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Save the Bees: How Engaging Students in Play Can Transform Learning Science

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Education

by

Christine Lee

2018

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ABSTRACT OF THE DISSERTATION

Save the Bees: How Engaging Students in Play Can Transform Learning Science

by

Christine Lee

Doctor of Philosophy in Education

University of California, Los Angeles, 2018

Professor Noel D. Enyedy, Chair

This study examines how teachers can structure and use pretend play for teaching science, as well as the impact it has on students' agency, engagement, and discussion. Using interaction analysis, I examine two teachers in two classrooms (n=52) of first and second grade students (6-8 years) at a progressive elementary school. To shed light on how differently play can be structured and integrated into curriculum, I designed two conditions or approaches of inquiry: guided approach and open approach. I argue that while the *guided approach* of inquiry often worked well in learning science concepts, the *open approach* of inquiry sustained student agency and engagement. Findings from the open approach condition also illustrated the impact play had on learning, as well as the importance of designing opportunities for students to experience affect. By understanding the impact affect has on play and learning, this study can inform how to design early elementary science curriculum.

The dissertation of Christine Lee is approved.

Megan Loef Franke

Federica Raia

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Noel D. Enyedy, Committee Chair

University of California, Los Angeles

2018

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Vitae

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Chapter 1. Introduction



Image 1. Students playing as bees with their teacher

Imagine children running outside, wearing hand-made cardboard wings, dancing, screaming, and picking flowers. At first glance, this looks like the typical picture of children playing. It may not look like much, but if you look closer (Image 1), you can see a teacher running alongside the twelve children. This interaction doesn't look like traditional school, but these students are actually learning about bees and pollination. If you walk closer, and hear the conversations, you would hear students exclaiming they found nectar and pollen. Some are even picking flowers from the grass and exclaiming that they would help it grow. The teacher asks students what they are doing, and many respond that they need to collect food for their hive, while others scream out they need to help flowers grow. Not five minutes before this scene, students were in a room with their teacher, pretending to be bees as they discovered how to gather nectar. The students ran up and down the room, sharing their ideas to the teacher and making observations on how bees collect nectar for the hive.

This excerpt is an example of how I see play for learning. On the outside, it seems students are having fun, screaming, jumping, and running as they pretend to be bees. However, if you listen closely, the students in this example are also sharing many observations to the teacher that are scientifically accurate. While playing as bees, students come up with ideas around what

bees do in our ecosystem. They observe, share, and try these ideas in play. In this setting, students are not only joyfully engaged in pretending to be bees, but are also making connections from play to the real world.

For the past four years, I have been observing kindergarten, first, and second graders in play and have witnessed students come up with surprisingly accurate and detailed conclusions on science phenomena outside of the classroom. This led me to question how play can change the way we think about learning science. Can we bring play into the everyday science classroom? If so, what does that look like and what are the roles of the adult in play for learning? In my dissertation I investigate play based learning from the perspective of the teacher—how can early elementary educators structure the wondrous and curious nature in play to design an engaging, reflective, and multimodal learning environment to push science inquiry?

Until recently, the reality of early childhood science education was that there was no clear consensus regarding if or how science should be taught to young children (Ginsburg & Golbeck, 2004). The dominant thinking in the 1960s was rooted in Piaget's extensive work on learning and development (Novak, 2005). The implementation of Piagetian literature caused some educators to assume that children younger than 11 years, who were assumed to be concrete operational thinkers, have trouble learning science concepts that they have not yet experienced in the real world. This included abstract science phenomena such as molecules, energy and complex systems like the bee-flower pollination system (Good, 1977).

More recently, educational policy rather than developmental theory limited science education in early elementary classrooms. The No Child Left Behind (NCLB) Act focused teachers to concentrate school time on subjects such as language arts and mathematics that appeared in high stakes tests. This caused teachers to spend less time teaching science. The

combination of Piaget's cognitive development theory and the rise of high stakes testing has created the conditions where many schools do not teach science in early childhood classrooms; and in the classrooms that do teach science, "it is too often a caricature of science that is presented to the children" (Eshach 2011, p. 1).

The state of early childhood science education caused professional scientists and engineers to speak out and advocate for teaching science through inquiry at an early age (National Science Teachers Association, 2003). The decrease in time spent teaching science in early elementary classrooms caused young students to miss "what many adult scientists experienced when they themselves were elementary and middle school age-an early experience with science that sparked their interest, curiosity, and imagination for the field" (Marx & Harris 2006, p. 475). Children are naturally wondrous and curious (Carson, 1984; Eshach, 2006), and it is these characteristics of childhood that leads to exploration and thinking of the real world that many educators believe makes young children capable of learning science (Eshach & Fried, 2005; Taylor 1987). They are continuously building essential scientific skills by engaging "with their environment to develop fundamental understandings of the phenomena they are observing and experiencing" (Trundle 2010, p. 8). By engaging in activities that provide opportunities for scientific observations and experiences, young students are encouraged to explore scientific findings, conduct experiments, and find meaningful connections to the real world (Athey, 1988; Charlesworth & Lind, 2003; Gabrielle & Jones, 2000; Saracho, 2012).

Play is one such activity that can build on children's observations and thinking for inquiry (Bergen, 2009; Sher, 2003). For young children, curiosity and wonderment often manifest as pretend play, where students play as things they do not fully understand. As a

defining feature in childhood, play is a natural and voluntary activity that builds on children's curiosity of the world (Fromberg & Bergen, 2006; Kleine, 1993; Mayall, 2002; Vygotsky, 1978).

Despite the wealth of research documenting the importance of play, play has been gradually disappearing from elementary schools (Beisser, 2008; Ginsburg, 2007). This may stem from a perception that play and academic content do not belong together (Nicolopoulou, 2010; Viadero, 2007). It is true that when play *is* integrated into learning, teachers have had difficulty mediating and guiding the activity. In an effort to direct play, teachers tend to over-mediate the play activity, focusing students on achieving content lesson goals, which strips away the wondrous and playful nature play can provide for children (Aubusson, Fogwill, Barr, & Perkovic, 1997). However, if this obstacle can be overcome, play has the potential to engage young children in scientific inquiry in a developmentally appropriate manner.

The goal of my dissertation is to examine how teachers can integrate play into science curriculum while maintaining a balance between the benefits of play (including the curious and wondrous nature in play) and the science content learning goals. My study took place in two elementary classrooms that were designed to follow different approaches of inquiry through play. I designed two conditions: a guided approach of teaching through play and an open approach of teaching through play. Through the following two research questions, I focused my analysis on how teachers can structure play differently in the two conditions as part of science curriculum. I also examined the effects of those structures on student interactions and learning:

Research Question #1: What are the different ways that teachers structure and integrate play as part of science curriculum? What types of structure do they provide?

Research Question #2: How does the variation of structure in teacher guided play shape and impact students' inquiry? How does it shape students' agency, engagement, and discussion?

Chapter Overview

In chapter 2, I present the theoretical motivations of my dissertation study. I first review the literature on *pretend play*, a form of play where children take on roles in an imaginary situation. I then identify some of the needs in early elementary science education, including an argument for why we can teach science in earlier grade levels. Combining these needs in early elementary science education with the characteristics of pretend play, I outline a framework for how play can fit and be a platform for learning science. I particularly attend to agency, engagement, discussion, and affect in this framework.

In chapter 3, I detail the methods of my dissertation study by describing the participants, the setting, the science unit that incorporated play, the design of the play space, and how I designed and analyzed the two conditions (guided and open approach). I then expand on how I analyzed my qualitative study, using interaction analysis.

In chapter 4, I present my analysis and findings on the guided approach condition with a teacher named Flora (pseudonym). I detail the play lesson by focusing on how Flora used play to shape the lesson as well as the impact it had on students' agency, engagement, and discussions.

In chapter 5, I present my analysis and findings on the open approach condition with a teacher named Lily (pseudonym). In this chapter, I mirror my organization and thinking from chapter 3, detailing both Lily's roles in play as well as the impact it had on students' agency, engagement, and discussion.

In chapter 6, I present an emergent finding based on my analysis and post-interview with Lily. Students in Lily's class sustained and continued their research, questions, and learning around bees and pollinations long after the play lessons I designed for the study ended. To further investigate and understand how play led to this longer interest in bees and pollinators, I

interviewed Lily and analyzed the moments in play that were attributed to the sustained level of agency and engagement students had on pollinators.

In chapter 7, I conclude my study by first comparing my findings across both conditions. I consider how the two teachers structured play differently, and how it impacted the students' interactions and learning experiences. Specifically, I discuss how play shaped and impacted students' agency, engagement, and discussions as a result of learning science through play. I also use my findings to conclude and argue for the importance of play, drama, and affect for learning science.

Chapter 2. Literature Review

In 2015, David Kohn from the New York Times published an opinion piece, “*Let the Kids Learn Through Play*” on the alarming decrease of play in schools. In this article, he expressed concern over the increase in teacher-led didactic instruction for children in early elementary schools (from preschool to second grade). *How and why did this happen?* In recent years, schools have decreased play, exploration, and imaginative activities due to the rise of high stakes testing and the overall worry of falling behind (Kohn, 2015; Nicolopoulou, 2010). As a result, activities like play were no longer a priority in elementary schools. This has been an interesting development in education because of the long historical emphasis on the importance of play varying from social, emotional, cognitive, and physical well being. Play is an essential and inseparable part of development and learning; and rather than viewing play and learning as a dichotomy, it is important that we view them as inseparable and intertwined activities.

Characteristics of Pretend Play

In 1933, Vygotsky delivered a well-known lecture expanding on the role and characteristics of play in development. He detailed the integral parts of sociodramatic or pretend play; the kind of play we typically see in preschool and primary grades such as playing house (Bodrova, 2008). Vygotsky presented three components of play: *roles, rules, and an imaginary situation* (Bodrova, 2008; Vygotsky, 1978). According to Vygotsky, an important type of play that contributes to learning and development is when children take on roles that are defined by specific behaviors and mental states. When children partake in play, “they take on and manipulate identity, and not just of stylized characters- they ‘play out’ the ideas and characteristics of their culture and their environment” (Hendy & Toon 2001, p. 3). The role or identity children take on is played with others in an imaginary situation, and it is the engagement

of others within this imaginary context that provides opportunities for reflection, improvisation, creativity, and exploration to take place (Elbers, 1994; Ødegaard, 2003). It is in these play interactions where children can “tease out relationships, try on and practice different roles, and exercise their growing capabilities” (Moran & John-Steiner, 2003 p. 69).

Imaginary situation, rules, and roles. Vygotsky emphasized a dialectic relationship between imaginary situation and rules; that one cannot exist without the other. Rules are always stemmed from the imaginary situation in play, and the imaginary situation is defined in-part by what actions are appropriate. According to Vygotsky, “If the child is playing the role of a mother, then she has rules of maternal behavior” (Vygotsky 1978, p. 95). These rules are not made clear in advance but based on the behaviors of the imaginary situation. During play, children can imagine themselves as the mother (role) and act according to his/her ideas of maternal behavior (rules); thus, in the imaginary situation, “play situation and reality coincide” (Vygotsky 1978, p. 94). In short, play is governed by the rules for actions that represent the culturally appropriate behaviors of the imaginary situation which in turn reflects reality.

One of the observations Vygotsky made in his lecture was how children reflected and negotiated rules in an imaginary situation during play (Cooper & Dever, 2001; Elbers, 1994; Hedegaard, 2016). The rules in play are reflective of children’s own understanding of the real world. Vygotsky drew from James Sully (1896) in his observations of two sisters pretending to play as sisters. In this example, Vygotsky stated that the sisters in the real world functioned and behaved without much pause or thought in their actions. However, during play, the children actively acted out how sisters should behave and made “real discoveries about what it means to be sisters” (Elbers, 1994 p. 225). They walked, dressed, and talked in ways that fell under the umbrella of rules of being sisters. These actions represented the rules behind the roles of sisters;

and it is through these dramatic experiences they learned and reflected on what it meant to be sisters (Elbers, 1994). When children are in play, they are much more aware of how the role they are taking functions in the real, social world (Elbers, 1994; Vygotsky, 1978; Youngquist & Pataray-Ching, 2004). This gives children the opportunity to actively share, learn, reflect, and make sense of the world with minimum amounts of risks and penalties (Aubusson, Fogwill, Barr & Perkovic, 1997; Christie, 2006; Kernan, 2007). These defining characteristics of play result in children actively sharing ideas and ongoing understandings of the real world with peers through reflection on rules (Youngquist & Pataray-Ching, 2004).

Student discourse in play. When students are in play, they often negotiate the rules and roles of the imaginary situation. While this helps children develop their social and language skills, it also gives children the opportunity to share and think about the social roles that occupy our world. Children often explicate the rules in order to share an imaginary situation. For example, Trawick-Smith (1998) presented an excerpt of two preschool children pretending to be in a car. In play, the first child suggested to drive to New York City while the child playing as the passenger suggested an alternative destination. The first child then re-negotiated the destination and decided to drive to both locations. These types of interactions, where children negotiate play scenarios, is a common practice. In the example by Trawick-Smith (1998), the children's discourse centered on the play's imaginary situation. They negotiated the narrative of the play by disagreeing and compromising on the rules (where they are pretending to drive).

Children in play also negotiate and argue the roles in the imaginary situation. While many interactions in play entail students negotiating the narrative and rules, we also see children negotiating and arguing over the roles in play. Perry & Dockett (1998), observed a group of preschool children pretending to play "mother". In this example, three girls are playing together.

However, two of the girls argued and negotiated throughout the play interaction on who was the mother. The children not only stated that they should be the mother but provided justifications and reasons for why they should play the role (Perry & Dockett, 1998). For example, one child stated that because she was bigger, she should play the role of the mother. They also articulated and displayed the actions of the mother to justify who should play the role (Perry & Dockett, 1998). The same child who used height to argue for playing the role of mother also began to carry out the actions of a mother. She started to cut vegetables and stated that since she was in the kitchen cutting vegetables, she was the mother (Perry & Dockett, 1998). In summary, negotiating the roles, rules and consequences of actions within the imaginary situation is commonplace for children. More to the point, the act of arguing and negotiation creates opportunities for articulations of what children do and do not understand, opportunities for reflection, and opportunities to learn from one another.

Props and tools as the symbolic function in play. Vygotsky also emphasized the important relationship between imagination, roles, and rules as part of the child's movement away from situationally constrained activities (Vygotsky, 1978). Play is a place to learn about reality, but it is also a place to imagine the possibilities for that reality. Piaget marked this ability to imagine the possibilities for a reality as the hallmark of formal operations and the pinnacle of his developmental stages (Piaget, 1968b). As children grow and develop, objects used in play can be transformed from what they actually are into objects that are appropriate in the play situation—a stick becomes a sword, and a box becomes a boat (Göncü, 1993; Pellegrini, 1984; Vygotsky, 1978). The meaning of the object is separated from the represented object with the use of a pivot (Vygotsky, 1978). This form of representation uses mental symbols to represent objects and events. Vygotsky gave the well-known example of the child playing and pretending

that a stick was a horse. The ability to attach meaning to objects or props is an essential part of play and development; therefore, a stick can be a horse and sand can be a birthday cake (Hedegaard, 2016; Vygotsky, 1978). Props used during play are determined by the imaginary situation instead of what is available to the child. When children use props in play, it “differs from the way the same objects are used in real life, because children use these props to perform pretend actions not real ones” (Bodrova & Leong, 2015 p. 380) Therefore, play gives opportunities for children to explore with props that symbolically give meaning to objects in order to engage and interact in the imaginary situation. This makes play the “first manifestation of the child’s emancipation from situational constraints” (Vygotsky 1978, p. 99).

Emotions in play. In his lecture, Vygotsky also talked about the relationship and role of emotions in play (Vygotsky, 1978). The opening of Vygotsky’s lecture challenged the common belief that pleasure was a definition of play; first, there are other activities in childhood that are pleasurable and second, there are games where the player experiences displeasure (example: losing a game of chess). Therefore, Vygotsky concluded that pleasure should not be a defining characteristic of play (Vygotsky, 1978). However, despite this conclusion, Vygotsky also emphasized that we shouldn’t disregard the child’s needs and wish fulfillment in play. As children develop, they have desires from the adult world that can be fulfilled through play (for example, a child may want to be a doctor and will pretend play as a doctor). Therefore, although pleasure isn’t the defining characteristic of play, there is an emphasis on the emotional aspect motivating the child during play.

When children are in play, they experience dual affect as they forgo their immediate emotions and align with the rules of the role and imaginary situation. Vygotsky’s 1933 lecture on play was translated and published in 1976 (Vygotsky, 1976) and then translated in 1978 in *Mind*

in Society (Vygotsky, 1978). While the overarching ideas remained the same across the translated versions, there were a few differences. One of the differences included the use of the term “dual affective plan” (Bundy, Piazzoli, & Dunn, 2015). In the 1976 version, “dual affective plan” or “affect” was replaced with “desire” and “impulse” in the *Mind in Society* version (Bundy, Piazzoli, & Dunn, 2015; Vygotsky, 1978). Regardless of which translated text, emotion and drama are part of engaging in dramatic play (Hedegaard, 2016). Vygotsky defined dual affect as when the player simultaneously “weeps in play as a patient, but revels as a player” (Vygotsky, 1976 p. 549). This is when players experience two different affective responses at the same time. The first emotion is from the real world while the second comes from the role within the imaginary situation.

