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AUTHOR McDonald, JoAnn Montes; McDonald, Robert B.

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ABSTRACT

This chapter is a part of a book that recounts the year's work at the Early Childhood Development Center (ECDC) at Texas A & M University-Corpus Christi. Rather than an "elitist" laboratory school for the children of university faculty, the dual-language ECDC is a collaboration between the Corpus Christi Independent School District and the university, with an enrollment representative of Corpus Christi's population. The chapter describes a curriculum model tested during a summer "discovery camp" for 3- and 4-year-olds at the ECDC. The chapter aims to illustrate key components of a developmentally appropriate and need- satisfying early childhood science curriculum model. The chapter discusses the curriculum's objectives, content, scope and sequence, and assessment. The chapter also describes evaluation of the curriculum, which revealed that the children benefitted from the opportunity to explore the natural world, and that teachers developed a greater awareness of the benefits of an inquiry-based science program. (Contains 12 references.) (EV)

Chapter 11

Nature Study: A Science Curriculum for Three and Four-Year-Olds

JoAnn Montes McDonald
Robert B. McDonald

Introduction

To many, the idea of designing a science curriculum for three- and four-year-olds may seem without merit. Distracted by personal and societal images of uncombed men in lab coats and spectacles, these individuals are perhaps deceived into believing that learning science is something only a "mature" mind can accomplish, and therefore, best left for the upper grades. In the worst examples of this type of thinking, we have observed primary and elementary schools that exclude the study of science altogether in order to focus on "the basics" of mathematics and reading. Typically, schools following this agenda serve high numbers of disadvantaged children and have a history of less-than-glowing scores on state mandated tests. If questioned regarding the practice, administrators at such schools will usually try to justify the exclusion of science by stating that children need to master the basic skills of reading and mathematics before they can attempt to master science concepts. In our opinion, arguments such as these arise from differing definitions and attitudes about what constitutes science rather than children's abilities to construct understanding involving science concepts. A lack of respect for children's ability to construct understanding from real-world experiences and an overemphasis on symbolic language systems also generally colors the perceptions of advocates of such practices.

But what is the solution to these and other problems surrounding the education of young children? If there is a need for science instruction during the pre-kindergarten years, what curriculum would be most appropriate? The following sections will discuss a curriculum model tested during a summer "discovery camp" for three- and four-year-olds at the Early Childhood Development Center on the campus of Texas A&M University-Corpus Christi. It is our hope that this article will illustrate some key components of what we believe to be a developmentally appropriate and need satisfying (Glasser, 1990) early childhood science curriculum model.

Program Description

The purpose of the summer discovery camp was to provide intensive integrated language experiences for pre-kindergarten students from culturally or linguistically different (CLD) and/or low socioeconomic backgrounds. A three-pronged interdisciplinary instructional approach emphasized learning through exploration of the natural world, dramatic play, and literature. The children were selected from a pool of students who had completed a year in a public school pre-kindergarten program and demonstrated a need for supplemental readiness instruction prior to kindergarten. The majority of the children enrolled were of Mexican-American heritage. Teachers and students were housed at two local public elementary school campuses and were bused onto the university campus for the one-week discovery camp that was a component of a larger five-week summer school program. During the summer of 2000, a total of five groups of 80 to 100 pre-kindergartners attended the weeklong camps along with their classroom teachers (N=~400). Preservice teachers enrolled in a biology course and an early childhood course at the university were participant-observers and served as "helping hands" during the discovery camp. Prior to the beginning of the program, university faculty, program administrators, and pre-kindergarten teachers met to explore and discuss the philosophy and nature of the curriculum for the discovery camp.

