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Scaffolding as a Tool for Environmental Education in Early Childhood

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This paper describes the process of "scaffolding" as a teaching strategy in early childhood education, and demonstrates how scaffolding can promote children's learning about the natural environment. Examples of scaffolding are provided from seventy-four running record observations made over a two-year period in a nature-based preschool program. Qualitative analysis examined the extent to which scaffolding was used to support children's learning about nature; the types of scaffolding strategies used by teachers; whether high- and low-support strategies were used in specific types of situations; the effectiveness of scaffolding; and what children learned when teachers engaged them in scaffolding. Examples illustrate specific pedagogical strategies used in scaffolding. Scaffolding was used relatively frequently within the program (21% of events analyzed), and inferential questioning was the most frequently used strategy. Analysis did not reveal a pattern of high- or low-support strategies used in specific types of situations, but teachers flexibly used a variety of scaffolding strategies to support children's learning about the natural environment. Preparation of physical and social environments for effective scaffolding is discussed, as well as the role of scaffolding in socializing children to engage in a culture of inquiry.

Keywords: early childhood, environmental education, scaffolding, nature

Burgeoning interest in environmental education in early childhood has been a catalyst for sharing theories, concepts, and methods across the disciplines of early childhood education and environmental education. There is a great deal of complementarity in the philosophies, theories about teaching and learning, and best practices in these disciplines. For example, developmentally appropriate practice in early childhood education (e.g., Copple & Bredekamp, 2009), the essential underpinnings of environmental education (NAAEE, 1999), and the various guidelines for excellence in environmental education (e.g., NAAEE, 2010) share principles of active, authentic learning experiences that are integrated across curricular domains and support holistic child development. Effective practice in early childhood environmental education requires mastery of skills from both disciplines. The purpose of this paper is to sustain the synergy between these disciplines by defining and describing the process of "scaffolding," a central teaching tool in early childhood education, and demonstrating through examples how scaffolding can effectively support children's learning in a nature-focused preschool. This paper is part of a larger investigation of how experiences in nature can support children's development, what children learn about nature and natural environments, how they learn it, and what teachers do to support children's learning about nature.

Scaffolding is a metaphor that refers to the ways in which adults or more sophisticated peers provide support for children as they learn (Bruner, 1957; Wood, Bruner, & Ross, 1976; Vygotsky, 1978). Analogous to the way that scaffolding is built to just the needed level when constructing a building and then removed when the building is complete, educators engage in scaffolding by providing the necessary level and type of support that is well-timed to children's needs. Vygotsky (1978) proposed that scaffolding is most effective in the "zone of proximal development" (ZPD), or support that is calibrated to skills or knowledge that is just above that which the child already possesses, and which the child can master with support but not alone. The process of scaffolding will be further described in the following sections. A variety of pedagogical strategies for scaffolding will be identified and the roles of teachers in scaffolding will be explicated. Finally, scaffolding will be situated within the context of natural environments. The abundance and spontaneity of learning opportunities in nature make scaffolding an ideal tool for environmental education.

Scaffolding and learning in the preschool years

Scaffolding is a manner of teaching whereby the instructor assists learners in their acquisition of some skill or knowledge (Wood et al., 1976). Whether the task is solving a math problem or mastering a skill, the learner must gradually become more knowledgeable about the topic; this can be accomplished in part through the use of scaffolding. Scaffolding has proven to be particularly effective during preschool years (Jacobs, 2001). The strategy works through a hierarchical program in which the learner first accomplishes simple, "lower order" skills or problems which aid the learner in approaching progressively more difficult (though related) topics and achieving more complicated, “higher order” tasks (Wood et al., 1976). While a certain level of intentionality and preparation is required of teachers in order to use scaffolding strategies, the teaching opportunities themselves arise spontaneously. The current study focuses on interactions between preschool children and teachers as they occurred during free play in nature and on nature hikes.

Teachers’ role in scaffolding

To effectively employ pedagogical strategies in scaffolding, a teacher must adequately understand the strengths and needs of each learner and adjust his or her strategy accordingly. This is especially pertinent for spontaneous teaching opportunities when the teacher must determine what level of support the individual learner needs (Wood et al., 1976). For instance, when a new concept or skill is being introduced, the learner requires high-support strategies (O’Connor et al., 2005). High-support strategies include eliciting, giving hints, and co-participating (See Table 1; Pentimonti & Justice, 2010). Low-support strategies are used when the learner begins to show signs of maturation and progresses to “higher order” tasks. Low-support strategies include generalizing and predicting; such strategies provide relatively less assistance (Echevarria, Vogt, & Short, 2004; Pentimonti & Justice, 2010). Both high- and low-support strategies require the teacher to take a step back and allow the child to make the appropriate connections between their previously mastered “lower order” skills and knowledge, and accomplish progressively more complex tasks (Norris & Hoffman, 1990). Teachers must then adjust their scaffolding strategies accordingly as the learner constructs knowledge and skills (Tharp & Gallimore, 1998).

Teachers play an important role in scaffolding the cognitive and social development of young children (Hovland, Gapp, & Theis, 2011; Howes & Ritchie, 2002; Pianta, 1999). Teachers help to scaffold children’s conceptual knowledge about phenomena and processes in nature by providing a physical environment where children can engage in play and have access to materials and experiences that provoke curiosity, exploration, and learning. For example, incorporating gardens into an outdoor play area can provide opportunities to explore and investigate insects, soil, and the life cycles of plants and animals. The presence of these organisms in the environment increases the likelihood that children will make observations and ask questions regarding them, which can subsequently be scaffolded such that children may better understand the natural phenomena. Teachers can also initiate scaffolding through strategies such as eliciting or drawing attention to relevant features of the environment.

