SERIOUS WORK THROUGH PLAY: TEACHING AND LEARNING SPATIAL REASONING IN EARLY CHILDHOOD

By

Paul N. Reimer

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ABSTRACT

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Research has established the importance of play-based experiences for young children's development and learning. Yet, facing the mounting pressure of accountability and standardized testing, some educators have turned to didactic methods of instruction. Guided play (Weisberg et al., 2016) provides a middle ground between play and instruction for teachers to take a participatory role in children's playful learning. However, teachers have struggled to enter into children's play in ways that support learning. The purpose of this study was to identify and describe ways teachers actively engaged in supporting children's STEM learning through play. Using qualitative analysis methods, I analyzed video recordings of guided play sessions in Head Start preschool classrooms to describe children's and teachers' participation in spatial reasoning activities. Children participated through *exploring materials*, *announcing activities*, *repeating ideas,* and *pursuing challenges*. Teachers participated through six lines of action, four of which were described by Bjorklund et al. (2018): *structuring the material environment, confirming direction of interest, providing strategies, situating known concepts, challenging concept meaning,* and *creating novelty.* Analysis of two case episodes provided insights into co-participation in play, including the role of intersubjectivity in guided play activities. Findings from this study provide practitioners with more explicit examples of teaching approaches that support children's STEM learning during play. This study also provides theoretical insight into the intricacies of teacher and child co-participation during guided play, including the role of playfulness in teaching and learning.

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To my family, whose support and encouragement made all the difference.

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CHAPTER 1

Introduction and Overview

"…children's play is itself a harmonization of seriousness and playfulness."

– Adrian Skilbeck

The merits of play-based learning in early childhood have been clearly articulated in the fields of educational psychology and early childhood education. Advocates for developmentally appropriate practices for learning suggest that young children should "engage in sustained play, investigation, exploration, and interaction with adults and peers" (NAEYC, 2009, p. 18). Science, technology, engineering, and mathematics (STEM) domains are particularly well-suited to take advantage of playful orientations in learning, because dispositions such as creativity, innovation, and problem solving required for success in STEM fields may be enhanced through playful learning experiences. However, the possibilities afforded by play-based learning in early childhood settings have often been limited by the rigidity and structure of educational policy and standards (Miller & Almon, 2009a). Educational programs have increasingly used academic and accountability-based techniques that emphasize required subject-specific skills and proficiencies in children, even in early childhood (Fleer, 2011; NAEYC, 2009). In many cases, academic expectations have led to curriculum and instruction moving away from, rather than embracing play in learning. Although educators generally agree that curricular goals are needed to structure children's learning, many educators have argued against didactic methods used to achieve those goals and have denounced the perceived loss of play in early childhood education (Miller & Almon, 2009a).

This tension is complicated by a perceived incompatibility between play-based learning and teaching (Thomas et al., 2011). Although there have been broad efforts to bridge this divide

and embrace the role of teaching in play-based learning, insufficient research and limited practical implementation have left early childhood educators with few examples of teaching practices during children's play that support their STEM learning.

This study explores the intersection of children's play and STEM teaching and learning at the preschool level. Situated within a professional development project focused on playful learning in Head Start preschools, the study examines ways teachers are actively involved in supporting children's STEM learning through play.

Background on Early Childhood STEM

Early childhood STEM has received increased attention in recent years (Early Childhood STEM Working Group, 2017; McClure et al., 2017; Park et al., 2017). Fueled by political agendas aimed at increasing the number of young people qualified to enter STEM fields and new standards documents (e.g., The Common Core State Standards for Mathematics, Next Generation Science Standards, and International Standards for Technology in Education), initiatives have called for increased emphasis on STEM education in early childhood classrooms (McClure et al., 2017). Early learning advocates have suggested that young children naturally encounter opportunities for developing STEM reasoning from early ages. In fact, researchers have found that children are naturally suited to learn to think like scientists, design and engineer solutions to real problems, and develop communication skills (Nayfeld et al., 2011; J. Sarama et al., 2018). In mathematics learning, for example, research suggests that children naturally understand and use mathematical ideas (Ginsburg, 2006), work with peers and adults to mathematize play content (van Oers, 2010; Wager, 2013), are capable of high levels of classification, sorting, and language use in block play (Ferrara et al., 2011; Ramani et al., 2014;

Wolfgang et al., 2001), and develop number and counting skills through board game play (Siegler & Ramani, 2008).

Building on young children's natural curiosity, early STEM experiences engage children in exploring the world around them, making sense of phenomena, and developing awareness of their actions in the world (Early Childhood STEM Working Group, 2017). According to McClure and colleagues (2017), in STEM learning young children "can make observations and predictions, carry out simple experiments and investigations, collect data, and begin to make sense of what they found" (p. 16). These skills are foundational for young children's development of dispositions and practices such as problem solving and critical thinking.

Despite findings that suggest children are naturally suited to engage in STEM learning, the field of early childhood STEM education faces "limited high-quality practical guidance to drive effective practice" (Early Childhood STEM Working Group, 2017, p. 5). There are questions regarding how the STEM disciplines build on one another (Early Childhood STEM Working Group, 2017), how interdisciplinary engagement in the preschool classroom may be accomplished (Simoncini & Lasen, 2018), and whether educators should focus on "practices that enhance STEM ideas and engagement rather than developing integrated content-based learning experiences derived from the respective disciplines" (Lowrie et al., 2017, p. 621).

Further uncertainty about effective STEM teaching practice is fueled by underlying questions about the role of adults in young children's learning and play, and to what extent children can learn subject matter content through play. At preschool levels, educators are faced with considering what teaching and learning look like and how they are to be accomplished. These concerns fold into a broader debate about the role of play in children's learning and how teachers can best facilitate learning.

CHAPTER 2

Review of Literature

Despite the established importance of early STEM learning, less is known about the teaching practices that can support young children's STEM learning in play-based activities. In this review, I describe how play and play-based learning have been conceptualized and studied. I then highlight recent trends toward didactic instruction in early childhood programs and describe efforts to bridge the divide between play and instruction. I conclude by identifying a need for further study of the ways teachers can support children's STEM learning in play-based settings.

Definitions and Perspectives on Play

Theorists have sought to describe play in broad terms. For example, play has been described as "a way of engaging and expressing our being in the world" (Sicart, 2017, p. 5). Across definitions and constructs, play is viewed as a voluntary, typically spontaneous activity. It can be pleasurable, involves norms, roles, and rules (Vygotsky, 1978), and may operate outside of reality. Huizinga (1949) characterized play as a voluntary and pleasurable, yet often serious, activity. Drawing on play as a cultural phenomenon, Huizinga emphasized that play is governed by emergent rules, yet also proceeds into uncertainty.

Sicart (2017) suggested that activities that are not play (in the sense described earlier) can still be approached with a disposition of *playfulness*. According to Sicart, playfulness embodies many of the attributes of play, but preserves the goals of the activity at hand. A playful approach to an activity can create a pathway of new possibilities: "Playfulness reambiguates the world. Through the characteristics of play, it makes it less formalized, less explained, open to interpretation and wonder and manipulation" (p. 28). Similarly, Davis (1996) suggested "the function of playing is to open a space of possibilities" (p. 220).

In sum, play is activity that involves voluntary engagement, goal selection, and self-direction. As such, play has been viewed as instrumental in children's social, intellectual, and emotional development.

Historical Views of Play in Early Childhood Education

Play in early childhood education has been conceptualized through the development of child-centered programs, approaches, and curricular materials. Sociodramatic play, as an example, has been used to support children's emotional understanding and regulation, social development, problem-solving, and perspective taking (Ashiabi, 2007). Froebel's *gifts*, which included a variety of carefully designed blocks, aimed to provide young children with materials that could aid their exploration and present opportunities for embodied learning about size, shape, and relationships through self-directed play, imagination, and creativity (Smedley & Hoskins, 2018). Since its inception, the Reggio Emilia approach to early childhood learning has valued play as a context for children's natural capacity for meaning-making, creative expression, and communication (Edwards, 2002).

At their core, these approaches draw on the notion that play provides a natural context for children's development. For young children, play provides opportunities for physical, cognitive, and social and emotional development in ways that are governed and managed by the child. An inherent value in these perspectives is that play affords children opportunities to construct their own understanding of their environments, roles, and interactions. A century ago, Dewey offered a critique of kindergarten and Montessori materials and techniques, claiming that they rushed to engage children in adult-formed intellectual ideas before providing time for experience. As Dewey (1916) explained:

> The first stage of contact with any new material, at whatever age of maturity, must inevitably be of the trial and error sort. An individual must actually try, in play or work, to do something with the material...and then note the interaction of his energy and that of the material employed. This is what happens when a child at first begins to build with blocks, and it is equally what happens when a scientific man in his laboratory begins to experiment with unfamiliar objects. Hence the first approach to any subject in school, if thought is to be aroused and not words acquired, should be as unscholastic as possible. (p. 181)

An unscholastic approach, for Dewey, involved the playful exploration of what might be possible with given materials. Similarly, Vygotsky (1978) proposed that in play, children develop their own rules and norms as they negotiate their actions based on situational constraints, such as limits imposed by physical objects or environments. When a child faces constraints in the environment, either based on limitations of actions or materials, play becomes possible. According to Vygotsky (1978), "Play seems to be invented at the point when the child begins to experience unrealizable tendencies" (p. 93). Play provides opportunities for children to voluntarily engage in activity, encounter constraints, and resolve them in playful and imaginative ways.

Where Did the Play Go? Accountability and Instruction in the Early Years

Increasing levels of accountability, a focus on standards-based instruction, and developing concern over the "achievement gap" have affected educators of young children (NRC, 2009; Schoenfeld & Stipek, 2011; Walter & Lippard, 2017). Research that traces discrepancies in achievement to early years has sparked concern for parents, teachers, teacher educators, and policymakers (Schoenfeld & Stipek, 2011). At pre-kindergarten levels, focus has

shifted toward determining what skills and abilities are needed for kindergarten success to "prepare students to demonstrate the required proficiencies later" (NAEYC, 2009, p. 3). In response to this focus on academic preparation, many preschool programs have turned away from play toward narrowly defined curricular goals within mathematics and literacy, an emphasis on standards, and scripted curricular materials (Parks & Bridges-Rhoads, 2012). Programs have also prioritized teacher-driven practices that "include excessive lecturing to the whole group, fragmented teaching of discrete objectives, and insistence that teachers follow rigid, tightly paced schedules" (NAEYC, 2009, p. 4).

