VIDEOS OF PRESCHOOL MATHEMATICAL THINKING FOR TEACHER LEARNING

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Recent reports on the state of mathematics education call for a deeper understanding of mathematics developmental progressions and recommend improved teacher training for early childhood educators. However, few studies have explored the nature of preschool teachers' existing knowledge, beliefs, and orientations toward children's mathematical thinking. This report describes the initial phase of a project aimed at deepening teacher knowledge of how young children construct mathematical understanding. The video interviews described in this report illustrate the counting stages through which preschool children progress and show potential for use in professional learning settings as teachers reflect on their existing knowledge and work to develop more sophisticated interpretations of children's mathematical thinking.

Keywords: Early Childhood Education, Learning Trajectories, Teacher Knowledge

Introduction and Purpose

Early childhood mathematics education has been a topic of increased interest and numerous recommendations (NAEYC and NCTM, 2010; Duncan et al., 2007). Early mathematics teaching requires a particular knowledge base that includes an understanding of children's developmental and learning processes (Sarama, Clements, Wolfe, & Spitler, 2016). While enhanced knowledge and skills have been shown to produce positive influence on change in teaching practices (Garet et al., 2001), less is known about the specific knowledge base needed for early childhood mathematics teaching (Parks & Wager, 2015).

We are engaged in a research and development project to explore ways to provide early childhood educators with increased opportunities to identify children's existing mathematical knowledge and maximize learning opportunities in mathematical play. In the initial phase of this project–the focus of this research report–we collected video examples of children's mathematical thinking in one-on-one play-oriented interviews with preschoolers and explored what might be noticed about children's knowledge and ways of thinking. In a future phase, we will use these videos with early childhood mathematics educators as potential routes for developing teacher knowledge, addressing beliefs, and strengthening child-oriented pedagogical practices. In this study, we addressed the following research question: What aspects of children's counting schemes are evidenced through interactions with play-oriented tasks in video-recorded interviews?

Theoretical Framework

This project's goals and activities are situated within a constructivist epistemic framework. Consistent with the theories of Piaget, we assume that children construct understanding and develop knowledge as a function of their natural ability to think (Kamii & DeClark, 1985). This epistemology points to the role a child's existing knowledge plays in the construction of new knowledge. We draw on work by Steffe, Richards, and Cobb to support the identification of the stages through which children progress as they develop a counting scheme (1983). Of particular interest to us is the "child's progress in counting…marked by decreasing dependence on perceptual material. The first step in that direction is the ability to count figural representations of perceptual items (i.e., visualized images), which, though presented in the context of the task, are not perceptually available at the moment" (Steffe, Richards, & Cobb, 1983, p. 36-37).

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For teachers, we acknowledge that enhanced pedagogical skills are needed to recognize and make use of children's knowledge during play (Wager & Parks, 2016). To structure our future work with early childhood educators, we will rely on the construct of teacher noticing (Jacobs, Lamb, & Philipp, 2010) and the use of videos of children's thinking in a professional learning setting to explore potential pedagogical strategies with teachers. Studies by Sherin and Van Es suggest that video use can support teacher noticing and may influence the focus of teachers' attention (2005). In fact, video from teachers' own classrooms has been shown to be a useful tool in helping teachers consider their current practices and explore new strategies (Borko, Jacobs, Eiteljorg, & Pittman, 2008). We also consider the role of teachers' beliefs as they develop and enact new teaching practices (Borko & Putnam, 1996). Consistent with findings that written vignettes of classroom activity have the potential to elicit preschool teachers' beliefs (Lee & Ginsburg, 2007), we suggest that the use of these videos will show similar potential.

Method

The data for this phase of the project were collected through video-recorded interviews with preschool children from two Head Start preschools in the Western United States. Research associates interviewed all preschool children whose parents provided consent. Twenty children were selected for ongoing interviews based on the goal of obtaining a sample of children representative of gender, initially observed counting level, and primary language. These 20 children were interviewed biweekly over the course of 12 weeks.

Interviews were conducted consistent with the constructivist teaching experiment goals of "formulating and testing hypotheses about various aspects of the child's goal-directed mathematical activity in order to learn what the child's mathematical knowledge might be like" (Steffe, 2002, p. 177). Within each 10-15 minute interview, children were presented with several short play-oriented tasks in which they were asked to count items, say a number word sequence, produce collections of a given number, tell the number of items in small sets without counting, sort plastic animals into groups by color and count them, count claps or marbles dropped into a cup, count hidden items, or build block towers and count the number of blocks used. Following each week of interviews, video episodes were analyzed for evidence of children's mathematical thinking and anecdotal notes were taken. During this analysis interviewers discussed observations and planned tasks and questions they would consider in the following interview.

Preliminary Findings

All interviews were video-recorded and analyzed by the team of research associates. Initial findings revealed that children brought a range of counting concepts and skills to the tasks, evidenced in the ways they counted items and responded to questions. Table 1 presents a sampling of our observations consistent with established research drawn from the analysis of the video interviews. We then offer one vignette from video collected to illustrate a specific example noted in the table.

In one interview [noted in bold in the table], the interviewer asked Mario (pseudonym) to count the number of marbles that were dropped into a cup. The marbles remained hidden from Mario's view while being dropped and while in the cup. The following portion of the interview took place after Mario had correctly produced counts of three and two marbles.

Mario: (Summarizes his previous two counts). I got three and two. (Shows finger pattern of three on left hand with thumb, forefinger, and middle finger. Shows finger pattern of two on right hand with forefinger and middle finger.)

Interviewer: Good job, you made them with your fingers. OK, let's do it again. (Slowly drops four marbles into the cup while Mario listens.)

Mario: Four. (Quickly shows finger pattern of three on his right hand with thumb, forefinger, and middle finger).
Interviewer: (Shows Mario the cup).
Mario: (Touches each marble inside the cup as he counts.) One, two, three, four. I got four!

Table 1: Observations Based on Counting Types (Steffe et al., 1983; Wright et al., 2006)

Emergent	Perceptual	Figurative
may use number word sequence, but may not coordinate words with items	counts to find out how many items are present	counts items in a screened collection or may count items in more than one screened collection
may count items of a collection multiple times and arrive at different number words	**counts perceptual unit items, coordinates correct number word sequence with items**	counts substitutes for perceptual items (visualized spatial patterns, sequentially raised fingers or other movements, verbal items)
may use number word sequence from "one" in response to "How many are there?"	may count two addends and not count joined collection when asked how many	
may make finger patterns for numbers one to five	may reorganize items to facilitate counting	

Mario recognized the sound of the marbles hitting the bottom of the cup as something to be counted, and progressively produced more accurate counts of the marbles. While Mario has some finger patterns for numbers to five, he may lack a consistent pattern for four. In further interactions with Mario, asking him about the finger patterns he shows for his counts may help him to reconcile this inconsistency.

Discussion

The videos collected during this phase of the project provide specific examples of preschool children's thinking in counting activities and demonstrate the range of counting types that may exist in a preschool classroom. Furthermore, our analyses suggest that early learning environments are comprised of children who are operating at varied levels of understanding. Our goal in the subsequent phase of this project is to use these videos as models of early mathematical thinking to encourage discussion and reflection among teachers in professional learning settings. Using the construct of noticing, we plan to support teachers in learning to identify ways in which children may be operating and encourage the implementation of child-oriented pedagogical practices that acknowledge these existing understandings. We believe these video artifacts have the potential to surface the implicit theories teachers hold about how young children come to know and understand mathematics and could prove to be helpful tools in developing early educators' knowledge, beliefs, and practices.

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