During outdoor activities, teachers provide feedback, hints, or assistance to scaffold children’s learning about their environment (Echevarria et al., 2004; Pianta, La Paro, & Hamre, 2008; Zucker, Justice, Pianta, & Kadaravek, 2010). Assistance may take the form of drawing children’s attention to relevant features of the environment or to relevant features of a particular problem. Teachers manage cooperative learning activities by providing materials, scaffolding competences, guiding children's learning objectives, and using inferential questioning (Lee, Kinzie, & Whittaker, 2012; Tarim, 2009; Zucker et al., 2010). For example, a teacher may prompt a verbal exchange with a child by saying, "Let's count how many maple trees we see." The teacher can thereby direct children's attention to observing something specific in their environment. They may use a high-support strategy, such as counting with them until they can count with less support ("what comes after 11?"), as well as provide validation ("yes, there are 14 trees") and feedback ("I think there might be less than 100"). Children can achieve more with these types of support than they could by themselves.

Preschool children learn from one another in addition to learning from their teachers. Peer interactions play an important role for young children in learning new concepts and developing social behaviors in preschool years (Damon & Phelps, 1989). Peer-supported learning, conceptualized as *peer tutoring*, is also based on Vygotsky's concept of ZPD (1978) and occurs when a child learns behaviors, concepts, or information from another child (Gordon, 2005). Therefore, it is important for teachers to provide opportunities and support for peer collaboration. Teachers create a context that is conducive to learning by providing social and emotional guidance that teaches important skills for life and promotes harmonious relationships so that maximal attention can be focused on learning, rather than behavior management (Inan & Katz, 2007; Trawick-Smith & Dziurgot, 2011).

Nature as a classroom

As children explore their environment, they develop new knowledge and connect it with their previously gained knowledge. Nature provides diverse opportunities for children to develop new concepts through interacting with nature during teacher-directed and self-directed activities. For example, a North American child learns how snow falls instead of rain at certain temperatures, butterflies fly in the day and moths at night, and to identify the living features of many animals by observing and interacting with nature (Kellert, 2005). Spontaneous exploratory play is positively associated with children's construction of knowledge concerning causal relationships (Schulz & Bonawitz, 2007). In a study by Schulz and Gopnik (2007), preschoolers were able to competently distinguish cause-effect relationships after spontaneous exploratory play with a gear toy. Likewise, children in nature activities have opportunities to develop scientific inquiry skills such as questioning about weather events, animal classifications, or plant names.

In summary, scaffolding is a teaching strategy that involves providing support for children's learning that is well-timed and well-matched to the situation and child, and that helps the child to be more successful than they would be without support. Scaffolding empowers children by providing them sufficient assistance to continue their self-directed and/or cooperative learning. Scaffolding also promotes *intellectual autonomy*, the understanding that learning arises from one's own efforts rather than answers to problems coming from authority figures (Kostelnik, Gregory, Soderman, & Whiren, 2012). Teachers may use high-support or low-support strategies to empower children in such a way (O'Connor et al., 2005; Pentimonti & Justice, 2010).

This paper will examine teacher scaffolding of young children's learning about natural environments within a nature-based preschool from the perspective of social constructivism (Berk & Winsler, 1995; Vygotsky, 1978; Watson, 2001). According to social constructivism, learners actively construct knowledge, and language is central for co-constructing meaning and to conceptual development. Constructivist learning is situated within authentic contexts that are shaped by socially mediated cultural scripts, symbols, rules, and meanings (Winsler, 2003). Scaffolding is often conceptualized as occurring in the dialectic of a dyadic interaction (e.g., between a child and teacher), however it is important to consider multiple levels of scaffolding within which a learner constructs knowledge and meaning (Winsler, 2003). In the present study, children bring unique characteristics, experiences, and culture to the program, and they also experience the culture of the program, which in this case can be described as a culture of nature and a culture of inquiry. These features of social constructivism lend themselves to the study of teaching and learning interactions between children and teachers in a natural environment. The study will examine specific strategies used by teachers during both planned and spontaneous learning opportunities in a nature setting with special attention to verbal communication between children and teachers. As part of a larger study focusing on what children learn about nature and natural environments, how they learn it, and what teachers do to support children's learning about nature, this paper will address the following research questions:

1. Do teachers use scaffolding to support young children's learning about nature, and if so:
    a. How often is scaffolding used?
    b. What scaffolding strategies do teachers use? Do teachers use high- and low-support strategies in specific types of situations as described by Pentimonti and Justice (2010)?
    c. How effective is scaffolding? What do children learn when teachers engage them in scaffolding?

METHODS AND PROCEDURES

Rationale for a qualitative design

A case study is a qualitative approach "in which the investigator explores a real-life, contemporary, bounded system *(a case)* or multiple systems over time" (Creswell, 2013, p. 97). In a case study, researchers define their *bounded system* as what is going to be studied (Merriam, 2009). In the current study, we defined our bounded system as a preschool program in the Great Lakes region of the U.S. Researchers conducted running-record observations of children's activities during their outdoor time on seventy-four different days over a two-year period. The case study approach is well-suited for examining processes, providing rich descriptions of phenomena occurring within a bounded system, and studying phenomena in the context in which they take place (Creswell, 2013). Researchers took the role of "observer as participant," meaning that the researcher's role was known by those who were observed, but researchers also participated in activities when appropriate opportunities arose (e.g., singing along with children during a group time or holding a child's hand when crossing the parking lot during a hike). Children and teachers became very familiar with the researchers, whom they addressed in the same manner as the other teachers ("Miss" or "Mr." followed by the first name). Field notes were transcribed and analyzed according to the procedures described below.

In the current study, we used "quantitizing", using numbers to support qualitative data (Sandelowski, Voils, & Knafl, 2009). Quantitizing is used "to facilitate pattern recognition or otherwise to extract meaning from qualitative data, account for all data, document analytic moves, and verify interpretations" (Sandelowski et al., 2009, p. 210). We used counts and frequency percentages to make sense of our data and the coding of observations (Green, 2011; Maxwell, 2010).