The trend toward didactic methods in early childhood classrooms may also be subtly fueled by a perceived dichotomy between play and learning (Clements & Sarama, 2014). Although educators may view play as important to children's development, there are varied perspectives about whether children's play is a context for teaching and learning. For example, Pramling Samuelsson and Johansson (2006) articulated one perspective: "Children's play has not been included in the learning process, but should be protected and kept free, joyful and carefree" (p. 48). Although some early childhood teachers express the view that play develops skills for future learning, they are typically less likely to agree that play supports academic learning itself (Pyle & Danniels, 2017). Even within play-based programs, some teachers view the learning of academic skills as a primarily teacher-led process involving direct instruction. At the same time, this view maintains that teachers should remain uninvolved in children's play. Pyle and Danniels (2017) found that teachers in play-based programs "struggled to negotiate a balance between the child-directed play they felt was essential and the mandated academic standards" (p. 280). Teachers in their study reported uncertainty about how to meet academic expectations while supporting children's play.

Play and Learning: Toward a Middle Ground

Other efforts have sought to counter the dichotomous view of play and learning by conceptualizing approaches that merge play, learning, and teacher involvement. For example, Miller and Almon (2009a) developed a continuum of early childhood classroom learning approaches. Didactic instructional approaches occupied the far-right end of the continuum, while free play, characterized as lacking sufficient adult support for academic learning, anchored the left. Because neither of these approaches centered both children's play and teacher involvement in classroom learning, the authors called for the development of two middle approaches: (a) classrooms rich in child-initiated play where children explore the world through play with the active presence of teachers, and (b) playful classrooms where teachers guide learning with experiential activities.

Weisberg and colleagues (2016) provided further support for Miller and Almon's middle approaches through their development of *guided play*. Building on the notion that "there is a vast pedagogical space between the stark dichotomy of free play and direct instruction" (p. 179), the guided play approach positions adults as facilitators of learning during children's play. Weisberg et al. described two forms of guided play: (a) adults design a setting or experience to center around a learning goal while providing children autonomy to explore, and (b) adults observe and participate in child-directed activities through questioning or extending children's ideas and interests.

Through their studies of guided play, Weisburg et al. (2016) reported that adults who use the guided play approach to advance learning goals for children ask questions during children's play or highlight key dimensions of problems children encounter during play. As the authors explained:

> In guided play, teachers might enhance children's exploration and learning by commenting on their discoveries, co-playing along with the children, asking open-ended questions about what children are finding, or exploring the materials in ways that children might not have thought to do. (Weisberg et al., 2013, p. 105)

Guided play introduces constraints to free play that limit the scope of a child's attention to "focus on those elements that are relevant to the learning goal" (Weisberg et al., 2013, p. 108). In this way, teachers' involvement in guided play centers on learning goals without turning to direct instruction or more didactic approaches.

Researchers suggest that in guided play children make more progress toward developing specific skills than in free play or didactic instruction. For example, Casey et al. (2008) found that guided block play with blocks promoted preschool children's spatial skills. Fisher and colleagues (2013) found that compared to free play and didactic instruction, preschool children learned more about geometric shapes and could identify features of shapes after guided play. They suggested that scaffolding techniques during guided play helped to "heighten children's engagement, direct their attention and exploration, and facilitate their 'sense-making' processes" (p. 1877). Aras (2016) further examined scaffolding provided by adults and found that in guided play teachers took on a variety of roles that supported children's learning, such as onlooker, stage manager, or co-player.

A recent study by Pyle and Danniels (2017) illustrates another effort to draw together play and learning in early childhood classrooms. They studied play episodes in 15 early childhood classrooms and found that teachers incorporated free play, inquiry play, collaborative play, playful learning, and learning through games. These types of play formed a continuum based on whether they were more child-directed (free play) or teacher-directed (learning through

games) and provided evidence of ways "teachers can direct, collaborate with, or extend the child's lead during times of play in the classroom in order to facilitate academic learning" (p. 286). Pyle and Danniels (2017) emphasized that the play-based continuum is child-centered, although each type of play is not entirely child-directed. By challenging views that conflate child-centered with child-directed, the continuum suggests that activities that are child-centered can retain elements of teacher direction.

Teaching Roles and Actions in Playful Learning

Maintaining children's agency in the learning process is one of the key concerns in the development of teaching approaches in play contexts. Teachers encounter questions of how learning should proceed, who directs the activity, and what goals guide interactions. Several studies have taken a closer look at the specific actions adults or teachers utilize in play contexts. These efforts have suggested that teaching should not be seen in opposition to children's play; rather, they have highlighted the ways teacher direction can retain child-centeredness in a variety of play-based settings and activities. In essence, these studies illustrate attempts to "resolve the conflicts between our own pedagogic hopefulness and the child's intentions" (Davis, 1996, p. 171).

Jasien and Horn (2018) identified moments of *trouble* and *repair* in children's mathematical construction play. They found that children often naturally encounter instances of trouble in their play and studied the ways children attempted to repair that trouble, either through their own ongoing efforts with physical materials or through the support of an expert adult. In one case analysis, they found that a mother effectively scaffolded a child's play by "taking up her questions while also allowing her to maintain control of the decision-making process" (p. 629).

Björklund et al. (2018) analyzed play activities in preschool classrooms to determine how teachers interacted with children to teach mathematics in play. Their primary goal was to examine "how teaching (mathematics) in a play-based and goal-oriented practice can be conducted" (p. 470). Analysis yielded four different *lines of action* used by the teachers: *confirming direction of interest*; *providing strategies*; *situating known concepts*; and *challenging concept meaning* (p. 473). In confirming children's direction of interest, teachers supported children's activity through confirming, questioning, or repeating a child's comments or actions, creating opportunities for developing children's mathematical reasoning. In providing strategies, teachers supported children's learning by encouraging the development of skills such as pointing at objects while counting or directing children's attention toward efficient methods for solving tasks. In situating known concepts and challenging concept meanings, teachers helped children contextualize familiar concepts and identify problems of interest. Teachers then worked together with children to establish concept meanings (e.g., the understanding of zero). The authors pointed out the careful balance needed to support children's learning in play without controlling the play, noting the primary importance of the teacher's responsiveness to the child's perspectives and ideas. At the same time, the emphasis on learning goals requires consistent attention to opportunities for joint solving of problems that emerge during the play activity.

Van Oers and Duijkers (2013) described *impulses*–teaching tools that support teachers in "evoking learning within the context of play" (p. 518). *Orienting* involved focusing children's attention on particular aspects of a setting or experience. *Structuring and deepening* involved the teachers' introduction of a structure or a problem to set the scene for a role play activity. Teachers used the *broadening* impulse to connect children's play with other activities in line with children's capacities and interests. *Contributing* involved introducing innovations or ideas

into children's play that address specific needs of children. Finally, teachers used *reflecting* to engage children in moments of discourse that helped children think about their activity and follow new directions. When compared to a traditional teacher-driven approach, the authors reported that children in the play-based program demonstrated expanded vocabulary development.

Across these studies, researchers have suggested that activities between teacher and child create opportunities for playful learning. Teaching characterized by participation with children in play fosters collaborative meaning-making and understanding. While allowing children freedom within the play context, teaching involves offering responsive contributions to the activity.

Summary of the Literature

The literature suggests that early childhood educators tend toward free play activities with little to no adult guidance or a reliance on more direct teaching methods to promote learning (Chien et al., 2010; Pyle & Danniels, 2017). Importantly, however, research also shows that educators can support children's learning through guided play. But there are still unanswered questions about how adults can support children's STEM learning during play and what role adults can take as they engage with children in playful learning. For teachers who want to draw on the potential that play affords children's learning, there are few examples of teaching practices, particularly in STEM realms, which are increasingly seen as natural domains of learning for young children. As Thomas et al. (2011) suggested, more work is needed to "find ways to think, speak, and do early childhood work that goes beyond the either play-based or intentional teaching divide" (p. 74).

Research Questions

This study explored how teachers support children's learning during guided play centered on spatial reasoning. Three research questions guided the inquiry:

RQ1: How do children participate in guided play episodes?

RQ2: What lines of action do teachers use during guided play episodes?

RQ3: How do teacher and children co-participate during the guided play episodes?

Conceptual Framework

In this study, I characterize *play* as an activity that is voluntary, self-directed, and pleasurable. *Playfulness*, as a disposition or orientation to activity, opens possibilities and introduces flexibility to activities that may be designed for specific purposes or goals. I interpret *learning* as occurring through participation in social and cultural contexts and communities (Lave & Wenger, 1991; Rogoff, 1998; Sfard, 1998). That is, children's learning occurs through social and collective activity (Vygotsky, 1978) and is dependent on experiences and interactions. Many such experiences and interactions occur through play.

To fuse the concepts of play and learning, I draw on a *guided play* framework (Weisberg et al., 2016) as a middle approach between didactic instruction and free play. In guided play adults actively and intentionally support children's learning. Teachers' and children's co-participation in guided play can be understood through Dewey's (1916) description of the participatory relationship between teacher and learner evidenced in shared activity:

> We can and do supply ready-made "ideas" by the thousand; we do not usually take much pains to see that the one learning engages in significant situations where his own activities generate, support, and clinch ideas—that is, perceived meanings or connections. This does not mean that the teacher is to stand off and look on; the alternative to

> furnishing ready-made subject matter and listening to the accuracy with which it is reproduced is not quiescence, but participation, sharing, in an activity. In such shared activity, the teacher is a learner, and the learner is, without knowing it, a teacher—and upon the whole, the less consciousness there is, on either side, of either giving or receiving instruction, the better. (p. 160)

Co-participation between teacher and child is a key feature of guided play episodes. Co-participation can be understood in terms of *intersubjectivity*, a "common temporary view" or a "joint understanding of what they are talking about" (Björklund et al., 2018, p. 471). In guided play, teacher and learner work jointly toward a coordinated view of contexts and actions: "In an interaction in which sustained shared thinking is established, both parties (teacher and child/ren) contribute to, develop, and extend their thinking" (Björklund et al., 2018, p. 472). In this study, I use an intersubjectivity lens to focus on how teacher and children co-participate during guided play. This draws attention to who is directing the play, and how teacher and children adjust roles and negotiate goals in the context of play. As Rogoff (1998) explains:

> Communication and coordination during participation in shared endeavors involve adjustments between participants (with varying, complementary, or even incompatible roles) to stretch their common understanding to fit with new perspectives in the shared endeavor. (p. 690).

Four *lines of action* identified by Björklund et al. (2018) describe the ways teachers support children's learning in guided play and provide initial scaffolding to understanding teachers' actions: *confirming direction of interest*; *providing strategies*; *situating known concepts*; and *challenging concept meaning*. I also draw out additional lines of action that emerged during the study.

CHAPTER 3

Method

This study was informed by an interpretivist research methodology and tradition. This methodology seeks to interpret human perspectives and interactions, with particular attention toward understanding how individuals make meaning in shared experiences (Glesne, 2015). Accordingly, I used qualitative research methods to explore how teachers and children co-participated during guided play.

Setting and Participants

This study was situated in the context of a multiyear professional development (PD) program with two Head Start preschool centers in central California. The goal of this PD was to support preschool teachers in developing learning environments and practices to support children's STEM learning. A small team of early childhood PD coaches and I facilitated sessions and classroom coaching conversations to support teachers in implementing guided play STEM activities. Because iterative development processes have been shown to improve teachers' self-efficacy in STEM teaching (John et al., 2018), the PD aimed to engage teachers in ongoing co-teaching experiences alongside PD coaches during guided play STEM activities.