The Curriculum

Objectives

Perhaps the logical place to begin the quest for a developmentally appropriate early childhood science curriculum is with a discussion of objectives. Objectives define what one is seeking to accomplish by exposing young minds to a course of study. Is the primary objective to teach some collection of factoids, words, skills, or processes? Perhaps the objectives are more focused upon affective outcomes such as teaching desired attitudes or fostering the development of a certain predisposition in the learners. The question of what to include in a curriculum is both ancient and perplexing. In practice, most commercial curriculum writers attempt to "cover their bases" and include objectives and content related to both the cognitive and affective dimensions of learning. While we endeavored to include materials, strategies and experiences to stimulate both cognitive and affective outcomes in our design, we went a bit further and attempted to include culturally relevant and developmentally appropriate materials as well. By using common local objects and organisms as a focus of lesson design, we hoped to include content and activities that were likely to be repeated and enhanced through the day-to-day experiences of the learners. This attempt to forge important connections between the learners' daily lives and the content illustrates our belief that, although the early childhood science curriculum should probably include certain key concepts and skills, attitudes and other psychosocial constructs are of at least equal importance in the development of young explorers. Liberty Hyde Bailey (1909) alluded to this important affective component in science learning with the following comments:

> At first the interest in nature is an affair of the heart, and this attitude should never be stifled, much less eliminated. When the interest passes from the heart to the head, nature-love has given way to science. Fortunately, it can always remain an affair also of the heart, but the dry teaching of facts alone tends to divorce the two. When we begin the training of the youth by the teaching of a science we are inverting the natural order. A rigidly graded and systematic body of facts kills nature study; examinations bury it (pp. 60-61).

Howard Gardner (1995) has further developed this notion of children as naturally curious and self-directed seekers of understanding in his identification of a basic "class" of intelligence he calls "the naturalist." For Gardner, there are many ways for a child to be "smart," and the naturalist intelligence is but one component in the overall human intellect (Checkley, 1997). As with other intelligences (e.g., mathematical or linguistic), Gardner theorizes that different individuals possess different levels of ability and skills as naturalists. According to Gardner (1995):

> "The intelligence of the naturalist involves the ability to recognize important distinctions in the natural world (among flora, fauna). It can also be applied to man-made objects in our consumer society (cars, sneakers). Obviously, this skill is crucial in hunting and farming cultures, and it is at a premium among biologists and

> others who work with nature in our own society. I first became aware of this intelligence when I realized that I could account for the abilities of many scientists, but not those of a Charles Darwin or an E.O. Wilson" (1996, 202).

Young children are naturally curious. By exploring and interacting with the world around them, three- and four-year-olds discover information about their environment. These personal experiences with nature influence their development of ideas about the natural world. Children construct "stories" or maps that represent their personal experiences and/or understandings about nature (Wilson, 1996). In our opinion, a primary consideration in developing early childhood science curriculum is creating a program of study that nurtures the young child's innate abilities (including their abilities as "naturalists") and connects to their personal experiences, but does not impose adult frameworks and motivations on young learners. In this spirit, much initial planning and consideration of the prior knowledge possessed by young children regarding the natural world is necessary in designing curriculum to meet the needs of young learners. With these considerations in mind, we set out to develop a meaningful early childhood science curriculum.

Content

Perhaps no other single topic has generated more debate in educational circles than the perplexing dilemma of "what knowledge is most worth knowing?" Since humans first began to recognize the importance of formal schooling, pedagogues and philosophers have repeatedly identified, embraced, and then abandoned content frameworks designed to provide a generic set of knowledge and skills that "all students need to know" to master various bodies of content. Generally, these collections of ideas have been organized into "conceptual frameworks" that supposedly follow the "logic of the discipline." Importantly, this practice has continued to this day.

Because much of a child's early experiences with nature occur around the home, we initially selected "science in the backyard" as our guiding theme. We quickly realized that even this well-defined topic was too broad for a summer program of short duration. When a colleague in theater arts suggested that "the garden" might be a more appropriate theme for a short summer experience, we enthusiastically agreed.

One final consideration in designing a curriculum for the summer discovery camp was the issue of relevance. Schollum and Osborne (1985) postulated that the relevance of what children do in school settings, to everyday events and to existing ideas, was of primary concern to the teaching and learning of science. In order for experiences to be relevant, they should relate to the world outside the classroom in ways that help children develop an understanding of that world and to make sense of it in new ways. With these and other lofty thoughts guiding our efforts, we boldly set out to design a developmentally appropriate science curriculum for four-year-olds.