Program description

The preschool is located within a 185-acre nature center that features prairie, hardwood forests, wetlands, and lakeshore. Children attend two, three, or four half-days per week. When the children arrive they meet their class in one of three natural outdoor play areas that feature open-ended elements such as logs, pine cones, sand, gardens, rocks, and trees. Teachers provide additional materials such as buckets, shovels, magnifying glasses, and field guides to support play and exploration. Children gather for circle time after playing for approximately one half hour and teachers introduce the concepts on which they will be focusing for that day. Concepts include topics such as camouflage, hibernation, migration, activation, or following the path that water travels to the lake. Teachers often share a story or a song about the concept with the children, and then give the children a "provocation" (Edwards, Gandini, & Forman, 1998) to focus their attention on the concept during their hike such as listening for sounds of spring, looking for white trees, or watching for different animal tracks. The hikes typically take 45 minutes to an hour. Teachers facilitate both structured and unstructured nature experiences during the outdoor time and hike.

Participants

The preschool enrolls nine classes of children ages three to five years, with a maximum of 16 children per class. Specific demographic information was not collected for individual children, but all enrolled children come from upper middle-class families and a majority were Caucasian. Enrollment is open to any interested family and parents pay tuition for their children.

Procedures

Seven researchers conducted running-record observations of children's activities during outside activity time and while hiking over a two-year period. Forty-four observations were conducted during the first year and thirty observations during the second year. Every class was observed, but because some classes only met two days per week, the classes that met three or four days per week were observed more frequently. Observers recorded children's and teachers' behavior and dialogue in field notes which were later transcribed and analyzed. An observation comprised all recorded field notes for a single day, derived from 1.5 to 2.5 hours of observing. Each observation included multiple "events," defined as sequences of related behaviors and/or interactions. The number of events recorded per observation ranged from 1 to 29 (Mean = 8.0). The total number of events recorded was 521.

Researchers were introduced to the classes early in the year, and children were told that the researchers wanted to learn about their school. Thereafter, children appeared to accept the presence of the researchers and to be comfortable in their presence. Some children even asked researchers where they had been after they had missed a day, or asked one researcher to pass on a message to another (such as to say hello and when are you coming back).

Materials

The primary investigator (PI) designed the framework for conducting observations. An "Observation of Child Development" form was designed to guide observations that included: (1) observer name, date, time, children present, and location; (2) domains of development, including physical/motor activity, observational skills of the child, attention/awareness, exploration, social development, and self-regulation; (3) specific child behaviors to look for, such as recognizing or responding to differences in the environment, discriminating properties of nature using a variety of senses, seeking information through observation to satisfy curiosity or seek answers to questions, asking questions or seeking information, testing possibilities, and using multiple strategies to solve problems; (4) space for detailed description of children's activity; and (5) space for the observer's interpretation and reflections, with the following probes: what is important about the observation? How did the environment support the child's development? What roles did teachers and/or peers play? The components of the guide were not designed to be exhaustive, but rather to help observers to identify sequences of events and behaviors upon which to focus.

Questions and prompts included in the form were designed to draw the observer's attention to children's behavior, teachers' behavior, features and function of the environment, and interactions among the three (children, teachers, and environment). The PI piloted the Observation of Child Development form and found it to be effective for guiding observations, but with too little space to record field notes. Therefore, the Observation of Child Development form was used as a guide but field notes were taken in a spiral-bound notebook.

Trustworthiness of the data. Several strategies were used to maximize the trustworthiness of the data. Research team members were trained and supervised to ensure consistency of the data collection method. Credibility was established through prolonged engagement, persistent observation, and triangulation of sources and analysis (Creswell, 1994; Lincoln & Guba, 1985).

Training of research team members. The PI trained the other six investigators in the data collection procedures. The PI explained the overall purpose of the study and the Observation of Child Development Form, and provided an orientation to the preschool program. The PI provided examples of completed and typed observations, which were discussed with investigators in training. A common notation format was adopted in which multiple children involved in an interaction were denoted as "C1, C2…Cn" and teachers as "T1" or "T2." Classes often had a volunteer, who was denoted as "V1." Each class had children with parental consent to participate in the study, and when target children were observed they were identified by their initials in order to compile those observations for case studies (not reported in this paper).

Investigators were instructed to focus more on quality of observations than quantity of observations; priority was given to thoroughness and level of detail recorded about a single "event," defined as a related sequence of behaviors and/or interactions, rather than to recording as many events as possible. The rationale for this operating principle was to generate richer observations that would permit analysis of associations between children's activity, learning, interactions, environments, and teachers. Investigators submitted their typed observations to the PI and they were discussed during monthly research team meetings.

Credibility. In qualitative research, concerns about internal, construct, and content validity are addressed as “credibility.” According to Lincoln and Guba (1985), “prolonged engagement,” or spending enough time in the observational context to understand the phenomena of interest within that setting, is one strategy for establishing credibility or confidence in qualitative data. Prolonged engagement permits a researcher to establish rapport with research participants, increasing the likelihood of observing “natural” behaviors. Prolonged engagement also allows the researcher to compare observations across time in order to determine what is “typical” or “atypical” in the setting. “Persistent observation” is another strategy for increasing credibility, and it refers to the depth and extent of observation that enhances understanding of the phenomena of interest. Persistent observation allows researchers to observe a phenomenon of interest as well as the associations with contextual features or sequences of interactions. “Triangulation,” or the use of multiple methods, sources, or analysts, is a strategy used to increase the comprehensiveness of understanding data. Two types of triangulation were used in this study. First, triangulation of sources took the form of comparing data collected by different researchers at different points in time across the two-year period. Second, analyst triangulation was used in the processes of coding and interpretation (Lincoln & Guba, 1985).

Transferability. In qualitative research, concerns about external or ecological validity are addressed as “transferability.” According to Lincoln and Guba (1985), providing a “rich description” of the phenomena of interest is a strategy for establishing transferability. Detailed description of the phenomena and the context in which it is observed allows readers to determine the contexts and conditions under which they can reasonably expect the results of the research to be relevant.