The guided play STEM activities focused on enhancing children's *spatial reasoning*. Verdine et al. (2017) pointed to spatial reasoning as a pivotal practice in young children's STEM learning. Longitudinal studies have demonstrated that spatial reasoning is a significant predictor of STEM achievement (e.g., Wai, Lubinski, & Benbow, 2009). Children learn spatial awareness and develop broader STEM understandings as they explore objects, navigate through their environments, and interact with physical materials to explore size and shape (Davis, 2015). Developing spatial reasoning involves creating informal "maps" to guide their movements and

directions, positioning and orienting themselves to landmarks, and using spatial language to describe their location (J. A. Sarama & Clements, 2009). Spatial reasoning also relates to how children learn about and interact with a wide variety of two-dimensional and three-dimensional shapes in their environments. Children draw on their spatial reasoning capacities as they learn to describe these objects, view them from different perspectives physically and mentally, and put them together to form new relationships. Cooperative activities such as block building and puzzle play provide children opportunities to develop spatial language and mental rotation in the context of problem solving (Ferrara et al., 2011; Verdine et al., 2014).

The play activities were facilitated throughout the year by 25 Head Start teachers, which included 22 Latinx women, two Asian women, and one African-American woman. In addition, activities were often facilitated by the PD coaches, who were also women. As a white male researcher, I was aware of my own positionality as an outsider based on race and social class, and worked to develop a more complex understanding of the Head Start context throughout the multi-year PD project through conversations with teachers, informal meetings, participation in community events, and interviews (Reimer, 2020). These opportunities afforded me a level of familiarity with the teachers and children and helped to contextualize my observations. I obtained informed consent from teachers and participating children's parents/guardians. Children were invited to play in the various activities and were allowed to enter and leave the play space on their own. To ensure confidentiality, all names reported in the study are pseudonyms.

Data Selection

During normal activity in the Head Start classrooms, children were invited to play in small groups with a teacher. The play sessions ranged from 10-15 minutes and centered around the use of materials and objects to encourage spatial reasoning. The structure of the activities

varied; some allowed for more unstructured play while others included prompts given by the teacher or were guided by emergent norms and goals. Children were free to come and go to the play sessions, although most sessions were incorporated into the existing center rotation in the classroom and involved the same children throughout the session. Table 1 provides an overview of the guided play activities that were implemented in the Head Start classrooms.

Table 1: *Spatial Reasoning Guided Play Activities*

Activity/Material	Learning goals	Description
21st Century Blocks	Develop spatial awareness, compare shape attributes, recognize congruence, make comparisons	Children created patterns, shapes, animals, and other familiar figures with nontraditional multicolored blocks. Teachers created figures alongside children and engaged in conversations.
Shapes on the Geoboard	Develop spatial awareness, replicate shape construction, identify attributes of two-dimensional figures, notice symmetry	Children and teachers stretched elastic bands over pegs to create a variety of shapes and designs.
Pattern Block Creations	Develop spatial awareness, identify shape attributes, perform transformations	Children and teachers explored pattern block pieces and created designs from idea cards.
Froebel Gift Three: The Divided Cube	Construct a cube, describe attributes, recognize congruence	Children and teachers created structures and figures with eight two-inch cubes.

There were 36 activity sessions video recorded across the four activities, with each recording approximately 10-20 minutes in length. Supplemental audio recordings were also created through the use of a tabletop digital recorder and merged with the video. Video recordings captured the entire play session, including moments when teachers were inviting children to play, addressing other needs in the classroom, or when children were playing on their own. Because I was interested in examining how teachers and children engaged together in guided play, I used purposive sampling across all sessions to identify episodes of observable interaction between teacher, children, and physical materials (see Appendix A for sample

episode identification). Episodes were selected based on the presence of several additional criteria: clear audio and video with minimal background noise (to aid transcription efforts), visible use of play materials, and audible conversation focused on the play activity. This selection process resulted in a set of 80 episodes with maximum variation across activities, teachers, and children. The identified episodes ranged in length from less than a minute long to 10 minutes.

Data Analysis

To prepare data for analysis, I entered all identified episodes into the qualitative analysis software ATLAS.ti. This software facilitated organization and coding of the episodes. Each episode was nested under the play session in which it occurred, allowing for continued recontextualization of the episodes within the broader play session.

The first cycle of coding focused on children's participation in the guided play episodes. I used descriptive codes to name children's ways of participating in each episode. I began with descriptors that identified children's actions, gestures, approaches, or interactions with materials. I then refined these codes by merging and collapsing them into broader categories of children's participation (see Table 2 for example). This intentional broadening of categories was meant to avoid fragmentation of participation patterns into discrete, siloed actions. During this analysis, I also attended to ways children's participation was shaped by materials, context of activities, peers, and teacher participation. A primary goal of this first cycle of coding was to understand how children guided the play activity based on their own goals and direction.

The second cycle of coding focused on describing actions taken by the teachers during the play episodes. I watched each of the episodes with particular attention to teachers' involvement in guided play. I began by using codes to broadly describe the teachers' approaches,

beginning with a priori categories documenting teachers' lines of action in play (Björklund et al., 2018), adding more categories as needed. I found that two of the initial categories—*questioning* and *probing for specificity*—were better suited to describe the details of teacher actions that organized their activity within the broader lines of action. For example, teachers used questioning in different forms throughout a number of lines of action. Hence, these two categories were collapsed into the lines of action that correlated with the teachers' broader goals and approaches.

Table 2: *Example of Coding*

Session	Episode	Coding	Memo
21st Century Blocks.4 Length: 20:36	Two children explore possibilities when putting two different shapes together. One makes a row of hexagons while the other makes several rhombi. C focus on repetition in play, building multiple copies of the same shape. C: I made a hexagon! Episode length: 1:31	*exploring materials, repeating, seeking patterns, announcing activities*	The participation moved from initially exploring materials to creating patterns or repeating constructions.

Throughout these two cycles of coding, I developed transcriptions and corresponding analytic memos that documented how teachers and children guided the play activity. I used this analysis to develop meaning for emergent categories (see Appendix B for codebook). I also attended to ways that participants moved between modes of participation and examined patterns related to how children and teachers selected goals within the play activity. This analysis yielded a broad understanding of several common trajectories in how teachers and children were participating in the guided play episodes.

Following these cycles of coding, I focused on teachers' and children's co-participation in guided play. This analysis centered on goals and direction in play activity and how participants maintained a playful approach. I reviewed the notes and transcripts from all 80

episodes to identify episodes where children and teachers guided the evolving play activity based on their own goals, while developing sufficient intersubjectivity to maintain shared activity. Episodes that were either too brief to allow for detailed analysis or that did not include sustained activity toward specific goals were excluded.

Through this process, I chose two episodes to further study co-participation in the guided play activities. In these two episodes (a) children and teachers were engaged in a playful exchange of ideas and actions, and (b) interactions suggested that sufficient intersubjectivity was established. With these episodes, I conducted a deeper analysis of how direction and activity in play was shared or distributed among teacher and children. For each, I created a table showing the guided play activity in four columns: activity summary, teacher line of action, children participation, and interpretation. These tables allowed me to focus on the coordination and communication children and teachers developed as they moved together through the play episode.

CHAPTER 4

Children's Participation in Guided Play Episodes

From the coding, I developed broad categories from the bottom up that described children's participation throughout the activities. Four ways of engaging in guided play emerged from my analysis: *exploring materials*, *announcing activities*, *repeating ideas*, and *pursuing challenges*.

Exploring Materials

Across all the spatial reasoning activities, children explored materials and tried out possibilities with what could be done or created with them (Figure 1). Children's play typically began with exploring the spatial properties of the given materials before moving into other play activities. Because some of the materials were not previously a part of the classroom repertoire, children's explorations seemed to follow several lines of questioning: What is this? What does this do? What can I do with this?

Figure 1: *Exploring Materials Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Children explored stretching bands to make shapes.*	 *Children stacked blocks, sorted and arranged by color, and explored how pieces fit together.*	 *Children explored the eight cubes within a box by lifting the lid to reveal the 2x2x2 cube.*	 *Children explored the pattern block pieces by touching the sides, noticing the different colors, and talking about the sizes.*

In the geoboard episodes children explored how to hook the elastic band onto one peg and stretch to other pegs without shooting the band off the board. In some cases, they released the bands before they were attached sufficiently, resulting in a loose arrangement on the

geoboard. Other children explored stretching the bands with four fingers before placing them on the board, forming an informal polygon before attaching it. The elastic bands on geoboards allowed children to easily transform one shape into another by stretching the border of an existing shape to a new peg on the board (a triangle becomes a square).

With the 21st century blocks, children explored the different blocks, noticing their colors and shapes. In these episodes, children explored what they could accomplish by rotating pieces, flipping them over, stacking them on top of each other, and lining them up. Some children began to sort by color and then either stack similar pieces vertically or line them up horizontally on the table. In some episodes, these explorations were prompted by encouragement from teachers (in response to questions such as What can you make?); in other examples, children took on ways of exploring materials that were prompted by what other children were doing with the materials and repeating or building on these ideas.

The Froebel play materials consisted of 8 cubes enclosed in a box with a lid. Children were encouraged by teachers to begin exploration by taking off the lid and turning the box upside-down on the table. They then gently pulled the box upward to reveal the 2x2x2 cube. Most children immediately began to take the large cube apart and explore the individual cubes, while others attempted to replace the box over the assembled cube. In these activities, children's exploration also included repacking the eight cubes into the box, stacking them on top of each other to form towers, seeing how many they could hold in their hands at one time, and shaking the box with a few cubes inside to explore sounds.

In the pattern block episodes, children explored the different pieces, talked about what they noticed with each other and the teacher, held the pieces and touched sides, and put pieces together on the table to form designs. In many cases, children noticed when two pieces could be

arranged along congruent sides. For example, in one episode, a child played with a yellow hexagon, an orange square, and a red trapezoid, discovering that she could create a design in which these pieces shared congruent sides.

Announcing Activities and Creations

Children also participated through *announcing activities or creations* (Figure 2). In the context of initial exploratory play, these exclamations often signaled a created object, usually something recognizable to the child. These announcements also signaled children's intention in the play activity, often marking a transition from exploratory play to activity motivated by a particular goal. In general, children used these announcements to articulate and make meaning of their various actions, whether past (i.e., Look what I made!), present (i.e. I'm making a shark!), or future (i.e., I'm going to make all squares!).

