exploration. The day began with the introduction of an ant farm during circle time followed by a short discussion about what an ant farm is, why the ants were moving in certain ways, and some ant facts. This was followed by 40 minutes of outside free choice time that included painting
plastic dinosaur figures with watercolors and building with Duplos (large Legos) and animal figures. After snack, the children returned to the classroom for a 20-minute long second circle time that included a discussion about the phases of the moon (using Oreo cookies to illustrate the phases). Immediately following second circle was inside free choice time that included a table with sea creature x-rays and fossils, seashells, and sorting boxes. The ant farm was placed on the floor along with various trains and train tracks.

**Circle time.** Circle time lasted approximately 20 minutes and began with a discussion about an ant farm:

Debbie: “Guess what I am going to show you? It’s something cool that the class put together.”

Child 1: “A sandwich with stuff you squish together?”

Child 2: “A puzzle?”

Debbie: “It doesn’t have to be a right answer, just a guess.”

Debbie placed an ant farm on the carpet.

Children: “Ant farm!”

Debbie: “This is very fragile, let’s not touch. You can watch the ants digging holes, doing work. Know what’s interesting about these ants? They are all girls! Girls do all the work, all the tunnels, all the jobs.”

The children pointed to brown items they saw in the ant farm.

Debbie: “The brown stuff is bread. And over here is where one ant died and another ant is carrying it. I wonder what it will do with it.”

Child 1: “Take it to the hospital.”
Debbie: “Let’s watch. Ants are not like people so they may do different things. After circle I will show you where it is easier to see the ants.”

Debbie pointed to a tube that looped out on the side of the ant farm and placed the ant farm on the shelf behind her. Circle time continued with singing the welcome song. After the song was finished, a child mentioned that she had recycled that morning. Debbie replied that they would “talk about it at second circle and put a leaf on our recycling tree.”

Outside free choice time. Immediately following circle time, the class went outside for free choice time. The following items were set out for the children:

Table 1: Large, plastic dinosaur figures, watercolor pallets, cups of water, and paint brushes.

Table 2: Duplo blocks and small farm animal figures with a plastic farmhouse and barn.

Dinosaur table (Figure 4.31). Debbie sat down at the table with two children that were painting dinosaur figures with the watercolors:

Child 1: “Some dinosaurs walk backwards.”

Debbie: “I don’t know about that kind of dinosaur.”

Child 1: “I have a dinosaur book!”

Debbie: “I know a little about dinosaurs.”

Child 2: “Did you see my dinosaur’s teeth?”

Child 2 painted her dinosaur’s teeth brown.

Debbie: “It looks like your dino needs to go to the dentist.”

Child 2: “Dinosaurs can have black teeth or brown teeth.”
Debbie: “Is it because they did not have toothpaste back then?”

Child 1: “Mine doesn’t have teeth.”

Debbie: “Maybe because it is a plant eater. A Stegosaurus.”

Child 2: “I painted all the way down here” (pointed down the dinosaur’s spine).

Debbie: “To his spine?”

Figure 4.31. Dragon Fruit classroom’s outdoor painting dinosaur figures with watercolors activity.

Another child approached the table and pointed to a balloon that was stuck in a tree in the school’s yard:

Debbie: “A balloon is in our tree. I wonder where it came from?”

Child 3: “Maybe someone let it go and it went down, down, with air. It’s really lucky!”
After outside free choice time, the children returned to the classroom for a second circle time.

**Second circle time.** Debbie began a discussion about the moon and showed the class a plate of Oreo cookies to illustrate the phases of the moon (waxing and waning) (Figure 4.32):

Debbie: “The moon is always full. Because we go around the sun and our planet also spins. Guess what the moon does to our planet? Do you remember that fancy word?”

Children: “Orbits!”

Debbie: “It orbits us. We orbit the sun and the moon is orbiting us. So sometimes the sun is shining right on the moon and that is when we see the whole thing. Sometimes the sun is behind us and the moon is over here so we don’t see any light from it and we don’t see the moon at all. So, that is called the phases of the moon. We made Oreos to show us the phases of the moon. The black part is the sky and the white part is what we can see. See how it’s always a circle? That is because this is only the parts we can see. The first one is called the New Moon. The New Moon is when you look in the sky and you can’t see the moon. The sky is black.”

Debbie then read from a book about the phases of the moon:

Debbie: “During the new moon, the moon is directly between the sun and the earth so the moon looks dark. There is no light. So what happens is as we move, we start to see a little more every day and forms a little crescent.”

While Debbie explained the new moon, she showed the class an open Oreo cookie
that had some of the frosting scraped away so that it resembled a crescent moon (Figure 4.32).

Debbie: “See the shape of white part? This is called a crescent moon. Can you guys try saying that?”

Child 3: “A crescent moon.”

Debbie: “My mom calls this kind of moon a cat claw.”

Children: “Cat claw?”

Debbie: “Because the shape of it looks like the claw of a kitty cat.”

In the middle of this discussion, the fire bell rang and the school participated in a fire drill. All the children left the classroom. When the drill was over, the class returned to their room and resumed the discussion about the phases of the moon.

Debbie: “Okay, do you want to keep talking about the moon, and the shapes, and orbiting?”

Children: “Yes!”

Debbie: “Then it gets a little bigger and becomes…”

Debbie showed an Oreo with a bit more white frosting on it. During the discussion, Debbie held up the Oreo that corresponded to the phase of the moon she was discussing.

Child 2: “A half.”

Debbie: “A half moon or a quarter moon, which means that it is a quarter of its way around the earth. Then you see a half moon. Next it gets a little bigger. Now it looks like only a crescent is dark and the rest is light. It is almost a full moon. It’s called a funny word, gibbous.”
Children:  “Gibbous!”

Debbie:  “And then is becomes a full moon. Some people think that if you see a full moon it will be a magical night.”

Child 4:  “I love cookies and I wish I could eat them.”

Debbie:  “Cookies are really good. But we are going to finish talking about these and if you have something that you want to say about moons then you can raise your hand but right now I am going to tell you all about these cool moons and then we will talk about it after. Can you remember your idea in your head?”

Child 4:  “Yes.”

Debbie:  “Ok, hold onto it. So then the moon is full in the sky and that takes about two weeks. So first we didn’t see it, then we saw a little more, and a little more and then we saw the whole thing. Then it starts to go away again but it doesn’t just go away right away. It gets smaller and smaller and smaller. So next one looks like the other gibbous but on the other side. We start to lose a little more. It’s called a waning gibbous.”

Child 3:  “A waning gibbous?”

The children giggled.

Debbie:  “Then we get another half moon but it’s on the other side this time because the sun is on the other side and it’s getting lit up on the other side. Then we loose a little more and we get a what?”

Child 1:  “A crescent.”
Debbie: “Right, a crescent. Now it’s been a whole month and we have a new moon. The one we don’t see, right? So is the moon always in the sky?”

Children: “No!”

Debbie: “It isn’t? Is the moon always there?”

Children: “Yes!”

Debbie: “It is, right? We just don’t always see the whole thing because the part that we see has what on it?”

Child 2: “Light.”

Debbie: “Light, right? Where’s the light coming from?”

Child 3: “Moon, and the sun.”

Debbie: “The sun.”

Child 4: “Are we going to eat those?”

The child pointed to the plate of Oreos.

Debbie: “This is another book about the moon.”

Debbie demonstrated how to separate an Oreo cookie and how to scrape off frosting to make different phases of the moon.

Debbie: “So you can make all the different shapes of the moon! You can eat while I read this book to you.”

Debbie handed out cookies to each child and began to read a book titled *Moon Plane*.

While referring to picture in the book, Debbie stated:

Debbie: “If you walk on the moon, you would take a step and bounce up. Why?”

Child 1: “A little gravity only.”
Debbie: “Yes, on earth we have a lot of gravity. See my water bottle? Does it float up?”

Children: “No!”

Figure 4.32. Dragon Fruit classroom’s Oreo cookie phases of the moon.

After Debbie finished reading, the children engaged in inside free choice time.

On one table were x-rays of various sea creatures (sea stars, coral reef, sea horses, sea shells), sea creature fossils (sea stars, sand dollars, sea snail shells, coral, sea sponges), seashells, and sorting boxes (small boxes with dividers) (Figure 4.33). On the floor were various trains and train tracks and the ant farm. Debbie sat on the floor with the children that were looking at the ant farm:

Debbie: “Lay on your belly to get a better look.”

Child 1: “He’s going back.”

Child 2: “He’s walking on the wall.”

Child 3: “Is that snow?”

Debbie: “No, it is a type of sand I think.”

Child 1: “I see dead ants.”
Debbie: “Yes, some are dead.”

Child 2: “What is the white stuff?”

Debbie: “We think it may be sand. Let’s look at the booklet to find out.”

Debbie read from the ant farm manual.

Debbie: “Ants take baths by rubbing their heads with their arms.”

Child 3: “That’s dead. Will they come alive again?”

Debbie: “I don’t know. I’m not sure. Do mom and dad talk about that?”

Child nodded yes.

Debbie: “I don’t think it will come alive. But some people believe that your spirit or memory goes on forever. That’s what some people think.”