RESULTS

Data reduction and analysis

Data reduction was used to analyze data from a rigorous perspective due to the large amount of observational data, common to qualitative studies (Miles & Huberman, 1994). The central research question of this paper is “Do teachers use scaffolding to support young children’s learning about nature?” In order to address this question and the sub-questions, the first step in data reduction was for one investigator to read through all of the observations and extract each incident of scaffolding, using a set of preliminary codes developed from reviewing previous research (see Table 1). A total of 103 incidents of scaffolding were extracted. Next, a second investigator read through all of the extracted incidents and assessed whether each constituted an example or non-example of scaffolding.

Ninety-eight scaffolding incidents were confirmed and five incidents were questioned. The third investigator read through all of the extracted incidents, confirmed 102 of the original 103 incidents, and questioned one. All incidents on which at least two investigators agreed were coded as scaffolding incidents.

Table 1
Scaffolding Code Descriptions, Examples, and Frequency of Occurrence

Code Description and Source	**Example**	**Frequency**
Eliciting: Teacher provides a prompt, which could be a statement or question that evokes a response from the children (Pentimonti & Justice, 2010).	Teacher: "When the leaf falls to the ground, it dries all up and turns into…" Children: "Soil!"	61 (15.4%)
Inferential Questioning: Teacher prompts children to use evidence to draw a conclusion (Walsh & Blewitt, 2006).	"What happened to this tree?" "Did it fall down or did someone cut it?" "What do you see?"	101 (25.4%)
Predicting: Prompting children to make a prediction about what will happen next (Pentimonti & Justice, 2010).	Teacher: "It was wet out here last time it rained. What would happen to the water today?" Children: "It would freeze!" Teacher: "Do you know what color they will be in the spring?"	9 (2.3%)
Drawing attention to relevant features of a problem or of the environment: Prompting the child to use senses to narrow the field of observation toward a current focus of inquiry or discourse; this can take the form of a statement or question (Stanulis & Manning, 2002).	"What do you notice about…?" "Is this the same shade of blue as it was yesterday?" "Good guess but I think it's an animal that's a little bigger than a deer."	35 (8.8%)

<u>Give hints</u>:		
The teacher provides a clue to help children's ongoing inquiry (Pianta, La Paro, & Hamre, 2008).	"What animal has four toes?" "What animals do the girls in class like to pretend to be?" (children are trying to figure out what animal made the tracks that the children think look like dog tracks, but they are coyote tracks) "It starts with a MMMMMM sound."	18 (4.5%)
<u>Provide materials</u>:		
The teacher provides tools to support ongoing activity or inquiry (i.e., buckets, shovels, magnifying glass) (Plowman & Stephen, 2007).	Teacher: "What tool do you need?" Child: "The sand is hard today. I need a shovel."	2 (0.5%)
<u>Validation feedback</u>:		
A statement that communicates "yes, that's true" (Hogan & Pressley, 1997; van de Pol, Volman, & Beishuizen, 2010).	"I think it was a woodpecker too!" "Great job – I think it's a spine, too!"	52 (13.1%)
<u>Correction feedback</u>:		
When a child makes a statement that is factually inaccurate or uses a term in a way that is inaccurate, the teacher offers information to clarify the factually inaccurate statement (Hogan & Pressley, 1997; van de Pol, Volman, & Beishuizen, 2010).	"There are no dogs here." "[yes it hibernates]…but not at the bottom of the pond. It's a land turtle, and hibernates under some leaves and branches." "Nothing? I see something."	12 (3.0%)

<u>Denomination</u>: Teacher provides a precise term for a concept after a child uses a vague or incorrect term, or has not used a term (for example, pointing) (Rosemberg & Silva, 2009).	Child: “Snow keeps the plants warm.” Teacher: “Snow is a good insulator!” Child: “The leaves will turn to soil.” Teacher: “That’s right – they decompose.”	9 (2.3%)
<u>Expansion</u>: The teacher adds information to a statement the child has made (de Rivera, Girolametto, Greenberg, & Weitzman, 2005).	“Did you know that before people could go to the store to buy brooms they used branches to sweep?” (In response to a child using a branch to sweep snow, and stating “Look! It’s a broom!”)	53 (13.4%)
<u>Generalization</u>: The teacher names a superordinate concept (the general case) that is related to a specific exemplar identified by a child (van de Pol, Volman, & Beishuizen, 2010).	Child: “Water vapor! It goes up and it comes back down again.” Teacher: “That’s the water cycle that you’re talking about.”	3 (0.8%)
<u>Exemplary</u>: The teacher gives a specific example of a general concept named or referred to by a child (van de Pol, Volman, & Beishuizen, 2010).	*Not observed in the current study.*	0 (0%)

Link to previous knowledge and/or experience: The teacher refers to what s/he knows is the child's previous experience or knowledge in order to address a new question (Echevarria, Vogt, & Short, 2004).	"What kind of mark would a turkey make?"	29 (7.3%)
Co-Participating: (Pentimonti & Justice, 2010)	Teacher counts along with child, starting a sequence or filling in numbers	2 (0.5%)
Contextualization: "…draw the new knowledge nearer by creating new intermediate levels of representation in order to link the introduced concepts to others that children build in direct experiences" (Rosemberg & Silva, 2009, p. 575).	Teacher: "Why would it be important for there to be a hole in the top of the wigwam if there's fire inside?" Children: "So the smoke can leave!"	7 (1.8%)
De-contextualization: Distancing a concept from the current context (Rosemberg & Silva, 2009).	Teacher: "Right! It [the hole in the wigwam] works as a vent just like the vents in your house for the air conditioning and the heat."	4 (1.0%)
	Total number of coded scaffolding strategies:	**397** (100%)

Next, the second investigator returned to the raw data to determine whether there were additional scaffolding incidents that had not been identified by the first investigator. The second investigator identified an additional 11 scaffolding incidents. The third investigator confirmed eight of those 11 incidents and questioned three of them. This yielded a total of 110 incidents of scaffolding verified by all three investigators.

