Inquiry in Inclusive Preschools

Preparing preservice teachers to plan and implement physical science learning centers

By Mary Donegan-Ritter and Linda May Fitzgerald

Young children learn foundational science and engineering concepts through experiences that allow them to explore big ideas in depth. They develop conceptual understandings and problem-solving skills through discussions with classmates and adults and by engaging in simple experiments (Gelman et al. 2010). During these experiences, the role of the early childhood (EC) teacher is a facilitator of knowledge who organizes the environment, observes children's interests closely, and asks questions and poses problems to engage children and further their theory building (Chaille and Britain 2003). Future EC teachers need professional development experiences that allow them to learn a range of strategies for teaching science and engineering through inquiry using an interactive, hands-on approach (NSTA 2014).

In this article, we describe how our unified early childhood/early childhood special education teacher education program prepares preservice teachers to plan and implement physical science learning centers in preschool classrooms inclusive of children with disabilities and other characteristics that benefit from individualization. We delineate steps future EC teachers take to integrate learning across curriculum areas and design their learning centers so that children with diverse abilities can fully participate, following the principles of Universal Design for Learning (UDL).

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Preservice teachers "messing about" with materials as they explore constants and variables.

Unified Early Childhood/Early Childhood Special Education Teacher Education

Unified EC/ECSE preservice teachers take courses infused with field experiences and content that prepare them to work in a variety of settings with children of diverse ability levels, from birth through age eight. Near the end of their coursework, during the semester before full-time student teaching, each EC major is placed in a diverse preschool classroom for a 40-hour, 10-week field experience. Placement in the field experience is individualized and intended to fill in any gaps they may have working directly with children who are culturally and linguistically diverse, have identified disabilities, and/or are from low-income families. While taking part in this field experience, each EC preservice teacher is enrolled in a course that focuses on how to design and implement a physics learning center.

The Case for Inquiry Science in Unified Teacher Education

Physical science activities, especially those listed in Figure 1, are ideal for diverse learners because children can interact directly with objects and materials, and teachers can immediately observe how they respond (Hoisington et al. 2014). Physical science activities in an inclusive EC classroom are best planned with a balance of child-initiated activities and teacher-guided experiences. EC teachers learn that children's behavior is a means of communication, and they use the child's expressions of interest and/or questions as a starting point, or child initiation, for playful focused learning. This approach differs from teacher-directed lesson plans designed apart from and before observing the child interacting with the materials.

Many young children who have special needs or who are dual language learners have limited verbal skills. Yet verbal ability is less crucial when one can respond with actions rather than words. By supporting the child's own natural drive to learn, to be curious, to figure out how stuff works, EC preservice teachers take advantage of "teachable moments." They look for the glow on a child's face after figuring out the answer with just a little scaffolding, realizing that the best source of confidence is competence and accomplishment on one's own. Developmental delays don't prevent inquiry and, through video-based discussion and assignments, future teachers learn to recognize and observe how curiosity or surprise leads to children looking closer. Memory constraints are less an issue if there is not one right answer to have to keep in mind. "Looking" closer can be done with any of the senses (i.e., vision, hearing, touch), so that sensory impairments are not insurmountable barriers. Behavioral problems can be reduced when the agitated child is following an interest and staying engaged. In doing so, preservice teachers can experience the motto of this course, which is "the best guidance is a good curriculum." The steps future EC teachers take to design an inquiry-based physical science learning center include:

- messing about with materials,
- deciding which materials to vary and which to hold constant,
- constructing anticipatory planning webs to plan for potential learning opportunities,
- linking to learning standards,
- removing barriers to participation by incorporating UDL principles.

FIGURE 1.

Early childhood physical science activities.