Summary. The characteristics of play presented in this chapter not only consider the symbolic function of play but values the emotional and affective characteristics. *First*, children in play are engaged in rules, roles, and an imaginary situation. Children in play take on roles in an imaginary situation (playing a sick patient visiting the doctor’s office for example) and play by the *rules* that define and constrain the actions of the role. For example, a child playing a sick patient might “cough” or lay down. *Second*, children reflect and often debate the rules of the imaginary situation. This can give children opportunities to think and reflect on the real world. *Third*, children can engage in argumentative interactions while debating the rules of the imaginary situation or the roles of play. *Fourth*, as children grow and develop, they are no longer situationally constrained. Children can use props in play to symbolically attach meaning; sand can be a birthday cake and a stick can be a horse. *Fifth*, emotions, particularly affect are an integral part of play. While Vygotsky’s lecture had variations in the translations, it is clear that emotions (affect or pleasure) are intertwined with play.

Elementary Science Education

Over the last several years, elementary science education has undergone a call for reform to highlight and implement science in elementary grades. The National Science Teachers Association (NSTA) supported and encouraged teaching science starting from early childhood. In the NSTA's position statement, inquiry science should be part of the daily curriculum at every grade level, "so that students develop problem-solving skills that empower them to participate in an increasingly scientific and technological world" (National Science Teachers Association, 2002).

Discovery and wonderment for learning science. In reaction to the effects of NCLB, the field of elementary science education began to push for opportunities to engage young students in science. One argument for teaching science in the early elementary grade levels is that children are already discovering and wondering about the world around them (Eshach, 2011). Children enjoy interacting with nature, "running after butterflies, pressing flowers, collecting shells on the beach, picking up pretty stones" (Eshach & Fried, 2005). These activities that practice a sense of wonder and imagination is one of the reasons why young children should learn science (Ryan & Deci, 2000). Teaching science would be an extension of the already curious and playful nature in children. By focusing on children's tendencies to explore and learn about the world, it becomes the foundation for building the inquiry skills needed to learn science phenomena (Worth & Grollman, 2003).

Argumentation and justification in young students' discourse. In addition to the disposition that young children are capable of learning science, there is also evidence that they can engage in argumentative discourse. Several studies found that young children were capable in providing an argument or justification for their actions and opinions (Bova, 2015; Goodwin,

1983; Pontecorvo & Pirchio, 2000). Young children often participate in disputes throughout the school day in both classroom activities and play (Orsolini, 1993). For example, in her observation of preschool children, Orsolini (1993) found that preschool children used justifications to prove or solidify the speaker's grounds for actions on the playground and in the classroom. Dunn & Munn (1987) furthered this argument and found that children as young as 3 years of age provided arguments and justifications during mother-child conflicts.

The *Framework for K-12 Science Education* identified argumentation as one of the core scientific practices (National Research Council, 2012). With the studies and findings briefly described above, children's engagement in argumentative discourse could be an extension of the scientific practices the National Research Council values (Reiser, Berland, & Kenyon, 2012).

Emotions of doing science. While most of the literature in science education focused on how to do and teach science, it is crucial to also understand how students *feel* when learning science. Although the Next Generation Science Standards (NGSS), National Research Council (NRC), and NSTA all hinted at the emotional characteristics in engagement and doing science (using words like curious), it was not recognized as an essential role (Jaber & Hammer, 2016). In science, “there has been a long-standing Newtonian– Cartesian tradition of separation, prizing apart the mind and body, divorcing and polarizing reason from feeling.” (Alsop & Watts, 2003 p. 1044). However, not only are emotions an integral part of science education, but it can also impact students' engagement (Alsop & Watts, 2003; Jaber & Hammer, 2016; Keifert, Lee, Dahn, Illum, Enyedy, & Danish., 2017).

Jaber & Hammer (2016) expanded on the embedded nature of affect in scientific practices with five themes, “the pleasure in studying phenomena, the feelings involved in scholarly interactions, empathy with the objects of study, affective signals of cognition, and

meta-affect” (Jaber & Hammer, 2016 p. 192). In the remainder of this section, I expand on Jaber & Hammer’s five themes.

First, the pleasure in studying phenomena, is the most common emotional aspects of scientific practices. This theme as the authors described, is the joy and excited feeling of discovery. This first theme that Jaber & Hammer (2016) presented is a pleasant and positive emotional part of practicing and doing science. The *second* theme expanded on the emotional responses from interacting with other scientists. While conversing with fellow scientific scholars, one can feel fear, be harshly criticized, rejected, and frustrated over their ideas. For instance, Jaber & Hammer (2016) pointed out that Darwin waited 20 years to publish his theory of evolution (Gruber, 1974). The *third* theme included the idea of scientists imagining and becoming their object of study to empathize and further understand the phenomena (Jaber & Hammer, 2016). To connect with their work, scientists often took the perspective of what they were studying (Ochs, Gonzalez, & Jacoby, 1996). The *fourth* theme, affective signals of ideas or questions, is metacognitive. Jaber & Hammer (2016) expanded on this theme as “having a question, for example, often comes with a sense of restlessness” (Jaber & Hamer, 2016 p. 193). It’s the feeling that something is awry or feeling excited over an idea (Jaber & Hammer, 2016). Finally, the *fifth* theme, meta-affect and affective regulation, expands on how scientists find motivation in frustrating experiences. For example, “perceiving confusion as motivating, associating puzzles and uncertainties with pleasure rather than intimidation” (Jaber & Hammer, 2016 p. 194).

Although the role of affect as part of learning and teaching has been acknowledged for years, research in science education that position emotions as an important part of learning is still scarce (Fortus, 2014). However, it is important to not only acknowledge the role of affect in

practice, but in science education as well. The importance of highlighting Jaber & Hammer (2016) is to not only illustrate the important role affect has on scientists in practice, but to also expand on the *variety* of affective journeys and responses while practicing science.

Summary. In addition to the NSTA and NRC advocating for teaching science in all grade levels, I presented three characteristics of childhood that furthered this argument. *First*, children are curious and wondrous. These characteristics not only reflect the early scientific practices of inquiry but practice the interconnected relationship between emotions and doing science. *Second*, children are capable of engaging in disputes and providing arguments and justifications. These argumentative interactions are also recognized as one of the core scientific practices (National Research Council, 2012). *Third*, part of being a scientist is to experience the emotions while practicing science. Practicing science requires a range of emotions; from the joy of discovering or understanding phenomena to the frustrations of a problem (Jaber & Hammer, 2016). These emotions are interconnected and essential in the pursuit of understanding and discovering the world and should also be reflected when teaching science.

Play for Learning Science

“I love the idea of play. Now it really has me thinking about how important and how much more play we need to be doing especially in the classrooms” (Lily, Post-Interview)

Play is a defining feature in childhood (Fromberg & Bergen, 2006; Kleine, 1993; Mayall, 2002; Vygotsky, 1978) and for many scholars, the activities that engage children in play can be integrated into curriculum. While many may view pretend play as children simply playing outdoors, play is much more and is central to development and learning (Eshach & Fried, 2005; Saracho, 2012). We can use both the characteristics and benefits of play to engage young children in learning, doing, and feeling science. The characteristics of pretend play I detailed earlier in this chapter not only align with early elementary science education but can be

integrated into classrooms in a way that remain true to young students' desire to inquire about the world (Fisher, Hirsh-Pasek, Golinkoff, Singer, & Berk, 2011; Saracho, 2012).

Teachers can use the characteristics of play in classroom settings to engage students in argumentative discourse, emotional experiences, and inquiry when teaching science. The characteristics that I've detailed as part of pretend play earlier in this chapter are well aligned with some of the needs and practices in early elementary science education. Not only does play offer insight on how young children can learn science, but the interactions in play are reflective of the core practices that are valued for science education. *First*, I detailed the nature of children's argumentative discourse in play. In these interactions, children not only reflect on the rules and roles of our social world, but they engage in argumentation, one of the core practices of doing science. *Second*, I also expanded on the importance of emotions in play. Vygotsky (1976) also mentioned that children in play are driven by emotional feelings (like pleasure). In particular, a translated version of Vygotsky's lecture introduced "dual affect", where a child can experience sad or negative role-playing emotions, while still enjoying play. This characteristic of play mirrored Jaber & Hammer's (2016) detailed description of the five themes; particularly the fifth theme, meta-affect and affective regulation. For these reasons, I believe play can be integrated into curriculum to teach science concepts. By doing so, we can not only engage young students in argumentative discourse, but also provide a rare opportunity to learn and feel like a scientist.

There is a common belief that play and learning are two different activities, where if children are in play, they are not productively learning. The notion that play is unproductive, or worse, that children do not learn in play is untrue (Eshach & Fried, 2005; Fisher, Hirsh-Pasek, Golinkoff, Singer, & Berk, 2011; Nilsson, Ferholt, & Lecusay, 2017). Although research

demonstrated play to have significance in developing language, literacy (Roskos & Christie, 2000), and positive learning dispositions (Sylva, Bruner, & Genova, 1976), play has been consistently caught up in the debate of academics vs. play (Fisher, et al., 2011; Miller & Almon, 2009; Nicolopoulou, 2010). This led play to be viewed as an either-or activity, where students are either freely playing outside without adults, or learning with teachers in classrooms.

Engaging in dramatic role-play can provide multiple opportunities for children to imagine and explore in science through language and body (Varelas, Pappas, Tucker-Raymond, Kane, Hanks, Ortiz, & Keblawe-Shamah, 2010; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001). Hendrix, Eick, & Shannon (2012) found that elementary students who used creative drama as a tool to explore abstract and difficult science concepts had significant learning gains. In this study, creative drama included students improvising in role-play to depict the science concept. This type of play, where spontaneous or improvised actions are used to help students actively explore and make meaning in difficult or abstract science concepts, was found to have positive learning gains when teachers guided the activities for science learning (Kamen, 1991).

Dramatic enactments of science concepts also provided multimodal meaning making opportunities. Varelas, Pappas, Tucker-Raymond, Kane, Hanks, Ortiz, & Keblawe-Shamah (2010), found that students “negotiated ambiguity and re-articulated understandings, thus marking this embodied meaning making as a powerful way of their engagement with science” (Varelas, et. al., 2010, p. 321). The study examined two science units (matter and forest) and found that students discussed the causal mechanisms in states of matter when students used their bodies to explore and imagine the microscopic bonds between molecules (Varelas, et al., 2010). In previous work, the students (6-8 years) in the Science through Technology Enhanced Play

project participated in a week long unit on the states of matter by playing as water particles or energy sources. This study also found that students who learned through pretend play had significant learning gains in not only the science concepts, but the causal mechanisms of the science phenomena (Enyedy, et al., 2016).

While this study attempts to showcase the potential of how play can be used *for* learning, it is important to note that it is not replacing the notion of play *as* learning. Instead, I argue that not only should we continue to make time for free-play activities, but to also benefit from the characteristics of play to engage young students in science classroom lessons as well.

Teacher Roles to Support Play for Learning

Guided Play. Guided play activities can engage both teachers and students with academic content and provide a space where different experiences and understandings come together to deepen science education (Hirsh Pasek, Golinkoff, Berk, & Singer, 2009). When play is integrated into a classroom setting, it can meet teacher's content goals as well as the child's developmental level and needs (Ash & Wells, 2006). Unlike free play, guided play emphasizes the importance of the teacher (Hirsh Pasek, Golinkoff, Berk, & Singer, 2009). The teacher can guide and facilitate play by providing play materials, discussion topics and thought-provoking questions (Bruce, 1996; Dockett and Fler, 1999). Despite the inclusion of a teacher in these guided play interactions, children are still engaged and involved in discovering academic content through play (Fisher et al., 2011). My dissertation is focused on what types of structure teachers can provide in play for learning and the consequences of different amounts and kinds of structure on children's interaction and discourse during play.

The notion of teachers using play to guide learning in classrooms need more work in addressing the question of *how* teachers can guide play activities. Teachers who stay focused on

the academic goals during play activities tend to over-mediate or constrain children's play that takes away the engaging aspects play can provide (Aubusson, Fogwill, Barr, & Perkovic, 1997). At the same time, teachers who do not provide enough guidance can result in students in free-play, where academic or lesson objectives are not met. Guided play requires a balance of both student agency and teacher-guided instruction.

Teachers using play props. In guided play, teachers can choose to introduce the activity by setting up the physical space and materials for play. The use of props and objects are an essential part of inspiring play (Bruce, 1996; Giffin, 1984; Jones & Reynolds, 1992; Perry, 2001). Once the materials are selected, the teacher can choose to model and scaffold for students how to use props. By modeling in play, teachers can establish a shared imaginary situation, “giving players and their imaginations the stimulation needed to get ideas flowing” (Dunn, 2011 p. 31). They can also observe how children are interacting with the props to inform the next steps of the activity. However, it is also important for teachers to refrain from over-modeling how to interact with play props and objects. This can impact student's agency and result in an overall decrease of exploration and discovery (Dunn, 2011).

Teachers co-play with students. In addition to observing their students, teachers can also interact as a co-player to help shape and guide the activity (Fisher et al., 2011). While teachers can observe children in play for informative purposes, they can also join students in the discovery and exploration of the activity. They can play alongside students to guide the activity within the shared imaginary situation (Dockett & Flear, 1999). An important part of co-playing with students is to also consider the level of dominance and support, “do they, for example, want to support the current direction of the text (narrative function), change it radically (intervening function), or simply offer support for a textual direction offered by one of the children but not

taken up by the group (reinforcing function)” (Dunn, 2011 p. 31).

Teachers ask questions and make comments. Teachers can also steer the activity by exercising their role within the participation structure of play. In addition to co-playing with students, it is also important for teachers to think about how teacher guidance can impact the flow of discourse. Typical classroom discourse patterns are substantially different from discourse in play. In traditional classroom discourse the teacher is firmly in control of who talks, what they talk about, and what is seen as acceptable forms of talk (Jurow & Creighton, 2005; Lemke, 1990). As noted earlier in this section, guided play is different and strives for a balance between teacher-guided instruction and student agency. One suggestion for the teacher’s role in play is similar to the suggested role of the teacher in other forms of inquiry-based learning—to influence the participation of the activity by asking reflective questions, commenting, and intervening to push the exploration of academic content (Ash & Wells, 2006; Ashiabi, 2007; Fisher et al., 2011; Rogoff, 2003). These questions and comments achieve lesson goals by highlighting students’ breakthrough observations that further understanding of the content. However, it is important to think about student agency while providing these comments and questions because, “classroom discourse patterns that focus on the authority of the teacher are limited in enabling students to become the kind of people who explore ideas, ask questions, create connections between ideas and experiences, and think and act critically” (Jurow & Creighton, 2005 p. 277; Lampert, 1990).

Teacher’s questions and comments can also change the pacing of the play activity. In typical classroom participation structures, the teacher holds the power to move science lessons forward based on curriculum goals (Bleicher, Tobin, & McRobbie, 2003; Lemke, 1990). However, in guided play, teachers balance both student agency and teacher guidance, resulting in more opportunities for student discourse. Therefore, due to increased student agency in guided

play, teachers pacing of a lesson would rely on the students' ideas and observations.

Summary. Although children are curious and wondrous during play, teacher guidance is especially needed to help transform these observations and thinking into inquiry skills and knowledge (Gonya, 2007). The teacher's role is essential in using play as an extension of bringing inquisitive questions into classrooms (Trawick-Smith, 1994). In order to maintain the balance of the student agency that we see in play, as well as teacher-guidance for meeting academic goals, teachers can be viewed on a "continuum between indirect planning for play to direct involvement in the play" (Kernan 2007, p. 11). The teacher's roles in guided play are fluid, and should be tailored to the students' needs.

Teachers can integrate the characteristics of play that fit the needs of early elementary science education through guided play activities. *First*, teachers can use props to guide play by setting up materials and objects for the imaginary situation. By modeling and scaffolding how to use props and objects, teachers can inspire and guide students' interactions in play. *Second*, teachers can co-play with students. By co-playing with students, teachers can closely observe students in play and can also choose to intervene or support play in various ways (Dunn, 2011). *Third*, teachers can provide questions and comments to guide students during play. The third characteristic of teacher roles in guided play is closely tied to the second characteristic of co-playing with students. While co-playing with students, teachers can choose to intervene and guide play. By doing so, teachers provide various comments and questions that can re-shape the play activity.

Research Questions

This dissertation explores the question of how teachers can best implement play into science curriculum. In order to maintain a balance between achieving lesson goals while preserving the benefits and characteristics of play, the role of teachers as the guiding figure in play is crucial. More work on understanding how the role of teachers shape and impact play is needed. My study participants included two first and second grade teachers at an elementary school, each of which implemented a play-based science unit using a variety of teacher guidance methods and structures during the play lessons. My research was focused on the following:

Research Question #1: What are the different ways that teachers structure and integrate play as part of science curriculum? What types of structure do they provide?

Research Question #2: How does the variation of structure in teacher guided play shape and impact students' inquiry? How does it shape students' agency, engagement, and discussion?