Figure 2: *Announcing Activities Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *I'm making dinosaur eggs.*	 *I made a shark!*	 *I can build the highest jumping trampoline.*	 *Look at me, look at me!*

Importantly, children's announcements during play varied across activities and were often dependent on the materials. In the geoboard play, children verbalized announcements of surprise when shapes formed as they stretched elastic bands around pegs and then let them go. For example, in the geoboard activities, when one child was successful in stretching an elastic band across four pegs on the geoboard, she exclaimed "I made a square!" In the Froebel block play, children announced the creation of tall towers, of what they were planning to build, and how their creations compared to others children had made. In the pattern block play, when

children matched task cards with their own pieces, announcements were often exclamations of satisfaction.

Look what I made!

Look what I did!

(after completing a pattern block design) Look at me, look at me!

Tada!

I want to make a house!

I'm gonna make a rocket! It looks like my picture. Now I made my rocket!

At times these and other announcements were prompted by a teacher's question, while other times they were voluntarily made. During the guided play episodes children also demonstrated nonverbal announcements of enthusiasm or joy, such as clapping hands, smiling, or giving high fives to others.

Repeating Ideas

Children repeated ideas and activities as they became familiar with the materials and possibilities within the play setting. In repeating ideas, children often built on and extended ideas they discovered when exploring materials (Figure 3).

Figure 3: *Repeating Ideas Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Children created repeated designs using squares, triangles, and other polygons.*	 *Children created repeating designs with multiple shapes.*	 *Children built matching "castle towers" made of equal numbers of blocks.*	 *Children repeated patterns or designs created during play.*

In repeating ideas, children repeated created designs or replicated constructions that they, other children, or teachers had made. For example, in one episode two children used 21st Century Blocks to create designs by fitting two different shapes together. As they played side-by-side, one made a row of hexagons while the other made several rhombi. These children focused on repetition in play, building multiple copies of the same shape.

In the geoboard activities, some children created repeating designs while attending to symmetry, congruency, and equal space between their shapes. For example, in one episode a child stretched bands to create two congruent rectangles (Figure 4). His attempt to create a third rectangle yielded a shape slightly shorter than the previous two rectangles. Noticing this, he adjusted the band by stretching it across two lower pegs, resulting in a third congruent rectangle.

Figure 4: *Repeating Congruent Rectangles on the Geoboard*

(a) (b) (c)

(d) (e)

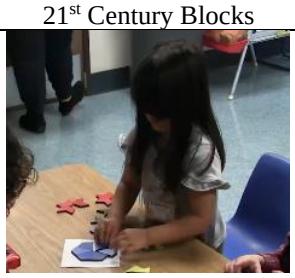
In the Froebel play episodes, children repeatedly took apart and reassembled the total cube, placing the box over cubes and removing it. They also arranged blocks in equal towers

(noticing whether they were touching on faces or edges) or repeated stacking routines. In both the Froebel and pattern block activities, children replicated designs created by teachers or provided in pictures at the play center.

Pursuing Emergent Challenges

Children pursued emergent challenges when motivated to accomplish a particular goal during play. These goals emerged through children's own explorations, task cards, teacher contributions, or other children's creations (Figure 5). When children pursued emergent challenges they moved beyond repeating or extending ideas to engaging in multiple attempts to meet their goals. These attempts included trial and error, asking for help, and taking up different strategies.

Figure 5: *Pursuing Challenges Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Children engaged in multiple attempts to create a star on the geoboard.*	 *Children rotated pieces to fit a puzzle outline.*	 *Children used various strategies to repack the Froebel boxes.*	 *Children's attempts to build upright presented a balancing/stability challenge.*

During the pattern block activities, several children used their pattern blocks to build upright, standing the pieces on edge and stacking them vertically. After multiple attempts at trying to stack his pieces on edge, one child expressed frustration that his house had crumbled. In construction play with the 21st Century Blocks, children attempted to create polygons that fit within puzzle outlines by rotating, flipping, and turning pieces to change orientation. In playing with the Froebel boxes, children employed various strategies to repack their boxes: after unsuccessfully trying to fit the box over the assembled cube, some children placed the cubes into

the box one by one, arranging them to create space for each succeeding block. Others created layers of four cubes and tried to place them carefully into the box. For one child, these layers came apart when she tried to place them in the box and she transitioned to packing one by one. In another episode, after packing his box Steven had one small cube remaining that would not fit. "This one ain't mine!" he exclaimed, giving it to another child seated next to him. After she filled her box and still had the one cube left over, Steven looked to see if other children were missing a block. "This one goes to…" he started. Then the teacher shook his box and a cube slid down into place, leaving an open spot for the extra cube. Steven gasped, smiled, and completed the packing, giving a high five to the teacher.

Summary

Taken together, children's various modes of participation in the guided play episodes form an informal play trajectory, moving from "messing about" with materials, to seeing what might be done or accomplished with them, to using them to meet goals or challenges emerging in play. Across the four types of play activities studied, children's participation typically began with *exploring materials* to discover what could be done with them. In many episodes, this activity resembled free play in that children were allowed to explore materials without specific goals or activities provided. As they experimented with figures and designs that could be created, they *announced activities or creations* to signal their accomplishments. Interestingly, these announcements also suggested a sense of agency in their play. In many cases, children followed announcements with *repeating* what they had created, often making multiple copies of the same design or building onto an existing figure. These repetitive activities offered children opportunities to develop complexity in their structures and develop spatial language. They also offered a context for children to *pursue emergent challenges*. These challenges emerged from

children's own play, from interactions with teachers, and from their observations of other children's activity. Notably, this is not a rigid, sequential path made of discrete steps, nor were children only observed moving in one direction; for instance, children also announced activities throughout the play session after completing a challenge or a repeated design. In some cases, children took up new patterns or ideas either during or after completing a challenge.

CHAPTER 5

Teachers' Lines of Action

From the coding of teachers' participation in guided play activities, I developed broad categories that described the ways teachers supported children's learning. Four a priori and two emergent categories yielded six lines of action that described teachers' participation: *structuring the material environment, confirming direction of interest, providing strategies, situating known concepts, challenging concept meaning,* and *creating novelty.*

Structuring the Material Environment

Teachers *structured the material environment* by setting out materials for play, drawing attention to the features of play materials, and suggesting ways they could be used. Structuring also involved introducing names and properties of the play materials throughout activities and highlighting material quantity, location, and orientation (Figure 6).

Figure 6: *Structuring Material Environment Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers showed children how to stretch elastic bands to create shapes of different sizes.*	 *Teachers named shapes like kite, hexagon, and dart in the collection of 21st century blocks.*	 *Teachers demonstrated how the 2x2x2 cube could be decomposed into layers.*	 *Teachers oriented children to material position by touching and talking about shapes in their creations.*

Across all the activities, teachers' structuring actions provided opportunities for children to engage in play. This occurred as teachers set the stage for play and introduced the play materials. In the geoboard activities, for example, teachers provided each child with a geoboard and oriented children to the elastic bands and how to stretch them around pegs to create a shape.

In one geoboard episode, the teacher exclaimed “Let’s make squares!” The teacher and children then quickly took to making squares and one child announced, “I did it! I’m making a square!”

Teachers introduced children to the Froebel materials by providing each child with a box of blocks. Then, teachers asked children to remove the sliding lid and turn the box upside down on the table. Children then engaged in slowly lifting the box off the cubes to reveal the 2x2x2 cube. In the pattern block activities, teachers placed blocks of all kinds in bowls on the table and invited children to explore. Teachers talked to children about the materials and their properties and encouraged children to name shapes like squares and hexagons, count the sides, and count the total number of shapes. Teachers also presented potential activity paths to explore by building figures alongside children and then asking them to replicate their figures using only the provided blocks. This provided scaffolding for the evolving play and helped to focus children’s attention on specific shapes and their features.

The 21st century blocks were typically spread across the center of the table and children began play by selecting blocks to play with. Teacher questions such as “What are we going to make?” prompted exploration and interaction with the play materials. In some episodes, teachers made simple figures from the blocks and placed them in the center of the table as ideas of what might be created. Structuring in this way involved demonstrating possibilities when putting pieces together.

Confirming Direction of Interest

Teachers *confirmed children’s direction of interest* by summarizing children’s activity or repeating children’s comments or actions (Figure 7). Teachers also used questioning to confirm children’s choices and encourage explanations during play.

As children explored materials and discovered what might be created, teachers observed children's activity and demonstrated interest in their play. Teachers used a variety of questions and statements to confirm children's direction of interest:

Your house is almost done. So, what are you going to do now?

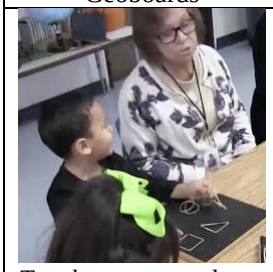
You're building with all blue pieces. Do you need more blue pieces?

What is our friend doing? Is he building a tower with blocks?

What are you making?

As seen in these examples, teachers' confirmations focused on pointing out specific aspects of children's creations or repeating their utterances or announcements to support their initiatives. When children announced what they had created or planned to make, teachers often confirmed these statements by repeating children's comments and adding a question. In many cases, teachers' interest in the direction of children's play also supported children's use of spatial language and imagination in describing their creations or next actions. In some episodes, confirming children's direction of interest seemed to helped to keep children engaged in play and encouraged their thinking about what they might do next.

Figure 7: *Confirming Direction of Interest Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers repeated children's explanations of the shapes they made.*	 *Teachers confirmed children's choices, such as sorting and building with shapes of the same color.*	 *Teachers asked children about what might be created and repeated children's initiatives.*	 *Teachers repeated children's comments about figures they were making and the pieces they might need next.*

Teachers also used confirming direction of interest to highlight children's initiatives in play and build on their reasoning. For example, after making a figure on his geoboard, one child

asked the teacher to make the same on her board. The teacher questioned, “You want me to make mine? Like you?” In this episode, the teacher confirmed the child’s invitation to involve her in the play and clarified what the child wanted her to do. In another episode, a child who was creating designs with pattern blocks announced, “I need more red pieces.” The teacher replied, “You need more hexagons? How many do you need?” Confirming children’s direction in this way also afforded opportunities to explore spatial language and numeracy in the context of play.

Providing Strategies

Teachers also supported children’s learning by *providing strategies*, defined as encouraging the development of skills such as pointing at objects while counting or directing children’s attention toward efficient methods for approaching challenges (Figure 8). These strategies allowed teachers to coordinate actions with children to integrate spatial reasoning into the guided play activities.

Figure 8: *Providing Strategies Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers identified target pegs to support children’s creation of geoboard designs.*	 *Teachers initiated rotation of pieces within designs to highlight symmetry within tiling patterns.*	 *Teachers encouraged rotation of cubes and attention to space within the box when repacking.*	 *Teachers encouraged counting to determine how many pieces were needed to complete pattern block puzzles.*

Across the episodes, teachers provided strategies to assist children in creating designs and completing tasks. Often, these strategies helped to break a large task down into parts, focusing children’s attention on the next step or course of action. In the pattern block activities, for example, teachers often provided children with picture cards of figures the children might

replicate. One card in particular showed a flower made with a yellow hexagon surrounded by tiling red trapezoids. In one episode, the teacher suggested that children count how many pieces were needed before they started to create the flower. The teacher asked questions such as: “How many pieces will you need? How many hexagons? How many trapezoids?” By encouraging children to count out pieces before they completed their constructions, the teacher sought to connect counting to a perceived goal or activity–to incorporate it as a strategy during play–rather than performing counting exercises that were unrelated to the play.