Figure 4.33 Dragon Fruit classroom’s table with sea creature x-rays, seashells, starfish, sorting trays, etc.
Table 4.7

Comparison of Researcher’s Observation Notes to Debbie’s Categorization Form

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<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Debbie’s Categorization Form</th>
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<tbody>
<tr>
<td>Ant Farm Observation</td>
<td>Science</td>
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<td>Moon discussion – 2nd circle</td>
<td>Science</td>
</tr>
<tr>
<td>Reading about moon phases</td>
<td>Language/Literacy and Science</td>
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<td>Moon phase Oreo project</td>
<td>Science</td>
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<tr>
<td>Recycling</td>
<td>Science</td>
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<tr>
<td>Painting dinosaur figures</td>
<td>Art</td>
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<tr>
<td>Balloon observation</td>
<td>Did not include</td>
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<tr>
<td>Outside playtime in sandbox</td>
<td>Science</td>
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Observation/Categorization Results: How Debbie Categorized the Day’s Science-Related Activities

- Categorized under science: 75%
- Categorized under other domains: 12%
- Not Categorized: 13%

**Figure 4.34.** Observation/categorization results. Debbie’s categorization of the day’s science-related activities.
Science questionnaire. Results from Debbie’s science questionnaire (Appendix C) showed that she “strongly agreed” with the following statements:

- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.
- I get ideas for science activities from the Internet.
- I do not have enough science materials in my classroom.

Debbie “mildly agreed” with the following statements:

- I am comfortable planning and explaining science-related activities to my preschool class.
- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- I do not have enough education in science to teach science.
- I am worried that the children will ask me a question about science that I cannot answer.

Debbie “strongly disagreed” with the following statements:

- It is not age appropriate for science to be introduced in preschool.
- Science only occurs in the science center.
- Science activities require too many materials.

From the short answer portion of the science questionnaire, Debbie reported that she did not learn much about science from her child development classes because “most courses focused more on art and music, all the science involved art (color mixing etc.).”
She reported that strategies and/or ideas on implementing science gained from her child development classes “involved cooking, measuring, and sensory activities rather than ‘experiments’ or projects.” Debbie noted that she finds most of her ideas for science-related activities from the Internet and that in her classroom, science activities are provided daily and focus mainly on “playing with sensory activities and a lot of cooking.” According to Debbie, science activities are both teacher and child initiated, “We make the calendar and plan projects but emergent science is always happening – the kids find a bug on the yard and ask questions.”

Debbie reported that science is very important in preschool because “it’s everywhere in their lives, they just don’t realize it. I also think it is a huge part of understanding and helping our world – nature, recycling, etc.”

**Dragon Fruit Teacher - Dot**

Dot is a Caucasian female between the ages of 26- to 40-years-old with a Bachelor of Fine Arts Degree in Acting that was completed in 1999. She has not taken any child development classes. She has been a preschool teacher for 13 years and has worked at this center for 13 years. She currently works with 3- to 4-year-olds as a co-teacher in the morning program.

**Observation.** The day began with an outside meeting. The children sat in a circle and Dot asked them to tell the group their name, their parents’ names, and what they had for breakfast. Dot discussed the plan for the day and explained that the class would make “eggs in a hole” with Gabby (owner of school). She explained that they would cut a hole in a piece on bread, crack an egg in the middle of it, and then cook it. Dot said, “You can call it whatever you want. Some people call it egg in a hole, some
call it sunshine toast. You can even call it boy or girl in a rocket.” Meeting was followed by outside free choice time.

**Outside free choice time.** Immediately following meeting, the children spent 30 minutes outside. The teachers had two tables set up with the following materials:

Table 1: Colored bowtie pasta, glue, paper plates.
Table 2: Pitchers of soapy water, small bottles, and a large metal bin with water and pitchers.

**Slide.** While a group of children were on the slide, Dot noticed each child’s hair standing on end when they slid down the slide.

Dot: “Lucas, your hair is standing up when you go down the slide! I wonder if everyone’s hair does that when you go down slide….”

Child 1: “I want to try!”

Child 2: “I want to try too!”

Dot: “Do you know what it is called? Static. Your hair just went flying up!”

Five additional children ran to the slide to see if their hair would stand up when they slid down.

Child 3: “Look at mine!

Dot: “Yours did a little bit.”

**Table 2: Water table.** One child spent 30 minutes working at the water table filling up bottles and pouring water from one container to another (Figure 4.35). After approximately 25 minutes of working alone, she figured out how to pour water out of the pitcher using the hollowed out handle as a spout and began to fill bottles.

Dot: “That’s a cool way to do it!”
Child 1: “Take it out like this!”

Dot: “You’ve invented a new way to use a watering can!”

Other children noticed the child pouring water out of the handle and joined in. One of the children picked up another pitcher and used the handle as a spout to fill up a pitcher. The children continued to work together for an additional 15 to 20 minutes. After outside free choice time, the children moved inside for circle time.

![Figure 4.35. Dragon Fruit classroom’s outside table with soapy water, pitchers, and cups.](image)

**Circle time.** Dot discussed the school’s upcoming field trip to see the Endeavour Space Shuttle at the Science Museum:

Dot: “Does anyone have any questions that they want to ask tomorrow when we go to the Science Museum to see the Endeavour? Think of questions we don’t have the answers to.”

Child 1: “Space food.”

Child 2: “How long did it take to get there?”
Dot: “How long did it take to get where?”
Child 2: “To space.”
Dot: “So you want to know how long it took for the space shuttle to reach space once it took off from earth?”
Child 2: “Yes.”
Child 3: “I wonder when it was made.”
Child 4: “Are we going to ride on it?”
Child 5: “How long it takes to get to space.”
Child 6: “A T-rex can go as fast as a car!”
Dot: “Wow! You guys have a lot of great questions! Remember to save your questions in your brain so that you can ask tomorrow, okay?”
Children: “Okay!”
Dot read a book about an astronaut traveling through space.

**Inside free choice time.** While Dot read the astronaut book, Debbie set up the following activities for inside free choice time:

Table 1: Three corded telephones (vintage, 1970’s rotary, and a modern digital phone), one cordless modern phone, and a walkie-talkie along with paper and pencils.

Table 2: Martian figures and zoom manipulatives.

Floor: Magnets and items that attract (paperclips, small metal items) and repel (plastic items, paper cut outs, etc.) and magnifying glasses.

*Floor.* Five boys on the floor investigated the magnets (Figure 4.36).

Dot: “Why don’t you separate all pieces in middle of carpet and go fishing?”
Child 1: “This is a big magnet! It could hold a car!”

Child 2: “This isn’t sticking.”

Dot: “Hmmm, I wonder why that plastic disc isn’t sticking to your magnet. What do you think?”

Child 2: “I don’t know. Maybe I need glue first.”

Child 3: “Because it’s plastic! Look, put your magnet on this” [a small metal disc].

Dot: “That’s a great suggestion. What do you think?”

Child 2: “It’s stuck! Look it sticks!”

Child 3: “I told you! No plastic stuff.”

Figure 4.36. Dragon Fruit classroom’s magnet activity.

The owner of the preschool entered the classroom with her Gabby “crater toast” – a piece of bread with small hole cutouts filled with egg (Figure 4.37):

Dot: “Wow! Friends look what Gabby made! It is crater toast. Does anybody remember what a crater is?”
Child 1: “A hole!”
Child 2: “It’s not a hole. It’s the moon.”
Child 3: “Yes, the crater on the moons.”
Dot: “Well, you all are correct. We learned in our book about the astronaut that a crater is a hole in the surface of the moon. I wonder why Gabby calls this crater toast.”
Child 4: “Because it’s yellow!”
Child 2: “No, because it has holes like the moon!”
Dot: “That’s right, it has craters just like the moon. Now who wants a bite? Who wants to taste a planet? We will be making these after lunch.”

Figure 4.37. Dragon Fruit class crater toast.
Table 4.8

Comparison of Researcher’s Observation Notes to Dot’s Categorization Form

<table>
<thead>
<tr>
<th>Researcher’s Observations</th>
<th>Dot’s Categorization Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide – Static electricity</td>
<td>Science</td>
</tr>
<tr>
<td>Water Table</td>
<td>Science</td>
</tr>
<tr>
<td>Questions about space shuttle</td>
<td>Not listed</td>
</tr>
<tr>
<td>Zoom manipulatives</td>
<td>Science</td>
</tr>
<tr>
<td>Astronaut book</td>
<td>Language and Literacy</td>
</tr>
<tr>
<td>Magnet play</td>
<td>Science</td>
</tr>
<tr>
<td>Crater Toast</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

Observation/Categorization Results: How Dot Categorized the Day’s Science-Related Activities

Figure 4.38. Observation/categorization results. Dot’s categorization of the day’s science-related activities.
**Science questionnaire.** Results from Dot’s science questionnaire (Appendix C) showed that she “strongly agreed” with the following statements:

- I am comfortable planning and explaining science-related activities to my preschool class.
- Science should be taught in preschool.
- It is important for my preschool class to have a science center that the children can freely explore.
- I get ideas for science activities from the Internet.

Dot “strongly disagreed” with the following statements:

- There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.
- Preparing science activities takes too much time.
- It is not age appropriate for science to be introduced in preschool.
- Science only occurs in the science center.
- Science activities require too many materials.

Dot mildly disagreed with the following statements:

- I do not have enough education in science to teach science.
- I am worried that the children will ask me a question about science that I cannot answer.
- I do not have enough science materials in my classroom.

Because Dot had not taken any child development classes, she learned about science activities for children “on the job and by doing.” She noted that “I have really educated myself in my classroom – what inspires me translates and inspires them, what
inspires them, inspires me.” She reported that she found strategies and/or ideas on implementing science from the Internet, books, and collaborating with other teachers and include “having open-ended sensory areas that the children can navigate an create without me telling them what it’s for.” Dot noted that science activities are provided “as often as possible” and often emerges from the children’s interests. In Dot’s classroom, science activities are both teacher and child initiated, “I like to have a balance between teacher initiated and child initiated.” Dot reported that science is very important in preschool because “it’s a way to build confidence and figure out the world around them.”