Chapter 3. Methods

In this chapter, I give an overview of the methods used to design and analyze teacher guided play activities. First, I describe the teachers and students who agreed to purposely experiment with different ways of structuring play-based pedagogies. Second, I describe the science unit and technologies I designed to support the teachers in their pedagogy and the students in their play-based learning. Third, I describe the two conditions for my study and how the teachers intentionally tried to implement the unit with different types and levels of structure. In this section I also discuss which lessons were selected as focal lessons and why they were chosen or excluded based on how the enactment of the lesson fit with the planned contrast in structure. Finally, I describe how I use Interactional Analysis to analyze students' agency, engagement, and discussion in relation to the way that the teachers varied the amount and type of structure for the lesson.

Participants

This research was conducted at a progressive elementary school with two teachers, Flora and Lily (pseudonyms). The demographics of the school were 36% Caucasian, 20% Latino, 12% Latino-Caucasian, 9% Asian, 8% Other, 7% African American, 5% Asian-Caucasian, and 3% African American-Caucasian. The students in this study were in the *primary level*, which consisted of both first and second graders (ages 6-8 years) and had a total of five classrooms with approximately 25 students in each room. Two of the primary level classrooms (n=50) participated in this study. The two participating classrooms were part of a dual language program that enrolled Spanish speaking students whose English was limited, as well as English speaking students who wanted to learn a second language. As mentioned earlier in this section, the two participating teachers of this study were Flora and Lily. Flora has been teaching for 15 years and

Lily has been teaching for 14 years. Both teachers have been teaching at the study site for 7 years at the primary level.

The study site presented a unique opportunity to design learning through play because of the wealth of experience the teachers had in teaching inquiry-based lessons. The philosophy of the study site is that inquiry is a central part of teaching and learning. Teachers at the elementary school level integrate inquiry throughout their curriculum including science, literacy, and math instruction. A large part of this dissertation focuses on how play can be implemented and infused into science curriculum. For this reason, the philosophy of inquiry the study site follows presents a unique opportunity to discover and explore new ways of engaging and teaching science through play.

Research Design

The science content for this study was based on the Next Generation Science Standards (NGSS Lead States, 2013) on interdependent relationships in ecosystems. The lesson goals for the unit were to learn how bees pollinate (LS2.A) and why pollination is important to our ecosystem (LS2.A). Additionally, the unit covered the structure and function of plants and bees (LS1.A), how bees process information through dance in the hive (LS1.D), and that the elements of the bee dance depend on the quality, direction, and distance of nectar (LS1.D).

Designing the play space. This dissertation study is part of a larger ongoing research project called the Science through Technology Enhanced Play project (STEP). The STEP project was funded by the National Science Foundation (NSF Award: 1323767). The goals of the larger STEP project are to investigate how embodied play shape students' understanding of science phenomena.

Through play, students in the STEP project interact with person-tracking technology (Danish, Enyedy, Saleh, Lee & Andrade-Lotero, 2015). This technology (Image 2) captures and transforms students' bodies through Kinect cameras. While walking in the space, the technology assigns digital costumes to each student on the screen (Image 2). In this experiment, as students walked around the play space as bees, they explored, discovered, and formed ideas about how bees function in the real world.

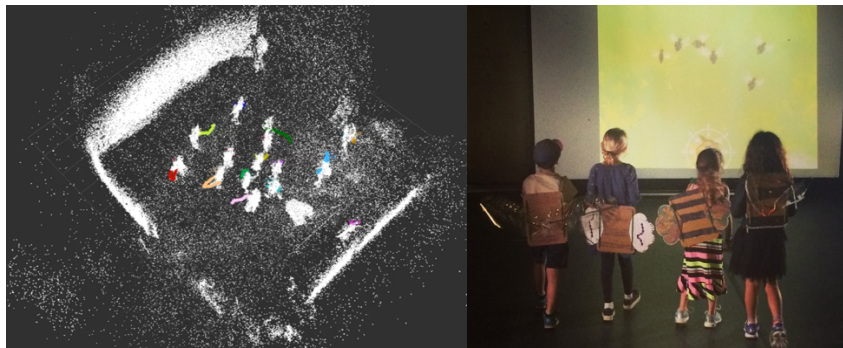


Image 2. The tracking technology assigned each student a digital bee costume

Through the use of the person-tracking technology, students embodied and assumed the perspective of a bee. Unlike many technologies that do not encourage full-body motion or open-ended play (Seitinger, 2006), this system encouraged multiple students to utilize their whole body in the space simultaneously. As they interacted in the space, discovering flowers and gathering nectar, students reflected and learned about the relationship between bees and flowers. As part of the STEP design, the team also designed features within the system to align with the lesson goals derived from the NGSS standards.

Before detailing the other technological features of the system, I want to first describe the space in which the research project took place (both this dissertation study and the larger STEP project). The play lessons took place in a large room with mounted Kinect cameras and a projected screen (Image 3). At the back of the room, students often sat together in a discussion led by the teacher. When post-its were used (documentation), they were usually placed on the

wall to the side of the space (Image 3). We also had a shared space that tracked students' motions in front of the screen (Image 3).

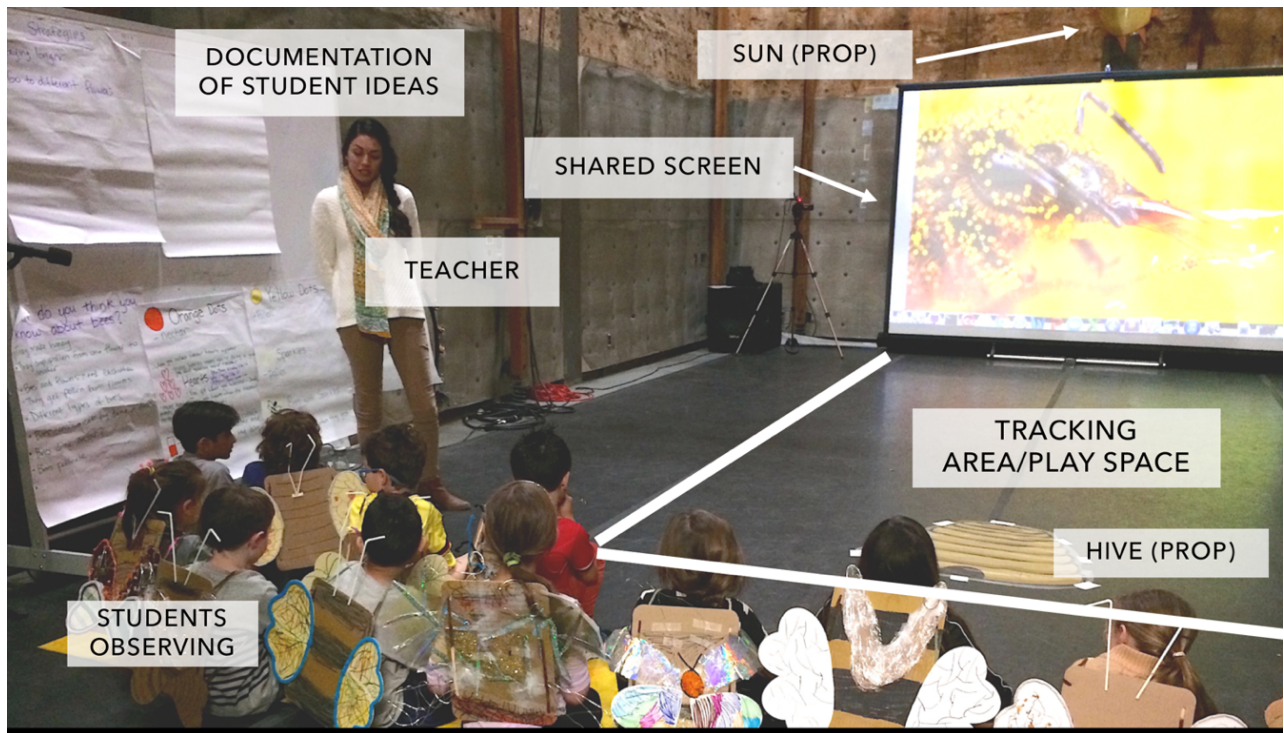


Image 3. The play space

In addition to students being assigned their own bee avatars, a variety of features within the technology helped students discover phenomena. First, in order to meet lesson goals, we designed flower fields. These flower fields started out as blank green fields on the screen (Image 4) Then, as students and teachers entered the flower field, their bee avatars found flowers with varying quality of nectar. The images below show bees hovering over flowers to gather nectar (Image 4). The technology provided feedback as each students' bee avatar gathered nectar from flowers. Once students found flowers, they would collect nectar for the hive. Three heart symbols above the flower indicated that the nectar quality was the highest, two hearts indicated that the quality was fine, and one heart indicated that the quality of the nectar was poor (Image 4). These features helped students not only discover flowers in an empty field, but also helped

guide students as they explored and discovered how best to gather nectar for the hive. We also designed a “tank” that was attached to each bee avatar on the screen (Image 4). As students’ bees filled up with nectar, their tanks would fill up. After filling up with nectar, the bees would go to the back of the room and empty their tanks in order to gather more nectar and fill the hive.

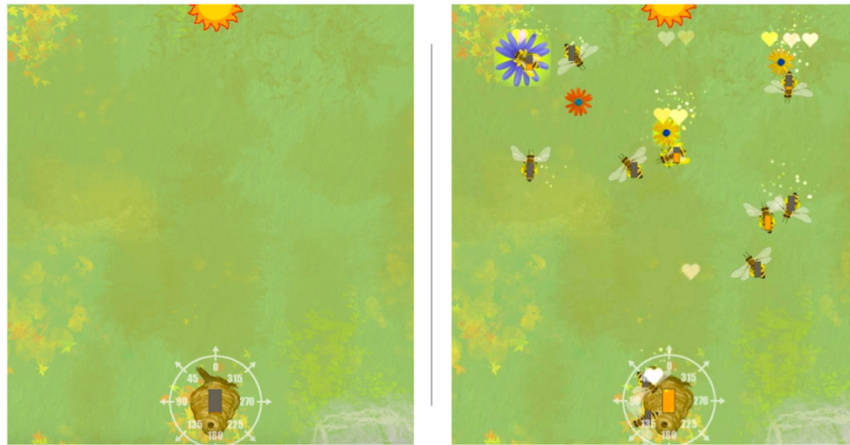


Image 4. Flower fields are empty before students explore and find flowers and nectar

In addition to the technology providing students with information about the nectar, the system also provided feedback as bees picked up pollen. The sparkling dots that surrounded the bees as they gathered nectar indicated that they were picking up pollen (Image 4). While the bees had a tank that indicated the quality of nectar being gathered, we did not design a similar feature that indicated the quantity of pollen being gathered.



Image 5. Predators (Eagle) swoop in and eats bees

Some of the additional technological features included predators, which students called the Eagle (Image 5), waggle dancing in the hive (Image 6), and pollination (Image 7). The purpose of the predator feature was to help students think about what bees would do if predators were near a food source. How do bees communicate that information? Do they communicate flower locations and food sources when a predator is nearby? We also had a waggle dance feature where computer bees would perform a dance that communicated flower locations in a dark hive (Image 6).

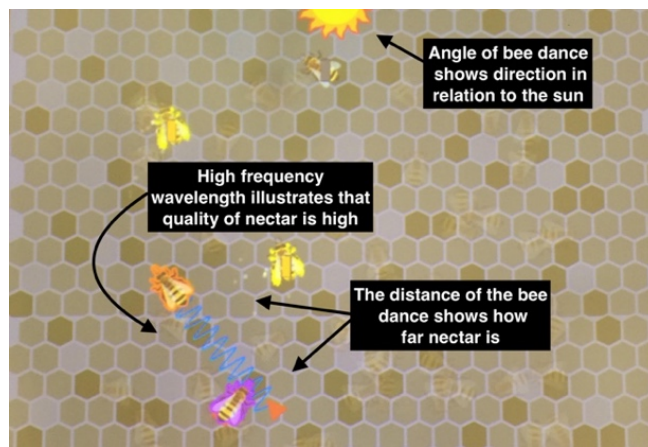


Image 6. Bee dance distance, direction, and quality of nectar



Image 7. Students play as bees and flowers

We also designed the technology to provide feedback about whether flowers were growing or dying for our lesson on pollination (Image 7). In this activity, students either played

as flowers or bees. Students playing as bees visited students playing flowers. As bees visited flowers to gather nectar, the tracking system caused the flowers to grow as pollen was brought from flower to flower.

Physical props. While the technology helped engage students in full-body pretend play, my dissertation study used a combination of physical props to help students more fully immerse in the space and express themselves (Garvey, 1977). This choice was made, in part, because play “depends largely upon the play materials, equipment, and role models available to them” (Isenberg & Quisenberry 2002, p. 36). Furthermore, studies have found that children who are given access to play props not only show increased amounts of imaginative play, but are also more immersed in their play roles (Griffing, 1983). I also wanted to provide teachers with play props and objects to help structure and guide students. For these reasons, I incorporated play costumes and props (Image 8) to further inspire and support students as they role-played as bees.



Image 8. Students made individual bee wings to wear as costumes in play

In this study, we created bee wing costumes (Image 8) and a hula hoop prop (Image 9) to engage students in play. The bee wing costumes were made individually by students before the play activities began. Students wore their bee wing costumes throughout the play unit whenever they pretended to be bees. We also created a prop for the students and teachers to walk through

in order to “turn into” a bee (Image 9). This was a hula hoop that was placed at the edge of the play space. As students walked through the hula hoop, they were “shrunk down” and “turned into” bees. In one class, the students named this hula hoop the “bee-o-matic 6000”. Although walking through the hula hoop had no bearing on whether or not players were assigned a digital avatar in the play space, the teachers and students still used the prop to immerse themselves into the role of a bee.



Image 9. The hula hoop prop

Designing play lessons. While play based activities were the focus of this study, an important decision in the design was to integrate play into an existing science unit. The purpose of this study was not to replace ongoing early childhood instruction with play. Rather, the design of the study’s unit was to integrate and make room for play in the classroom. Therefore, the six-day unit combined four play based activities with the technology, and two in-class lessons (Table 1).

Table 1.
Activity and Lesson Goals Based on NGSS

Lesson in Unit	Activity Goals	NGSS Learning Goals
Play Lesson #1	<ul style="list-style-type: none"> • Try to gather nectar for the hive • Notice that picking up pollen and collecting nectar are two different actions 	<ul style="list-style-type: none"> • How bees pollinate (LS2.A)
Play Lesson #2	<ul style="list-style-type: none"> • Bees spread out and go to different flowers for nectar • Bees communicate to other bees where to find those flowers 	<ul style="list-style-type: none"> • Bees communicate through dance in the hive (LS1.D) • How bees pollinate (LS2.A)
Lesson #3	<ul style="list-style-type: none"> • Bees communicate through a waggle dance the quality, direction, and distance of nectar • Bees use the sun and the hive as references when dancing in the hive 	<ul style="list-style-type: none"> • Bees communicate through dance in the hive (LS1.D) • Elements of the bee dance depend on quality, direction, and distance of the nectar (LS1.D)
Play Lesson #4	<ul style="list-style-type: none"> • To interpret the waggle dance and find the right flowers 	<ul style="list-style-type: none"> • Bees communicate through dance in the hive (LS1.D) • Elements of the bee dance depend on quality, direction, and distance of the nectar (LS1.D)
Lesson #5	<ul style="list-style-type: none"> • The structure and function of the bee and the structure and function of the flower depend on one another 	<ul style="list-style-type: none"> • How bees pollinate (LS2.A) • Why pollination is important to our ecosystem (LS2.A)
Play Lesson #6	<ul style="list-style-type: none"> • Pollinators are essential to our ecosystem • In order for pollination to occur, bees need to bring the same types of pollen to flowers. 	<ul style="list-style-type: none"> • Why pollination is important to our ecosystem (LS2.A) • How bees pollinate (LS2.A) • Bees communicate through dance in the hive (LS1.D) • Elements of the bee dance depend on quality, direction, and distance of the nectar (LS1.D)

Play Lesson #1. The goal of the first play lesson was to introduce and help students feel comfortable with the technology and space as they explored and played as bees. We also wanted students to notice the various features of the technology that would eventually serve as tools for students as they interacted in the space as bees. The setting of the first activity was a series of large flowers that showed a distinction between pollen and nectar (Image 10). As students hovered their bees over the darker orange center, they gathered nectar. The surrounding yellow area at the center of the flowers indicated that pollen was present. Students also discovered that when their bees hovered above the orange center, a tank attached to their bees would fill up with nectar. They also discovered that if they walked back to the hive, their tanks of nectar emptied into the hive. In this way, students in the first play lesson got acquainted with the technology and features of the imaginary space that illustrated pollen and nectar, and discovered that bees dropped off nectar into the hive.



Image 10. Students discover that pollination and gathering nectar are different

Play Lesson #2. In the second guided play activity, students played as bees to find and share the location of flowers. The goals of this lesson were to discover that the best way to gather nectar was to spread out, and that bees communicated and shared flower locations in the hive (LS1.D). In this lesson, students walked around an empty field (Image 11) and tried to find

flowers on the screen. After finding flowers in the field, students gathered nectar and brought it back to the hive. The students also started to brainstorm ideas on how to share and communicate those flower locations to other bees.



Image 11. Students play as bees looking for flowers in a large field

Lesson #3. In this first in-class lesson, students learned about the components of the bee dance. The purpose of this lesson was to learn that bees were looking for food and needed to communicate information about nectar locations in the hive. Specifically, that bees communicated the quality, direction, and distance of nectar in relation to the sun and hive in a waggle dance. Students watched a video about the waggle dance while the teachers led an in-class activity on documenting ideas for how bees might communicate where to find nectar.