To begin the process of identifying appropriate content for our early childhood science curriculum, we consulted several contemporary sets of "standards" for elementary science programs, including the *Texas Essential Knowledge and Skills* (TEKS) and the related (but far from identical), *Academic Standards* of our local school district (Texas Education Agency, 2001; Corpus Christi Independent School District, 2000). Using these documents as references, we began to try to identify key concepts and skills that could be taught in a short period of time and were relevant to our student population. We found that four basic inquiry process skills emerged as key elements of the standards for early childhood science education: a) observing–using the four senses, b) classifying–sorting objects, organisms, or events, c) quantifying–comparing, counting and measuring, and d) communicating–sharing findings. It should be noted, that these process skills are interdisciplinary, cutting across curricular areas. The same four process skills key to science learning are prerequisites to reading and mathematics. Indeed they are the basic tools children have used since birth to explore and make sense of the world around them.

In addition to process, the standards contained a substantial amount of material relating to biological concepts such as distinguishing between living and nonliving objects, the basic needs of all living things, and characteristics and parts of living organisms. Taking into consideration the process and content emphasized in the standards and the need to connect to the learner's real world experiences, it was ultimately decided that we would focus on our local environment. That established, we began to identify natural phenomena that most four-year-olds would be likely to have experience with in their personal environments.

Scope and Sequence

One of the challenges facing the prospective designer of curriculum for young learners involves the conceptual sequence in which the content is to be presented. The writer is confronted with the problem of deciding, "what comes first?" In traditional curriculum design, the curriculum writer often relies on various established guidelines in order to sequence learning experiences. This process involves using traditional outlines such as textbooks to organize experiences designed to teach content knowledge. Another method of structuring learning experiences uses the writer's "reconstructions" of personal learning experiences as a template with which to understand, and make predictions concerning, the behavior of all learners. Clearly, the use of this strategy poses a number of problems, including the obvious potential for mismatch between the curriculum writer and the learners in a particular classroom. With these shortcomings in mind, we began to contemplate appropriate content for a lesson on gardens. First, we brainstormed ideas concerning what concepts are important in designing a gardening unit for very young children? What kinds of concepts should be included?

Soil

We decided that the program would begin with one day of soil exploration. Intuitively (and incorrectly), we initially assumed that most, if not all, children would have generated considerable understanding regarding "dirt." We believed this because both of us had spent considerable time playing in the dirt as children. We also had prior knowledge of our own daughter's early years, and these included substantial experiences making "mud pies" and sand castles, and engaging in other activities involving soil. In our experience, young children enjoy holding, squeezing, and shaping soil. By capitalizing on children's interest in soil, we hoped to focus their attention on the following questions:

What is soil made of?
What are the living and nonliving components?
How can components of soil be separated?
How is soil important?
Do seeds need soil in order to grow?

Large tubs of a variety of soils were placed in classrooms along with a variety of strainers, sifters, sieves, scoops, trowels, spoons, bowls, and trays. Children were encouraged to find out what soil was made of and to sort the materials they found onto trays. Teachers asked students to identify what they found in soil and decide if it was living or nonliving. Children used magnifying glasses to further examine the soil and the small living organisms found in the soil samples. Their discoveries were recorded in pictures and words on large charts used to facilitate further discussions of soil. During story time, books on soil were read aloud and children talked further about their soil experiences.

Seeds

Days two and three focused on the study of seeds. Seeds provide a perfect spring board to explore numbers, color, shape, size, taste, texture, and patterns. We viewed seeds as culturally important because children's first experiences with seeds are often through the foods they eat. Most four-year-olds know that many of the fruits and vegetables they eat contain seeds. However, we also assumed that many children could identify the names of foods that they didn't realize were seeds (e.g. peanuts, corn, and beans). We wanted to capitalize on and enhance the children's prior knowledge of seeds by posing the following questions:

How are seeds alike? How are they different?
How many ways can seeds be sorted?
Where do seeds come from?
What sounds do seeds make when shaken in a container?
How many seeds are in particular fruits or vegetables?
What do they look like?
Which seed do you like to eat best?