Synthesis

In an effort to describe the prevalent themes found when investigating all five schools as a whole and all eight teachers as a whole, the following is a synthesis of the results from the observation/categorization exercise (all teacher results combined $N = 8$), science materials checklist (all schools combined $N = 5$) and science questionnaire (all teacher responses combined $N = 8$):
Figure 4.39. Results of researcher’s observations notes compared to all teachers’ categorization forms ($N = 8$).
Figure 4.40. Science Materials Checklist, Tools for Observation and Measurement results. All classrooms combined ($N = 5$)
Figure 4.41. Science Materials Checklist, Natural Items results. All classrooms combined ($N = 5$).
Figure 4.42. Science Materials Checklist, Reference Materials results. All classrooms combined (N = 5).

Science Questionnaire

Questions 1 – 12. The results from the science questionnaire’s questions 1 to 12 revealed that 100% (N = 8) of the teachers strongly agreed with: “Science should be taught in preschool” and strongly disagreed with “It is not age appropriate for science to be introduced in preschool;” 87.5% (n = 7) strongly agreed with “I am comfortable planning and explaining science-related activities to my preschool class” and “It is important for my preschool to have a science center that the children can freely explore.” Additionally, 87.5% (n = 7) strongly disagreed with “Science only occurs in the science center”

However, while 62.5% (n = 5) strongly disagreed with “There is not enough time to teach science because I have to focus on other areas such as language/literacy and math,” 25% (n = 2) mildly disagreed and 12.5% (n = 1) mildly agreed. Additionally,
while 62.5% \((n = 5)\) of the teachers reported that they strongly disagree with “I do not have enough education in science to teach science,” 37.5% \((n = 3)\) only mildly disagreed. For the question, “I am worried that the children will ask me a question about science that I cannot answer,” 50% \((n = 4)\) of the teachers strongly disagreed, 37.5% \((n = 3)\) mildly disagreed, and 12.5% \((n = 1)\) was neutral. Additionally, results showed that 50% \((n = 4)\) strongly disagreed with “I do not have enough science materials in my classroom” while 12.5% \((n = 1)\) mildly disagreed, 12.5% \((n = 1)\) was neutral, 12.5% \((n = 1)\) mildly agreed, and 12.5% \((n = 1)\) strongly agreed. In response to “Science activities require too many materials,” 75% \((n = 4)\) of the teachers strongly disagreed while 25% \((n = 2)\) were neutral.

**Short answers.** The following four charts reflect a synthesis of all eight teacher responses to the short answer portion of the Science Questionnaire (Appendix C):
How Often are Science-Related Activities Offered to the Children in Your Classroom?

*N = 8*

![Chart showing frequency of science-related activities offered per week.](image)

**Figure 4.43.** Frequency of reported science-related activities offered per week. All teacher responses combined (*N* = 8):
**Figure 4.44.** How do you come up with ideas for incorporating science in your classrooms? All teacher responses combined ($N = 8$).

**Figure 4.45.** Science in your preschool classroom: Teacher initiated or child initiated? All teacher responses combined ($N = 8$).
Figure 4.46. Was science in preschool discussed in your college level child development classes? All teacher responses combined (N = 8).
CHAPTER FIVE

DISCUSSION

Introduction

Is science in preschool necessary? As the research presented in this paper has shown, science is an often neglected and misunderstood domain within early childhood education, many preschool teachers avoid and/or miss science opportunities and have low self-efficacy in teaching science, and college level child development courses place little emphasis on the subject. Yet, as was reported by the Georgetown University Center on Education in the Workforce, STEM jobs are expected to grow by 17% over the next decade “making it one of the most dynamic occupation clusters in the economy” (Carnevale, Smith, & Melton, 2011, p. 20) compared with only 10% U.S. job growth overall. However, as the researchers discovered, “our education system is not producing enough STEM-capable students to keep up with the demand both in traditional STEM occupations and other sectors across the economy that demand similar competencies” (Carnevale et al., 2011, p. 10). What is the best way to reverse this trend and better prepare our children for jobs in the 21st century? While the research by Carnevale et al. (2011) suggests that changes to the education system are necessary, at what level (preschool, elementary, or high school) would changes and/or an implementation of science be most beneficial? Are the preschool years an important time to integrate science into the curriculum?

As the research presented in this paper has shown, the integration of science into preschool curricula develops critical thinking and analytical skills, encourages collaboration, and lays the foundation for success across all readiness domains.
throughout the elementary school years and beyond (Greenfield et al., 2009; Maier et al., 2013; Nayfeld, et al., 2011; Roehrig et al., 2011). Additionally, brain research has identified the preschool years, when learning occurs most efficiently and rapidly, as the ideal time to introduce scientific learning and investigation (Eshach & Fried, 2005). However, as was shown in the research conducted by Greenfield et al. (2009), deficiencies in science scores have been discovered in children entering kindergarten whose scores were “significantly lower than their readiness scores in the seven other domains” (p. 247). This suggests that the current approach to science in preschool appears to be ineffective and/or non-existent.

In order to better understand the prevalence and significance of science in early childhood education programs, the purpose of this exploratory research study was to observe the type and frequency of science activities that occurred in eight teachers’ preschool classrooms during a typical day. Additionally, the goal was to investigate whether or not teachers (N = 8) recognized both planned and spontaneous science unfolding throughout the day, and if their self reported perceptions of and self-efficacy in teaching science were reflected in their classrooms.

The research presented in Chapter 2 included empirical studies on the influence of science experiences in kindergarten on later science achievement, preschool science environments, teachers’ attitudes, beliefs, and involvement in science activities, children’s interest in and use of science materials during free choice time, the connection between the lack of science instruction found within preschool environments with in-service preschool teacher’s feelings of low self-efficacy, and the design of two professional development programs focused on improving preschool science programs.
Chapter 3 outlined the development and design of the current study including a description of the sample, demographics, procedure, and the five instruments created for this study: researcher’s observations, demographic survey (Appendix B), teacher categorization form (Appendix D), science questionnaire (Appendix C), and science materials checklist (Appendix E). Chapter Four presented the findings including direct quotes from the observations organized by school with a focus on each individual teacher in addition to a synthesis of the findings that showed prevalent themes that emerged when looking at all four schools as a whole and all eight teachers as a whole.

In this chapter, the prevalence and type of science activities observed will be discussed followed by a discussion of themes that emerged when observation notes were analyzed and compared to each teacher’s categorization form. Each classroom’s science environment will be discussed as will themes that emerged from the teachers’ responses to the science questionnaire and demographic survey. The following topics that developed from the observations and instruments will be presented first in relation to the review of literature, followed by interpretations, reflections, and questions from the researcher:

- Quality of classroom science environments (indoor and outdoor)
- Prevalence and quality of science-related activities observed
- Teachers recognition of planned and spontaneous science and whether or not education and teaching experience impacted this recognition
- Teachers perception of and self-efficacy in teaching science and how it was reflected within the classroom
- Missed opportunities
**Discussion**

**Quality of Science Environments**

**Designated science centers.** While having defined learning centers in preschool classrooms supports best practices, science centers in particular provide children with a focused area to engage with the natural world, manipulate materials, investigate theories, test hypotheses, and share findings with peers and teachers. In addition, science centers support the incredibly beneficial practice of observation, reflection, and documentation.

However, while 87.5% of the teachers strongly agreed that science centers are important, only 60% of the classrooms ($n = 3$) observed had designated science centers. Additionally, with the exception of the Coconut School, the science centers located in the Apple Seed and Apple Stem classrooms were overcrowded, unorganized and not located near any windows. As was noted by the University of Louisiana’s Picard Center for Child Development and Lifelong Learning, it is best to place science centers by a window to ensure that the children have the ability to observe the outside world, utilize natural sunlight, and explore reflections and shadows while working in the center (Carmouche, 2011). Moreover, regardless of whether the population served is infants, toddlers, or even adults, an overcrowded and unorganized learning area is not welcoming or inspiring; in fact, it may result in avoidance. As Bronfenbrenner’s ecological theory of development proposed, the organization and quality of the environment “initiates transactions with the child that either promote or thwart development” (Thomas, 2005, p. 352).

**Science materials.** While science materials were available and accessible in 80% of the classrooms observed, the majority of items noted were sensory tables ($n = 5$),
magnets \((n = 5)\), globes \((n = 4)\), live animals \((n = 4)\), plants \((n = 4)\), ocean items (seashells, starfish, etc.) \((n = 4)\), and tactile materials (sand, playdough, etc.) \((n = 4)\). While this appears sufficient, it must be noted that one of the schools had two sensory tables that were empty and tipped over in the corner of the outdoor area and the majority of the animals listed were goldfish \((n = 2)\). The Dragon Fruit School was the only program that had hands-on, interactive animals, specifically chickens and chinchillas. In addition, the Dragon Fruit School had a multi-level chicken coop that was built outside the classroom window thereby providing a “chicken observation deck” located inside the classroom (Figures 4.29, 4.30). Items such as test tubes, thermometers, rocks, maps, and outdoor edible gardens were only found in only one of the five classrooms observed while measuring cups, prisms, rulers, and goggles were not found in any of the observed classrooms.