In some episodes, teachers provided strategies that did not seem to coordinate with children’s objectives. For example, after one child attempted to stack pattern blocks on end and build upright on the table, the teacher asked him to place the blocks flat on the table. The child ignored the teacher’s request and continued to build upright. The teacher again told the child to build with the pieces flat on the table, tapping on the table in front of the child. After several more attempts to balance the pieces on top of each other, the child expressed frustration when his structure fell. In this example, the teacher’s expressed strategies did not align with the child’s goal in play, resulting in missed opportunities for playful learning about balance or height.

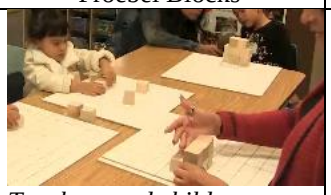
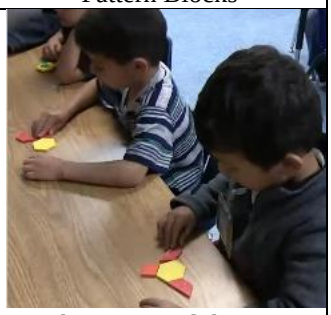
During the Froebel episodes, teachers offered strategies for packing and unpacking the boxes. In one episode, a teacher offered pathways for replacing the cubes into the box: “See if you can put it back in the box. Play around with it and twist the pieces around. Remember, you can turn these around in different ways.” In other episodes, teachers coordinated efforts to repack boxes with children, drawing attention to the space in the box when packing and talking about features of pieces that might allow them to fit in specific ways.

Other strategies across the episodes included encouraging starting points when children worked on pattern block puzzles and asking questions during construction play such as Where does that go? How does that fit? How can you make that piece fit?

Situating Known Concepts

Teachers *situated known concepts* within play by helping children contextualize familiar concepts and discern problems emerging in play (Figure 9). In situating known concepts, teachers interacted with children through dialogue and coordinated actions to draw out the meaning of concepts encountered in play, such as size, sameness, quantity, directionality, and shape.

Figure 9: *Situating Known Concepts Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers highlighted quantity of created shapes through counting with children.*	 *Teachers contextualized concepts such as sameness within children's constructions.*	 *Teachers and children made "chairs" and talked about the size needed for a doll to sit.*	 *Teachers situated the concept of size as they made birds with children.*

This line of action provided children opportunities to think and reason spatially in the context of play. For example, in one pattern block episode, the teacher created a design and invited a child to put pieces together to match the design. After a few attempts, the child diverged from the task and began to repeatedly add pieces onto her own creation, making it as long as she could (like a snake). The teacher exclaimed, "Wow, yours is so loooong! How many pieces did you use?" The teacher situated the concept of length into the play, offering an opportunity to explore how the number of pieces might be related to the length of a creation. In

the Froebel episodes, teachers supported concepts of "fit" and "space" as they discussed ways to pack and unpack boxes.

In the geoboard activities, teachers' situated concepts of shapes such as triangles and squares by emphasizing children's construction of these shapes. Rather than only identifying existing shapes as found in books or curricular materials, teachers situated the concept of these shapes in children's own constructions made by line segments, or in this case, elastic bands. In one episode, a child made six congruent squares on her geoboard (Figure 10). She then changed one square to a right isosceles triangle by removing the elastic band from one peg. When the child looked at the teacher inquisitively, the teacher playfully exclaimed, "Uh oh, I see something that's different!"

Figure 10: *Child Points to the Shape That is Different*

The child then began to change the remaining squares into triangles, to which the teacher responded, "Now you're changing them all to triangles!" Difference became a concept that the child could meaningfully engage as she both created and resolved differences in her geoboard shapes. Here, the teacher's playfulness supported this exploration without explicitly directing the activity.

In other geoboard activities, teachers seemed to take advantage of opportunities to connect number and counting to shape creation. For instance, in one episode children were making squares on the geoboard. After one child made a square and announced, "I made a square!" the teacher asked, "How many corners does the square have?" Touching the pegs, the

child counted to four. The teacher then asked, “Can you show me four on your fingers? Are you four years old?” These questions drew on different expressions of the concept of four, encouraging representation of features of play creations in various ways to develop conceptual understanding. In this episode, the child continued to make squares on his own, counting the squares on his geoboard. He followed this with “Now I want to make a circle!”

Some episodes revealed the challenge in maintaining children’s self-direction when situating concepts in children’s play. In contrast to the previous example, at times teachers’ efforts to situate content seemed to take the play in a different direction than perhaps the child intended. For example, when teachers asked children to count sides of designs or number of blocks used, children were given tasks to accomplish that may not have aligned with their own interests in play.

Challenging Concept Meaning

Teachers also supported children’s learning by *challenging concept meaning*, defined as introducing new or contrasting meanings to concepts emerging in children’s play (Figure 11). Across the activities, teachers challenged concept meaning through questioning children about ideas or notions that developed in play.

Figure 11: *Challenging Concept Meaning Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers encouraged children to elaborate how they knew shapes were triangles, together counting sides created by elastic bands.*	 *Teachers introduced meanings of congruence by contrasting ways to make the same shape.*	 *Teachers introduced the concept of equal when children compared rows of cubes.*	 *Teachers introduced directional concepts such as “straight” to help children align pieces in puzzles.*

These questions encouraged children to explore new meanings through dialogue and their own constructions. For example, in one geoboard episode a child made a triangle with an elastic band and announced what she had made to the teacher: “Look, a triangle!” Then, looking at the teacher, she held up her fingers together, thumbs and index fingers from both hands touching in the shape of a triangle. She then slid her thumbs downward together, exclaiming “A diamond!” The teacher asked, “Did you make a diamond? Let’s see your fingers again…do they match the shape that you made?” In this way, the teacher encouraged exploration of congruence between the child’s creation and modeled representation with fingers.

In one episode with the 21st century blocks, a child put together two shapes and then asked the teacher, “What is that?” The teacher responded, “That’s a dart and a rhombus, and then it turns into a kite.” Gathering more materials, the teacher asked, “Did you see what you just did? Look! They’re the same shape! (putting together another dart and rhombus next to a congruent blue kite).” Another child playing nearby made the same figure, but added another dart to the rhombus and lifted it into the air, saying, “But kites are like this – lookit!” as he flew it side to side. “Yeah!” the teacher exclaimed. “You used two darts and a rhombus!” In this exchange, the emergent concept of “turning into a kite” provided opportunity for contrasting meanings through teacher questioning during mutual play.

In an episode with Froebel cubes, children explored putting their cubes into rows. When a child made two rows of four cubes, the teacher asked: “Which one is more, this one or this one?” The child touched and counted each cube in the first row, ending at “four”; she then counted the second row. “Four!” she exclaimed with a giggle. “But which one is more, this row or this row?” The child then used her hands to align the edges of the two rows, saying “Let me squish them together. They’re the same!” The teacher responded, “They’re the same, they’re equal!” This

introduction of the concept of "equal" was in contrast to the idea of "more" in the teacher's initial question, and the child experienced the notion of sameness through her own physical manipulation of her play materials.

Creating Novelty

A final way teachers supported children's learning was by *creating novelty*, which occurred when teachers pursued avenues or took on roles to extend or enrich children's play (Figure 12).

Figure 12: *Creating Novelty Across Activities*

Geoboards	21st Century Blocks	Froebel Blocks	Pattern Blocks
 *Teachers used stories to extend constructions during geoboard play.*	 *Teachers copied children's creations and children determined when they matched.*	 *Teachers pretended not to know where hidden blocks were.*	 *Teachers transitioned between shape names and imaginary objects.*

In creating novelty, teachers encouraged playfulness during activities by suggesting an avenue to extend play or inviting change in the direction of play. In some cases, these suggestions were prompted by what teachers noticed children doing or saying in play. For example, in one Froebel episode, a child packed cubes into the box and put the lid on. She then showed the teacher with a smile and asked, "Where are they?" The teacher replied, "I can't see them. Are they all in there? What happened to them? They all disappeared, huh?" Turning the box over, the child asked again, "Where are they?" The teacher responded, "I don't know, I think they're all under the table." After the child lifted the box and revealed the cubes, again smiling at the teacher, the teacher exclaimed, "They're right in front of my eyes–I can see them now."

Teachers also took on different *roles* in play that allowed them to support children's imagination and interest. For example, when children made pizzas with the 21st century blocks, a teacher blew on a hot pizza to cool it while a child added red blocks (announcing "Tomatoes!") and yellow blocks (announcing "Cheese!"). In other episodes, teachers invited children to show them how to replicate their designs or introduced impromptu matching games. In the geoboard activities, for example, teachers often asked children to show them how they created figures or designs. In one episode a child created several of the same shapes on his geoboard.

Child: (to the teacher) Can you do that?

Teacher: I'm gonna try. Let's see if I can do that.

Child: I can, I can show you how to do that!

Teacher: OK, show me how you did that. I forgot how you did it.

Child: (building on the teacher's geoboard) Like this, and you get a one, do this, do this, do that.

Teacher: Nice!

Teachers used acknowledgements of not knowing how to build, or forgetting how to create designs, to encourage children to recreate designs with verbal explanations. These invitations provided children opportunities to explore spatial reasoning through sequenced communication and explanation.

Summary

Teachers' lines of action were not time-bound in the sense that they occurred sequentially or only in concert with specific forms of children's participation. Rather, lines of action often occurred in response to children's initiatives. For example, teachers *structured the material environment* by setting out play materials and orienting children to possible activities. This

structuring occurred when children were *exploring materials* and helped to both open possibilities and identify constraints in play. Introducing structure involved more than setting the stage, though it may take that form; teachers introduced structure at different points during the play episode. When children were *repeating ideas* or *pursuing challenges* with 21st century blocks, for instance, teachers provided structure by encouraging attention to shape location or orientation. This structuring was embedded within the play activity, allowing children to notice spatial relationships emerging through their own creations and activities. Structuring, in response to children's initiatives, focused attention on spatial relationships and concepts.

In *providing strategies*, *situating known content*, and *challenging concept meanings*, teachers took more initiative in supporting children to make content connections in the context of play. These lines of action also encouraged children to move from trial and error to strategic or systematic approaches in play—for example, when placing cubes in boxes or creating complex designs with blocks. When teachers used these lines as children were *repeating ideas* or creating patterns, play activity often shifted to identifying emergent challenges. Importantly, using these lines of action in coordination with *confirming children's direction of interest* surfaced children's goals and direction in play and provided opportunities for teachers to adjust their own play alongside and with children.