Extent of scaffolding used by teachers

To address the first research question, "Do teachers use scaffolding to support young children's learning about nature, and if so, how often is scaffolding used?" we compared the total number of events recorded (521) with the total number of scaffolding incidents (110) and found that 21% of all events were scaffolding incidents. Similarly, comparing the average number of events per observation (8) with the average number of scaffolding incidents per observation (1.7) revealed that 21% of the events within each observation were incidents of scaffolding. Considering that many events did not include teachers (e.g., peer interactions or individual children's behavior), this suggests that scaffolding was a relatively common feature of teacher-child interactions in this particular setting.

Scaffolding strategies used by teachers: Quantity and quality

The research question, "What scaffolding strategies do teachers use?" was addressed by examining descriptive statistics regarding the specific types of scaffolding strategies teachers used overall, and qualitatively examining the types of strategies used within selected scaffolding incidents. The total number of scaffolding codes (397) is greater than the total number of scaffolding incidents (110) because several incidents had multiple codes. Frequency counts and the proportion of all incidents that each scaffolding strategy comprised are presented in Table 1.

The most frequently used scaffolding strategy was inferential questioning, which constituted 25.4% of the reported scaffolding incidents, followed by eliciting, expansion, validation feedback, and drawing attention to relevant features of a problem or the environment (see Table 1). Providing materials and co-participating were the least frequently observed strategies, each constituting 0.5% of the 397 total scaffolding codes. One scaffolding strategy included in Table 1 was not observed. The exemplary strategy appears in the table because it is an important strategy that was identified in the literature, despite the fact that it was not observed in this particular series of observations, and because non-findings are often as important as findings.

Effectiveness of scaffolding strategies used by teachers

The research questions, "Do teachers use high- and low-support strategies in specific types of situations?," "How effective is scaffolding?," and "What do children learn when teachers engage them in scaffolding?" were addressed by qualitatively assessing children's verbal responses to scaffolding employed within the selected incidents. Below we present and analyze a selection of scaffolding incidents to illustrate the patterns of scaffolding strategies used and their effectiveness. The incidents presented progress from simple to complex, with the first examples using fewer strategies and later examples involving more strategies, the introduction of outside information, and a greater number of considerations.

C = *individual child*
C1, C2…Cn = *multiple children's individual responses*
CM = *multiple children, group response*
T = *teacher*
V = *voluntee*r

The following exchange was initiated by a teacher and includes four feedback loops in which the teacher used two different scaffolding strategies which supported children's observation and reasoning skills. This example of scaffolding occurred while the class was on a hike.

> T: Look up at that tree up there – what do you notice about it? **(Draw attention)** Is there something different? **(Inferential)**
> CM: Holes!
> T: How did they get there? **(Inferential)**
> C1: Spiders!
> C2: Chipmunks!
> C3: Squirrels!
> C4: Woodpeckers! Woodpeckers love trees!
> T: What do they look for in trees? **(Inferential)**
> C: Bugs!
> T: What do they do with the bugs? **(Inferential)**
> CM: Eat them!

As seen above, the teacher began by drawing children's attention to something interesting and asking an inferential question. Children then offered different hypotheses about what might have made the holes, and engaging the group in the discussion permitted children to compare their hypotheses and ultimately arrive at an accurate answer. It was important for the exchange to continue until it was established that woodpeckers would eat bugs from the trees, because this allowed children with different hypotheses to compare their answers with the "data" which included "holes" plus "bugs" and the knowledge that woodpeckers eat bugs. Repeated use of inferential questioning effectively helped to sustain the interaction, and children successfully solved the puzzle of what could have made the holes, and why. While it is possible for teachers to achieve their learning goal(s) in a single feedback loop (as seen in the following scenario), multiple feedback loops can aid in ensuring the efficacy of teaching depending on the level of scaffolding support necessitated by the specific situation and learner.

The following example occurred as children were throwing leaves up in the air on their nature hike. This observation also demonstrates an instance where the teacher asks an inferential question, and it particularly exemplifies the way in which teachers tend to employ combinations of scaffolding strategies.

T: Are these new or old leaves?
C: Old.
T: What are these leaves going to turn into? (Teacher pauses.) The leaves are decomposing and will turn into soil. **(Inferential; prediction; denomination)** (The suggestion is that we really should only throw new leaves up in the air to fall on us – old leaves can get you dirty.) (**Expansion** to cause-effect)

In this single, apparently simple suggestion, the teacher used four scaffolding strategies. The first question – "Are these new or old leaves?" – is inferential; the teacher is looking for the children to draw a conclusion based on the facts at hand. The teacher follows this up by using prediction, whereby the children are encouraged to think about what happens to leaves in time. Lastly the teacher answers her own question: "The leaves are decomposing and will turn into soil." This final statement is an example of denomination because the teacher offers specific terminology for the concept she has been scaffolding throughout the interaction. The progression of strategies used by the teacher, particularly the use of denomination, is moreover an instance of expansion, as she is introducing new information related to the original topic (e.g., leaves). This manner of using multiple scaffolding strategies in a single feedback loop can be an effective way of achieving multiple ends within an exchange. Children listened carefully and stopped throwing leaves onto themselves and each other, indicating they understood that the old, decomposing leaves would get them dirty.

In contrast to the previous three examples, the following interaction differs in that the teacher uses the child's question as an opportunity to engage the entire group of children in the process of inquiry by initiating discourse amongst the class, rather than responding solely to the individual child who asked the question. The exchange involves five feedback loops and repeated use of inferential questioning to sustain the interaction. The observation was recorded while the children were at a pond. Most of the children were lying on their stomachs on the wooden dock and looking into the water. A few children had sticks they were poking down into the water, and one child noticed that the water did not go up as high on the stick as it had on a previous visit. The child asked the teacher where the water went, prompting the following exchange.