Additionally, there was a wide gap between classrooms with abundant science materials and those with little to none. For example, Angelina’s classroom (Apple Stem LAUP classroom) had a corner of the classroom devoted to the science center with the most science materials of all the classrooms observed. In fact, the Apple Stem classroom had items that were not listed on the checklist such as a light box and a mold of human teeth (upper and lower jaw). Interestingly, Anne’s Apple Seed classroom (from the Apple School) had a much smaller science center and far fewer materials than the Apple Stem classroom. In fact, Anne noted that she “strongly agreed” with “I do not have enough science materials in my classroom” while Angelina “strongly disagreed” with the same statement from the science questionnaire. While this may be the result of additional
state funding provided to Angelina’s LAUP classroom, it is still worth noting the
disparity found between classrooms within the same school.

In contrast to the abundance of materials and centers found in the Apple school,
the Banana School did not have a science center and contained a minimal amount of
science-related materials that were accessible to the children. For example, the results
from the Banana School’s science materials checklist showed that there were no items
from the Tools for Observation and Measurement category found, three items from the
Natural category (two sensory tables, a container of seashells, flowers in a vase), and two
items from the Reference Materials category (science-related books and a globe).
However, the Banana school’s two sensory tables were empty and tipped over in a corner
of the outside area and the seashells were high on a shelf and inaccessible to the children.
It is important to note a disparity found within the results from the Banana School’s
teachers science questionnaire results: While Bobbi “mildly agreed” with the statement “I
do not have enough science materials in my classroom,” Brenda “strongly disagreed”
with the same statement. This disparity was again found in their responses to the
statement “It is important for my preschool class to have a science center that the children
can freely explore;” Brenda “mildly agreed” while Bobbi “strongly agreed.” While these
may not be dramatic differences, the data does demonstrate how critical teachers’
perceptions are in how they approach the curriculum, a theme that will repeat throughout
this chapter.

The Coconut School and the Dragon Fruit School were also on opposite ends of
the materials spectrum. While the Dragon Fruit school did not have a designated science
center and the majority of the classroom’s science materials were relegated to two
medium-sized Tupperwares titled “Science Boxes,” the Coconut School had the only science center placed by a window that was neatly organized with a wide variety of science materials available to the children all day (Figure 4.18). On the other hand, the Dragon Fruit School was the only program that had live animals (chickens and chinchillas) that were accessible to the children in addition to a multi-level chicken coop and a chicken observation deck within the classroom (Figures 4.29, 4.30).

**Do Science Centers and Materials Influence Scientific Inquiry?**

Although all the classrooms observed had different science environments and materials, the children from the Coconut and Dragon Fruit classrooms had more interaction with science materials than all the other classrooms observed. How is it possible that a classroom with a designated science center and an overabundance of materials such as the Apple Stem classroom had fewer scientific investigations than the Dragon Fruit class that had far fewer materials?

As the research presented in Chapter 2 showed, even if “rich science materials exist in a classroom, teachers and students tend not to use them” (Nayfeld et al., 2011, p. 973) and that “teachers tend to interact most often in the art area… and least often in the science area” (Tu, 2006, p. 250). Moreover, Nayfeld et al. (2011) discovered that the science center was empty “77.6% of the sampled time across all six classrooms” and that “the children spent a total of 4 minutes in the area when a teacher was not there” (p. 978). This was reflected in the current study’s observations of the time spent and interactions within the Apple Seed, Apple Stem, and Coconut Milk science centers. While these three were the only classrooms that had dedicated science centers, the children and teachers spent more time in the art and dramatic play areas, regardless of where the children were.
For example, during Angelina’s observation, she spent the majority of free choice time in the art area regardless of the fact that a student asked her (and the researcher) multiple times to “watch me do science.” Although the child continued to walk back and forth between the science and art areas and continued to ask Angelina to join her in the science area, Angelina did not leave the art area. The child eventually abandoned her work in the science area and sat down in the art table to participate in the art project.

Based on the review of literature and the results of the current study, it appears that successful preschool science programs depend on more than simply supplying materials and creating science centers. In fact, a prevalent theme that has emerged is the importance of teacher/child interactions within the science center and/or with science-related materials. Unlike the many self-explanatory, familiar items found in the art and dramatic play areas, science materials may be foreign or abstract to many children. Placing these items in a context that the children will understand may encourage further investigations. As was discovered by Nayfeld et al. (2011), “children are unlikely to benefit fully from the presence of science tools through autonomous exploration alone because they do not go to the science area to use these materials on their own” (p. 982). When tools are explained and demonstrated, research has shown that interactions with these once ignored materials dramatically increases: “[after the intervention] Children’s presence in the science area increased so dramatically that there were times the area was filled beyond capacity” (Nayfeld et al, 2011, p. 978).

While the results of this study showed that the majority of the classrooms observed had sufficient science-related materials, was the quality of each school’s science environment and materials indicative of the quality of the science programs? Moreover,
was there a correlation found between quality of materials and the quality and prevalence of science activities?

Prevalence and Quality of Science-Related Activities

**Planned science activities.** While 62% of the teachers noted that science activities are offered daily, throughout the course of all eight observations, there were no planned, science specific or science focused, hands-on activities noted in any of the classes observed. While the Dragon Fruit School provided science “lessons” on an ant farm and on the phases of the moon using Oreo cookies, they were not interactive or hands-on activities but teacher led/teacher directed lessons that were not expanded. In fact, as was shown in the dialog listed in Chapter 4, the children were more interested in eating the Oreos than hearing about the phases of the moon. And while the children appeared excited and interested in the ant farm, they were instructed not to touch it thereby making it an observation and not a hands-on activity. Additionally, there was no follow up to the ant farm observation such as exploring books, looking at the ants through a magnification device, hypothesizing, experimenting, or documenting. As was noted by Eliason and Jenkins (2012), “teachers must recognize that there is a difference between a ‘science demonstration’ and a ‘hands-on’ science experience” (p. 215).

This is similar to what was observed during Brenda’s snowman discussion (Banana Peel Classroom). While Brenda planned the introduction of the snow, the way it was presented was abstract and disjointed; the snowman was shown to the children yet they were instructed not to touch it thereby eliminating the vitally important, sensory interaction. Again, it was a teacher led/teacher directed lesson with little interaction from the children. As research has repeatedly shown, “children learn best through

Additionally, the science centers and/or science materials that were available were not highlighted or mentioned during circle or meeting times in any of the classrooms observed. While science materials such as tile magnets and seashells were placed on tables and sand-filled sensory tables were open for use in the science centers, they were simply set up and left for the children to explore on their own during free choice times. For example, the Dragon Fruit school placed seashells, starfish, sand dollars, sorting trays, and x-rays of sea creatures on a table for free choice time (Figure 4.33). However, there was not an introduction or explanation of what the materials were or the purpose of having them available. While a few children did interact with the materials, only one child spent more than 5 minutes at the table. This highlights the importance of intentional teaching and purposeful curriculum development. While the materials were all interesting items, they did not appear to engage the children. Simply placing science-related materials on a table does not inspire interaction; an interactive discussion about the materials and a purpose for using them is as important as the materials themselves. As was noted by Roopnarine and Johnson (2013), materials should be “purposefully and sometimes creatively arranged or displayed to convey the message that they are important, interesting, and worthy of respectful attention” (p. 335).

In contrast, the inadvertent handling of science materials was in direct opposition to how art activities were introduced. Each school observed provided planned, detailed art projects during each day of observations. For example, in 80% of the classrooms observed, the day’s art project was discussed at circle time including an explanation and
example of each of the materials and a reference to where in the classroom the art project would take place (e.g. the art center, the back tables, outside, etc.). The majority of the children went to the art center during free choice time leaving the science centers vacant for the majority of the days observed. Was this because art was emphasized more by the teachers? What might have occurred if the teachers had asked provocative questions about seashells and provided measuring devices, sorting materials, and recording instruments?

To summarize, planned science activities were not noted in any of the eight observations yet a science lesson on the phases of the moon, an ant farm, and snow were noted during two of the eight total observations (or in 25% of the classrooms observed). In 100% of the classrooms observed, science-related materials (magnets, sensory items, sea creature x-rays) were available during free choice time and multiple examples of spontaneous science emerged during each observation.

**Spontaneous science.** Although there was a lack of planned, hands-on science activities observed, spontaneous science occurred in 100% of the classrooms observed. The most dynamic interactions noted were the spontaneous investigations that emerged from the children’s outdoor play. For example, at the Coconut School, the discovery of a caterpillar inspired a group of children to create habitats inside bug catchers and use magnifying glasses to search for additional insects hidden in the bushes. The children participated in the insect search for almost an hour, collaborating and learning from each other and seeking out their teachers when needed. Additionally, watering the flowers in the yard sparked discussions on the life cycle of plants, roots, and how butterflies and caterpillars ingest water.
This child directed, spontaneous, outdoor discovery also unfolded at the Dragon Fruit School. During Dot’s observation, pitchers, cups, and soapy water in a large bin were placed on an outside table. One child spent over 30 minutes pouring water from the pitchers into the cups using both the spout of the pitcher and the handle (which was hollow) (Figure 4.35). Once the hollow handle was discovered and tested as a spout, the child poured water exclusively from the handle. Other children noticed this discovery and joined the table, working together and sharing the pitchers so that they could all experiment with pouring water through the handle. Immediately following this, static electricity became a topic of conversation when a trip down the slide resulted in a child’s hair standing on end.