In *creating novelty*—in some cases, taking the role of a novice—teachers opened possibilities for extending and enriching play. When teachers playfully asked children for help or followed children's challenges, they acknowledged children's agency and attitudes in play. These experiences provided opportunities for children to guide play in ways that were meaningful to them.

CHAPTER 6

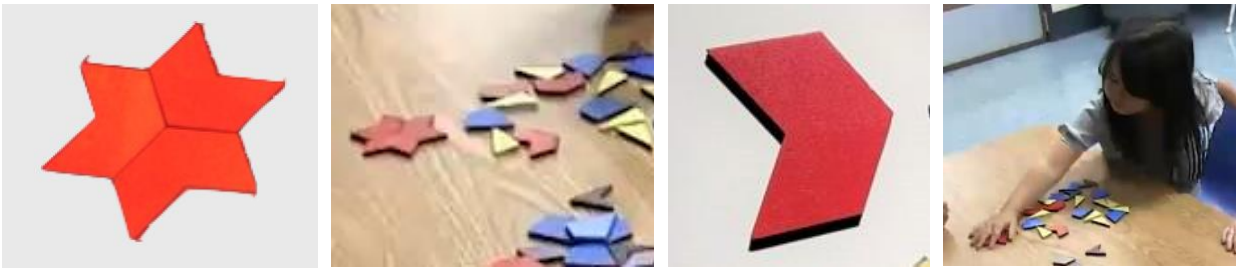
Co-Participation During Guided Play

In this chapter I present a deeper analysis of two episodes of guided play. I use the lens of co-participation, defined as shared activity in the context of play. Co-participation is characterized by how the teacher and child work jointly toward a coordinated view of contexts and actions. In particular, the analysis of co-participation focuses on whose goals are directing the play activity and what adjustments teachers and children make as they play together. Furthermore, these two episodes show how intersubjectivity and playfulness may have structured children's learning opportunities.

Episode 1: It's Gonna Be a Kitty Cat!

In this episode, children were invited to play with the 21st century blocks at a small group table. As children began exploring materials, the teacher made a star with three red hexagons (Figure 13a) and silently moved it to the center of the table (Figure 13b). Meanwhile, two children sorted blocks by color, making piles of the blue pieces. Holding up one red hexagon (Figure 13c), one child exclaimed, "This guy's PacMan!" and made chomping noises as he moved it to gobble other pieces. A few moments later Dalia joined the table and pulled the red star toward herself (Figure 13d).

Figure 13: *Episode 1, Part 1*



(a) (b) (c) (d)

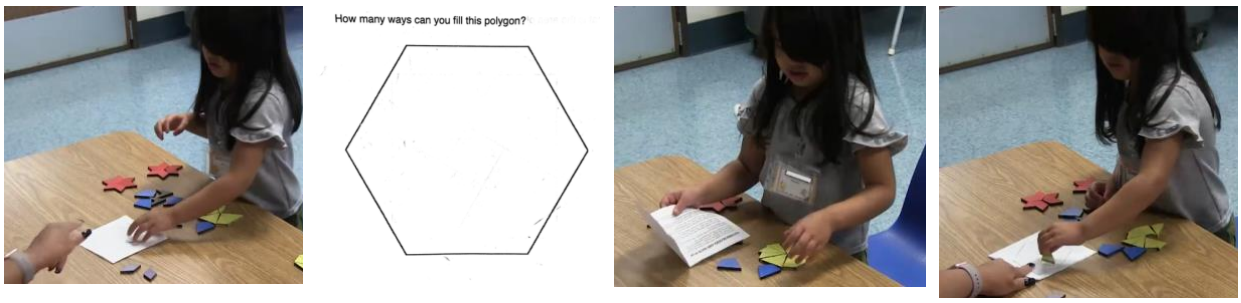
Dalia's moving of the star caused it to separate (Figure 14a). Dalia reassembled the star and then used three more red hexagons to create another star below it (Figure 14b). Noticing Dalia's creation, the teacher asked, "What did you make over there?" Pointing at the original star first, then her replica (Figure 14c), Dalia said "A star, a star!" The teacher replied, "Oh, a star?!" Dalia then began arranging yellow triangles side to side (Figure 14d), rotating them around an imaginary center point.

Figure 14: *Episode 1, Part 2*

(a) (b) (c) (d)

"Ooh, what are you making?" the teacher asked. "A pizza!" Dalia responded. The teacher replied, "A pizza? You know what, I think your pizza can fit into this piece of paper. What do you think?" The teacher gave Dalia a folded booklet (Figure 15a) with an outline of a hexagon on the cover (Figure 15b). With a puzzled look on her face, Dalia opened the paper, possibly considering how she might put her pizza inside (Figure 15c).

Figure 15: *Episode 1, Part 3*



(a) (b) (c) (d)

Closing the booklet and pointing to the hexagon (Figure 15d), the teacher clarified, “Well here, can you put your pizza so that it fits on that?

After placing two yellow triangles inside the hexagon border, Dalia removed them and began to create a figure with the blue pieces, again aligning the edges and rotating around an imaginary center. When she had put together five pieces, she tried to pick them up and transfer them to the paper (Figure 16a). The figure came apart, so Dalia shifted to placing the pieces one by one onto the paper (Figure 16b). When she finished, her design did not quite fit within the template boundary. Noticing this, the teacher asked, “Does that fit in there?” Dalia shook her head. Together, the teacher and Dalia negotiated the orientation of the pieces (Figure 16c). The teacher assisted with aligning several pieces to the template, but did not rotate a block that is beyond the template boundary. Once five of the blocks were aligned with the hexagon border, Dalia rotated the block that did not fit and celebrated her accomplishment (Figure 16d).

Figure 16: *Episode 1, Part 4*

(a) (b) (c) (d)

“You did it!” the teacher exclaimed. “Nice! Well, what about these (pointing to the yellow triangles)? Do you think you could put yellow on top?” Dalia replied, “I think so.” Then the teacher said, “You think so? Let’s see if we can put yellow on top… (Dalia placed two yellow triangles on top of the blue hexagon) and make it so that it fits the same circle—or your hexagon, sorry.” Dalia continued to adjust the two yellow triangles on top of the blue hexagon, and then announced, “It’s gonna be a kitty-cat.” The teacher replied, “Oh, a kitty-cat? Are you

making a kitty-cat? Are those the ears?" Dalia nodded, and continued to add triangles until she finished and exclaimed, "That is a kitty-cat!"

Analysis of this episode suggests several ways the teacher and Dalia's co-participation supported learning in play. Figure 17 provides an interpretative analysis of several key interactions in this episode.

Figure 17: *Analysis of Co-participation with 21st Century Blocks*

Activity		Teacher	Children	Interpretation
[4:02] Dalia creates a figure with the yellow triangles, rotating each piece to match sides. Teacher: Ooh, what are you making? Dalia: A pizza. Teacher: A pizza?		*confirming direction of interest*	*repeating ideas, announcing activities or creations*	In exploring materials, Dalia begins to repeat ideas and make meaning of her creations.
[5:25] Dalia begins to tile with blue pieces, using a hexagon outline on paper. When she is unable to make the blocks fit, she pauses to look at the figure. Teacher: "Does that fit in there?" Dalia: *shakes head*		*situating known concepts (discerning a problem)*	*pursuing emergent challenges*	While Dalia used blocks to build figures, the teacher's question helps to situate the concept of "fit" and discerned an emergent challenge in play.
[5:30] Together the teacher and Dalia negotiate the orientation of the pieces.		*structuring material environment, providing strategies*	*pursuing emergent challenges*	The teacher takes a collaborative role in supporting Dalia's problem solving in spatial play.
[6:17] The teacher asks Dalia if she thinks she can lay yellow blocks on top of the blue blocks so that they fit the same hexagon. Dalia thinks for a moment, then says "I think so."		*creating novelty*		In extending play, the teacher poses a problem while Dalia pauses to consider.

Figure 17 (cont'd)

[6:34] Dalia begins by putting on two yellow triangles. She then says, "It's gonna be a kitty-cat."			*exploring materials, announcing activities*	Dalia redirects the next sequence of play, articulating her goal and choosing the next course of action.
[6:38] Teacher: Oh, are you making a kitty-cat? Are those the ears? Dalia: (nods) It's a kiiiiitty-cat.		*Confirming direction of interest*	*announcing activities or creations*	The teacher reorients to Dalia's interpretation of play and demonstrates shared understanding.

As this episode began (before Dalia joined the group), the teacher created the red star—an example of what might be created (structuring the material environment). When Dalia came to the table, she took up the star and explored how the red hexagons could be rotated and assembled to form it (exploring materials). Taking up this "seed" allowed Dalia to investigate the physical properties of the materials and discover ways they could be combined to create figures. As Dalia created a replica of the star, the exploration quickly turned to intentional repetition of ideas. Dalia continued to transfer ideas about rotating pieces around an imaginary center point to make various creations with other pieces. The teacher introduced structure in coordination with Dalia's play—namely, to support Dalia in positioning the blocks within the template boundary. Orienting Dalia to the position of materials within the constraints of the boundary aided Dalia's efforts to pursue emergent challenges in the context of her play.

Later in the episode, in suggesting that Dalia build on top of the blue hexagon, the teacher's goal was to help Dalia explore the spatial relationship between the blue kite and the yellow right triangle (two yellow triangles are congruent to one blue kite) and create a congruent hexagon with the yellow triangles. The line of action used by the teacher—*creating novelty*—

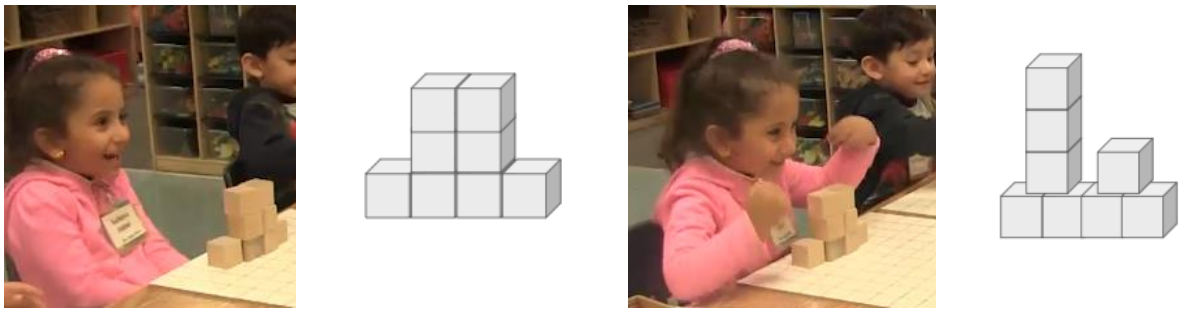
took the form of seeking to extend or enrich play. However, Dalia did not recognize or take up the challenge as the teacher intended; rather, she took the play in her own direction by pursuing the construction of an imagined figure—a kitty-cat. *Creating novelty* offered Dalia an opportunity to reopen play through *exploring materials* and what might be accomplished by creating layers. Her announcements during this exploration mark her evolving sense-making of the created figure. The teacher, demonstrating a playful openness to Dalia's interpretation, swiftly confirmed Dalia's interest by aligning her questioning with Dalia's imaginary situation: "Are those the ears?" Confirming direction of interest, particularly when Dalia was announcing activities or creations, suggested a level of intersubjectivity between the teacher and Dalia—namely, a shared understanding of what they were talking about. The established intersubjectivity and playful approach offered Dalia continued opportunities to explore the spatial features of her kitty-cat in play.