Play Lesson #4. In the fourth lesson, students had the opportunity to apply what was learned from classroom lesson #3 by using the components of the bee dance to find nectar. The goal of this activity was to *investigate* the three elements of the dance: quality, direction, and distance of the nectar. In this play activity, students played as bees looking for a waggle dance in the dark hive. The screen was a dark image of the inside of a hive. As students walked around, they found

bees doing a waggle dance. Students interpreted the bee dance and tried to find the corresponding flower. The goal of this lesson was to solidify students' understanding of the complex system of bee communication in the hive.

Lesson #5. In this in-class lesson, students began to think about the flower's perspective. Teachers divided the class into groups (seated at different tables) and prompted the class with a writing assignment. The question the teachers prompted students to answer was why flowers would attract bees to come and take their nectar. Each group wrote a narrative around the teacher's prompt and presented their writing out loud to the whole class.

Play Lesson #6. In the last play lesson, students investigated why pollinators were important in our ecosystem. This lesson also highlighted the dependency between flowers and bees by examining the effects of pollination. The technology tracked student's movements from flower to flower and helped flowers grow once they were pollinated (Image 7). However, we designed the field of flowers to have several flowers of the same species as well as one flower of its own species. For example, in the field of flowers, we had several red flowers, several yellow flowers, and only one blue flower. In order for pollination to occur, bees need to bring pollen from same type flowers. When students flew to gather the nectar from all the flowers, the one blue flower died because there were no other same type flowers. From this, students learned how pollination occurred and why the role of pollinators were important in our ecosystem.

Progression of Teacher Guidance and Structure: Two Conditions

The purpose of this study was to examine how teachers can structure guided play activities. While there has been a push for integrating play into curriculum, there is a lack of research on the defining features of guided play. More work on understanding the role of the teacher in curriculum-driven guided play and how to maintain the balance of student agency and

instruction is needed. To do this, I designed guided play lessons that varied how teachers structured play.

Although both participating classrooms had the same learning goals, the degree of teacher-guidance and structure during play differed. The two teachers, Flora and Lily, each taught the unit with varying levels of guidance. Flora followed a teacher-led design. She began the unit with a heavy amount of guidance, focusing students on science content to lead inquiry. By contrast, Lily followed a student-driven learning design, where she began with a student-driven model of instruction before progressively adding teacher-guidance and structure to meet lesson goals.

Building off of Sengupta-Irving & Enyedy's (2014) work, I incorporated the characteristics of student-driven and teacher-led inquiry into the various ways teachers can use guided play for learning. Sengupta-Irving & Enyedy (2014) designed two approaches of inquiry, guided approach and open approach in their study, which were derived from the body of literature around teacher-led and student-led inquiry (Sengupta-Irving & Enyedy, 2014). I applied this contrasting approach of teaching to design the different conditions with Flora and Lily. I also used the design principles of guided and open approach to inform my analysis.

While Sengupta-Irving & Enyedy (2014) illustrated the timing and overlap of each principle within each of their two conditions for inquiry, I only drew from the first three principles and excluded their principles that are relevant to inquiry but not play. Doing this focused my analysis on how the variation of structure and guidance provided by teacher roles can shape agency, engagement, and discussion. Of the design principles used in Sengupta-Irving & Enyedy's (2014) contrasting conditions, I drew from the following: problem given or problem articulation, guided seeing or invention, and formalization or exploration and discussion (Figure

1). Each of these design principles were used to inform how Flora and Lily provided more or less structure and guidance throughout the guided play unit.

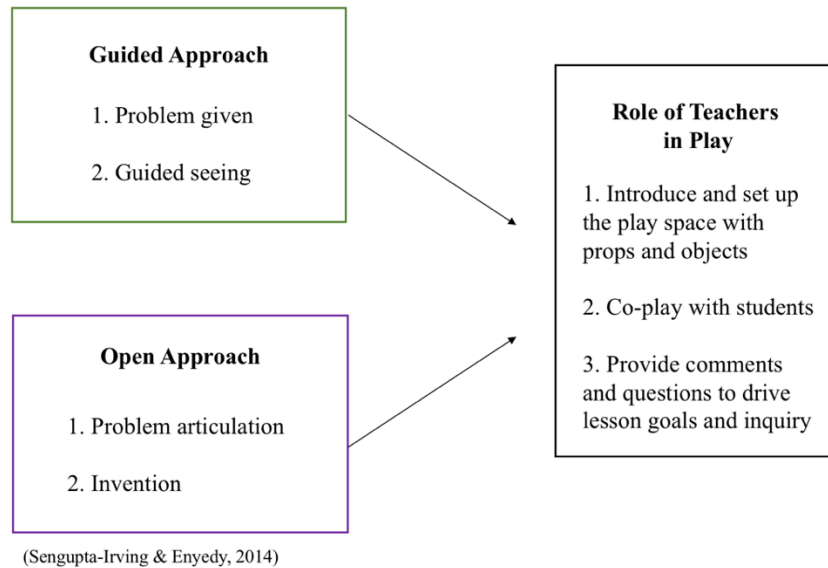


Figure 1. Design and analysis of data

The design and analysis of each condition was rooted in how the three roles of teacher guided play (identified at the end of the previous chapter) could be applied to the contrasting approaches to teaching. With Flora, the three characteristics of the teacher's roles in guided play (introducing the play space with props, co-playing with students, and providing comments and questions) were applied and analyzed within the guided approach. To elaborate, I examined how Flora used the teacher roles of guided play to lead a guided approach of teaching (problem given and guided seeing). In contrast, I also examined how the teacher's roles in guided play were applied within the open approach in Lily's class (Figure 1).

The first principle identified by Sengupta-Irving & Enyedy (2014), problem given or problem articulation, is how teachers introduce a problem. In the guided approach, students are provided with directions as teachers are more explicit with the problem. In the open approach of teaching, students are given the opportunity to first explore, debate, and wonder before defining

a problem to address (Sengupta-Irving & Enyedy, 2014). The second principle identified by Sengupta-Irving & Enyedy (2014), guided seeing and invention, is how students are led to the solution of the problem. Following the first principle of the guided approach, when students are given the problem, they are also closely led and guided towards the solution (Sengupta-Irving & Enyedy, 2014). In contrast, the students in the open approach of learning come up with their own ideas for how to address the problem (Sengupta-Irving & Enyedy, 2014).

Flora: Teacher-guided play. In Flora's classroom, I designed the unit to begin with formal instruction on content to lead inquiry (Kirschner, Sweller & Clark, 2006; Sengupta-Irving & Enyedy, 2014). While this condition was teacher-led, it did not mean that there was an absence of play or student ideas. Instead, Flora provided the students with problems, prompts, and questions at the start of the play lesson. This gave Flora the opportunity to structure and guide students' play and interactions so that they remained focused on the lesson goals. After initially providing a heavier amount of guidance in play, we designed and planned for Flora to implement a student-driven model of teaching towards the end of play lesson #2. However, as I expand in chapter 4, the teacher-guided set up and introduction of the activity influenced the remainder of the play lessons, resulting in all of Flora's play activities to remain teacher-guided.

Lily: Student-led play. In the student-driven approach, students refined ongoing understanding of the content. Lily offered a small amount of guided instruction to allow for student-generated investigations (Klahr & Nigam, 2004). In keeping with Sengupta-Irving & Enyedy's (2014) work, Lily began each play lesson with opportunities for students to co-construct their own problems, solutions, and ideas. As the lessons progressed, Lily organized and formalized students' ideas according to the lesson goals.

Data Selection

For my analysis, I examined play lesson #2 and play lesson #6 to qualitatively analyze how teachers structured and guided play for teaching science. While the original intent was to analyze all play lessons, I am not including play lesson #1, play lesson #4, in-class lesson #3, and in-class lesson #5 in my analysis. Both lesson #3 and lesson #5 were in-class lessons (Table 1) that did not use play. As a result, the two in-class lessons were not used as part of my analysis of examining learning through play. In play lesson #1, students and teachers were focused on getting acquainted with the technology and tracking system. Most of the students couldn't find their bee and had to continuously enlist the help of the adults in the room to understand the system. Unsurprisingly, since most of the time spent in the space was either dedicated to introducing the system or troubleshooting how to find students' bee avatar on the screen, I eliminated this lesson from the analysis due to the inconsistent implementation of play across both teachers.

In play lesson #4, students had difficulty understanding the components of the waggle dance. Since this was a difficult concept to understand, neither teacher followed the structure and guidance that was originally planned. Additionally, students had few opportunities to play in the space due to the confusing nature of the waggle dance. Most of this lesson was spent on the floor as students and teachers discussed and tried to understand the components of the waggle dance. As a result, we ended up with a lesson that followed a more traditional classroom interaction. Since the aim of my analysis was to examine how teachers varied structure and guidance in *play*, I began my analysis with play lesson #2.

While analyzing play lesson #2, I uncovered a major difference between the two conditions in student interactions. In Lily's student-led condition, I found evidence of agency

and affect that didn't consistently hold in Flora's teacher-guided condition. This emergent finding led me to conduct an interview with Lily to further investigate this difference. By doing so, not only did I find that students in Lily's classroom sustained their interest in bees, but I also found that this level of engagement and agency in learning was unique to Lily's students. This led me to analyze play lesson #6 differently from play lesson #2. During my interview with Lily, she attributed the sustained engagement of her students past the end of the unit to what took place in play lesson #6. She recalled a specific moment in play lesson #6 that began a longer conversation around pollination which sustained until the end of the school year. For this reason, in my final findings chapter, I qualitatively analyzed this moment in play lesson #6 to examine how affect influenced student engagement and learning and combine the teacher interview with my video analysis in a more exploratory fashion.

Participant Selection. Part of the consent process for the students in both classrooms was to choose how images and video could be shared. For this reason, each class was split into two groups. Students in the first of the two groups had consented to all forms of data collection (video, pictures, etc.) while students in the second group had opted out of having video and images of themselves shared to the public. As a result, each lesson was taught twice (once for the first group with no film restrictions and again for the second group with film restrictions). Since students in the second group hadn't opted out of the study, I was still able to collect the talk or conversations that occurred during the lesson. Analysis of their data (the group with film restrictions) was briefly presented at the end of chapter 4 and chapter 5 to confirm or complicate the analysis on the groups with no film restrictions.

Analysis

Interaction analysis. Using interaction analysis (Jordan & Henderson, 1995), I analyzed the video data of play lesson #2. I first transcribed the play lessons for both the film and no film groups, looking specifically for the defining moments when Flora and Lily structured play. While the design of the two conditions used some of the principles identified in Sengupta-Irving & Enyedy's (2014) work to structure play, the analysis of how the variety of structure influenced play and students' interactions was driven by the three types of teacher roles in play. In my previous chapter, I identified the three roles of teachers in guided play: introduce and set up the play space with props and objects, co-play with students, and provide comments and questions. The observations I marked in my transcripts throughout the lessons were centered around these three teacher roles and the students' responses to these roles. I notated each of the instances in my data when teachers introduced and set up the play space with props and objects, co-played with students, and provided comments and questions. I also marked students' discourse and interactions in play that resulted from these teacher roles throughout the lesson. Due to my focus on the teacher roles and student interactions in play, my transcriptions do not capture all forms of talk and movement in the lesson. Rather than trying to transcribe every moment of thirteen individuals moving and talking simultaneously in the same space, I watched my video data several times, paying close attention to how the three roles of teacher guided play impacted students' interactions. This focus makes my analysis teacher-focused and positioned the students as reacting to teacher roles in play. As Ochs (1999) pointed out, taking a different stance to transcription and interaction analysis may result in a very different interpretation of the data. However, I think this focus and bias is appropriate given my research questions.

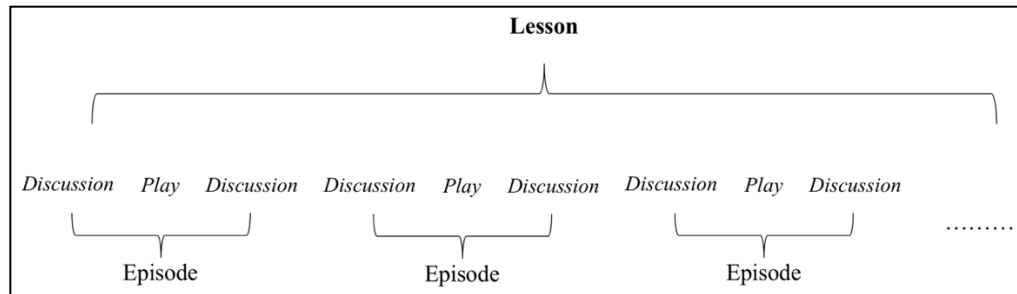


Figure 2. Defining an episode

After transcribing the lessons, I grouped the events of each lesson into “episodes”. In this dissertation, I define an episode as an entire unit of events that include both play and discussion (Figure 2). Across both conditions, Flora and Lily always held discussions following and preceding play. These discussions were an important part of planning and reflecting on play activities. An episode consisted of an opening or introductory discussion, a play activity, and a concluding discussion (Figure 2). Many episodes were centered around a specific theme or idea, while other episodes were simply opportunities to re-play or re-visit ongoing ideas. For example, the first episode of Flora’s play lesson #2 consisted of an introductory discussion that reviewed the conclusion made from the previous day as well as a conversation about what students wanted to try during play. The same episode then included the play activity that immediately followed the introductory discussion. Finally, the episode ended with a discussion led by Flora about what students noticed and discovered while playing.

After organizing my data into episodes, I then selected clips from the group of students with no film restrictions for further analysis. I did this by identifying specific moments in each episode that illustrated how each teacher used her roles to structure play. I also more closely transcribed students’ discourse and interactions as both Flora and Lily shifted and applied their roles in the play activities. I used a version of Gail Jefferson’s transcription guidelines (Figure 3) to present my data from the group of students with no film or video restrictions Since the video

recordings captured both audio and picture, I adopted a multimodal approach while closely transcribing the clips in each episode. I identified and analyzed not only talk, but non-verbal actions as well. This included prosody and tone (for example, a student screaming in the play space). While modern-day video technology allow researchers to easily capture interactions and phenomena, the play lessons in this study often had twelve excited students in overlapping talk and interactions. For this reason, it was difficult to capture all of the talk and action that occurred in the play lessons.

[Overlapping talk between more than one speaker.
(0.1)	The numbers indicate the length of time the speaker paused in seconds.
.	Falling intonation in the word.
?	Rising intonation in the word.
:::	Colon marks are when a word is stretched out by the speaker.
~	Indicates that the talk was rushed by the speaker.
<i>hi</i>	Bold and italicized are words that are emphasized by the speaker.
HI	Capitalized words are spoken loudly (shouting or screaming) by the speaker.

Figure 3. A version of Jeffersonian transcript is used

After closely transcribing episodes from the group of students with no film restrictions for play lesson #2, I also organized my data from the group of students with film restrictions into episodes. I then cross-referenced my findings from the group of students without film restrictions to my analysis of the group of students with film restrictions in play lesson #2. While the larger findings remained consistent throughout the conditions, I also summarized the smaller differences at the end of chapter 4 and chapter 5. While I found no differences in Flora's teacher-guided lessons, I did find subtle differences in Lily's student-driven condition which I summarized at the end of chapter 5.

In the second phase of my analysis, I drew from my post interview with Lily and play lesson #6 to further investigate the impact of Lily's role in play. I focused my analysis in two ways. First, I used Lily's interview to find the specific moments of play lesson #6 that stood out to her. Second, as part of my emergent findings while analyzing play lesson #2, I examined how those moments in play lesson #6 engaged students through affect. In chapter 6 of my findings, I present my analysis and findings of Lily's interview and play lesson #6 on the role of affect in student agency and engagement.

In my analysis of play lesson #6, I transcribed the moments of affect that Lily attributed to the emergent finding on student agency. I once again used a modified version of Gail Jefferson's transcription, and adopted a multimodal approach while analyzing my video data. I paid attention to students' movement in the play space, prosody and tone, as well as students' actions as they played as bees and flowers. I focused my analysis on the role of dual affect (using Vygotsky's (1976) definition) as students engaged in dramatic interactions while discussing, playing, and learning about pollination.

Challenges and Limitations

While Flora, Lily, and I carefully planned our play units to vary the types of structure and amount of guidance used, the lessons were still messy and unpredictable. As I noted earlier in this chapter, I was unable to analyze play lesson #1 and play lesson #4. Often, teachers made adjustments and changes as students discovered and discussed different things. Depending on where each group of students were in the unit, teachers made in-the-moment changes to the curriculum. Play lesson #4, for example, was supposed to be a discovery lesson on the waggle dance. We planned on using a variety of additional physical props to help students explore and make sense of the dance. However, the waggle dance proved to be too confusing for the students.

As a result, both teachers ended up teaching the waggle dance without engaging students in play. For this reason, I compared the lessons as enacted and not as two conditions implemented with fidelity. My method was to document the types of structures and the amount of guidance and how they affected student inquiry and interactions.