While the majority of spontaneous science occurred outdoors, there were a few instances in which it occurred indoors. For example, while working with magnets (Figure 4.36), a group of children from the Dragon Fruit School entered into a peer-to-peer discussion about what types of items attract and repel magnets. At the Apple School, working with tile magnets and dominos provided rich investigation and conversations about patterns, force, stability, weight, volume, geometric shapes, and inspired collaboration between the children (Figure 4.4). At the Banana School, scientific exploration was observed when three children utilized the rulers imprinted on the circle time rug to measure their hands and when a child spent over 10 minutes observing ants while they crawled on the outside trashcan.

While spontaneous science emerged from the children in 100% of the classrooms observed, how did the teachers respond to this emergent curriculum?
Teachers Recognition of Planned and Spontaneous Science

Based on the results of the teacher categorization forms, as a whole, 35% of science activities noted were correctly categorized as science-based topics, 41% were not noted, and 24% were categorized under other domains (Figure 4.39). Though variations occurred between teachers (from 25% missed/misclassified to 84% missed/misclassified), overall, every teacher observed missed or miscategorized at least three science-related activities and/or discussions. With regard to the three preplanned science-related lessons noted (ant farm, snowman, phases of the moon), all three were correctly categorized on each teacher’s respective categorization form.

Looking at each teacher individually, the following lists the percentage of science activities that were miscategorized and/or not listed on the teacher categorization form:

- Apple School
  - Anne: 83%
  - Angelina: 84%

- Banana School
  - Brenda: 80%
  - Bobbi: 67%

- Coconut School
  - Cathy: 50%
  - Carrie: 80%

- Dragon Fruit School
  - Debbie: 25%
  - Dot: 43%
While there are always activities and discussions that occur during a preschool day that will be overlooked, some of the percentages listed above are excessive and support the research that referred to science as an often neglected domain (Greenfield et al., 2009; Nayfeld et al., 2011; Tu, 2006). For example, the percentages listed above for the Apple School and the Banana School were indicative of the attention paid to science and level of inquiry noted throughout each observation. In these two schools, the examples of spontaneous science that were not categorized resulted in lost opportunities (ants on trashcan, child asking for help with science, sandbox, mud in yard, etc.).

However, it is important to note that although the Coconut School had a high percentage of missed and/or miscategorized science activities, both Cathy and Carrie were keen observers who were quick to pick up on their children’s investigations and provided open-ended questions and support when needed (e.g. insect investigation, shaving cream table interaction, rocket and meteor discussion at snack time, zoologist and dinosaur book). For example, during the bug investigation, Cathy interjected open-ended questions and suggestions when needed, yet allowed the majority of the discussion and investigation to remain between the children. It is here that the delicate balance between teacher guidance and child led discovery was illustrated (Nayfeld et al., 2011).

The Impact of Education and Experience on Science Recognition

When comparing these results to each teacher’s level of education and experience in the field, a higher level of education and more experience in the field did not correlate with more science recognition. For example, Brenda has over 20 years of experience teaching preschool yet missed science 80% of the time and Bobbi, who is currently working towards a master’s degree in early childhood education, missed science 67% of
the time. Anne completed over eight child development classes and has 5 years of teaching experience yet missed science 83% of the time and Angelina, who has a degree in Child and Adolescent Development and is a lead teacher in a LAUP classroom, missed science 84% of the time. On the other hand, Dot, who has not taken any child development classes, only missed science 43% of the time and Debbie, who has a Degree in Journalism, a Child Development Certificate, and 6 years of teaching experience, only missed science 25% of the time.

The purpose of investigating how often preschool teacher’s recognize science unfolding within their classrooms was to explore if there was a serious lack of science occurring or if science was prevalent yet not recognized. The results listed above support the original hypothesis that more science is occurring in preschool classrooms yet teachers often miscategorize or do not recognize it within their classrooms. Was this due to human error and/or oversight or was it the result of more intentional actions? Was Roehrig et al. (2011) correct in their assumption that there is a “systematic bias against the inclusion of science in pre-kindergarten classrooms” (p. 568)? To explore this, teachers’ perceptions of science and their self-efficacy in teaching science as reported on the science questionnaire will be explored in comparison to the researcher’s observations.

**Teachers’ Perception of and Self-Efficacy in Teaching Science**

Looking at the results from the science questionnaire as a whole (all teachers combined $N = 8$), it is interesting to note that 100% of the teachers agreed that science should be taught in preschool, is age appropriate, and important and 87.5% of the teachers reported feeling comfortable planning and explaining science activities. However, only 62% felt confident in their own education in science, and only 50% felt
strongly in their ability to answer children’s science-related questions. These results show that while teachers have a strong, positive perceptions of science in preschool and feel confident planning and explaining their preplanned activities, expanding on the topic and/or fielding unknown questions appears to be a concern. These results were reflected in the following three observations:

• Anne (Apple School): Anne noted that science “is very important in preschool” because “children learn through exploration and science opens that avenue for young children.” Yet, when building with the children using tile magnets, Anne frequently directed the building (“Let’s build a train” and “Let’s connect the train to the boy’s castle”) and did not encourage problem solving. In fact, she often problem solved without collaborating with the children at all: “Let’s build it first and then put bears in because the bears are too heavy and are breaking it.” Anne also asked many closed-ended questions such as “Have you been to a zoo?” and “Have you ever seen a polar bear?” Her reliance on closed-ended questions and directing play were reflected in her neutral response to the question, “I am worried that the children will ask me a question about science that I cannot answer.”

• Brenda: When Brenda presented the snowman to the class, she did not want the children to touch the snow and asked many closed-ended, abstract questions such as “What is this?” and “What did this used to be?” (referring to a bag filled with water). Moreover, Brenda frequently referred to cartoon snowmen such as Frosty the Snowman and Olaf (from the movie Frozen) when discussing real snow. Interestingly and in contrast, Brenda noted that “Hands-on experiences work best, we try not to force learning on them, stick to topics they are interested in. We try to
nurture the child’s sense of adventure and curiosity.” However, closed-ended, abstract questions and controlling the direction of classroom discussions and activities does not support this statement; it is indicative of a teacher who may lack confidence in her abilities.

- Bobbi: The strawberry art project Bobbi planned for the children was a closed-ended, product over process, and wholly a teacher directed art activity (while this was technically an art project, strawberries were the subject and Bobbi categorized it under science and art). Children were given precut strawberry shaped pieces of paper with black crayons and red watercolor. Bobbi held a plate of strawberries cut in half with the stems and leaves removed. She told the children that the spots on the berry were seeds. She also instructed the children not to touch the strawberries and held the plate the entire time while she walked between the two art tables. The children were instructed to use the black crayons to make the seeds and when done, to color over it with the red watercolor. However, Bobbi noted that children learn science best when they can be “physically involved and hands-on.” Again, her answers are not reflected within her planned activities.

These three examples uncovered another prevalent theme, a serious disconnect between teachers’ classroom practices and their self reported perceptions of science. While all three teachers expressed positive perceptions of science, when faced with putting this into practice in their own classrooms, their lack of self-efficacy in teaching science hindered their practice. In contrast, there were also instances of positive perceptions of science coupled with positive self-efficacy reflected in the results from the science questionnaire and the classroom observations:
• Cathy: Cathy engaged with the children in every instance of spontaneous science that was observed. From the insect hunt to watering the “sick” flowers to the rocket fuel discussion, Cathy picked up on the children’s interests and cues and supported the children with open-ended questions when needed. Her self-efficacy in teaching science was highlighted in her ability to stand back, observe, and allow the children to work together without directing the learning. Cathy responded that: “The children are also frequent initiators (unbeknownst to them) of the science learning. Scientific exploration and discovery are a natural consequence of their daily play.”

• Carrie: Carrie’s interactions with the children were full of collaboration and questioning. Whether she was reading a book about dinosaurs or discussing the consistency of shaving cream, Carrie appeared to be genuinely interested in the children’s ideas and what they had to say. For example, while reading a book to the children, a child correctly guessed that the mystery animal was a monkey. While Carrie could have acknowledged that the child was correct and continued reading, she stopped reading and asked, “How did you know? How was it so obvious to you that it was a monkey?” This illustrates the natural back and forth, reciprocal relationship observed between Carrie and the children in her class. Carrie reported that science is important in preschool because children “have hundreds of questions regarding their surroundings – all to do with discovery and curiosity – how, what, where, why?” From the observations, it appeared that Carrie had just as many questions as the children and collaborated with them to discover the answers.

• Dot: Dot provided a rich environment for the children to explore and allowed the children to investigate without direction or interruption. For example, Dot observed
while a child explored the different ways to pour water from a pitcher. She did not direct or try to interject unnecessary questions; she simply observed and allowed the child to make the discovery. At the end of her observation she stated, “You’ve invented a new way to use a watering can!” 

As was noted in the observations, Dot responded that her class enjoys “having open-ended sensory areas that the children can navigate and create without me telling them what it’s for.”

- Debbie: Debbie felt comfortable enough to honestly express her own lack of knowledge when asked questions that she could not answer. For example, Debbie shared with the children that she did not know the answer to their questions about the ant farm and referred to the instruction manual to find the answers: “We think it may be sand. Let’s look at the booklet to find out.” This shows that Debbie is confident in her abilities as a teacher and it models that it is perfectly acceptable to not have all the answers. Additionally, because she invited the children to explore the instruction booklet together, she reinforced the importance of problem solving through investigation and collaboration.