Episode 2: I Could Do This!

In the second episode, four children and one teacher were building structures with their Froebel cubes. Ronaldo built tall towers, while Luis maintained the 2x2x2 cube and repeatedly pulled the box off to reveal the cubes. After creating several different structures with her blocks, Cristina placed blocks together to form a three-layer structure (Figure 18a) with a row of four blocks on the bottom, a row of two in the middle, and a row of two on the top (Figure 18b). Turning her attention to the teacher who was building her own figure, Cristina said, "You could do that. Could you do that? Could you do that?" The teacher replied, "Yeah!" Cristina then motioned up and down with two fists (Figure 18c) as she chanted, "Do it, do it, do it!" As the teacher began to replicate the figure, she asked Cristina, "Let's see, you're gonna tell me if it's

right or not?" Cristina nodded in reply. After the teacher had built her figure (Figure 18d), she asked Cristina, "Is that the same as yours?"

Figure 18: *Episode 2, Part 1*



(a) (b) (c) (d)

Cristina shook her head (Figure 19a) and, pointing to the top row of her figure (Figure 19b), said "I put two." "You put two? Where?" the teacher asked. Before Cristina could answer, Ronaldo, who had built a tall tower, asked the teacher, "You dare me to cut one in half?" The teacher nodded and Ronaldo knocked off one block. The teacher asked, "That's one?" Ronaldo then knocked over the whole tower. Just as the tower hit the table, the teacher exclaimed "Ah!" and Luis asked the teacher to close her eyes. The teacher, focused on returning to building, asked Cristina, "Um, is this right?" as she removed two blocks from her figure (Figure 19c). Cristina shook her head and Ronaldo said "Noooo." Cristina said to the teacher, "Try again!"

Figure 19: *Episode 2, Part 2*

(a) (b) (c) (d)

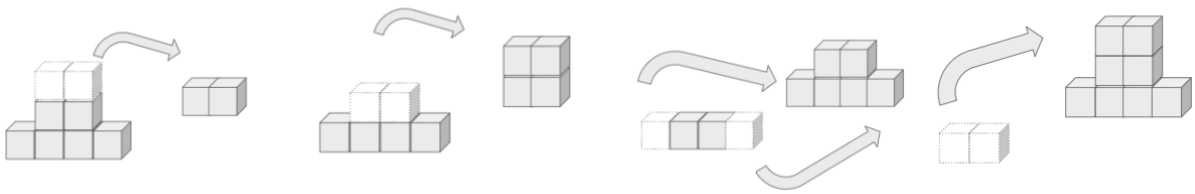
The teacher then placed one each of the two removed blocks on the ends of her top row (Figure 19d). “Is this right, two and two like this?” she asked Cristina. Shaking her head, Cristina explained, “No, like this.” Using two index fingers, Cristina touched the top row (Figure 20a) then the second row (Figure 20b), saying “One, two” and then repeated the motion, saying “One, two. You’ll get it right.” The teacher replied, “Ok, I’ll get it right.”

Figure 20: *Episode 2, Part 3*

(a) (b) (c)

The teacher paused for a moment and Cristina began (Figure 20c), “Now, now you have to do four like—you have to do much like this.” Touching one of the blocks on the bottom row of her figure, the teacher replied, “Four like this, right?” Smiling, Cristina said, “K, let me show you.” Cristina then deconstructed her figure from top to bottom and rebuilt it from the bottom up as the teacher copied her moves. She began by placing the top row of two blocks on the table (Figure 21a), then stacked the next row of two on top (Figure 21b).

Figure 21: *Episode 2, Part 4*



(a) (b) (c) (d)

She partitioned the remaining row of four into two blocks added to the bottom row (Figure 21c) and two blocks added to the top of the figure (Figure 21d).

The teacher followed each step of this sequenced reconstruction, arranging her blocks as Cristina modeled. Finally, the teacher was able to replicate Cristina's figure. "Oh, that's like yours!" the teacher exclaimed. Cristina nodded and smiled. Luis again asked the teacher to close her eyes. As soon as the teacher had closed her eyes, Luis said, "Open your eyes" and lifted the box off the cube. The teacher gasped and smiled.

Figure 22 provides an interpretative analysis of several key interactions in this episode.

Figure 22: *Analysis of Co-participation with Froebel Cubes*

Activity		Teacher	Children	Interpretation
[15:18] Cristina: (as she places cubes) I could do this. I could do this. One here, and one here. Tada! Teacher: That's nice! Cristina: I made it really really really like that. Teacher: You did!		*confirming direction of interest*	*announcing activities or creations*	Cristina emphasizes her own creative direction in building a structure.
[15:38] Cristina: You could do that. Could you do that? Could you do that? Teacher: (while building something else) Yeah! Cristina: (chanting) Do it, do it, do it! Teacher: Let's see, you're gonna tell me if it's right or not? Cristina nods. Teacher: OK.		*confirming direction of interest, situating known concepts*	*repeating ideas*	Following Cristina's invitation, the teacher agrees to replicate her structure, inviting Cristina to determine whether the two are the same.
[16:00] The teacher builds a figure that is slightly different than Cristina's. Teacher: Is that the same as yours? Cristina shakes her head. Teacher: Hmm.		*challenging concept meaning, creating novelty*	*repeating ideas, pursuing emergent challenges*	The teacher takes up a novice role in play that positions Cristina as expert.

Figure 22 (cont'd)

[16:06] Cristina explains the difference. Cristina: (pointing with each index finger to the top of her figure) I put two. Teacher: You put two? Two where? Teacher and Cristina look over at Ronaldo, who has built a tower and asked the teacher, "You dare me to cut one in half?" The teacher nods.		*challenging concept meaning*	*pursuing emergent challenges*	Cristina's explanation and gestures identify a difference in the two structures. The teacher challenges Cristina's meaning of "putting two" and then turns attention to Ronaldo.
[16:18] Ronaldo knocks off one block. Teacher: That's one? Ronaldo knocks over the whole tower. Meanwhile, Luis asks the teacher to close her eyes.		*challenging concept meaning*	*exploring materials, repeating ideas*	The teacher attends to ways other children play within the episode.
[16:27] Teacher (to Cristina) Um, (taking off two blocks) is this right? Cristina shakes her head and Ronaldo says "Noooo." Cristina: Try again!		*structuring material environment, challenging concept meaning*	*repeating ideas*	The teacher's repeated attempts to replicate Cristina's structure provide opportunities for spatial comparison.
[16:40] Cristina: Now, now you have to do four like—much like this. Teacher: Four like this, right? Cristina: K, let me show you. (rebuilding her figure one row at a time) You have to do that, like that. Teacher: Oh, like this. Cristina: And then, you put these here. And then you put some like this. Like that. Teacher: Oh, (completing her structure) that's like yours! Cristina nods and smiles. Luis: Close your eyes. Teacher closes eyes. Luis: Open your eyes (lifts box off cube). Teacher gasps and smiles.	 	*creating novelty*	*repeating ideas, pursuing emergent challenges*	Cristina decomposes her construction through a series of movements, recreating the shape again for the teacher as she describes the location of the pieces. The teachers' expressions of satisfaction communicate her position as a learner, and that Cristina had presented a worthy challenge.

In this episode, the teacher and Cristina co-participated in developing two identical constructions with eight Froebel blocks. Throughout the play, they fostered a shared understanding of the construction play activity and what was needed to accomplish Cristina's articulated goal. The teacher's own construction play at the outset of guided play communicated that she was a potential play partner—one who could be called on to engage in play. In confirming Cristina's interest in building matching figures, the teacher positioned Cristina as one who could direct the play, not only for herself but for co-participants. In this case, guided play engaged them both in working jointly toward a coordinated view of congruency while negotiating a shared sense of whether the emerging challenge had been sufficiently met.

Cristina and the teacher adjusted their actions in a number of ways to maintain intersubjectivity and a joint sense of their progress. For the teacher, this occurred through creating novelty—the teacher took on the role of beginner, a learner engaging in multiple attempts to reach her goal. For example, she took up Cristina's challenge but added to it by asking Cristina to tell her whether she had matched the figure correctly. She also situated the concepts of "same" and "right" into the play, offered Cristina opportunities to incorporate these concepts into her own explanations, elaborating with gestures to communicate how the figures were different. Although Cristina did not respond to the teacher's question of "Two where?" the teacher was able to situate the idea of "two" by taking off two blocks simultaneously and by asking "Is this right, two and two like this?" For Cristina, adjustments involved a variety of actions and verbalizations in response to the teacher's attempts. Overall, these took the form of explanations, gestures, decompositions, and reconstructions that offered her opportunities for spatial reasoning. Notably, Cristina's deconstruction and reconstruction of her figure was a deliberate attempt on Cristina's part to draw the teacher into a shared understanding and

indicated her own intention to scaffold play for the teacher. At the same time, it offered her an opportunity to take apart a figure and put it back together in a different way, preserving the original shape of the construction.

Summary

Co-participation in these guided play episodes involved ongoing adjustments from both teachers and children. These adjustments served to maintain sufficient intersubjectivity for the play activity to proceed. Furthermore, when participants oriented toward others' perspectives, play continued with a jointly coordinated view of contexts and actions. Although not every episode in this study illustrated such a responsiveness to children's direction, the episode of Dalia presents an instance where a teacher's playfulness opened possibilities to support Dalia's evolving play. In this example, the teacher did not insist on a particular approach or strategy, but rather offered Dalia opportunities to establish meaning and direct the play.

The episode of Cristina presents an instance of a child initiating a challenge, introducing structure, and providing strategies to the teacher—namely, deconstructing a shape to demonstrate how to build it as the teacher pursued the challenge of building. This "role reversal" was made possible by the teacher's playfulness and exemplifies play activity that may take participants into fluid roles of both teacher and learner. Importantly, the teacher did not have to abandon learning goals by following Cristina's lead. Instead, the teacher's playfulness opened possibilities for Cristina to demonstrate her understanding in ways that were situated within play. Cristina's episode illustrates a level of playfulness from both child and teacher that stood out among the analyzed episodes and suggests what might be possible when teachers are open to novel approaches within guided play.