Children dissected a variety of fruits and vegetables and collected the seeds. They counted the seeds and glued them onto cards. The teachers helped them create a chart to display their discoveries. The students also had a seed-tasting party in order to identify their favorite seed to eat and graphed their results. By gluing seeds on popsicle sticks, children created original patterns and had opportunities to count. They created musical instruments by placing a variety of different seeds into containers made of various materials. During dramatic play, the students used their instruments to simulate the sounds of rain and thunder as well as to move rhythmically to the sounds they created. Finally, children had the opportunity to plant seeds in soil and put them in small baggies with moistened cotton balls to create living plant necklaces. A variety of picture books on seed topics were available for the students to "read" independently and teachers utilized these books during read aloud and shared reading time.

Leaves

Plant parts, specifically leaves, were the focus for day four of the discovery camp. We believe that plants are an integral part of every human's experiences. Humans use plants for food, shelter, and clothing. Plants are found just about everywhere, even in urban environments. For these reasons, we felt that plants were an important component of this unit of study. Questions to guide the leaf explorations included:

What are leaves?
Where do leaves come from?
How do we use leaves?
How are leaves alike? How are they different?

As soon as children arrived on day four, teachers announced that the class was going on a leaf scavenger hunt. A short discussion of the rules of collecting plants (e.g. Don't pull up the entire plant.) and a safety warning (Some plants are poisonous. Don't put leaves in your mouth.) ensued. Children received paper sacks in which to collect leaves that caught their fancy. University students and teachers guided the scavenger hunts to appropriate areas of the campus for collecting leaves.

Once back in the classroom, children went to one of three leaf centers. One group gathered in a circle to share their collections with one another. Questions were used to encourage students to communicate their observations. Some questions included:

Which is your favorite leaf?
Why?
What does your leaf feel like?
What is the shape of your leaf?

Another group of children used the leaves they collected to make leaf rubbings and presses, while others sorted their leaves by shape onto a large sorting chart. All the while, teachers encouraged children to discuss their thinking and share their ideas with one another. Finally, the class had a leaf relay in which each child ran down to a large container of leaves looking for one to match the leaf they already had in hand. Children enjoyed the game immensely and insisted on running the relay over and over, changing their leaves each time.

Discovering insects, spiders, and crustaceans

Although the study of insects, spiders, and crustaceans was formalized on day five of the discovery camp, it really began on day one when students discovered the many small living organisms hiding in the soil they explored. The excitement and interest generated when a small eye detected a shy earwig or rolly poly scurrying beneath a decomposing leaf validated our inclusion of this topic for exploration. Because insects make up the majority of living organisms in the natural world, young children have many opportunities to observe and study them. Because of limited time, we focused on three organisms: crickets, spiders, and rolly pollys. These organisms seemed particularly appropriate because they are common visitors to the garden, and many four-year-olds have already herded a rolly poly or listened to the chirping of crickets prior to coming to school. In order to guide students' observations, we posed the following questions:

What kinds of things might we find living among the plants in the garden?
What kinds of living things did we find in soil?
What do crickets (rolly pollys or spiders) eat?
Where do crickets (rolly pollys or spiders) live?
How are crickets and spiders different? Alike?

Earlier in the week, several somewhat large tunnel spiders were captured from the soil samples and placed in clear plastic habitats along with soil, leaves, and small sticks. Much to the delight of the children, these enterprising weavers quickly constructed silk tunnels connecting their burrows underground to the surface of the leaves. Each day the children eagerly ran to the containers to see if the spiders were perched near their tunnels waiting for an unsuspecting insect to happen by. On day five, large clear plastic tanks filled with crickets and rolly pollys were placed on tables along with hand lenses, drawing materials, and clay. Children were divided into three groups for learning centers. Each group had the opportunity to observe closely the living organisms and participate in a discussion of their characteristics. Then they were asked to make a model from clay or to draw a picture representing the organism of their choice. In addition, students conducted simple investigations to find out what environmental conditions the organisms preferred. They placed different items of their own choosing such as grass, soil, a wet sponge, or a rock into the tank to see where the organisms would congregate.