These examples exposed another prominent theme that emerged from the study: the importance of observation, open-ended questions (when necessary), and the ability to find comfort in the unknown and confidence in collaborating with the children to explore the possibilities. As was noted by Tu (2006), it is important for teachers to remember that “the processes of science are learning processes for us all” and that “it is acceptable for educators to say ‘I don’t know, why don’t we find out together?’” (p. 251).

Scientific inquiry relies on collaboration, investigation, questions, mistakes, problem solving, hypothesizing, and sharing results.
Missed Opportunities

**Materials.** Although the majority of the classrooms observed had science materials and/or science centers that were accessible to the children, during free choice times, very few children visited the science center or engaged with the materials. Aside from the child that retrieved a bug catcher from the science center at the Coconut School, there were no instances in which the children freely explored the available science materials and/or the science center unless there were items set out on a table (tile magnets, sand in a sensory table that was open, etc.). What has been established by the research by Tu (2006) and the current study is that simply having science-related materials accessible to the children does not result in engagement or scientific inquiry. However, properly introducing these mostly unfamiliar and often abstract items to children and demonstrating their function inspires children and results in further exploration and less missed opportunities. As Nayfeld et al. (2011) discovered in their balance scale study, a combination of teacher led instruction and autonomous exploration has shown promising results. This is not to say that free exploration should be replaced with teacher-led instruction. Rather, it is important to strike a balance between the two in which the learning is meaningful, intentional, and placed in a context the children will understand yet still honors the children’s unfettered exploration.

**Spontaneous science.** As was noted earlier, the majority of the spontaneous science that was observed occurred during outside free choice time (insect investigation, water pitcher exploration, static electricity). This is important to note because the classes that had the least amount of planned or spontaneous science (Apple Seed, Apple Stem, Banana Peel) also had the least amount of outside free choice time. Therefore, there
appears to be a correlation between the frequency of spontaneous science and time spent outdoors. In fact, although the Banana Peel children were only outdoors for 30 minutes each day and their outdoor area was small and lacked scientific tools, the children discovered, questioned, and investigated (ants on the trashcan, mud in the yard). Therefore, simply altering the schedule to allow for more outside time may increase children’s ability to engage with the natural world resulting in more scientific investigations and less missed opportunities.

**Art versus science.** One of the most glaring examples of a missed opportunity was illustrated when a child in Angelina’s classroom asked multiple times for someone to watch her “do science” in the science area. None of the teachers accepted this child’s invitation. It was only after the child asked the researcher to join her in the science center, led her by the hand to the science center and said to Angelina, “I’m going to show her [researcher] that I’m a great scientist!” that Angelina finally responded to the child: “You can do science in the art center also.” Again, a teacher missed a wonderful opportunity to support a child in their scientific inquiry. Instead, she was dismissed and her desire to engage in science appeared to be thwarted. As the child stated, “I love science but nobody watches me do science.” The lost opportunity was further magnified when the child eventually gave up and joined Angelina in the art center.

Because “children begin by thinking with others, or at the prompting of others, before they can think in equivalent ways alone” (Seifert, 2006, p. 13), it is important for teachers to create and support an environment that encourages students and teachers to work together as co-researchers. Therefore, it appears that establishing a collaborative learning environment benefits both the children and the teachers. Within this
environment, teachers play an active role in each child’s scientific journey as a co-researcher, explaining the function and purpose of new materials while providing provocations that deepen and extend learning. In essence, preschools may benefit from creating a Zone of Proximal Development around their science programs that support the individual child, scaffolds the learning, and aids the child in reaching the next level of learning.

**Ants on a trashcan.** Another missed opportunity was observed in Brenda’s class. During outside free choice time, a child observed a trail of ants crawling up a trashcan. When Brenda noticed the child’s interest in the ants, she referred to the ants as something that needed to be cleaned up (“See, that’s why we have ants. Spilled yogurt. We need to clean that up.”). She then told the child not to touch the ants, tried to redirect his attention to a blimp passing overhead, and finally removed the trashcan from the yard. Brenda’s systematic disregard for her student’s interest and her attempt to discourage further scientific inquiry is in direct opposition to best practices. In fact, according to Eliason and Jenkins (2012), “National and state standards stress that all children can learn science and that they have the right to become scientifically literate” (p. 214).

In addition to thwarting the child’s scientific inquiry, Brenda’s handling of the situation may have also negatively impacted the child’s development. As Bronfenbrenner illustrated in his Ecological Systems Model, a child’s interaction with and interpretation of the people and events within their microsystems (immediate surroundings) influence development. According to Thomas (2005), this is a reciprocal relationship, while the child initiates transactions with the environment
the environment also initiates transactions with the child that either promote or thwart development. In effect, how the child grows up is also strongly affected by what is said or done to the child – or in the child’s presence – by parents, siblings, other relatives, peers, teachers, coaches, club leaders, and the like. (p. 352)

Because preschool (as a microsystem) is an environment that the child has daily interactions with, interpretations of events within this system will have a direct impact on development.

**Planned Science Activities**

While there were no hands-on, planned science activities observed, the “lessons” (snowman, phases of the moon) that were planned were heavily teacher centered and didactic. Simple adjustments would elevate these lessons to hands-on activities where learning is supported and expanded.

**Brenda’s snowman.** Snow is a multi-faceted and fascinating substance to introduce in preschool. However, for a class that is located in Southern California, snow is something that many of the children may not have experienced. Therefore, it is vitally important to place new items into a context that is relatable to the children. Discussing what snow is, where it comes from, and allowing the children to explore the snow in its natural form would allow them to understand the properties of snow: its natural appearance, temperature, weight, and consistency. Unfortunately, the snow Brenda introduced was formed into a snowman (with button eyes and a carrot nose) and was only brought out of the cooler for a few minutes at a time. Additionally, the children were not allowed to touch it thereby missing out on the vitally important tactile experience that snow offers.
As was noted earlier, Brenda repeatedly referred to the mythical Frosty the Snowman and Olaf when discussing snow with the class. Directing the children to engage in magical thinking when discussing a scientific topic stunts a teacher’s ability to expand on and reinforce scientific concepts and provides the children with inaccurate information. As Piaget’s theory explained, children in the preoperational stage form ideas from their direct experiences in life and “base their general belief about something on a single experience, which may cause a false conclusion” (Mooney, 2013, p. 88). Associating science with fantasy and/or magic handicaps a child’s ability to investigate, hypothesize, or substantiate their findings. According to Eliason and Jenkins (2012), preschool teachers should “avoid making science activities magic; make them a part of the real world and help children to see the cause-and-effect relationship” (p. 220).

Finally, during the second circle time (which was long after the snowman had been put back in the cooler), Brenda held up a Ziploc filled with water and asked the children, “What is this?” to which a child replied, “Water.” Brenda then asked, “What did this used to be?” and another child replied, “A lake.” Brenda replied, “No, not a lake! How could I fit a lake in a bag?”

The expectation that preschool aged children will understand that a bag filled with water was once snow seems to illustrate a lack of understanding of child development and theory. Associating a bag filled with water with a body of water makes complete sense, especially from a child that lives in Southern California and may not have had any experiences with snow. Moreover, it appears that Brenda expected the children to recognize and understand a solid to liquid metamorphosis that they did not actually witness. As Piaget’s theory explained, while in the preoperational stage, children’s
“thinking is focused on states rather than on transformations. Children [often] fail to track what has happened to the materials and simply make an intuitive judgment based on how they appear ‘now’” (McLeod, 2010). Therefore, children need to see changes occur in order to grasp the concept of metamorphosis. According to Thomas (2005), children at this age “are still strongly dependent on perception (how events seem to the eye) rather than on logic (what principles govern events)” (p. 205).

Simply placing snow in a sensory table and allowing the children to freely explore its properties, watch it melt, discuss it with their peers, and support the learning with open-ended questions would have transformed this lesson into a hands-on, interactive activity. Additionally, questions that emerge from free exploration often extend the learning and may provide additional opportunities for exploration.

**Phases of the moon.** As was seen in Brenda’s snowman lesson, Debbie’s phases of the moon lesson could have been adjusted to more effectively meet the needs of the children. Not only was this another example of a hands-off lesson, it was teacher focused and relied heavily on direct instruction. For example, throughout the lesson, Debbie spoke 648 words or 94% of the time while the children as a whole only contributed 44 words (16%). While Debbie attempted to engage the children using Oreo cookies to illustrate the phases of the moon, the children were more focused on when they could eat the cookies than they were the phases of the moon. In fact, 16 of the 44 words spoken by the children (35%) were related to eating to the cookies. A small adjustment such as allowing the children to make their own Oreo cookie moons would have engaged them in their own learning by allowing hands-on participation.
Moreover, the phases of the moon may be a difficult concept for preschool aged children to fully understand. According to the California Department of Education’s *Preschool Learning Foundations Volume 3* (2013):

From a development perspective, the appropriateness of activities for young children that focus on learning about planets in space is highly questionable. Preschool children are not ready to grasp the idea that the earth spins around or that the earth moves around the sun. Therefore they cannot intuitively reason about everyday phenomena such as the day-and-night cycle and causes of weather. (p. 60)

This is not to say that preschool aged children should not be exposed to the phases of the moon. Rather, a less intense, more hands-on approach may be more beneficial. For example, actually observing the moon with the children and documenting the phases (drawings) may have been a more developmentally appropriate approach for this age. As John Dewey stated, “Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results” (“Quote by John Dewey,” 2013).