> T: Where's the water going, guys? C wants to know what's happening to it. **(Inferential)**
> C: It's going down a waterfall.
> T: Do you see a waterfall around here? **(Inferential; draw attention to details)**
> CM: Nooooo!
> T: Do you ever have a puddle in your yard? What happens to it? **(Contextualization)**
> C2: Water vapor! It goes up and it comes back down again.
> T: That's the water cycle you're talking about. **(Generalization)** What happens to the water in the puddle? Does it all go up? **(Inferential)**
> C2: It goes down in the ground…some evaporates, and some goes down in the ground.
> T: Do you think that's what's happening here? **(Inferential)**
> CM: Yes!

The teacher's strategic use of the child's inquiry as a teaching opportunity for the rest of the class empowered the children to actively take charge of their own learning. The fact that the teacher directed the question to the children, rather than answering it herself, communicates that she has confidence in their ability to reason, and also conveys that knowledge and "answers" do not come only from authority figures but from one's own intellectual activity (Kostelnik et al., 2011). Engaging the group with the question also communicates that knowledge and discovery are social processes. This strategy of engaging a group of children to investigate an individual child's question is frequently used in the program.

In this example, the teacher began with a low- to moderate-support strategy in the form of <u>inferential questioning</u>. The reason this is coded as inferential rather than eliciting (a lower-level strategy) is because the question required children to use information available in the environment as well as their own knowledge to make an inference about what was happening to the water. When the first child suggested a waterfall, the teacher asked a question that was both inferential and <u>drew the children's attention to details in the environment</u>. She waited several seconds before asking the next question, which is an example of <u>contextualization</u> because asking children whether they ever had a puddle in their yard served to "draw the new knowledge nearer by creating new intermediate levels of representation in order to link the introduced concepts to others that children build in direct experiences" (Rosemberg & Silva, 2009, p. 575). This helped the children to see the similarity between what happens to a puddle in their yard and what was likely happening to the pond, which is essentially a bigger puddle. The strategy helped one child to make the inference that the water was becoming vapor, and the child demonstrated knowledge that the water vapor would rise and then come down again. The teacher then used the strategy of generalization to name the superordinate concept that is related to a specific exemplar identified by a child, in this case the water cycle. The teacher further extended the inquiry with another inferential question about whether all of the water evaporated, and a child inferred that some evaporated and some went down into the ground.

Examining this sequence of interactions as a whole, the teacher engaged children in five feedback loops and used four different scaffolding strategies calibrated to the level and type of support the children needed. She worked within the zone of proximal development to support children's reasoning, and maximized the potential learning opportunities in the situation. It is important to note that the teacher did not leave or end the interaction when the child named "water vapor," but extended the interaction further to link the child's response to a larger concept (the water cycle). The teacher then pushed the children's thinking further by asking whether they thought all the water went "up." This is an example of providing a deep and meaningful experience in which children can investigate, reflect, and elaborate on important concepts. This kind of interaction is an example of prioritizing experiences that promote deep knowledge over experiences that expose children to a large number of concepts but lack depth, as described in the Next Generation Science Education Standards (NGSS Lead States, 2013) and related documents (Michaels, Shouse, & Schweingruber, 2008). This example is also very powerful because the teacher effectively helps children to connect the new experience and knowledge with previous experience and existing knowledge. These elaborations and connections help children to construct knowledge that connects abstract concepts with specific experiences and draw parallels between similar situations. These interactions also facilitate children's development of reasoning skills (Copple & Bredekamp, 2009; Pianta et al., 2008).

It is also important to note the children's demeanor during this encounter. They were relaxed as they lay on the dock observing the water, and when the teacher engaged them with the question about the water all of the children were quiet as they considered the question. The children then listened as one child offered their hypothesis. Adults often doubt the ability of preschoolers to engage and maintain attention in extended, meaningful discussions of inquiry, but the quality of the social and physical context is a key potentiator of inquiry (Ash, 2000; Ray, Bowman, & Brownell, 2006). Moreover, children in this program are accustomed to participating in meaningful discussions about environmental phenomena, and so this is a familiar process for them. It is important for teachers who aspire to this level of scaffolding to understand that it takes time and patience to socialize children into a culture of inquiry (Kirch, 2007), but it is also important to understand that young children are fully capable of doing so (Duschel, Schweingruber, & Schouse, 2006; Michaels et al., 2008).

The teacher in the following example demonstrates such an understanding, showing patience while repeatedly employing eliciting (a high-support strategy) in an effort to support the children's development of knowledge on the topic of trees and nesting. The teacher pointed to a clump of trees (or a tree with a split trunk), directing the attention of a small group of children.

> T: Is this one or two trees? **(Eliciting)**
> C: Two trees!
> T: Look at the bottom of it. **(Draw attention)**
> *Child looks more closely.*
> T: What are you noticing, C? **(Eliciting)**
> C: Chlorophyll!
> T: C said this tree has chlorophyll in it. It also has something else in it. Look very carefully way up into the tree. What do you think that big bundle of leaves in the top of the tree might be? **(Expansion, draw attention)**
> C: It's a nest!
> T: A nest! I think you're right! **(Validation)**

In this example, the teacher repeatedly elicited the children's ideas about the object that they were trying to identify and understand. The teacher also drew the children's attention by saying "look very carefully way up into tree." The child then focused on the tree and began hypothesizing, and the teacher validated the child's answer ("I think you're right!"). Through eliciting and drawing the children's attention to a specific feature of the environment, the teacher guided and supported children's learning about the tree. The teacher then validated the child's answer to ensure they understood the target concept.

The following example is unique in that it involves ten feedback loops, further evidencing the level of patience and persistence needed by teachers to appropriately and effectively employ scaffolding strategies. In this exchange, the teacher used strategies offering different levels of support to not only identify a feature of the environment (a male duck) but also to incorporate other concepts about the environment.