The following activities are available to any early childhood teacher to download to explore how they can design a learning center to facilitate children's reasoning in science, engineering, the development of technology, mathematics, literacy, self-regulation:

- Air dynamics
- Bubbles
- Cooking
- Physics of Sound
- Ramps and Pathways
- Shadows
- Target Ball
- Tops
- Water Dynamics

Source: *https://coe.uni.edu/special-programs/regents-center-early-developmental-education/classroom-activities*

Messing About

Due to ready access to a model EC classroom, all of our EC preservice teachers are given an opportunity to "mess about" with a variety of materials found in physical science learning centers. This time of hands-on exploration with materials, inspired by the work of David Hawkins (1974), allows our EC preservice teachers to begin the process of inquiry, deepen their understanding of force and motion, and prepares them to select and design a beginning physics lab for their field experience classroom.

Identifying Variables

We start teaching about inquiry by providing EC students with an experience in which they are given a cardboard roll, a film canister, and a straw. They are given time and encouragement to play and explore the materials and brainstorm questions about what they can do with them. They are then told to sort the three materials into two categories based on common attributes (e.g., things that are hollow, things you can blow through). Then the concept of materials that can be held constant (i.e., no choices, at least for this time) and that can be variable (more than one kind of material to choose from) is introduced. They are instructed to extract characteristics that matter from the experimental materials and put them in relation to each other. By doing so, they can more clearly see what relationships a child can construct in the process of playing with the materials. By thinking of the category names as "Titles" for the collection of items in them, rather than using names of objects themselves, they abstract out from each collection of items what characteristic they share.

EC preservice teachers are faced with the challenge to limit some of the variables so the children's investigations will provide valid results, that is, to have a constant against which to vary other characteristics. For example, in target ball, they might limit the choice to one kind of target (six empty water bottles—all the same size), making the kind of target the constant. The children can then focus on how variable characteristics of balls relate to the number of targets they knock down. This requires that the process variables of distance the children are standing from the targets and the force of the roll are also kept constant. If both target and ball characteristics are held constant, then the child can make effects by varying distance and force. The conceptual understanding of constants and variables sets the stage for us to introduce preservice teachers to the inquiry teaching model (Figure 2). We then guide them as they plan questions they can ask to support children engaging in observation, prediction, investigation, and reasoning.

FIGURE 2.

Inquiry teaching model.

Anticipatory Planning

We challenge the EC preservice teachers to construct an anticipatory planning web for the first week of the learning center. As shown in the sample web in Figure 3, they draft questions they will ask children, materials they will hold constant and/or vary, and various standards that can be addressed. Inquiry science experiences are foundational to later learning.

Linking to Learning Standards

Although the *NGSS* performance expectations are designed for K–12 classrooms, the EC preservice teachers can see them in action as they implement their physical science learning center. Many early childhood math, science, and literacy standards are readily met through rich inquiry learning experiences. EC preservice teachers review early learning standards and identify the easily measurable indicators they can assess in the learning center through the materials, productive questions, and follow-up activities they plan to use. For instance, they have to consider: Will they have any materials for which shape matters to the physics of the center? Will counting make sense in the center? How can emergent literacy, such as dictating a drawing for a teacher to caption, take place during the investigations in the center?

FIGURE 3.

Anticipatory planning web for an air dynamic learning center.

Using UDL to Remove Barriers

Preservice teachers are introduced to the framework of Universal Design for Learning (UDL) (CAST 2011) in earlier courses. From the beginning, their designs must be flexible enough to accommodate the different ways of learning of a wide range of children, provide multiple means of representing the content, and allow a student multiple ways of expressing understanding or mastery. As teachers plan learning centers with the abilities and needs of all possible learners in mind, the UDL framework provides them with multiple options to present content, gather feedback, and recruit interest in the learning center activities.