This study also used a people-tracking technology that immersed students into the role of bees. While it was an important part of immersing students into role-play in this experiment, this technology is not a readily available tool for other teachers and students. It is not my assertion this specific technology is necessary for students to engage in learning through play. The purpose of this dissertation study was not to argue for the need and implementation of this technology, but rather to understand how teachers can integrate the characteristics of play into classroom discussions and science curriculum. Technology in this study was only one of the tools used to engage and immerse students into role-play. A variety of physical props that were hand made by students and teachers were also used, and highly valued as part of inquiry and play.

Chapter 4. Flora: A Teacher Guided Approach to Learning through Play

In this chapter, Flora led play lesson #2 with a teacher guided approach to play. We structured the lesson using the roles of the teacher in guided play as well as research on teacher-guided instruction (Sengupta-Irving & Enyedy, 2014). I not only analyzed and presented my findings on how Flora applied the teacher-led approach to play, but how it shaped and impacted student interactions as they role-played as bees. Specifically, I pay attention to how Flora's role in the guided approach condition structured the lesson, influenced play, and impacted students' interactions in the play space.

In this lesson, Flora led four episodes that were each tailored to test and conclude student observations around lesson goals. Flora organized the lesson into two parts. In the first two episodes, she guided students in play to learn that a dispersed plan of collecting nectar worked best. In the final two episodes, Flora highlighted the need to communicate flower locations to other bees in the hive. The idea behind this lesson was to help students realize that bees needed to spread to many flowers to successfully gather enough nectar for the hive. While many children may think that the Queen Bee directs and oversees all the bees in the hive, she is only responsible for laying eggs. To be efficient and to avoid disruption, it is vital that forager bees communicate and spread to many different flowers. Not only is this crucial for collecting nectar, but it is also an integral part of pollination.

Episode One: Introduction of Lesson and Spreading Out to Collect Nectar

In the first episode of the lesson, Flora guided students toward the discovery that a dispersed communicative strategy was necessary in order to efficiently collect nectar. In the following events, Flora built on students' ideas from the previous day and guided their activity throughout the episode. After leading the students in a review, Flora used the documentation

(Image 12) from the first lesson to guide them as they tested their first strategy for going to different flowers.



Image 12. Flora led a discussion with the documentation

1. Flora: So we see:: also that when you **go** when you turn into a bee and you go into the space we also see that there are **hearts**. Hearts that come up and each flower has a different number of hearts and we decided **last** time that one heart means that they **kinda** like it two heart means they **like** it and then three hearts mean that they **love** that nectar right? That's what we decided as a group and once you get that **nectar** you fill up the *(Flora pauses while pointing to her back)*
2. Students: Tank
3. Flora: The **tank** and then what do you do with that?
4. Students: Go back to the hive
5. Students: Go bring it to the hive
6. Flora: You go back to the hive and you empty your tank and then you go out and get *(Flora pauses while looking at students)*
7. All: More
8. Flora: So **that's** just a review of what we did last time.
9. Flora: So what we're going to do now is you're going to have an opportunity to go into the space **but** before you go into the space I want you to think about something
10. Flora: So we're going to have an opportunity *(Flora brings out the Bee hula hoop)* we're going to have an opportunity for you to walk through **the?** *(Flora pauses)*
11. Students: Bee-o-nator
12. Flora: The Bee-o-nator and when you walk through this bee-o-nator you are going to transform **into?** *(Flora pauses)*
13. Students: A bee::

14. Flora: A bee. So when you're in the space you have to then think like a bee **think** like a bee so you're going to stop thinking of yourself like a student but you're going to think like a bee. What do I need to do? What is my job out there?
15. Flora: So I have a couple of questions I want you to **think** about. When you're out in the space, **how** do the bees gather the nectar? What's the best way to gather the most nectar?
16. Ash: Spread out?
17. Flora: How do they organize themselves? Remember? So we did (*Flora points to the documentation of strategies*) we did have an opportunity **yes** that's right we did have an opportunity to brainstorm some strategies the last time so we had said go to different flowers.
18. Flora: So I want you to when you go out into the space I want you to think about **that** strategy and what other strategies there might be. Okay?

Transcript 1.

At the start of the lesson, Flora reviewed the overarching goal for students to consider during play. First, she provided an overview of the technology and observable characteristics of the play activity. This overview was structured by the use of pre-made documentation (Image 12) that identified for the students the important elements of the simulation. The overview also explicated the students' goal in the simulation and the action needed to achieve that goal, "you go back to the hive and you empty your tank" (Transcript 1, Line 6). Before she invited students into the play space, Flora stepped back from the technical aspects and talked to the students about their dual role as students and bees, "you're going to have an opportunity to go into the space but before you go into the space I want you to think about something" (Transcript 1, Line 9). She then readied the students by focusing on, "So when you're in the space you have to then think like a bee think like a bee so you're going to stop thinking of yourself like a student but you're going to think like a bee. What do I need to do? What is my job out there?" (Transcript 1, Line 14). Here, Flora made clear the importance of role-playing as a bee with a specific goal in mind. Using the documentation (Image 12) from the previous day, students had already suggested going to different flowers as a possible strategy for collecting nectar. She began the lesson with the conclusions made from the previous day to continuously build towards the lesson

goals. As students entered the play space, Flora closed the introduction of the lesson and asked several specific questions, “So I have a couple of questions I want you to think about. When you’re out in the space, how do the bees gather the nectar? What’s the best way to gather the most nectar?” (Transcript 1, Line 15). Flora’s introduction set the tone and structure of the episode—it laid out specific goals for the students, what to attend to, what actions to perform, and what to reflect on—and in the remainder of the lesson, we continued to observe Flora guide role-play, where each play activity was organized and structured to achieve content goals.

Just as she did in the introduction, Flora’s setup of the lesson shaped student discourse and helped keep it focused on the lesson goals throughout play. What is unique in both the introduction and play activity is how Flora used the resources in the play-based environment to help structure and guide students. Not only did she reference the documentation to organize and build on student ideas, but she also used role-play to shape and guide their actions. In the following play activity, Flora not only reminded students of the strategy the bees needed to try but also paid attention to the various play resources in the space to help them collect nectar. After Flora ended her introduction, students entered the play space through the hula hoop prop (Bee-ordinator) one at a time.

Not only did Flora articulate the lesson goal before entering the space (in the introduction), but she also reminded the students to spread out to different flowers while students played. During the students’ first opportunity to play, Flora remained outside of the space and provided guidance through regular comments and reminders to the students (Image 13). Flora continuously prompted students the goal of play as students quietly gathered nectar for the hive.



Image 13. Flora remained outside the play space

19. (Flora is standing to the side while students are collecting & taking nectar back to the hive)
20. (Student does a trumpet sound while collecting nectar)
21. Ash: I don't *see:::* me
22. Flora: So the STRAATEGY that we had discussed before was spreading out going to different *flowe:::rs*. Your goal is to get *nectar* to fill the hive
23. (Students are silently walking back and forth from flowers to the hive)
24. Corey: I can't see where I am::
25. Student: Into the hive::
26. Flora: Soo some of you are saying you still can't find yourselves
27. Corey: I think there's too many people
28. Flora: When you are in the space you can use do you see the sun up there? (Flora walks from the back of the room to the front to point out the sun) Do you see the sun? Do you see a little bit of the rays? And then the hive? *Use* the sun and the hive to help you find your bee
29. Student: The hive is full
30. Reid: I have a FULL tank now
31. (Students are collecting nectar quietly)
32. (Flora walks back to the back of the room)
33. Corey: It looks like the hive is full
34. (Students quietly continue to gather nectar from flowers and walk back to the hive)
35. Reid: Can you make (inaudible) new hive? (Reid is speaking to the researcher at the side of the room)
36. (Student makes a trumpet sound)
37. (Students continue to quietly gather nectar)
38. Flora: So do you notice the flower that turns grey?
39. Flora: Why do you think it turns grey?
40. Clover: It's dried out
41. Flora: Because why Clover?
42. Clover: It's dried out
43. Flora: Because it doesn't have any more what?
44. Clover: Nectar
45. Flora: Nectar! So do you think the bees are going to want to stay on that *flower*?
46. Ash: No::
47. (Students continue to quietly gather nectar)

Transcript 2.

Flora also addressed the issue of having trouble finding their bee by highlighting the sun and hive as resources (Corey in Transcript 2, Line 27 stated that “there are too many people”). While watching the students in play, Flora also asked in Transcript 2, Line 38, “So do you notice the flower that turn grey?” Clover answered Flora’s question by stating that it meant the flowers had run out of nectar. Flora restated Clover’s response to the class and questioned if bees would want to stay on those flowers. The students continued to collect nectar from various flowers and bring it back to the hive until Flora called for a discussion.

Throughout this first play activity, Flora 1) reminded students of the goal of play 2) drew attention to the grey flower, suggesting that bees might want to go to flowers that still had nectar, and 3) addressed Corey’s struggle to find his bee by pointing out resources like the sun and hive. In these moments of play, we also saw that the majority of student discourse was focused on finding and gathering nectar. Flora’s articulation of the object of the activity, both in the introduction and during play, impacted students’ goals, interactions, and discourse. As a result, students’ interactions during play remained focused on the lesson goal and their individual role and observations related to that goal (e.g., “my tank is full”), leaving little room for other ideas to be shared and explored.

Flora’s guiding approach to play resulted in a participation framework that aligned more closely with a traditional guided inquiry classroom culture (Sengupta-Irving & Enyedy, 2014). First, we saw the typical teacher question and student response when Clover answered Flora’s question about the grey flower. We also saw an overall lack of the overlapping talk typically exhibited by children during play (most of the time spent in play was quiet as students gathered nectar for the hive). This is peculiar given that children in play are usually engaged in disputes and are more vocal with one another.

Although the majority of student discourse in play remained focused on finding and collecting nectar, Corey brought up the issue of having too many people in the space. Flora interpreted Corey's concern as a technical problem and offered the solution of using the sun and hive to re-locate bees on the screen. The response Flora gave to Corey served not only to help students locate themselves on the screen, but also to resolve the issue so they could continue carrying out the goal of the play activity. Corey's concern about too many bees crowding around flowers was viewed as a roadblock which interfered with his ability to test the strategy. Therefore, Flora's interactions with students in the play space not only organized students' actions but also regulated and provided rules for play. As a result, Flora's use of role-play helped students stay focused on her lesson plan.

After students had filled the hive with nectar, Flora gathered them for a discussion in the back of the room. When Flora asked how well spreading out worked for collecting nectar, students had mixed feedback on the success of the strategy. Although the play activity seemed to focus and successfully center around spreading out to find nectar, the discussion following play revealed a shared issue related to Corey's earlier observation.

48. *(Students gather at the back of the room and sit in the discussion space)*
 49. Flora: So:: (0.2) **last** time we talked about goi::ng to different flowers a~nd is that the strategy you guys were testing-were-trying out right now? Spreading out?
 50. Ash: No
 51. Flora: Do you feel like you were **all** moving in different places?
 52. Students: Yes
 53. Students: Noo
 54. Flora: You don't? What do you think?
 55. Ash: Because there was only four flowers and some of them turned grey
 56. Students: Yea a::: because
 57. Flora: But were all of you going to just one?
 58. Students: No::
 59. Flora: No you were going to different even though there weren't that **many** right?
 60. Flora: Is there another strategy that you think that bees might use in order to get as much nectar as they caan to take back to the hive? Clover?
 61. Clover: To move to each flower then to another before it turns grey.
 62. *(Flora laughs)*

63. Flora: *Yea* so when they turn grey we realize that~that's because they don't have any nectar so::: (*Flora points to documentation at the strategy of spreading out*) moving to different flowers that's just that's~another way of moving to different flowers.

Transcript 3.

As Flora began the discussion and asked the class if students were spreading out, a disagreement emerged. Ash responded that they weren't able to spread out because of the shortage of flowers within the technology (Transcript 3, Line 55). His response marked the second time within this episode students mentioned the issue of having too many bees and too few flowers within the space. Corey first stated this problem during play in Transcript 2, Line 27. For this group, this was a reoccurring series of teacher-student interactions. When students shared observations related to the technical aspect of the play environment, Flora did not position these difficulties as intellectual challenges to be investigated, but instead provided solutions for students so that they could return to the goals of the planned lesson. In this discussion, Flora responded to students by stating that students weren't only going to one flower, "even though there weren't that many" (Transcript 3, Line 59). Although students stated that they were not spreading out due to the shortage of flowers, Flora reassured students that this was not the case. She then proceeded to ask if students had any other strategies to test. Clover responded to Flora's request and suggested in Transcript 3, Line 61 that bees could move to different flowers before each one turns grey.

However, instead of positioning Clover's idea as a different or revised strategy to test, Flora concluded: "that's another way to move to different flowers" (Transcript 3, Line 62-63). Here, Flora continued to guide the students towards the lesson goal of discovering the need for a de-centralized strategy when collecting nectar. As a result, Flora didn't investigate either the issue of having too few flowers or Clover's grey flower strategy. Instead, she assured the class

that they were spreading out to different flowers. However, despite her guidance students didn't reach a consensus that the strategy of spreading out worked well for them.

In this first episode, Flora interacted with students by guiding both their play and discussion towards recognizing the need for a dispersed strategy to collect nectar. She tried to achieve this goal by highlighting the rules of bee behavior, reminding students to spread out, and guiding students' interactions and discussion towards the lesson goal. Although students' interactions in play remained focused on lesson goals, Flora's more heavily guided approach left little room for the exploration of students' ideas or misconceptions. Not only did we see evidence of this in play, but we also saw a lack of student ideas being further explored in discussion. When Clover shared her idea about the flower running out of nectar during discussion, Flora moved the discussion forward because Clover's idea didn't directly lead to the conclusion that spreading out was successful. Despite the fact that Flora opened up the discussion space for "other strategies", she continued to focus on listening for ideas that aligned with the lesson goal. Instead of allowing them to explore other strategies, Flora continued the conversation to help students discover the effectiveness of a dispersed or decentralized strategy of collecting nectar.

Episode Two: Queen Bee Strategy

As we saw in the ending of *episode one*, Ash and Corey had a moment of disagreement with Flora. Due to the lack of flowers, the two students felt that they couldn't adequately spread out to different flowers. To help students draw conclusions about the best nectar gathering strategy, Flora introduced a new strategy for them to test. In this episode, Flora introduced the "Queen Bee" as another possible nectar gathering method to compare with the strategy of spreading out. When students in the ending discussion of *episode one* didn't clearly articulate the success of the dispersed strategy of collecting nectar, Flora led the second episode to provide a

sharp contrast between the two strategies. After Flora introduced the Queen Bee strategy, she organized and led a play activity in which she played the role of the Queen.

The following discussion took place immediately following the first episode. Flora introduced the new strategy and readied students for another play activity. Just as she did in *episode one*, Flora guided the discussion and set up the students before play.

1. Flora: What if I told you that there was there might be another strategy? **NOT** that it's~the not~that I'm saying this is THE strategy but I'm gonna throw out a strategy okay?
2. Flora: So the goal for them is to go:: and get as much nectar as they can to bring to~the to~the hive right? They want that nectar right?
 - They need it to make the honey.
3. Ash:
 - They want to work together
4. Flora: And they want (0.1) wELL
5. Ash: They're working to
 - gether
6. Flora:
 - They're working together
7. Flora: Right? By going to the different flowers to get the (0.1) the nectar. What if I told you one **POSSIBLE** strategy could be the **queen**?
8. Flora: How many of you know that there is a queen in the hive?
9. (10 Students raise their hands)
10. Flora: Oh good a LOT of you know. SO: is there only one queen or many queens?
11. Student: Many
12. Students: One One!
13. Flora: There's actually only **one** queen and what~if~I~said~that that **queen tells** the bees where to go? So we have (*Flora points to the strategy on the documentation*) the strategy of going to different flowers
 - which is
 - Wait I have an idea
14. Corey:
15. Flora: Which is having the bees spread out (*Flora writes down queen strategy on documentation*) and then we have the queen strategy

Transcript 4.

At the start of this episode, Flora introduced students to the Queen Bee strategy; this strategy represented a more centralized method of gathering nectar (Transcript 4, Line 1). In this strategy, students gathered nectar from flowers by following directions from the Queen Bee. Instead of spreading out, students had to follow the rules of the one (and only) Queen Bee and only go to flowers when directed to do so (Transcript 4, Line 13). The goal of this episode was to not only illustrate the inefficiency of having a centralized system of communication, but also to

start thinking about how bees communicate within the dispersed system. If having one bee in charge is not efficient, how do multiple bees communicate and disperse to various flowers?



Image 14. Flora asked students to form a line in the hive

After ending the discussion, Flora invited six students to join her in play while the remainder of the class stayed seated to observe. Here, Flora entered as a co-player for the first time by taking on the role of the Queen Bee. Although Flora never entered the designated tracking space, she played as the Queen Bee in the “hive” and organized and gave directions to the bees (Image 14). Similar to the first episode, Flora continued to highlight the importance of role-play as a bee to solidify and organize student understanding. In this play activity, Flora (as the Queen Bee) organized the students so they could test the centralized strategy by asking forager bees (students) to wait in line until she sent them to a flower. Throughout play, Flora purposefully delayed in sending forager bees into the space by pretending to carry out all her jobs as the Queen Bee.