> T: We saw an animal this morning and I'm going to give you a clue, and you guess what it was. The clue is that it was partially green. **(Hints)**
> *Children guess frog, toad, and turtle.*
> V: It had 2 wings. **(Hints)**
> C: Turkey.
> C: Bird.

T: You're right; it's a type of bird. **(Validation)**
C: Flamingo.
C: Flamingos are pink.
T: And I've never seen a flamingo here. **(Correction feedback, previous knowledge)**
C: Duck!
T: Was it a mommy duck or a daddy duck? **(Inferential)**
Children guess.
T: Daddies have green heads and moms have brown heads. **(Expansion)**
C: In the Himalayas there are poison spiders.
T: Click on your listening ears. Why do you think the mommy ducks are all brown? **(Inferential)**
C: To blend in.
T: Yes, to blend into what?
C: Grass, twigs, leaves. **(Inferential, contextualization)**
T: What's that word that means blending in? It starts with a "C" sound **(Hint, denomination, previous knowledge)**
C: Camouflage!
T: That's right, and when the mommy sits on the eggs she needs to blend in. **(Validation, expansion)**
T: They saw the daddy duck. The mommy duck might have been there, but she may have been camouflaged. We'll have to see.

The teacher did not ask or name the animal in the example above, but instead provided hints to let the children guess and reason about it. The teacher started giving hints about general features of the animal and proceeded to hint about specific features. The teacher then used <u>validation feedback</u> to scaffold a child's response, validating their statement by saying, "You're right, it's a type of bird" (we differentiated between validation and <u>correction feedback</u> in data for the current study). The teacher also referred to previous knowledge and experience, stating that she has not seen any flamingos at the nature center. The teacher maintained the children's attention and helped them to narrow their focus by asking inferential questions. These types of questions also helped children to correctly identify the animal.

The next exchange occurred on a nature hike. The teacher used a variety of strategies to explore the insulating properties of snow, support the children's reasoning, provide an experiment for the children to test their knowledge, connect to previous knowledge, provide specific terminology, and both generalize and contextualize the concept.

T: See how warm your face is when it is inside the snow! What kinds of houses are made of snow? **(Draw attention to details; link to previous knowledge; de-contextualization)**

C1: Igloos!
T: Do you think that igloos would stay warm? **(Inferential)**
C1: Yes!
T: That's because snow is a good insulator! **(Generalization; denomination)**
C2: (He speaks with his head in the snow. His words are hard to hear.)
T: C2, the snow is so great of an insulator that we could barely hear what you said! **(Contextualization)**

This observation exemplifies the teacher using a variety of scaffolding strategies to facilitate the children's learning. The teacher began the dialogue by <u>drawing attention to a relevant feature of the environment</u>, specifically the insulating property of snow, prompting children to use their senses to narrow the field of observation toward the focus their inquiry. It is common for teachers to use this strategy on nature hikes and in the play area as it allows for many common occurrences to become effective learning opportunities. The teacher then asked, "What kinds of houses are made of snow?" thereby <u>de-contextualizing</u> the information such that the children could grasp the new concept when it was removed from its original circumstances. The combined use of drawing attention and de-contextualizing the concept is also an example of the teacher connecting the subject matter to <u>previous knowledge</u> that is familiar to the children, the insulating property of snow. The accurate response of "Igloos!" by C1 indicates the efficacy of that connection to previous knowledge. The teacher then scaffolded the connection through <u>inferential questioning</u>, which also proved effective. C1 acknowledged that an igloo would indeed stay warm. At that point, the teacher employed <u>generalization</u> and <u>denomination</u> to show that all snow is a good insulator (not just in the case of igloos) and give the children a precise term for the property they had described: "insulator." C2 responded to that generalization by sticking his head in the snow, testing whether it was in fact a good insulator. The teacher then contextualized the information (after initially de-contextualizing the topic), bringing the strategy full circle. Her decision to employ <u>contextualization</u> demonstrates an attempt to show the children how their newfound knowledge of the terminology can be applied in their own lives, outside the context of igloos (Rosemberg & Silva, 2009). The strategy was prompted in part by the act of C2 talking with his head in the snow. Through employing seven scaffolding strategies and four feedback loops, the teacher effectively supported the children in their understanding of snow as a good insulator.

DISCUSSION

This paper described how scaffolding can effectively support children's learning in a nature-focused preschool, and provided several examples of strategies that can be used in a variety of EE contexts. Scaffolding was observed relatively frequently in the current study, comprising 21% of all observed events. The prevalence and complexity of scaffolding is particularly remarkable considering that observers were not trained to focus specifically on scaffolding pedagogy. Observers were given general guidelines but individually determined what was salient to record within the contexts as incidents occurred. The extent and nature of scaffolding at the nature center became apparent upon examination of the many dialogues among teachers and children. Inferential questioning was the most frequently used strategy, followed by eliciting, expansion, validation feedback, and drawing attention to relevant features of a problem or the environment. The exemplary strategy was not observed. Its absence may be a result of preschoolers primarily asking questions about their immediate experiences, rather than about overarching concepts. Use of the exemplary strategy by teachers may increase as children get older and ask more questions about general concepts or words they may have heard.

Qualitative analysis did not reveal a pattern of differentiating high- and low-support strategies being used in specific types of situations (e.g., high-support strategies used when engaging more complex concepts). Instead, teachers in this study flexibly used a range of strategies to match the apparent needs of the children at the time. This involves patience and persistence, as illustrated by the number of feedback loops used in some of the examples. Additionally, teachers often sustained interactions after a child arrived at a particular “answer” or solution to a problem (e.g., water vapor or an animal “blending in” with the environment), which provided extended opportunities to construct a more detailed understanding of concepts and phenomena. In order to provide rich environmental education experiences that are consistent with the various guidelines for excellence in environmental education (NAAEE, 2010) and the Next Generation Science Standards (NGSS Lead States, 2013), it is important for teachers to understand the importance of engaging in this extended process and to develop skills to engage children in extended inquiry discussions.