**Recognizing the Spark**

As was shown in the preplanned science lessons that were observed, a prevalent theme that emerged was a reliance on teacher directed, controlled lessons. When compared to the results from the science questionnaire (Appendix C), a correlation between a teacher’s self-efficacy and classroom practices was discovered. While the majority of teachers reported feeling comfortable executing preplanned science activities, they are less confident in their ability to field questions from the children. To eliminate
this discomfort, children are instructed to listen, not touch, and answer closed-ended questions. These teaching methods eliminate the interaction needed to develop scientific inquiry and douses any sparks of interest.

As the philosopher Jean-Jacques Rousseau said, “The issue is not to teach [a child] the sciences, but to give him the taste for loving them” (“Quote by Jean-Jacques Rousseau,” 2013). Therefore, it is important for teachers to build upon children’s interests and support scientific inquiry when engaging in science-based activities.

According to Siry and Kremer (2011), “We suggest that in building upon these [science] ideas one can work with children to make new discoveries and develop new perspectives that move towards what might be considered to be canonical expectations for science” (p. 653). Moreover, the researchers stressed that rather than trying to teach scientific concepts to children, educators should strive to activate a child’s thought process and support the illumination of their ideas: “Rather than seeing science as a set of ‘truths’ that young children need to learn, we see that in these conversations children reveal their shifting and changing interpretations of what they are investigating and wondering about” (Siry & Kremer, 2011, p. 653). Therefore, science curricula should emerge from the children’s interests with the teacher playing the role as the children’s research partner in the journey.

Furthermore, establishing a collaborative learning environment benefits both the children and the teachers. Within this environment, teachers play an active role in each child’s scientific journey as a co-researcher, explaining the function and purpose of new materials while providing provocations that deepen and extend learning. As Peterson and French (2008) explained “early educators can successfully engage 3- and 4-year-old
children in scientific explanation and inquiry. With supportive adult guidance, young children are capable of engaging in complex, collaborative discussions involving prediction, observation, and explanation” (p. 406).

**Limitations**

The limitations of the current study include a small sample size of eight teachers and only one day (4 hours) of total observation time per teacher. While the original design included 2 days of observations per teacher, due to illness, only one day of observations per teacher was used in the final study. However, while the data was confined to only eight teachers, the findings appear to be consistent with other researchers’ findings. A larger sample, over a longer period of time, would have improved the reliability of the findings. Specifically, a random sample of a variety of early childhood programs may have resulted in a wider-range of findings.

**Recommendations for Future Research**

As has been shown by the review of literature and the current study, the key to successful preschool science programs appears to be confident, inspired, and intentional teaching practices. The spontaneous science that was observed in 100% of the participating classrooms has shown that science is happening all around us, everyday, regardless of the amount of science materials and/or science centers available. However, if teachers do not recognize science or support scientific inquiry, the opportunity to expand on the investigation is lost.

What is the best way to inspire teachers to create collaborative learning environments and embrace scientific exploration in their own classrooms? The progression of the research presented in this study has led to the same overarching
conclusion: sustained pre-service and in-service professional development shows the most promising results. As research has shown, professional development appears to enhance teachers’ own knowledge of science, their understanding of how young children learn scientific concepts, and how to best support and extend children’s science learning through a combination of instruction, scaffolding, and encouraged autonomous exploration (Greenfield et al., 2009; Nayfeld et al., 2011; Roehrig et al., 2011). This is especially important because the majority of the participating teachers reported that science was not discussed in any of their college level child development classes; this lack of education in science may have influenced their own self-efficacy in teaching science. Providing professional development appears to empower educators by increasing their self-efficacy and reinforcing the idea that learning is a lifelong, ever-evolving process. This is especially important in science. As noted by Tu (2006), “it is important for preschool teachers to know that the processes of science are learning processes for all of us” (p. 251).

However, time is an important component of successful professional development. As noted by Roehrig et al. (2011), “Meaningful instructional change takes time and one-shot workshops with limited follow-up in classrooms are ineffective in producing instructional change” (p. 577). Therefore, sustained, long term professional development appears to provide the most promising results. As was shown in the research provided by Roehrig et al. (2011), the successful implementation of an inquiry-based science program into a community that held a bias towards science illustrated the power that sustained professional development and cultural sensitivity may have on all ECE programs.
While the research presented suggests that quality professional development produces positive outcomes, the research did not expose “which of the many components of professional development were the most important in producing these [positive] effects” (Greenfield et al., 2009, p. 259). Additionally, 100% of the teachers in the current study reported that they look online to find ideas for science-related activities. On the other hand, only 14% of the teachers reported that they used ideas from workshops in the classroom. Therefore, further research on science in early childhood education, including the impact the Internet and workshops have on classroom practices and teacher’s self-efficacy, is needed.
REFERENCES


APPENDIX A

Teacher Consent Form

California State University, Northridge
CONSENT TO ACT AS A HUMAN RESEARCH PARTICIPANT

Do You See What I See?
Exploration of Preschool Teachers’ Curricular Practices

You are being asked to participate in a research study. Do You See What I See? Exploration of Preschool Teachers’ Curricular Practices, a study conducted by Katie Leon as part of the requirements for the M.A. degree in Educational Psychology & Counseling. Participation in this study is completely voluntary. Please read the information below and ask questions about anything that you do not understand before deciding if you want to participate. A researcher listed below will be available to answer your questions.

RESEARCH TEAM
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PURPOSE OF STUDY
The purpose of this study is to examine early childhood educators’ curricular practices.

SUBJECTS
Inclusion Requirements
You are eligible to participate in this study if you are currently working as a lead teacher in an early childhood education program.

Exclusion
Assistant teachers are excluded from participating in this study.

Time Commitment
This study will involve approximately 1 hour of your time spread throughout the 2 days the researcher will be visiting your classroom. Actual observation time will be an additional 2 to 3 hours per day for 2 days (4 to 6 total hours of observation); during this time you will continue your regular routine. The final interview should be no longer than 30 minutes.

PROCEDURES
The following procedures will occur: You will be contacted by the researcher to confirm participation and to set up a date and time to begin observations. The researcher will observe your classroom for 2 to 3 hours per day over the course of 2 days (4 to 6 total hours of observation). During this time, you will continue your normal activities. At the end of each day of observation, you will be asked to complete a short survey to categorize that day’s classroom activities. Additionally, you will be asked to complete a short demographic survey gathering information about your educational and employment experiences. A final survey will include questions relating to your classroom curriculum development and implementation to better understand what was observed. Once all surveys have been collected, researcher will schedule an interview to reflect on the observations, to ask any questions needed for clarification, and to answer any questions you may have.

The categorization and demographic surveys should each take no longer than 10 minutes to complete. The final survey should take no longer than 20 minutes to complete. The final interview should take no longer than 30 minutes.

RISKS AND DISCOMFORTS
The possible risks and/or discomforts associated with the procedures described in this study may include: mild emotional discomfort from the experience of being observed or answering questions about your classroom. This study involves no more than minimal risk. There are no known harms or discomforts associated with this study beyond those encountered in normal daily life.

BENEFITS
Subject Benefits
The possible benefits you may experience from the procedures described in this study may include: Understanding how classroom activities can be categorized into different domains and how these activities may cross into multiple domains.

Benefits to Others or Society
Your contribution to this study will help bring awareness to the importance of intentional curriculum development and implementation practices.

ALTERNATIVES TO PARTICIPATION
The only alternative to participation in this study is not to participate.

COMPENSATION, COSTS AND REIMBURSEMENT
Compensation for Participation
As a token of my appreciation, you will receive a $10.00 Starbucks gift card once the visits and surveys have been completed.

**Costs**
There is no cost to you for participation in this study. You will not be reimbursed for any out of pocket expenses, such as parking or transportation fees.

**WITHDRAWAL OR TERMINATION FROM THE STUDY AND CONSEQUENCES**
You are free to withdraw from this study at any time. If you decide to withdraw from this study you should notify the research team immediately. The research team may also end your participation in this study if you do not follow instructions, miss scheduled visits, or if your safety and welfare are at risk.

**CONFIDENTIALITY**

**Subject Identifiable Data**
All identifiable information that will be collected about you will be removed and replaced with a code. A list linking the code and your identifiable information will be kept separate from the research data.

**Data Storage**
All surveys and audio recordings will be stored at the researcher’s home office in a locked drawer. The surveys and audio recordings will be destroyed immediately after the researcher’s thesis is published.

**Data Access**
The researcher and faculty advisor named on the first page of this form will have access to your study records. Any information derived from this research project that personally identifies you will not be voluntarily released or disclosed without your separate consent, except as specifically required by law. Publications and/or presentations that result from this study will not include identifiable information about you.

**Data Retention**
All surveys and audio recordings will be stored at the researcher’s home office in a locked drawer. The surveys and audio recordings will be destroyed immediately after the researcher’s thesis is published. All written research data will be stored on a laptop computer that is password protected.

**Mandated Reporting**
Under California law, the researcher is required to report known or reasonably suspected incidents of abuse or neglect of a child, dependent adult or elder, including, but not limited to, physical, sexual, emotional, and financial abuse or neglect. If any researcher has or is given such information, she may be required to report it to the authorities.

**IF YOU HAVE QUESTIONS**
If you have any comments, concerns, or questions regarding the conduct of this research please contact the research team listed on the first page of this form. If you have concerns or complaints about the research study, research team, or questions about your rights as a research participant, please contact Research and Sponsored Projects, 18111 Nordhoff Street, California State University, Northridge, Northridge, CA 91330-8232, or phone 818-677-2901.