16. Flora: Let's make a line right here at the hive so since we're testing out the QUEEN strategy I'm going to be the queen. Ok? So I'm going to step into the space with you let's make the line this way we need to~the~queen likes her lines very

- organized so Lavender will be the first one and everybody else will line up behind Lavender.
17. Flora: All right so **I** will be the queen and as the queen I am going to **tell** them what flower to go to but as the queen I also have some other things I might need to do during this time. So I want to pay attention and see what happens during **this** strategy. So we're testing out strategy number two Corey and Cypress. Observe see what happens.
18. *(Flora whispers to Lavender and asks her to go out into the space and look for a flower)*
19. *(Lavender enters as the first forager bee in the tracking space while Flora whispers to the bees)*
20. Flora: So as the forager bee you're gonna move **around** and **forage** flying **around** trying to find a **flower**
21. *(Students in line are quietly waiting in line while students sitting down are quietly observing)*
22. Students *(whispering as they watch Lavender)*: I see a flower
23. Flora: Keep moving Lavender the more you move you **might** come across one
(Lavender finds a yellow flower and gathers nectar)
24. *(Ash and Cypress comment that Lavender filled up and should go back to the hive)*
25. Flora: I'm going to check on the babies so you're going to have to wait. Sorry guys *(as Flora walks over to the researchers)* you need to wait because I have to take care of the babies because I'm the queen.
26. Flora: My babies are super hungry

Transcript 5.

To test the centralized strategy of the Queen Bee, Flora assigned six students the role of forager bees to wait for directions. Flora began the play activity by asking students to stand in a straight line, “the Queen likes her lines very organized” (Transcript 5, Line 16). In this play activity, Flora’s role as Queen Bee defined the rules of the activity. These rules were used to guide student interactions during play. To help students conclude that a centralized strategy was inefficient, Flora used the rules bound by the roles to dramatically make this point. As Queen, Flora took her time when she gave out directions and only sent Lavender into the space. Before giving the other five bees a chance to gather nectar, Flora walked to the other side of the room to “check on the babies” because they were “super hungry” (Transcript 5, Lines 25-26). As the play activity progressed, Flora continued to use her role so that she could spend time fulfilling the many duties of the Queen Bee. The following transcript took place as the Queen Bee play activity came to an end.

27. *(Ash, who is in line, tries to go into the space)*
28. Flora: Nope you can't go out I haven't told you to GO. You have to wait the queen gives the orders
29. Cypress: Lavender go to a different flower *(Cypress is sitting down)*
30. Ash: Ok now what?
31. Researcher: Is that what the queen told her to do though?
32. *(Flora walks away from researchers and back to where the line of students are waiting)*
33. Flora: Oh no. You have to **wait** for me to **tell** you to go because I was with the babies so I also have to go tell some of the other workers what to do so you have to wait for me to tell you what to do.
34. *(Flora continues to tell students that she is the queen and has much to do)*
35. *(Students in line are still quietly waiting while students sitting down are quietly watching)*
36. *(Flora sends in Rosemary to forage and gather nectar while Lavender is back in line)*
37. *(All students are quietly watching Rosemary gathering nectar and bringing it back to the hive)*
38. *(Flora asks Rosemary to come back and now everyone is back in the hive waiting for orders from the queen)*
39. Flora: All right. I THINK our time's **UP**. Oh:: sorry guys you didn't get a chance to go OU::T. Yea because~I~was **REALLY** busy. Sorry so go ahead take a seat
40. Ash: **WHA::T?!**

Transcript 6.

In this play activity, Flora used her Queen Bee role to help manage and organize the students in order to test the centralized strategy. The rules of the play activity were enforced in three ways. First, Flora made several statements about the rules of being the Queen Bee and how busy her job kept her. Throughout play, Flora narrated her actions as she pretended to be the Queen Bee. Not only did she explain the rules of being the Queen Bee at the beginning, but she continued to tell the students how busy she was. Second, when Ash tried to enter the space to gather nectar, he was quickly reminded of the rules of play. When Ash tried to enter the play space to look for flowers without the Queen Bee's direction (Transcript 6, Lines 27-28, 31) both Flora and myself reminded him of his role and asked him to wait for the Queen Bee's orders. By enforcing this rule in play, students stayed in line and had to watch and wait as Lavender and Rosemary gathered nectar. Third, Flora dramatically acted out her role as Queen Bee. She took her time feeding the babies, whispered directions to one bee at a time, and limited the number of bees foraging in the play space. She did this to highlight the inefficiency of the centralized

strategy and guide students towards the lesson goal. In this case, Flora efficiently used her role as the Queen Bee to appropriately test and compare strategies. She took time sending bees into the space and made herself busy as she walked around giving directions and feeding her babies.

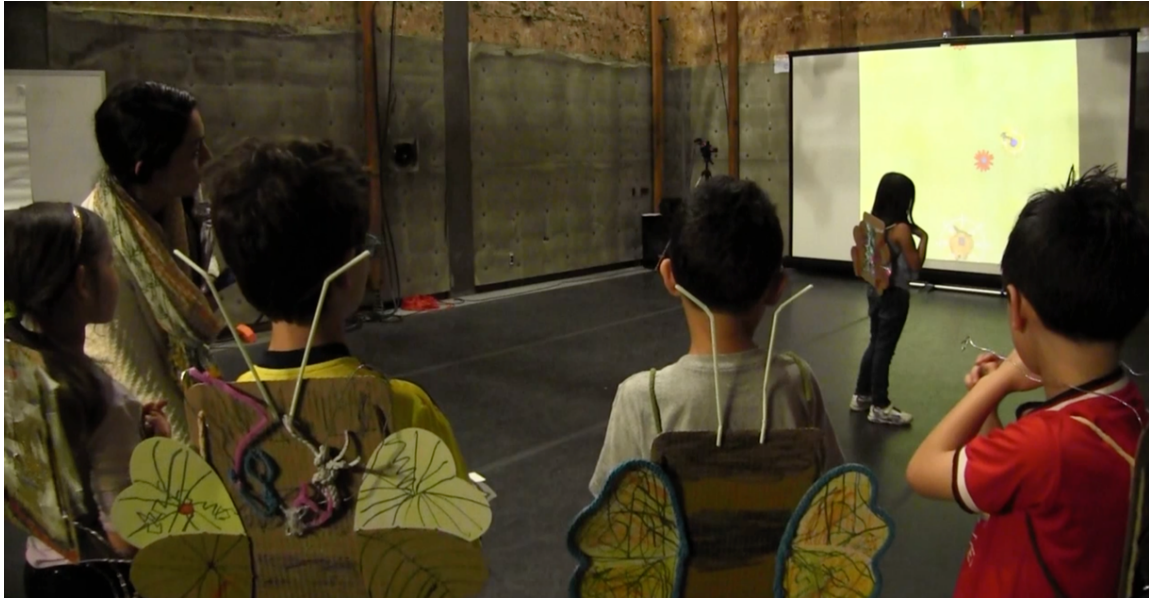


Image 15. Rosemary collected nectar while Flora and the other students watched

Just as in *episode one*, student discourse throughout this play activity was minimal. In the few moments students did speak, their conversation remained focused on Lavender’s actions as she gathered nectar (Transcript 6, Line 29). At the end of the play activity, we also saw Ash’s emotional response in reaction to the strategy, “what??” (Transcript 6, Line 40). Only two students had the opportunity to gather nectar in the space and, for the most part, students didn’t interact or engage in discourse throughout the activity while waiting in line. At this point, Flora brought the class together for a discussion. She referred to the negative emotional response and used it to begin her discussion and comparison of strategies. Here, Flora attempted to wrap up her discussion and make clear the importance of a dispersed strategy of collecting nectar.

41. Iris: What was the point of taking~them~putting them UP?
42. Flora: What did you guys think of this strategy? Think about it. Remember you're thinking as bees. You're thinking as bees you're goal is to go out and get nectar so:: we have strategy one spreading out going to different flowers and we have

strategy two the queen strategy where the **bees** have to wait for the queen. What~did~you~think? Raise your hand tell me I wanna hear your thoughts. **SO** you can say something like it was a good strategy beCAUSE OR it wasn't a good strategy **because**. So think about it especially those of you who were standing there

43. Ash: [waiting
Waiting the whole time
44. (Flora laughs)
45. Flora: I can see that you're not very happy so tell me why you're not very happy.
46. Clover: I don't think the queen strategy worked because
47. Flora: Can you tell me that again? You think that
48. Clover: I don't think the queen strategy worked because umm you kept checking on your babies and the bees didn't get to work because they didn't have enough **honey** to feed their babies
49. Flora: Ok so because queen kept having to check on babies?
50. (Flora writes Clover's response on documentation)
51. Clover: Uh hu
52. Flora: Why else was this not~so you're thinking like bees why else this not the **best** strategy? Corey?
53. Corey: It was a good strategy but you should send a couple of bees out at the same time so that you can get more **honey** and so that all the bees you **said** could go CAN go.
54. Flora: So: was **this** a strategy that would help to get more honey?
55. Iris: No::
56. Students: No
57. Flora: Why not? What were you going to say Briar?
58. Briar: I was just saying that the queen bee strategy is a good strategy because because the tank only has two people it's like almost filled
59. Flora: Right but I had to keep going with the babies so is **that** enough nectar to feed ALL my babies?
60. Iris: You only had two babies
61. Flora: I know but real bees have lots of babies

Transcript 7.

What is interesting about the first part of this discussion is the lack of a unanimous decision on the best strategy to collect nectar. Between Ash's emotional disbelief and Iris's opening question (Transcript 6, Line 40 & Transcript 7, Line 41, 43) which displayed their negative stance on the Queen Bee strategy, students still commented that it could be a good strategy. Despite Flora's rules and actions that dramatically displayed the inefficient nature of a centralized system, we didn't see students align with Flora's intended lesson goal. While Clover shared her view on the Queen Bee strategy with Ash and Iris (Image 16), students like Corey and Briar made suggestions about how to better or improve the Queen Bee's roles (Transcript 7, Line

53, 58). Corey thought the Queen Bee strategy worked but suggested, “you should send a couple of bees out at the same time” (Transcript 7, Line 53). However, Flora didn’t take up his suggestion or try to modify the Queen Bee strategy according to his ideas.

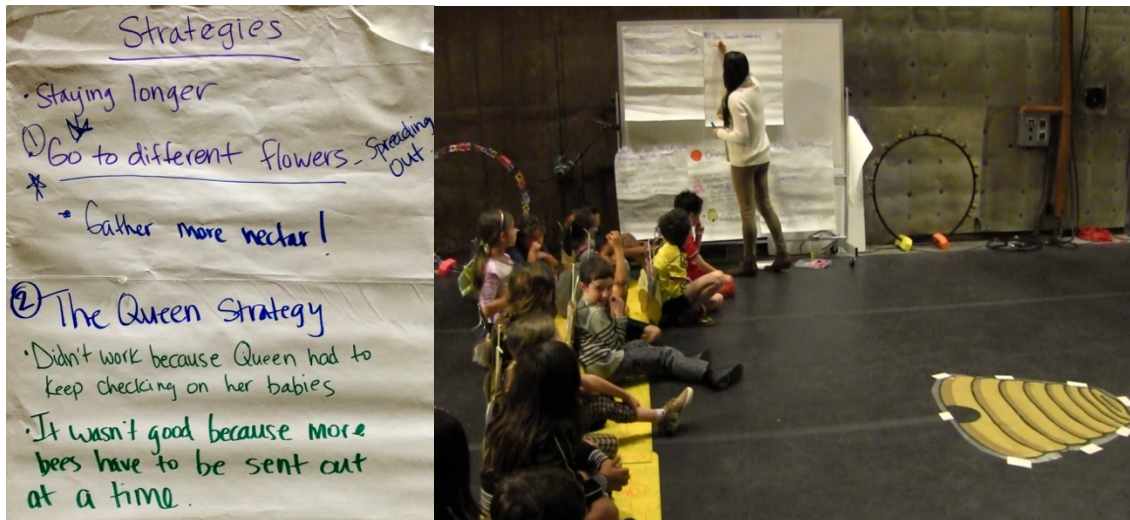


Image 16. Flora documented Clover’s ideas on how the Queen Strategy didn’t work

What was also interesting in these first moments of discussion was Briar’s comments on the Queen Bee strategy. Not only did she state that it was a good strategy, but she offered a reason for favoring the Queen Bee strategy that had the potential to address previous issues seen in *episode one*. In *episode one*, both Ash and Corey voiced their observation on the lack of flowers and surplus of bees within the space. However, during the Queen Bee strategy, students experienced the exact opposite of this concern. Here, students were given the chance to gather nectar one at a time, thus eliminating the issue of having too many bees in the space. Briar pointed out that the reason why she believed the Queen Bee strategy worked was because the bees who had the opportunity to be in the space were actually able to fill up with nectar (Transcript 7, Line 58). Similar to the previous episode, Flora responded to Briar’s point and reminded her that although each bee had the opportunity and space to gather nectar, the

collective amount of nectar did not fill the hive. Once again, Flora provided a response for students' ideas instead of testing the strategies to move forward with the lesson plan.

In the following transcript, Flora continued the discussion and tried to steer the students towards the articulation that a dispersed strategy of collecting nectar worked best. As Flora concluded the discussion, she listened for students to clearly conclude and make a decision about which strategy worked best. Throughout this discussion, and as we saw earlier in the transcript, Flora repeatedly responded to students' ideas and suggestions instead of exploring and testing them out. For instance, when Corey suggested that the Queen send more bees out of the hive, Flora redirected the conversation and made the point that not enough honey was gathered. However, instead of giving the students the opportunity to play and conclude on their own that modifications to the Queen Bee strategy may or may not work, Flora asked leading questions or comments. In these first two episodes, Flora continuously listened for students to articulate, align, and decide that a dispersed strategy worked best. As a result, the other variations, misconceptions, or ideas students came up with were not explored.

62. Cypress: I watched this movie and like the queen bee and she had to check on her babies a lot she would ask all these um men to like go and get the um get the nectar and then come back like like a whole group of men and just go and then come back like half of us go and come back um and when the tank is filled then the other like last time
63. Flora: Like last time? So:: so: when we're thinking about spreading [out
64. Corey: I~don't~I~don't think we should
65. Flora: What if the queen bee just sent everybody to **one** flower just **one** flower? You're only allowed to go to one flower.
66. Ash: That wouldn't be good cu:::z:::
67. Flora: Wha~that wouldn't work? [Because
68. Ash: [Because everybody would be bunched up and no body would get a lot of nectar
69. Flora: So then what Cypress is saying is that if the queen asked **all** the bees go to the one flower it wouldn't work but it's **best** if they all go (Flora points to the documentation and pauses)

70. Students: To different ones
 71. Flora: Different ones. It's best if they all go to different ones?
 72. Cypress: It's kind of like the spreading out strategy
 73. Flora: It's like the spreading *out* strategy where they all go to different ones *SO* when a bee so~if~we're thinking about if we're thinking about bees and what they need (0.2) let's make that decision is it best if they all go to one flower the~queen~tells~them~all to go to ONE flower or is it best if they spread out?
 74. Students: Best if they spread out
 75. Flora: Do we all agree on this?
 76. Students: Yes

Transcript 8.

Similar to the first episode, Flora continued to use role-play to direct student actions to lead inquiry. She adopted the role of the Queen Bee and managed, organized, and guided students into experiencing the lack of nectar collected for the hive. She continued to focus students on the lesson goals and directed them to test a different strategy than spreading out to different flowers. Similar to what we saw with Clover's "grey flower" idea in *episode one*, Flora re-directed conversations to align with the lesson goals. For instance, when Briar pointed out the potential of the Queen Bee strategy, Flora moved the conversation forward and continued to listen for ideas that would help make conclusions.

What is unique about this episode is how much Flora led both the discussion and play activity. Although she co-played with students as the Queen Bee, the rules that established her role gave little room for students to make modifications. From the lack of student discourse in play, to the question and answer interactions during discussion, *episode two* contained several moments that mirrored typical classroom culture.

We also saw that Flora's early decision to introduce and lead the Queen Bee idea led to a lack of agency. This then impacted discussion; even after the frustrating play activity, students were still unable to unanimously decide to favor the spreading out strategy. It wasn't until the very end when Cypress shared what he learned from a movie he watched that Flora made the

connection for the students. Flora transformed Cypress' comment and eventually asked the deciding question, "let's make that decision is it best if they all go to one flower the~Queen~tells~them~all to go to ONE flower or is it best if they spread out?" (Transcript 8, Line 73). Due to the lack of students making a decisive conclusion that the Queen Bee strategy was unsuccessful, Flora heavily shape and ask leading questions. However, in the pursuit for achieving the lesson goal, Flora and students began to misalign in the objectives of play. While Flora was listening for students to conclude that spreading out worked best, students were more invested and interested in their own ideas.

Throughout this episode, Flora made decisions to guide and shape the lesson in order to achieve lesson goals that impacted students' alignment and conclusions. Flora's more heavy guidance throughout role-play impacted students' discourse and activity. While the intent was to illustrate the importance of spreading out, students had alternative ideas and modifications. What is interesting in this episode, is that Briar's reason for thinking the Queen Bee strategy had potential was related to another issue the students brought up in the previous episode. However, as Flora also practiced in *episode one*, she continued to move the conversation forward and didn't provide opportunities for students to explore and conclude on their own. As a result, we saw a decline in agency in both play and discussion. Since the Queen Bee strategy was heavily related to the need for students to articulate that a dispersed strategy worked best, discussions were also rooted in providing Flora with verbal confirmation. We saw this whenever students like Corey, Briar, and Iris brought up ideas that further complicated or strayed away from the lesson goals. Flora always moved forward and continued the discussion until students agreed that spreading out worked best.