Multiple means of representation

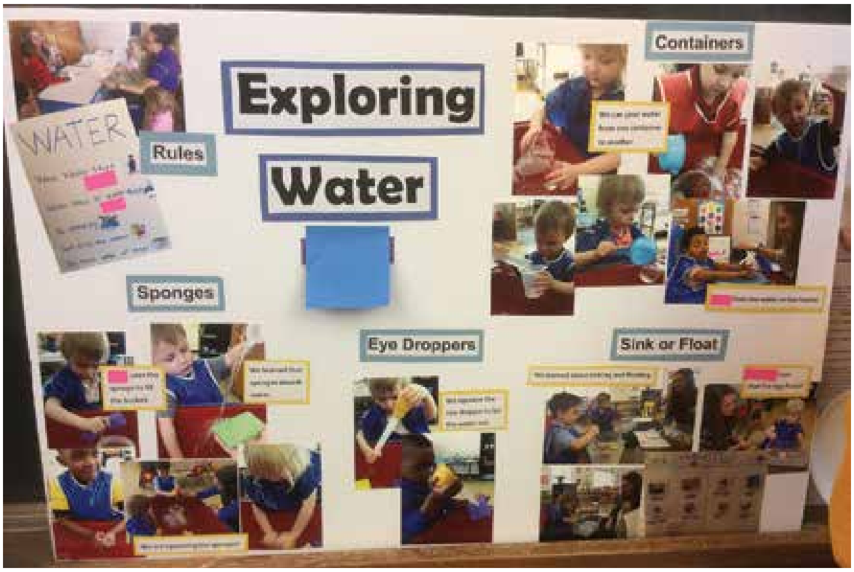
Children differ in the ways they perceive and comprehend information (CAST 2011). Teachers ensure that the activities, questions, expectations, and learning opportunities exist in various formats and at different levels of complexity. Using multiple media ensures all children will understand concepts. Visual supports are helpful for many children with special needs and dual language learners. Simple icons representing items that might sink or float are an example of how a preservice EC teacher encouraged nonverbal children to make predictions before experimentation.

Multiple means of expression

Children differ in how they express their ideas and benefit from having a variety of materials and flexible arrangements. Children with limited communication skills are given the option to point to materials or icons to make requests for materials they need or indicate constructions they plan to make. Teachers can help children record observations and constructions using photographs, drawing, and tallying. Creating these permanent products from their explorations allows children to revisit their ideas and extend their learning. With open-ended media (e.g., glue, tape, cardboard, clay) children can express their ideas in two- and three-dimensional products so that teachers can assess children's developing understandings. Pairing a nonverbal child with a verbal peer at a STEM learning center provides an opportunity for the verbal peer to express ideas and communicate what both children are trying to accomplish together.

Multiple means of engagement

Children differ in ways in which they can be engaged or motivated to sus-



The documentation board that Kelsey made to show the sequence of learning experiences she planned and implemented for water dynamics.

tain effort and learn. Young children with special needs rely on teachers to plan engaging materials and interactions by stimulating interest, excitement, and motivation for learning. We are vigilant about possible attitudinal barriers among our EC preservice teachers that result in low expectations about the ability of children with special needs to benefit from inquiry experiences. We expect and support them to be intentional about arousing children's attention, curiosity, and motivation to participate in inquiry science learning centers.

Adding tactile, visual, and auditory appeal to materials sparks interest and draws attention to exploration possibilities. For example, adding puffy paint to the holes in clear plastic cups can interest children in the speed water travels through different size openings. Blowing objects across a white board and tracing the path the objects travel with bold markers helps children see and recall how air makes objects move. Using balls that make sounds when they move can appeal to some children and foster their interest in making objects move more quickly down an incline in order to create the desired sound.

Conclusion

This article describes how preservice EC teachers are guided to design a beginning physics lab in which inquiry is supported in inclusive preschools. We expect our EC students will experience a fair amount of error-informed learning, so we provide ample written feedback and in-person meeting time to scaffold their learning. These future teachers receive ongoing supervision and feedback from faculty and mentoring from their cooperating teachers to use questions to encourage children to focus their observations and deepen children's thinking. Cooperating teachers who are committed to the goals of inclusion and the benefits of inquiry learning are important partners in preservice teacher education. Before long, many of our preservice teachers gain teaching experience and confidence to take on the role of mentoring a new group of preservice teachers in inquiry learning for all children. ■

Mary Donegan-Ritter* (mary.donegan-ritter@uni.edu) *is an associate professor of early childhood education at the University of Northern Iowa in Cedar Falls, Iowa. Linda May Fitzgerald* (linda.fitzgerald@uni.edu) *is a professor of early childhood education at the University of Northern Iowa. Both are also affiliated with the Regents' Center for Early Developmental Education located at the university.

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