In another center, we introduced the children to a large tarantula using a video microscope that projected an enlarged image of the spider onto a television monitor. With the spider displayed on the screen, a university biology professor talked with the youngsters about the anatomy, characteristics and habits of spiders. Scientific language was introduced to describe the body parts of the spider. Children were encouraged to compare the spider's body parts to their own anatomy and to use the new science terms that had been introduced (e.g., abdomen). They could approach the television monitor and point out or identify body parts as well as ask questions about the spider's anatomy. It also gave them an opportunity to compare the tarantula to the smaller tunnel spider they had been observing all week.

At other stations, teachers placed a wide assortment of picture books dealing with insects and spiders onto tables for children to explore. Many of the teachers chose Eric Carle's *The Very Quiet Cricket* (2000) or *The Very Busy Spider* (2000) for the day's shared reading activity. Finally, the children sang "There was an Old Woman Who Swallowed a Spider" and acted out the animal parts.

Assessment

Because the intent of the summer discovery camp was to provide the students with rich experiences with the natural world and to develop their language skills, and not necessarily to teach facts or content, no attempt at formal science knowledge assessment was planned. However, we used several nice informal performance assessments during the summer program to help us monitor students' construction of understanding. These included sorting and graphing information, building models of spiders and insects, acting out the sprouting of seeds, using tools, and classifying living, non-living and once living objects. Finally, a survey of teachers was conducted to find out how they felt about the curriculum used in the summer discovery program and how well it served their needs.

Data Collection

In addition to our roles as facilitators of the discovery camp, we also acted as "participant observers" (Patton, 1990), collecting and triangulating qualitative data in a variety of ways, including direct observation and recording of anecdotal evidence; informal interviews with children, teachers, and university students; video-tape of teachers and students working together, and written field notes collected by university student helpers.

University students working in the classrooms acted as participant observers recording their observations of the four-year-old students' responses to the explorations. Prior to entering the classrooms, the preservice teachers and their biology professor discussed the guiding questions framing each day's investigations. These discussions served as advance organizers for categories of data collection. For example, on day one, university student helpers were prompted to ask soil related questions and to note the responses to the questions as well as the behaviors exhibited by the four-year-olds. After each observation, university students compiled their field notes and turned them in to the professor. These data points were particularly rich because they not only provided insights into the responses and behaviors of the four-year-old students, but reflected the learning and concerns of the preservice teachers as well.

What We Learned

Reflections on the Program

At the conclusion of the five-week program, we felt that the experiences and skills we identified as key components of the program proved to be appropriate. We also realized that some of our initial assumptions about the prior experiences common to four-year-olds were heavily colored by our own prior knowledge. For example, we chose topics and objects that we assumed the young learners had probably already encountered in their real world experiences. Although many of the young children shared personal stories about their experiences with soil, plants, insects, and other natural materials, this was not the case for all students. We also observed that some children came to the program with reservations about interacting with some of the natural materials or living organisms we provided. When we introduced the students to soil, a few students commented that soil was dirty and they didn't want to touch it. They seemed frightened of what they might find. They were persuaded to join in the soil explorations only when they observed their peers gleefully sifting leaves, roots, sticks, and worms from the dirt. While not all children had positive prior experiences with the topics presented in the garden unit, it seemed that they all were naturally curious about the objects, organisms, and events explored. When children either lacked experience or had negative prior experiences, they seemed to hold back and watch other children interact with the objects or organisms before deciding to join in the explorations. They often chose to sit or stand near other children and carefully observe them, participating vicariously through their peers. However, we also noted that there was not a single child who didn't voluntarily join in the activities by the end of each day. These findings strengthen our belief that learning is a social activity (Vygotsky, 1978).