Episode Three: Communicating Flower Location and Misalignment of Activity Goals

While the first two episodes focused on discovering the best strategy for collecting nectar, Flora concentrated the remaining episodes on how bees *communicate*. As was previously mentioned, Flora led the lesson in two parts. First, to discover that bees needed a dispersed strategy of collecting nectar. Second, to discover how bees communicated within that dispersed method of collecting nectar. In the final two episodes of this lesson, Flora struggled to move students towards the discovery and need for communication. While students concluded at the end of *episode two* that spreading out was better, there was still a misalignment between Flora and the students. This misalignment, which first occurred during *episode one*, persisted throughout the entire lesson.

In the following transcript, *episode three* began with Flora steering the discussion towards a communicative strategy. Although the decision that spreading out worked best had already been made, students still had concerns about sending too many bees into the space. In the discussion, students continued to voice their issue with crowding around flowers while Flora tried to move forward. However, the misalignment between Flora and the students that first began in *episode one* impacted both students' discourse and play. As a result, Flora had difficulty engaging students in her question.

1. Corey: I think umm it wouldn't be a good idea to send like umm too *many* people out at the same time cause *then* it~will~get~all bunched up and there won't be that many flowers and then you would start to like going two three bees on one flower
2. Flora: You're thinking as a student from the class *we're* thinking about thinking like bees
3. Cypress: We're bee students from the class.
4. Ash: We're bees from the hive
5. Flora: Now that we feel spreading out works *best* (0.2) *why*~how do you think that the bees when they get to that *flower* when they all spread out they get to that flower do they keep that information to themselves? Do they just say *OH* I found nectar this~is~*good*~nectar i'm~not~going to tell *anybody* about it?

6. Students: No
7. Flora: No right?
8. Cypress: You should tell um other bees so that then they can get good nectar too so then um: when they come back they all have good nectar umm to~to~make honey
9. Iris: But then the
10. Flora: So their job is *to* be able to get that nectar to the hive so that all those babies get fed. So my question to *you* is Lavender yes?
11. Corey: But do they eat nectar
12. Lavender: I'm not sure about what Cypress said because then they're all going to get umm one flower that it's the best um nectar
13. Cypress: No wait but~I
14. Iris: They're all going to get bunched up on one flower
15. Flora: But is there only do~you~think there is only one flower that has good nectar or are there many? So if there are many bees going *out*
16. Iris: Cause they're~cause~they're~there are not
17. Flora: I know (Flora points to the screen) you're thinking of this picture in front of you and how there aren't that many flowers but in the real world are there a lot of flowers?
18. Cypress: Yes there are lot of good flowers so there wouldn't be one flower with bees bunched up there could be many of them.
19. Flora: So
20. Cypress: But there are some that aren't that good.
21. Flora: So that's what Cypress is trying to say. So how do you think bees tell other bees about all those other good flowers?
22. Ash: In bee language like dances
23. Researcher: Let's go and see~if we can figure it out

Transcript 9.

While the goal of this episode was to guide students and help brainstorm ideas about communication, a large part of the discussion was actually spent clarifying or moving away from the issue of bunching around flowers. The opening of this discussion began when Corey reiterated the issue of sending too many bees into the space (Transcript 9, Line 1-2). While Flora responded and tried to steer students away from this issue, they had trouble letting it go. Following Corey's talk, Flora responded that he was thinking like a student instead of a bee. She then continued the discussion and asked if bees kept flower locations to themselves (Transcript 9, Line 5). However, Flora's attempt to move forward was not as successful. Although Cypress engaged in Flora's prompt and suggested they communicated flower locations with good nectar, students continued to display moments of misalignment. Lavender responded to Cypress and

began to point out the flaw in only communicating flowers with good nectar (Transcript 9, Line 12). This is then taken up and agreed by Iris in (Transcript 9, Line 14). The importance of this conversation is that while Cypress wanted to communicate flowers with “good nectar” (Transcript 9, Line 8), Iris and Lavender raised the question of overcrowding around that one good flower. This was a valid concern, because if bees only communicated about flowers with good nectar they wouldn’t have enough nectar to fill the hive. By relying on only one source of food, bees would overcrowd and quickly deplete nectar from that flower. Instead, bees need to spread to all flowers with varying qualities of nectar. After Iris built on Lavender’s comment, Flora responded, “you’re thinking of this picture in front of you and how there aren’t that many flowers but in the real world are there a lot of flowers?” (Transcript 9, Line 17).

Once again, Flora responded to students by differentiating between the technology and the real world. Flora first made this distinction with Corey (Transcript 9, Line 2). As a result, we saw two moments of misalignment between Flora and the students. First, Corey and Ash in *episode one* and *episode two* were concerned with the number of bees within the space. This continued to be an issue for Corey throughout all three episodes. Second, as we saw in this discussion, students identified a flaw in only communicating the locations of flower with good nectar. In both cases, Flora moved the conversation forward and continued towards the lesson goals by differentiating between the limitations of the technology and the real world. However, the level of guidance in this play lesson impacted students’ agency and exploration of ideas.

What is different about this episode, and in this discussion, is the relevance of Flora’s overarching prompt. In the first two episodes of this lesson, students were engaged in finding and collecting nectar. This was a collective, classroom wide goal that was important during play. Therefore, Flora was able to engage students with the question or problem of finding out the best

way to collect nectar. However, the question of “do they keep that information to themselves?” (Transcript 9, Line 5) was not of importance at the current point of the discussion. This was an interesting start to the episode because as Flora tried to problematize the nectar gathering system by suggesting a need for communication, not all of the students aligned with Flora and Cypress. Flora continued to re-direct and respond to Corey, Iris, and Lavender with the difference between technology and the real world. Thus, when students entered play, the misalignment of ideas began to impact students’ interactions. As Flora tried to engage students in her guiding question about communication, students displayed a lack of interest and engagement during play. In the following transcript, Flora invited all students into the space and co-played as a bee for the first time (Image 17).

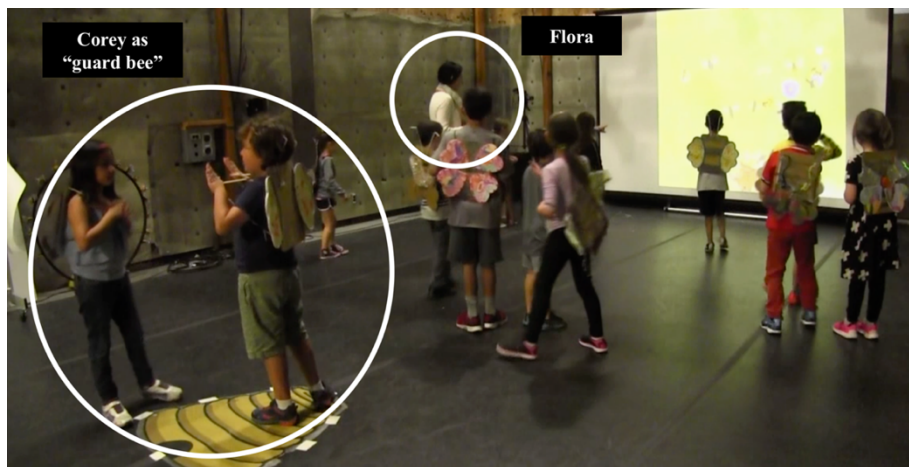


Image 17. Flora co-played with students as a fellow bee & Corey pretended to guard

24. Corey: You guys i'm the guard bee. I am the guard bee:: *(while standing on the bee hive)*
25. Flora: Once you find where you are
26. Reid: Oh I found a flo::wer
27. Ash: I found a **GREAT** flower!
28. Reid: It gave me three hearts at the same time
29. Corey: I am the guard bee::. You have to enter with my permission I am the guard bee! *(standing in the back hive)*

30. Reid: Can I enter? (*standing in the back hive with Corey*)
31. Corey: Yes you can. (*standing in the back hive*)
32. Flora: Be thinking about it be thinking about how do you think you can tell somebody else about this really great flower that you found
33. Reid: Let's go!
34. Researcher: Lavender what did you do? Tell her!
35. (*Lavender whispers to Danica*)
36. Corey: Every once in a while come back to the hive
37. Flora: Also Lavender is already sharing with another bee friend about a flower that she found
38. (*Students quietly gather nectar and walk back to the hive*)
39. Researcher: I see a lot of bees getting nectar and going back to the hive and keeping it to themselves. I don't see anyone telling others.
40. Flora: Ye::s
41. Ash: There's a lot of good flowers! Buzz buzz buzz buzz
42. (*Rosemary tells Corey about a flower*)
43. (*Cypress tells Danica about a yellow and blue flower and points to the screen*)
44. (*Students are quietly gathering nectar again*)
45. Flora: I see some bees talking to each other
46. Reid: Ash that **purple** one right there
47. Ash: I can't see myself
48. (*Students quietly fill up their hive*)

Transcript 10.

A major difference between the play activity in this episode is Corey's unguided and dramatic enactment of a guard bee. For the first time, we saw students engage in play unrelated to Flora's overarching question (Transcript 10, Lines 29-31). In earlier episodes, students' interactions and talk were focused on gathering nectar for the hive. However, in this play activity we saw Corey engaged in play unrelated to Flora's overarching lesson goals. While Flora was in the space co-playing as a bee, she continued to remind students of their job, "be thinking about how do you think you can tell somebody else about this really great flower that you found" (Transcript 10, Line 32). Despite the guidance provided by the adults in the room (Flora and myself), Corey took on the role of a guard bee on his own. He maintained his role as the guard bee throughout the play activity and stayed near the hive. Instead of following the given instruction to think about how to communicate flower locations, Corey remained in the hive and gave permission to Reid to enter (Transcript 10, Lines 30-31). This kind of unscripted and

unguided play aligns closely with typical interactions in play. As a result, Corey's interactions with Reid had little resemblance to typical classroom participation structure. While Flora continued to focus on the question, Corey was not engaged in her inquiry; instead he engaged in moments of free play disconnected from the lesson goals.

The lack of engagement in this round of inquiry is also different in comparison to earlier episodes. While students remained interested in role-playing as bees by gathering nectar for the hive, they were not engaged in playing to answer Flora's prompt. As a result, the researcher (myself) and Flora made several comments during play. These comments aligned with the lesson goals and tried to highlight and shift students' play activity towards discovering and sharing ideas about how bees could communicate flower location. The lack of engagement and interest in answering Flora's question prompted the adults to continuously ask questions and comment during play. Within one minute of play, the adults in the room interjected five times (Transcript 10, Lines 32, 34, 37, 39, 45) to shape and highlight student activity in the space. The lack of evidence that students were engaged in answering Flora's question led to these adult-driven interruptions. After Flora reminded students to think about how to communicate flower locations, the researcher (myself) further attempted to achieve this goal by saying to Lavender, "tell you friend about the flower you found!". Although a few students did respond to these prompts and requests (Transcript 10, Lines 35, 41, 42, 43, 46), it did not spread to the collective body of students in the space. Even after Flora highlighted students' actions to tell other bees, "I see some bees talking to each other" (Transcript 10, Line 45), the majority of students in the play space didn't participate in exploration of how bees could communicate or tell one another about different flowers. Instead, students continued to quietly gather nectar for the hive. To engage students in her inquiry, Flora paused play and re-organized the class. The following transcript

was the discussion that was prompted by Flora due to a lack of student engagement in the lesson goals.

49. Flora: What I want you to think about it right now is I noticed a lot of you were moving around filling~the~tank *yes* that's *important* but right now we're thinking about how can *we sha::re* with our other bee friends where we found it? So one thing I want to point out is do you see the sun at the top (*Flora points at the sun on the screen*).
50. Student: Talk
51. Students: Yea
52. Flora: And the hive down below (*Flora points to the hive on the screen*). Do you think you can use those to tell other *bees* where the flowers that you found?

Transcript 11.

In reaction to students' engagement during play, Flora paused the class and began a conversation to reorganize play activity. She stated that although gathering nectar was important, students needed to start thinking about how to share the location of flowers. (Transcript 11, Line 49). For the first time, Flora acknowledged the misalignment. Perhaps to promote alignment, she pointed out resources within the play area, including the sun and the hive, which could be used for telling other bees where flowers can be found (Transcript 11, Line 52). By pointing out the sun and hive, Flora gave clues about the kinds of response and thinking she wanted students to practice. Therefore, the misalignment of goals, when students shared their concern about crowding around flowers, impacted the students' interactions and discourse in the play activity. The lack of students playing to answer her question led the adults to interject during play. This in turn led Flora to specifically point out the sun and the hive to provide further directions and clues about the answer to her question.

In comparison to previous episodes of this lesson, this is the first time Flora (or any other adult) commented during play in order to engage students with the problem or question at hand. While Flora had previously used role-play to direct and highlight lesson goals, she never needed to re-articulate her question due to a lack of student engagement. However, Flora and the

researcher continued to interject play when students in this episode quietly collected nectar and displayed a lack of engagement in answering the overarching question. As it continued to remain clear that students were not interested in thinking about how bees communicate with one another, Flora paused the play activity and started to re-organize and re-articulate the goals.

Episode Four: Conclusion of Lesson

After pointing out the sun and the hive as possible solutions to her prompt, Flora gathered the students in the discussion space to try the play activity one last time. Before sending the students back into the play space, Flora took the time to re-organize the class in order to engage students with the overarching question of how bees communicate. Just as she did in *episode two*, Flora established clear rules to guide and organize students into discovering and articulating scientific ideas.

1. Flora: You are going to listen very carefully you are going to find a flower that has the nectar the best nectar that you want and you are going to bring in a friend that's sitting down to find that flower. You're not going to go and take them there you're going to (0.2)
2. Cypress: It's like guessing
3. Flora: Tell them. But how do you think bees tell each other?
4. Students: Dancing::
5. Flora: So you think that the bees
6. Reid: It's sort of like a dance
7. Flora: Bees have a dance?
8. (*Corey is wiggling back and forth in the back*)
9. Reid: It's kind of like a sign language
10. Flora: Oh:: so did everybody hear what Reid said? So Reid said that the he has some background knowledge that the bees have a dance it's kinda like sign language but they don't use their hands but what do they use?

11. Reid: Their bodies
12. Ash: Their feet
13. Flora: Their bodies so: let's try that out

Transcript 12.

In the short discussion before entering the play space, Flora re-established the purpose of play by articulating the goals and actions of bee behavior for this round of inquiry. First, she

requested students to “listen very carefully”, then “you are going to find a flower that has the nectar the best nectar”, then “you are going to bring in a friend”, but “you’re not going to go and take them there” (Transcript 12, Line 1). However, as Flora focused on clarifying and establishing the rules of play, Reid answered Flora’s question, “But how do you think bees tell each other?” (Transcript 12, Line 3-9). Reid’s response was not only scientifically accurate but met Flora’s lesson goal. The reason why the sun and the hive are important resources for bees is because they are the components of the waggle dance. When bees perform a waggle dance in the hive, they communicate the distance, direction, and quality of nectar by vibrating and moving their bodies. When bees dance, they use the sun and hive to orient and communicate distance in the hive. For this reason, Flora focused on the importance of the sun and the hive in the last half of this lesson. When Reid shared his background knowledge, he described the dance as a form of sign language. Since this was not the immediate goal at this point in the lesson, thinking through the waggle dance as a form of sign language wasn’t discussed further. Although Flora acknowledged the dance and spent time questioning and asking about it, the concept wasn’t furthered or organized to test in play. Instead, Flora went back to focusing play on articulating the need for the sun and hive as communicative resources. Following discussion, Flora divided the class in half and instructed the bees to find flowers and share locations to students sitting and waiting in the hive.

14. *(Rosemary, Trevor, Danica, Ash, Reid, and Lavender go in the space. Flora is standing in the back)*

15. *(Reid and Ash finds a flower)*

16. Reid: I found a three heart flower

17. *(Rosemary, Trevor, Danica, and Lavender are quietly gathering nectar for the hive)*

18. *(Ash goes to Cypress to share where he found a flower)*

19. Flora: How are you going to tell him.

20. Ash *(Ash points at the screen for Cypress)*: It's up there

21. Flora: You're not going to take him there so what can you do?

22. Ash: Up in the sun *(Ash runs to the flower in the corner and Cypress follows)*

23. Flora: Ash remember we're not going to take them there you have to describe it to him

- or how are you going to communicate?
24. *(Rosemary, Trevor, Danica, and Lavender are quietly gathering nectar for the hive)*
 25. *(Students waiting in the hive are yelling out that bees are filling up with nectar and need to go back to the hive)*
 26. Corey: Cypress you have to go back
 27. Cypress: No but Ash told me where the flower is
 28. Corey: You still can't bring him there
 29. *(Ash is singing that he is filling up)*
 30. Flora: You're supposed to find flowers and communicate with them and how are you going to communicate with them. So once you find a flower please make sure you come back and bring in another bee.
 31. *(Lavender goes to the back and takes Briar to a flower)*
 32. Reid: ASTER! Come I found a flower.
 33. *(Students are now taking other students into the space and bringing them to flowers)*

Transcript 13.