Although scaffolding is, of necessity, spontaneous, intentionality and preparation are necessary for effective scaffolding to occur. Early childhood teachers must prepare a physical and social context that is conducive to learning (Inan & Katz, 2007). Teachers should provide an enriched physical learning context where children can easily access learning materials and engage with them. Providing a supportive social context promotes social competence as well as opportunities to scaffold children’s learning. Teachers need to observe children and listen closely to be aware of, and capitalize on, opportunities for scaffolding. It is important to understand the strengths and needs of each child in order to anticipate scaffolding opportunities and to match effective strategies to specific learning situations. Teachers in this study often facilitated group discussion by addressing a child’s question to the entire class. This is a particularly effective strategy, as it gives children an opportunity to verbalize their understanding to each other and compare their hypotheses or representations. Teachers facilitated children’s expression of ideas and their listening skills, for example, by inviting one child to share a question with the whole group and asking the group to listen to the individual child’s ideas. These discussions also conveyed the social nature of science, and helped to socialize children into a “culture of inquiry” in which questioning, investigation, and discovery are highly valued. A culture of inquiry develops

over time, and it is important to be patient as children gain the social, emotional, and cognitive skills to participate in that process of inquiry.

This paper focused on teachers’ scaffolding of children’s learning about the natural environment. Scaffolding, however, can also take place in peer-to-peer interactions and this can support the learning of the more competent peer as they take the role of teacher or mentor, as well as the less competent peer (Tudge & Rogoff, 1999; Wertsch, 1999). Inquiry discussions also can promote children’s self-efficacy in the domains of environmental education and science, as children come to realize that answers to their questions or problems come from their own mental activity that is made visible to them through the discussion. Inquiry discussions can also help children to examine questions from multiple perspectives.

Teachers in this study effectively connected children’s current experiences with their past knowledge or experiences (“do you ever have a puddle in your yard?”) in naming a superordinate concept represented by a specific example (“that’s the water cycle you’re talking about”; Van de Pol et al., 2010); drew children’s attention to relevant features of the environment (“do you see a waterfall around here?”); provided corrective feedback (“I’ve never seen a flamingo here”); gave hints (“it had two wings”); and asked inferential questions (“why do you think the mommy ducks are all brown?”). These strategies effectively helped preschool-aged children to develop their understanding of the natural environment, which is Guideline 4.3 of the *Early Childhood Environmental Education: Guidelines for Excellence* (NAAEE, 2010). Engaging in exploratory play also supported children’s learning about nature (Lee et al., 2009), as they had opportunities to observe and interact with natural phenomena such as the water in the pond, the decomposing leaves, a nest, and snow, which are examples of Key Characteristic 3 of the ECEEGE (NAAEE, 2010). Exploratory play has a central role in environmental education in early childhood, as children can investigate and reflect upon phenomena of their own interest and in a playful way (Gelman, Brenneman, MacDonald, & Roman, 2010; Wilson, 2012), allowing them to elaborate on important concepts in ways that are meaningful to them.

Limitations and future directions

While measures were taken to ensure the credibility of data and analyses (e.g., triangulation of sources and analysis), there were limitations to the study. Researchers gathered the observations and individually decided which interactions were significant to record. While the “Observation of Child Development” form provided guidance, there remained the potential for variability between researchers. Future research should address this potential threat to validity by having at least two researchers simultaneously conduct observations or by capturing video that can be coded by multiple researchers. Teacher interviews could also be used to triangulate the observed teaching strategies.

Another limitation in the current study is that children observed came from affluent families, and teachers at the preschool program exceeded the minimum level of education required by the state in which the program was located and therefore may not generalize to other preschool programs. These characteristics of the case under investigation in this study limit the generalizability of findings (the extent to which we can conclude that scaffolding occurs in other programs and the degree to which it is effective), but not necessarily the transferability of findings (evidence that scaffolding can be a useful pedagogical tool for early childhood EE) (Creswell, 2013). However, future research should investigate a broader and more diverse sampling of early childhood education programs that include teachers with a wider range of educational backgrounds and children of diverse demographic backgrounds. In addition, the ratio of teachers to children also exceeded the minimum required by the state (1:10 for children ages 3-4 years; 1:13 for children ages 4-5 years; Wisconsin Department of Children and Families [WDCF], 2009). The maximum class size was 16 children and there were always two teachers. Scaffolding may be less frequent in larger groups or when the ratio is smaller.

CONCLUSION

In the current study, teachers fostered a culture of inquiry in their classes, prompting children to engage with their natural surroundings, ask questions, and make connections with past knowledge and experiences. The culture of inquiry observed is consistent with the physical and social context described by Inan and Katz (2007) as necessary to facilitate learning. Context is especially pertinent to considering the use of scaffolding, a pedagogy that requires teachers to calibrate the level of support they offer within each individual learner's zone of proximal development (Vygotsky, 1978). Indeed, the importance of teachers knowing their children, and the level of support necessitated by different situations must be emphasized. Additionally, knowledge of a variety of scaffolding strategies is also necessary to effectively scaffold children's learning. Evidence from this case study suggests that the teachers in this study understood the strengths and needs of the children in their classes and were familiar with children's previous experiences. They were able to adjust the level and type of support necessitated by differing contexts and learners to effectively scaffold the children's learning.

Teachers in this study were adept at flexibly utilizing a range of scaffolding strategies to promote young children's environmental learning. Analyses indicate that scaffolding can be an effective strategy for supporting young children's learning about the natural environment. Scaffolding strategies were regularly employed by teachers at the nature center to aid children's learning in a variety of contexts. Some strategies were observed more than others (e.g., inferential questioning), an occurrence that may be a result of preschoolers inquiring about their immediate experiences, as opposed to overarching concepts that tend to engage older children. Examination of the effectiveness of scaffolding early childhood environmental education in a variety of settings is an important question for future research.

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