One of the strengths of the summer discovery program was the participants' development of language. Children often delighted in the new words they encountered during interactions with teachers and other adults. It was common for the children to repeat a new word numerous times, stretching out the sounds as if they enjoyed the way the words rolled off their tongues. The word "bamboo," for example, became "bamboooo." Importantly, much of the new vocabulary was internalized and children were able to use it during independent conversations without prompting from the teachers.

As children constructed understanding from their experiences with the natural world, they often lacked the appropriate labels for objects or organisms. This lack of vocabulary did not limit their ability to describe their observations. For example, when one young boy spied an earwig disappearing into the soil, he called out, "Look a pincher bug!" This child generated a word to describe the earwig, an odd-looking insect with small pincers extending from its abdomen, based on a single critical attribute. This ability of young children to invent language to describe objects, events, or organisms was observed in previous research (McDonald, 1993). As students needed to communicate with others, they often invented descriptive terms or labels to convey meaning. In order to invent these terms, the students first observed the organism or object, categorizing the new phenomena based on some prior knowledge of the natural world. In the case of the "pincher" bug, the young boy explained that he thought the pincer like appendages at the end of the abdomen-resembled pincers of a crab. Because the child understood that animals with pincers could pinch, he adopted the name of an attribute to help describe an unknown organism with a similar anatomical feature.

One final finding of interest concerns the emergence of children's schema regarding soil/plant/insect interactions. Although, most of the preschool children lacked a clear understanding of the exact nature of the important interactions between soil, plants, and insects, they were beginning to develop a sense of "connectedness" among the three. When asked what soil is made of, the four-year-olds most often replied that it is made of seeds, plants/leaves, worms, or insects. Because children often find plant or animal parts in soil, they may have drawn the conclusion that soil originates from such sources. Alternatively, perhaps the children had assumed that plants, seeds, insects, etc. are produced by soil! This notion of spontaneous generation of life from soil has had its proponents, including respected thinkers such as Aristotle.

In addition, the students had begun to develop schemas regarding plant and soil relationships. When asked about the importance of soil, the four-year-olds often described plant and soil interactions. The following student comments reflect the children's growing awareness of these ecological principles (personal communication, July 2000):

> "Dirt is good because it grows things like plants.
>
> Soil helps plants because that is where they put their roots so they can hold onto the ground.
>
> Plants stick their roots into the ground and suck up all the water and food.
>
> Dirt is important because bugs live in it and plants grow in it".

Regarding Preservice Teachers

While our primary interest was in evaluating the effectiveness of the curriculum, other important trends emerged from the notes and observations of the preservice teachers helping in the classrooms. All of the university students appeared to be positively impacted by their participation in the discovery camp. They enjoyed interacting with the four-year-old students as they got the opportunity to try out instructional approaches and strategies that they had learned about in university classes. Moreover, the preservice teachers expressed an excitement for teaching science. The following comments are typical of those made by preservice teachers in field notes or during informal conversations:

> The [four-year-old] students really enjoyed these activities. I also enjoyed seeing the students so excited about science. I hope to use these activities in my future classroom. I hope I can make science meaningful and exciting for my future students. (Judy, personal communication, June 19, 2000)

> Thanks again for letting me experiment with the kids and showing me what to expect in the classroom. The kids are the best explorers to hang around with. (Diana, personal communication, June 27, 2000)

> The children can't wait for us to come back. It was a lot of fun working with the children. More interaction with children during university classes is needed when someone is going into the field of education. It gives us a chance to try out methods and activities to see what works.
> (Diana, personal communication, June 19, 2000)

> I had the opportunity to teach and talk to a small group of children during the activity. I really enjoyed this, as it gave me a chance to practice teaching before I have to student-teach.
> (Tina, personal communication, June 26, 2000)

Preservice teachers also valued the opportunity to watch young children as they constructed knowledge. Many of the preservice teachers expressed surprise at the amount of prior knowledge the four-year-olds demonstrated during their science investigations. The following statement was typical:

> I thoroughly enjoyed this program and working with the young children. It is incredible the knowledge that each one brings to class. I couldn't believe the words they already knew...like sprout and roots. I am anxious to return to this class and observe the students and their seed plantings. Working with these young children stirred in me the excitement of teaching science and the incredible force of curiosity.
> (Martha, personal communication, June 19, 2000)

One university student noted that working in the discovery camp validated her choice of teaching as a career:

> I believe that the students were very excited and that they learned a lot from our discussion about dirt, as I did. This just confirms the fact that I want to be a teacher, and I cannot wait until I get into a classroom of my own and teach and learn.
> (Tina, personal communication, June 20, 2000)

One particularly interesting finding was that the preservice teachers viewed the practicing classroom teacher with whom they were paired as either a facilitator or a barrier to their learning about teaching. Many of the university students reported that their teacher partner allowed them to guide their own small group of students through the investigation. In every reported instance, the preservice teacher felt that the experience was a positive one in which they had the opportunity to practice their skills and learn more about young children. Preservice teachers placed with more teacher-centered partners reported frustration. University students compared two different classroom teachers with whom they had been partnered:

> I found this visit to the classroom was quite different from the first one. This head teacher seemed to hold a tighter grasp on her classroom; she more limited our activities with the students.
> (Ann, personal communication, June 26, 2000)

> Comparing this week with last week to me is hard because I didn't have any say in what was done last week. The teacher would not let us [preservice teachers] have any control over anything. This week the teacher was a lot more willing to try things. She asked our opinion. We made modifications from group to group.
> (Araceli, personal communication, June 26, 2000)

Overall, preservice teachers enjoyed working closely with in-service teachers, particularly if the partner teacher encouraged and nurtured the prospective teacher's active participation in the activities. Preservice teachers felt that they learned most about teaching when they were able to try out instructional strategies during small group investigations and then have an opportunity to discuss the day's activities with the classroom teacher. The following comment from one student reflects the general attitude of most of the preservice teachers:

> The teacher I worked with this week was a lot better than last week's teacher. She made me feel comfortable with the children and I liked her teaching skills. We always talked about the activities, but she let me do things in my own way. She let me work with a small group of children by myself.
> (Kathy, personal communication, June 27, 2000)

Conclusion

The results of this study strongly suggest that early childhood programs developed as a result of university/public school partnerships can reap benefits for all involved. Young children benefit from the variety of science experiences offered and the opportunities to explore the natural world. Preservice and in-service teachers develop a greater awareness of the benefits of an inquiry-based science program. Such experiences can also foster positive attitudes toward science and science teaching among preservice and in-service teachers as well as young children. By working cooperatively with in-service teachers, perspective educators are given valuable experience in hands-on science instruction in a safe environment where they are not solely responsible for planning and teaching. University students are also afforded opportunities to observe more experienced educators modeling instructional strategies and techniques for managing the pace and direction of instructional delivery. Therefore, it is equally important that preservice teachers work cooperatively with caring and competent in-service teachers that understand their crucial roles in nurturing the knowledge and skills of future generations of teachers.

These findings have important implications because most teacher education programs have eliminated or substantially cut back "methods" courses. For prospective educators to develop a strong sense of self-efficacy for teaching science, they need opportunities to observe effective teachers. In addition, these results indicate that providing opportunities for preservice teachers to practice what they have studied in university classes may be critical if true learning is to take place.

As teacher preparation programs move from university lecture halls into public school classrooms, opportunities for greater collaboration between universities and public schools will certainly flourish. These collaborations can provide the environment in which strong inquiry-based science programs for young children can be developed and tested.

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Author(s): Cassidy, Jack and Garrett, Sherrye (eds.)

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Signature: Jack Cassidy

Printed Name/Position/Title: Jack Cassidy Author

Organization/Address: 6300 Ocean Drive Corpus Christi, TX 78412

Telephone: (361) 825-5611

FAX: (361) 825-3377

E-Mail Address: ~~jcassidy@tamucc~~ jcassidy@falcon.tamucc.edu

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