CHAPTER 7

Discussion

This study examined how children and teachers participated in guided play centered on spatial reasoning. Through analysis of episodes in Head Start preschool classrooms, I identified and described ways children participated in guided play. I also examined teachers' lines of action and how they supported children's learning in play. Analysis of two focal episodes provided insights into co-participation in play, including when children seemed to take initiative to offer contributions and how teachers' responses supported children's contributions. These episodes also offered opportunities to elaborate the role intersubjectivity played in guided play activities. Discussion of these findings begins with insights gained from focusing on participation in guided play activity. Then I discuss the potential of playfulness within co-participation to disrupt the play-versus-teaching binary. I conclude with implications for practitioners and researchers.

Guided play offers teachers a middle ground between free play and direction instruction. Yet, early childhood teachers have reported leaning toward either free play (for fear of disrupting children's play) or direct methods of instruction (to meet learning goals). This divide is only reinforced through references in the literature to teachers' actions during children's play as "smuggling," "hijacking," "destroying," "disrupting," or "controlling." This study's findings suggest that teachers can and do co-participate with children in multiple ways to support learning—ways that, in this study, did not seem to disrupt, control, or hijack children's play. These lines of action drew teachers into co-participatory roles with children wherein, as seen particularly in the two focal episodes, teachers sought to establish intersubjectivity with children. Together, they accomplished shared activity as defined by Dewey (1916), where "the teacher is a learner, the learner is a teacher" (p.160).

These findings extend research that suggests when teachers stay "inside" children's play there are opportunities to situate content and genuinely use learning goals. Such shared thinking, according to Fleer (2015), occurs when "teacher intent is in parallel with the children's play intent" (p. 18 08). Yet, teachers clearly sought to build on children's play to support learning about spatial reasoning. Bjorklund et al. (2018) describe this as "handling the delicate balance between remaining within the play frame and extending the children's experiences" (p. 477). Maintaining this balance involved adjustments by both children and teachers; teachers adjusted based on noticing children's actions and interpretations, and children adjusted based on their own ideas, directions, and teacher's contributions. What is striking is that children, not just teachers, initiated co-participation: the child who spontaneously built on the teacher's geoboard to "show her how to do it," or the child who invited the teacher to replicate her design, or the child's continuous request to "close your eyes." These invitations within guided play speak clearly to the child's perception that the teacher is not far off or seen as an authority figure to determine correctness or evaluate answers, but rather a viable play partner whose intent may be drawn into alignment with the child's.

Notably, the notion of co-participation raises questions about scholars' continuum models that describe classroom activity on the basis of less structured (free play) to more structured (didactic instruction) (Miller & Almon, 2009), or child-directed to teacher-directed (Pyle & Danniels, 2017). Positioning direction and structure on such continua suggest that, if teachers desire to take an active role in supporting children's playful learning, they must only occupy the middle spaces. Instead, it may be worth refocusing attention on how teachers and children playfully co-participate in a variety of learning activities. To illustrate, children initiated playful interactions throughout guided play episodes, even when teachers were providing more structure.

Similarly, teachers initiated conceptual conversations into episodes, even when children were engaging in imaginative play with materials.

Such a rethinking leads to the notion of *playfulness*— the kind Sicart (2017) said "reambiguates" the world and offers renewed wonder and curiosity in experiences (p. 28). This notion supports Dewey's (1910) claim that playfulness "is a more important consideration than play" and an "attitude of mind," whereas play is "an outward passing manifestation of this attitude" (p. 162). Drawing on these notions of playfulness can further disrupt the play-versus-teaching binary and help to reimagine opportunities for teaching within guided play. In teaching there can be moments of playfulness, and in play there can be moments of teaching. When teachers were playful, they remained opened to the child's initiatives and intentions, making adjustments to their approaches. When children were playful, they suggested directions in play such as hiding materials and engaging other children and teachers in impromptu games. Playfulness is less dependent on the activity on hand, but offers a means for "taking over a world to see it through the lens of play" (p. 24).

Teachers' playfulness was observed in ways they *created novelty*—in some cases, taking a beginner's mindset in their interactions with children. This was seen as they suggested new ideas, used materials in new ways, or took roles of learners. In some cases, novelty disrupted notions of teacher as expert knowledge-holder and positioned teachers as novices ("You'll tell me if I'm right"). In this approach, possibilities were opened for extending and enriching play. In this approach, possibilities were opened for extending and enriching play. As Shunryu Suzuki (2010) said, "In the beginner's mind there are many possibilities but in the expert's there are few" (p. 1).

Limitations

The findings of this study should be viewed in context of the limitations presented by the materials, activities, and participants in the study. For instance, the materials used in the guided play activities were designed to highlight spatial relationships—other materials or activities may present opportunities for different types of guided play. Further, the ways children and teachers participated in guided play are not the only ways they may engage together. Other activities or forms of play, including pretend play, role play, collaborative play, and outdoor play may introduce additional participation patterns between children and teachers. The generalizability of these findings is limited by the specific nature of the Head Start context studied, and by the teachers who participated in the professional development and guided play episodes. Other groupings of teachers and children within formal and informal learning environments may provide a wider array of engagement forms. Further attention to children's individual play, their collaborative play, and their play with teachers is needed.

Implications

Despite these limitations, this study's findings have consequences for practitioners and researchers in early childhood education. For practitioners, this study's findings point to the importance of developing teacher lines of actions to support children's learning in guided play. Structuring various play environments, both before and during play, can lead to enhanced spatial reasoning opportunities for small groups of children. Providing strategies during play that encourage children's persistence in pursuing emergent challenges can support positive dispositions for STEM learning. When considering lines of action, teachers should take careful notice of children's participation. Building on work by Jacobs, Lamb, and Philipp (2010) that emphasizes the role of noticing, interpreting, and responding to children's thinking, this study

provides specific ways teachers can respond to children's thinking as they explore rich materials. For example, teachers' confirming direction of interest, as Bjorklund et al. (2018) found, serves to make children's intentions more explicit in play. In addition, teachers should examine how they co-participate with individual children in play, how they coordinate actions with these children, and how they can create novelty to extend and enrich learning in play. This requires careful attention to what situations and actions mean for children, and what storylines children might be interested in pursuing. Such attention can foster intersubjectivity between teachers and children, leading to sustained shared activity and learning.

Practitioners need professional development that encourages playful engagement in STEM activity. In these learning settings, teachers are encouraged to engage in the same activities that young children do to develop playful ways of engagement. Professional development should then aim to transcend the play-versus-teaching binary by situating learning goals and lines of action within playful contexts. This support would help teachers better understand when and how they might draw attention to structure, how to highlight material location or orientation, and how these insights might be useful in the child's play. One additional professional development pathway worth exploring may be to counter the notion of "expert" and encourage teachers to take on a beginner's mindset when co-participating with young children. With this mindset, teachers can explore new possibilities when engaging in play and learn to take up children's perspectives. As seen in this study, this positioning can support children's agency and foster joint activity in play and learning. In the classroom, instructional coaches can play alongside teachers in small group guided play to model lines of action and co-participation roles, helping teachers to gain better understanding of the potential adjustments to actions and roles that can support learning.

For researchers, this study lends support to inquiry that elaborates roles teachers can take as co-participants in children's play and explores what lines of action open up new possibilities for learning STEM content. One approach might be to study which lines of action are most common and whether different guided play activities afford specific lines of action. Future research could also explore whether children engage differently in particular activities or whether certain materials offer children opportunities to pursue emergent challenges more than others. Given the academization of early childhood education programs, we need more ways to study and conceptualize playful teaching and learning approaches. In particular, more research is needed that further examines how teachers can co-identify emergent challenges in guided play that develop STEM dispositions such as persistence, trial and error, and critical thinking.

Conclusion

In this study, teachers engaged with children in ways that offered new perspectives on learning within play. This study contributes a better understanding of the nature of co-participation between teachers and children and the ways teachers can participate in children's play to encourage spatial reasoning. For early childhood educators who are challenged to envision their roles in children's play, approaching STEM teaching and learning with insights from this study may provide new opportunities to reconsider how learning goals may be realized in play-based environments. For as was seen in this study, play is, indeed, serious work for both children and teachers.

APPENDICES

APPENDIX A: *Sample Episode Identification within Session*

Figure 23: *Sample Episode Identification*

A	B	C	D	E
Session 1	Episode	Episode Timestamp	Screenshot	Description
 21st Century Blocks (17:44)		0:00-1:20		Teacher describes shapes, introduces children to various blocks and asks children names of shapes, distributes materials
		1:21		T: What can you build? Children begin to sort pieces, put them together; children negotiate over who has pieces; one child puts pieces in his pocket
	Episode 1.1	3:15-4:15		T: What did you make? C: a robot! T: a robot?! Show me your robot - where is it? Where is its head? (c points) Where is your robot's face? Does your robot have hands? Does your robot walk? (c nods) What shape is the feet? (no response)
	Episode 1.2	7:26		T: I like how you were standing yours up. Do you want to keep standing these up? Teacher places three yellow triangles standing up and then leaves. C continues to add yellow triangles to design.
	Episode 1.3	8:28-9:15		T: I saw you trying to get all these blue ones together. Were you trying to connect these, like this? T arranges three blue pieces in connected pattern. C continues to add onto blue figures.
	Episode 1.4	11:08-13:00		T: Do you want to play a game with me? Try to copy mine. Can you match mine? See if you can make the same thing. C1 makes initial attempt. T: Can you turn it to make it fit? C2 creates a match. T places all three matching figures side by side. T: Do they all match?

APPENDIX B: *Codebook of Categories*

Category	Definition
Children's participation	
Exploring materials and environments	Children engage in exploring physical materials and trying out possibilities with what can be done or created with them (e.g., What is this? What does this do? What can I do with this?).
Announcing activities or creations	Children use these announcements to articulate (make meaning of) their various actions or results of play (past: Look what I made! Present: I'm making a shark! Future: I'm going to make all squares!).
Seeking patterns and resolving irregularities	Children create designs and objects based on replicating or extending patterns or reproducing peers' constructions.
Pursuing emergent challenges	Children's play focuses on attacking a particular challenge through repeated trials, persistent effort, and multiple strategies.
Lines of action	
structuring material environment	Teachers provide structure to play activities by drawing attention to material features and providing potential activity paths to explore.
confirming direction of interest*	Teachers support children's activity through confirming, questioning, or repeating a child's comments or actions, creating opportunities for developing children's mathematical reasoning.
providing strategies*	Teachers support children's learning by encouraging the development of skills such as pointing at objects while counting or directing children's attention toward efficient methods for solving tasks.
situating known concepts*	Teachers help children contextualize familiar concepts and discern problems emerging in play. Joint exploration of the meaning of a concept occurs when the teacher or child takes initiatives to situate the concept within the play.
challenging concept meaning*	Teachers highlight a concept emerging in play and children are challenged and inspired to explain their view and elaborate their expressions of meaning, in order to establish a shared (and more advanced) understanding.
creating novelty	Teachers suggest an avenue to extend play, invite change in direction of the course of play, or take on different roles within play by introducing impromptu games or ideas.

* lines of action (Björklund et al., 2018)

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