Preschool Pathways to Science: Fostering and Assessing Scientific Reasoning in Preschoolers

Kimberly Brenneman Rochel Gelman Christine Massey Zipora Roth Irena Nayfeld Lindsay Downs

Rutgers University University of Pennsylvania Rutgers University

Our labs work with teachers to create science learning opportunities in the preschool classroom. One aspect involves designing learning experiences that support preschoolers' emerging understandings of the notion of a variable. Here we present preliminary results, using three tasks designed to elicit this emerging understanding that a comparison yields useful information.

Method 1 - Choosing a Comparative Test

Participants

• 19 preschoolers (*mean age = 4;11 range = 4;4-5;4, 12 girls*)
• Ethnically and socio-economically diverse sample
• Before assessment, all participants engaged in activities designed to illustrate that comparative tests are more informative than demonstrations when answering "find out" questions (Figure 1).

Method

• Children heard 6 simple stories with photographs. Each story had the goal of finding out which of two "contestants" performed better: which cream heals boo-boos faster; which sponge cleans up more juice; which toy car goes faster; which wind-up toy travels farther; which glove keeps hands warmer; and which ball bounces higher.

• Children were asked to choose between a comparative test and a non-comparative test as the best way to answer the "find out" question and to justify their responses.

Q: Remember, he wants to find out if one of the cars, the blue or the yellow, goes faster. If you had to find that out, which way would you do it? This way or that way?

Comparative - Method of difference

Non-comparative

Figure 1: Sample Test Questions and Stimuli

Findings

• Each child received a score (out of 6) for the number of times s/he chose a comparative test.
• Group scores exceeded chance, *mean proportion correct = .67, t (18) = 2.43, p < .05.*
• As shown in Figure 2, 8 children showed a robust tendency to choose the proper test (5 or 6 correct).

Presented at the October 2007 meeting of the Cognitive Development Society; Santa Fe, NM.

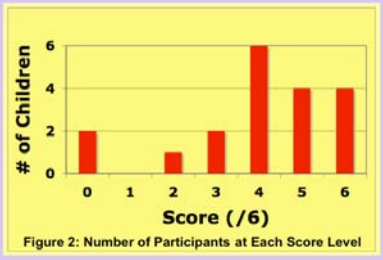

Figure 2: Number of Participants at Each Score Level

• Children generated a reasonable scientific explanation for 24% of their correct, comparative test choices. Examples are given in Figure 3.

Why Would You Do It That Way?

• To see how fast each one would go. But these two are the same, so you wouldn't see how fast the blue car would go. So I would do it like this so you would see how fast these two would go.

• Because to see which one bounces higher, and if I did this one (non-comparative), then I wouldn't know if the green bounces higher.

• Because if he putted two blues or two blacks, we wouldn't know how to find out so I think I would do it that (comparative) way.

• Because I wanted to see if the yellow or the blue would go faster.

Figure 3: Examples of Relevant Justifications for Comparative Test Choices

Method 2 - Generating a Test: Try It Task

Participants

• 18 preschoolers from the same sample

Method

• Short, scaffolded interactions between child and experimenter
• The experimenter presented a testable question (e.g., Which pads work better to protect your hands?) and asked the child to "find out," using the materials provided. The procedure varied slightly between schools due to changes after piloting.

Findings

• 7 children generated the best kind of test (simultaneous comparison while varying the variable). Two additional children did so with minor prompting.
• As a point of comparison, among children who did not participate in our intervention, only 1 (out of 14) constructed a simultaneous, comparative test.
• Sequential testing seemed the default response to the materials. Five intervention and 9 non-intervention students employed this method.

Figure 4: Classroom Activity Similar to the Try It Task

Method 3 - Prompted Recall

Participants

• 17 preschoolers from the same sample

Method

• Photos and a graduated prompt procedure were used to probe children's memory for, and understanding of, a previously completed classroom experiment testing the insulating properties of gloves created with plastic bags and various filler materials such as feathers and solid vegetable shortening (Figure 5).

• Children answered questions about: 1) the purpose of the test, and 2) the method used to find the answer.

Figure 5: Photos Used to Prompt Recall

Findings

• 12 children answered the "What were we trying to find out?" question without prompting, and 2 did so after a prompt.
• 12 children gave an appropriate answer (verbal or pointing) to the question "What did we do to test which gloves keep hands warmer?" and 3 did so after a prompt.

Taken Together…

• We have complete data sets from 16 children.
• Robust performance was considered to be: 5 or 6/6 correct for the Judgment Task; generating a simultaneous comparative test for the Try It task (prompted or not); and correct recall with minimal prompting for the Recall task.

Figure 6: Children Scoring Robustly

• Figure 6 shows the variation across individual performance patterns. The dynamic, scaffolded nature of the Try It and Recall tasks was expected to support performance in ways not tapped by the more traditional and verbally complex Judgment task.

Discussion

We are encouraged by our preliminary results with respect to our goal of designing experiences that can both support and elicit emerging reasoning about comparisons. Learning about variables and controlled experiments is a lengthy process, but our results suggest that preschool children have begun this journey in a problem-solving context in which a simple comparison can provide an answer to a "find out" question. Some children are able to perform robustly in a straightforward judgment and justification task. A few can even reflect on their own scientific thinking to justify their responses. Others display their knowledge only under more supportive, interactive conditions. The three methods we employed - recognizing a good test, generating a test, and recalling the purpose and procedure of a test - afforded a more complete picture of the nature of children's understanding. Further, the Try It and scaffolded interview techniques lend themselves well to classroom use, both as tools and as opportunities for learning.

Acknowledgments

This work was funded by the National Science Foundation REC-0529579.

We thank the schools, parents, children, and research assistants who made this work possible.