VOLUNTARY PARTICIPATION STATEMENT
You should not sign this form unless you have read it and been given a copy of it to keep. Participation in this study is voluntary. You may refuse to answer any question or discontinue your involvement at any time without penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect your relationship with California State University, Northridge. Your signature below indicates that you have read the information in this consent form and have had a chance to ask any questions that you have about the study.

I agree to participate in the study.

___ I agree to be audio recorded
___ I do not wish to be audio recorded

Participant Signature ____________________________ Date

Printed Name of Participant ____________________________

Researcher Signature ____________________________ Date

Printed Name of Researcher ____________________________
APPENDIX B

Demographic Questionnaire

1. What is your age? If you are comfortable giving your exact age, please do so.
   - ___ 25 or younger
   - ___ 26-40
   - ___ 41-55
   - ___ 56+
   - ___ Exact age

2. What is the highest level of education you have completed?
   - ___ High School
   - ___ Some college
   - ___ Bachelor’s Degree

   If you have a BA, what was your major and year of graduation?

   - ___ Master’s Degree

   If you have a MA, what was your focus of study and year of graduation?

3. What child development/early childhood education classes have you completed?

4. What is your gender (please circle)?   Female   Male

5. What is your first language? How many languages do you speak?

6. What is your cultural background?
7. How long have you been a preschool teacher? How long have you been employed at your current center?

8. What age group are you currently working with?

9. What other age groups have you worked with in the past?

And about your class:

1. Ages, class size, and background of the children:

2. Is this a full-day or half-day program?

3. How would you characterize the families of your children?

   _____ Poverty or below
   _____ Low income
   _____ Middle income
   _____ High to very high income
APPENDIX C

Science Questionnaire

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate statement:

1. I am comfortable planning and explaining science-related activities to my preschool class.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

2. Science should be taught in preschool.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

3. It is important for my preschool class to have a science center that the children can freely explore.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

4. There is not enough time to teach science because I have to focus on other areas such as language/literacy and math.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

5. Preparing science activities takes too much time.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

6. It is not age appropriate for science to be introduced in preschool.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

7. I do not have enough education in science to teach science.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

8. I get ideas for science activities from the Internet.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

9. Science only occurs in the science center.

   Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

10. I am worried that the children will ask me a question about science that I cannot answer.

    Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

11. I do not have enough science materials in my classroom.

    Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree

12. Science activities require too many materials.

    Strongly Agree   Mildly Disagree   Neutral   Mildly Disagree   Strongly Disagree
Please write short answers to the following questions:

1). Reflecting on the Child Development classes you have taken, please answer the following questions:

   • Do you remember learning about science in preschool from your Child Development classes? If so, what class and can you share a few things you learned?

   • Were you given strategies to help implement science activities in your preschool classroom? If so, what were some of the ideas discussed?

2). How often are science-related activities offered to the children in your classroom?


4). How important do you feel preschool science activities are for preschoolers? Why?

5). To what extent do you initiate the science learning in your class? To what extent do the children initiate the science learning?

6). Do you participate in professional development opportunities (e.g., workshops, trainings)? If so, will you please list a few workshops that you have attended within the last year? What do you find most useful as a workshop participant?
APPENDIX D

Teacher Categorization Form

LOOKING BACK AT THE MORNING…. WHAT ACTIVITIES ENGAGED THE CHILDREN?
Please write down each of the activities your class participated in today in one or more curriculum categories. For example, if the class did an art project, note that specific project in the “ART” column (e.g., “Painted with watercolors on paper.”).

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APPENDIX E

Science Materials Checklist

SCIENCE CENTER

TOOLS FOR OBSERVATION & MEASUREMENT

Goggles
Test tubes
Eyedroppers
Funnels
Magnets
Balance scale
Magnifying glass
MIRRORS
Binoculars
Tweezers
PRISMS
3-D shapes
RULERS
Measuring tape
Thermometer
Tactile items (sand/flour/goop) & tools to investigate
(spoons/scoops/funnels/jars/forks/tongs)
Measuring cups
Cookie sheets
Muffin tins/egg cartons (sorting, categorizing)

**NATURAL ITEMS**

Natural items (Shells/pinecones/rocks/feathers/leaves/fossils)

Plants

Animals

Water/sand table

Outdoors garden

**REFERENCE MATERIALS**

Clipboards

Paper, pencils

Science-related books & magazines

Maps

Globes
Dear Committee Members:

Katie Leon has permission to conduct the project entitled, Do You See What I See? Exploration of Preschool Teachers’ Curricular Practices at Van Nuys Civic Child Development Center. I have reviewed the project and am aware of all the activities involved in the project including observations, questionnaires, and interview.

Signed,

[Insert name and title of authorized official]
APPENDIX G

Human Subjects Protocol Approval

Student Researcher

HUMAN SUBJECTS PROTOCOL APPROVAL FORM
CALIFORNIA STATE UNIVERSITY, NORTHridge

1. Title of Research: Do You See What I See? Exploration of Preschool Teachers' Curricular Practices

2. Principal Investigator: Katie Leon
   Home Address: 4949 Placidia Avenue North Hollywood, CA 91601
   Email: katie.lean.980@my.csun.edu Mobile: (618) 395-2974
   Major or Department: EPCEOE Course Name/Number: EP 686

3. Co-Investigators: Name and University (if applicable):
   1. 
   2. 

4. Faculty Advisor: Carrie Rollstein-Fisch
   Email: carrie.rollstein-fisch@csun.edu Ext: 292

5. Recruitment/Data Collection Start Date: 1/13/14 End Date: 2/28/14

6. Check one: Unfunded or Funded
   Name of Funding Source: 
   Submission Date: 

7. History of Protocol: New Continuing (Previous Approval Date ______)

8. Existing Data: Will this study involve the use of existing data or specimens? YES NO
   If Yes, attach documentation indicating the authorization to access the data if not publicly available and if accessing from an agency outside of CSUN.

9. Subjects to be recruited (check all that apply): specify in Section 2.
   a. Adults (18+ years)
   b. Minors, specify age:
   c. Cognitively or emotionally impaired
   d. CSUN students
   e. Other, specify:

10. Data will include (check all that apply): specify all checked items in the Project Information Form.
    a. Names of people
    b. Email address
    c. Street address
    d. Phone numbers
    e. Age
    f. Gender
    g. Ethnicity
    h. Marital status
    i. Income
    j. Social security
    k. Job title
    l. Names/types of employers
    m. Physical health report
    n. Other, specify:

11. Will subjects be identified by a coding system (i.e., other than by name)? YES NO

12. Is compensation offered? YES NO If yes, describe: $10.00 Starbucks gift card

13. Projected number of subjects: 8 to 10


15. Will there be any deception (not telling subjects exactly what is being tested)? YES NO
    Provide justification for deception and explain how subjects are debriefed in Section 2.

16. Potential Risk Exposure: Physical Psychological Economic Legal Social
    Other, specify: 
    Risk must be specified and elaborated in Section 4.

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17. Data Collection Instruments (check all that apply)
   a. ☐ Standardized tests
   b. ☐ Questionnaire
   c. ☐ Interview
   d. ☐ Existing data
   e. ☐ Other, specify: Observation notes

18. Recorded by (check all that apply)
   a. ☐ Written notes
   b. ☐ Audio tape
   c. ☐ Video tape/film
   d. ☐ Photography
   e. ☐ Observation
   f. ☐ Existing data

19. Administered by (check all that apply)
   a. ☐ In person (group/individual)
   b. ☐ Telephone
   c. ☐ Text message
   d. ☐ Email/website
   e. ☐ Mail
   f. ☐ Existing data
   g. ☐ Other, specify: 

20. Findings used for (check all that apply)
   a. ☐ Publication/presentation
   b. ☐ Evaluation
   c. ☐ Needs assessment
   d. ☐ Thesis/dissertation
   e. ☐ Other, specify: 

21. Are drugs or radioactive materials used in this study? ☐ YES ☐ NO
   If yes, list the drugs or radioactive materials used in Section 1 and provide a detailed description of each, with justification for its use.

22. Are any medical devices or other equipment to be used in this study? ☐ YES ☐ NO
   If yes, describe in detail the medical devices or equipment to be used in Section 2.

23. Did you attach a copy of any questionnaire(s), survey instrument(s) and/or interview schedule(s) referred to in this protocol? ☐ YES ☐ NO

24. Is a letter of permission for subject recruitment attached (if recruiting from an agency outside of CSUN)? ☑ YES ☐ NO ☐ N/A

25. Does your research require international travel? ☐ YES ☐ NO
   If yes, your travel must be approved by the Office of Insurance and Risk Management. Please visit http://www.admin.csun.edu/irm/ for procedures and guidelines.

26. SIGNATURES: All signatures must be obtained prior to submission.
   Faculty signature on this Protocol Approval Form indicates that:
   You and your student are familiar with the regulations for human subject research as defined by California State University, Northridge's Standing Advisory Committee for the Protection of Human Subjects (SACPHS) and you and your student intend to follow those regulations when conducting this study. You have reviewed and approve of this Protocol Approval Form and accompanying documentation. You approve of the manner in which human subjects will be involved in this study.

Signature of Faculty Researcher ___________________________ Date 10-11-13
Student Investigator ___________________________ Date 10-11-13

FOR SACPHS AND RESEARCH OFFICE USE ONLY
☐ Noted, Exempt ☐ Approved, Minimal Risk ☐ Approved, Greater than Minimal Risk ☐ Approved, Expedited Review

Chair, SACPHS ___________________________ Date 10-17-13

CSU, Northridge
Human Subjects Committee
Approved: 10/22/13
Void After: 10/22/14

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Revised 9/13