At the start of play, students seemed to follow Flora's directions by walking back to the hive to share flower locations. For example, shortly after entering the space, Reid (Transcript 13, Line 15-16) announced he found a flower. Both Ash and Reid (Transcript 13, Line 18, 20, 32) went back to the awaiting students to share flower locations. However, when Flora set up the play activity, she made it clear that students needed not only to communicate flower locations to their friends, but to avoid taking them there. In both cases, Ash and Reid took their friends to the flowers in the space. Flora interjected when she saw Ash taking Cypress to the flower and reminded him, "You're not going to take him there so what can you do?" (Transcript 13, Line 21). Ash's second attempt to describe the flower location was "up in the sun" as he pointed and ran to the flower (Transcript 13, Line 22). However, Flora interjected again, "Ash remember we're not going to take them there you have to describe it to him" (Transcript 13, Line 23). Not only did Flora continue to interject during play, but she also reminded Ash to describe the location even after he stated that it was up in the sun.

In this moment, Ash developed a misalignment with Flora. Not only did we continue to see a majority of students quietly gathering nectar, but students also brought classmates to flowers by pointing or by physically bringing them into the space. From the students'

perspective, pointing and taking bees to different flowers was a successful strategy for collecting nectar. As Flora tried to engage students in thinking about alternative methods of communication, students didn't align or engage with her prompt because they already had a strategy they perceived as successful. As a result, despite the clarification and re-organization of activity, students continued to use strategies that worked for *them* in the space.

During the second half of play, students and Flora were regularly rotating from gathering nectar and bringing friends to flowers. However, while students were visibly following Flora's directions, they continued to quietly take and point to flower locations on the screen. During the second half of play, Flora also joined the students as fellow bee. She engaged in gathering nectar and shared her information with Corey. As the class continued to quietly walk back and forth, the Eagle swooped over a flower.

34. (*Eagle swoops in and kills a bee*)
35. Students: AH:::: I'm **dead**
36. Students: I'm not
37. Flora: Did you find it?
38. Students: OH NO THE EAGLE (*Students run to the back of the room*)
39. Corey: I'm going to the hive EVERYBODY GO BACK TO THE HIVE
40. Flora: But if we go back into the hive we're not going to be able to get the nectar
41. Reid: LET'S GO::
42. Ash: AH::
43. Flora: As bees we need to get the nectar
44. (*Students come back into the space and try to collect more nectar*)
45. Flora: We have to~that's we have to find the flowers and tell other bees
46. Iris: **Ah!** I'm dead again
47. Clover: I just came back to life
48. (*Students quietly get some nectar from flowers that are away from the Eagle*)
49. Clover: Am I dead or alive I don't know
50. Flora: Oh it's me Clover
51. Clover: You?
52. Flora: I died yes (*Flora walks to the back of the room*)

Transcript 14.

While the Eagle was designed to promote discussion and discovery around strategically avoiding flowers near predators, it actually served as counter space for Flora's students. What is

interesting about this moment in play is how quickly students' interactions shifted with the introduction of the Eagle. Prior to the Eagle, students in this episode played according to Flora's organized set of rules. They were rotating between groups by finding flowers and sharing their locations (see interactions in Transcript 13). The organized play interaction, as a result of Flora's guidance, was the typical form of participation in play for this class. When the Eagle came out, we saw several moments of students shouting and even running for the first time (Transcript 14, Line 35, 38, 41, 42). For Flora's students, the Eagle seemed to serve as a symbol for breaking out of teacher-guided play and gave students the opportunity to interact in free, unguided play interactions.

In the following transcript, Flora led a final discussion after play to discuss the communicative strategies of collecting nectar. This was the second play activity Flora organized in the hopes of students discovering and articulating the need for the sun and hive. However, students continued to share strategies that were successful to them during play. Flora continued the discussion, listening for students to indicate the resources aligned with the lesson goals.

53. Flora: So what did you do? *Besides pointing*, what other words did you use? Did anybody use any other words besides *pointing*?
54. Aster: They did to me c'mo:::n I found a flower
55. Flora: *Yea* but how did they tell you where it *was*?
56. Aster: He ta~he~made~me I followed him
57. Flora: O::h:: so
58. Aster: I told him if he's the one with the tank full then he said yea
59. Flora: Oh we were *not* supposed to take them there. Did anybody *USE* a strategy other than *pointing* to it to *tell* another bee how to get to that flower? Corey?
60. Corey: Danica just said it's that one in the corner
61. Flora: It's that one in the *corner* ok. (0.2) Ash?
62. Ash: I told Cypress it's the yellow one with the blue dot inside it
63. Flora: It's the
64. Reid: But there's two of them
65. Ash: There's *two* of them but they *both* (0.1) one has three hearts and one was two hearts
66. Flora: So how did you know which one to go to?
67. Cypress: Because I figured it out

68. Ash: Yea
69. Flora: Anybody else? Something different? Corey?
70. Corey: You told me be::: you pointed like bzz bzz bzz
71. Flora: Other than pointing? (0.3) Yes?
72. Iris: I said it's one of the yellow flowers
73. Flora: All right so you described [them
74. Cypress: [Oh right she said that to me
75. Flora: So (*Flora enters the space and points to the sun and hive on the screen*) so there are also so here I am the forager bee. [Oh no! (*Eagle kills Flora*)
76. Students: [Ah: you died
77. Corey: YOU HAVE TO GO BACK IN THE HIVE when you're dead
78. Flora: The:::re is also the **sun** does everybody notice the sun? [And the hive?
79. Corey: [Wait the sun can bring you back to life
80. Flora: So since there are two **listen** friends since there are two~we're~thinking~about~ways that **bees** can tell each other so since there are **two::: flowers** that are **both** yellow they **both** have the blue dot in the [center
81. Reid: [Left or right
82. Flora: They're both the same size **how** can we use **the sun and or** the hive to share with another bee. So we're focusing on my question how can we use the **sun or the hive and or** the hive to show what flower we want to go to? So let's **say** that I wanted to go to this flower here how would I communicate that using the sun or the hive?

Transcript 15.

Throughout this discussion, students continued to respond with strategies that didn't align with Flora's lesson plans and goals (Transcript 15, Line 54, 56, 58, 60, 62, 65, 67, 70, 72). When Flora asked students to share strategies, the first several turns of talk were students sharing versions of pointing and taking friends to flowers. In response to students' strategies, Flora continued to ask the class to share different ideas, "other than pointing?" (Transcript 15, Line 71).

Although Flora continued to hint and listen for specific answers to achieve the lesson goal, students continued to articulate strategies that worked for *them*. This led Flora to walk into the space to point out the sun and the hive again (Image 18). This was Flora's second time (See Transcript 11) where she pointed out the sun and the hive to give students clues to the types of responses she was looking for.



Image 18. Flora walks up to the screen to point out the sun and the hive

Once again, we see both the presence and effects of the misalignment of goals towards the ending of the episode. Not only did Flora begin the episode with the question of how bees communicated flower locations, but she re-organized the play activity with rules. She gave specific directions (to avoid directly taking bees to flowers) and hinted at specific resources to structure the play activity. However, this did not work as intended. Instead, students continued to point and take friends to different flowers.

More importantly, the misalignment of goals impacted the quality of the discussion. While discussion was typically used to help articulate and conclude ideas in earlier episodes—to retrospectively make sense of previous activity to give it meaning related to the lesson goals—Flora now had to spend a lot of time establishing rules during conversations in order to organize students to answer how bees communicated. For this reason, the final discussion of this lesson also lacked a deeper conversation around communication because Flora focused on reminding the students of the rules and achieving lesson goals. When students shared ideas that were not directly related to the lesson goals, Flora didn't take time to pursue or further explore them. She continuously *listened for* one particular strategy—using the hive and the sun as a resource for the waggle dance.

As the lesson came to an end, the final discussion in this episode fell short in culminating student ideas around using the sun and the hive to communicate flower locations. The misalignment of goals and Flora’s guiding move in listening for a specific response led students to disengage from her prompt. To the students, spreading out, pointing, and taking their friends to other flowers simply worked. For this reason, whenever Flora tried to inspire the use of the sun and hive, students didn’t buy into her given problem. Flora’s attempt to problematize and achieve lesson goals impacted students’ agency and their final discussion.

Conclusion of Chapter

In this chapter, I analyzed the structured play condition with a guided approach to inquiry. In addition to concluding my findings from this chapter, I also cross-referenced my findings with the group of students with film restrictions. To avoid confusion, I will call the group of students without film restrictions group 1, and the group of students with film and image restrictions group 2. Both of Flora’s groups had a total of four episodes in play lesson #2.

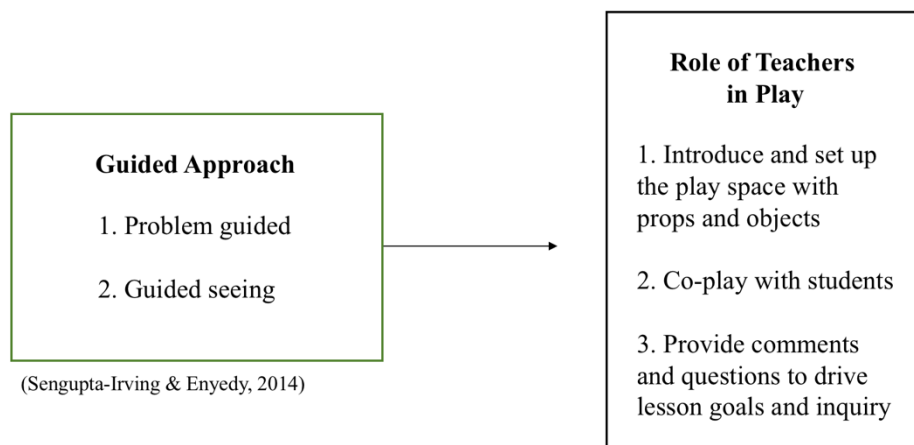


Figure 4. Analyzing teacher roles in a guided approach to play

For my conclusion, I used Sengupta-Irving & Enyedy’s (2014) principles of guided approach as well as the three roles of teachers in play that I detailed in my literature review

(Figure 4). The remainder of this chapter will summarize my findings and cross-reference my conclusions to group 2, the group of students with film restrictions (Table 2).

Table 2.
Flora’s Guided Approach in Play

Role of Teachers in Play	Flora’s Roles in a Guided Approach of Play
Introduce and set up the play space with props and objects	<ul style="list-style-type: none"> • Introduce play by using the documentation as a resource to organize students’ ideas • Uses props to prompt the goals of the lesson • Articulate the goals of play by clarifying the jobs of being a bee • Prompts the problem that students needed to think about during play
Co-play with students	<ul style="list-style-type: none"> • Co-play to help students make conclusions on scientific ideas
Provide comments and questions to drive lesson goals and inquiry	<ul style="list-style-type: none"> • Comments are made to re-articulate the goals of the lesson • Comments are made to highlight resources in the play space • Questions in play re-position student actions towards the goals of the lesson

Guided approach of introducing and setting up play. In the data presented in this chapter, Flora invited group 1 with overarching goals for students to achieve during play. When Flora invited the students into the space for the first time in *episode one*, she used the Bee-o-nator (hula hoop prop) to “transform” students into bees. However, she positioned the Bee-o-nator in group 1 as a tool to help students accomplish the goal of gathering nectar for the hive (Table 2). When Flora brought out the Bee-o-nator, she placed the prop in the space while stating the overarching goals of the activity. By connecting the prop to the overarching prompt of the

activity, the hula hoop became a tool that was used to transform students into bees with given problems and jobs. This caused students' discourse to remain focused on Flora's prompts, resulting in a lack of overlapping unguided discourse that we typically see in play.

Flora also used documentation (post-its) to organize and lead the conversation that took place before students played (Table 2). Throughout the introductory discussion, Flora continued to reference the documentation to clarify which strategy students were expected to test in the play space. When students offered modifications or variations of strategies, Flora referred back to the documentation to move the lesson forward. For example, in group 1, when Clover tried to suggest a strategy around the grey flower, Flora pointed to the documentation and stated that her idea was already tested.

Group 2. Similar to group 1, Flora used the hula hoop and documentation to introduce and prompt the students for play (Table 2). In group 2, Flora also brought out the hula hoop in the middle of her explanation of the play activity's goals.

“How do bees organize themselves to get to the flowers and get nectar? I'm going to repeat the question again so really if you don't understand what I'm saying I want you to raise your hand. So when you transform into a bee and you come into the space and you're thinking like a bee well. How am I going to get to the different flowers to get nectar? Do they only go to one big flower?” (Flora, *Episode One*, Group 2)

The introduction presented above took place in *episode one* during group 2's play lesson #2. Flora continuously used props in the play space across both groups to prompt and set up the overarching goals of the lesson. As a result, students discourse in group 2 also remained focused around the job of collecting nectar. The use of props and documentation were used across both groups to communicate to students the goals of playing as a bee. As part of my design, Flora gave students in both groups the problem to examine during play, which made the props and

documentation in the introduction a part of successfully answering her questions and carrying out their jobs in play.

Guided approach of co-playing with students. In addition to the use props and objects to structure play, Flora also co-played with students as the Queen Bee. In group 1, Flora used the role of the Queen Bee to illustrate the efficiency of the spreading out strategy (Table 2). As part of my guided approach design, Flora dramatically and purposefully pretended to be a busy Queen Bee as she made students wait in line to gather nectar. Flora made sure that she took her time sending forager bees into the play space so that students would compare and conclude that the Queen Bee strategy, or the centralized strategy was inefficient. The importance of this episode in group 1 was not only that Flora suggested the Queen Bee strategy, but that she used her role to guide students into making accurate conclusions. This meant that Flora not only gave students a problem, but she guided the students into seeing the conclusion she wanted them to articulate. As a result, students in play did not have agency over either the idea or how the Queen Bee was tested in play. Here, Flora guided seeing by using her role as Queen Bee to clearly illustrate the inefficiency of the centralized strategy of collecting nectar (Table 2).

Group 2. As mentioned earlier in this section, both groups 1 and 2 had a total of four episodes in this lesson. Part of the design of this lesson was to include a comparison between a centralized and dispersed strategy of collecting nectar. Due to our guided approach condition, Flora continued to co-play with students as the Queen Bee in group 2. Similar to my findings in group 1, Flora suggested a play activity to test the Queen Bee strategy. Once again, Flora took on the role of the Queen Bee and illustrated the inefficient nature of a centralized strategy due to the many jobs the Queen Bee had in the hive (Table 2). The effects of the guided approach to this lesson remained the same across both groups. Students in group 2 had a lack of agency when

Flora co-played with students in a role that aimed to make conclusions. This resulted in students engaging in a play activity that was organized to guide students to articulate a specific answer, that the Queen Bee strategy was not efficient.

Guided approach of providing comments and questions. Flora's guided approach also included a set of comments and questions that were used to remind students of the given problem (Table 2). In every episode of the lesson, Flora not only reminded students that they had a job to carry out as bees but commented on students' play to guide their actions. For example, in group 1, when Ash pointed to a flower for Cypress, Flora interjected and reminded him that he couldn't point or take Cypress to the flower. Flora's comments in play caused students' discourse and actions to remain focused on her prompts.

A result of Flora's role as a teacher in the guided approach condition was that there was a lack of student agency and exploration while playing as bees. This caused a misalignment between students and Flora to develop in episodes 3 & 4. Since the design of this lesson asked Flora to begin exploring the aspects of the waggle dance (sun and hive), Flora continued to prompt and guide students towards the articulation of this lesson goal. However, while Flora tried to prompt students with the question of how bees communicated, students were more engaged with the question of how to remedy the problem of crowding around flowers. As a result, play did not evolve with students' ideas. Instead, Flora worked hard to keep play on track from her pre-set lesson goals. In the end, Flora had to heavily hint and eventually give the answers (the sun and hive) to the students because they did not discover and articulate them within the guided play condition that was designed.

Group 2. Although Flora continued to provide guiding comments, questions, and prompts across both groups, a difference that I found was the lack of a misalignment between Flora and

students in group 2. In group 1, students were more focused on the issue of crowding around flowers. While group 2 had a variety of emerging problems, it didn't build over episodes and cause students to disengage from Flora's prompts. This was because Flora successfully redirected students in group 2 towards the pre-determined set of lesson goals within the guided approach condition. Unlike students in group 1 with the problem of crowding around flowers, students in group 2 did not have a collective emergent problem. As a result, individual students' ideas and problems did not spread to the rest of the class, making Flora's prompts, comments, and guiding questions successful in group 2.

Summary of student agency, engagement, and discussion. As a consequence of the guided approach design, the students in Flora's class had minimum opportunities to try student generated ideas and strategies. The guided approach to play focused students on the lesson goals in a way that left little room for students to connect, explore, and experience different strategies of collecting nectar. Instead of student agency, the guided approach caused students to narrowly focused play for the articulation of academic goals. In some parts of this condition, students were engaged in activities that looked more closely to classroom participation structures instead of playful ones.

In conclusion, Flora's guided approach to play seemed to impact students by influencing their agency, engagement, and conversations. In the moments Flora's guided approach seemed successful, students were aligned with Flora's goals and shared in her thinking. For example, when Flora introduced the first problem of how to best gather nectar, this was a relevant issue for students. Therefore, students in group 1 were engaged in finding the best strategy to collect nectar for the hive. However, when students and Flora were interested in different emergent problems, both engagement and discourse misaligned. Instead of making room to test students'

ideas and strategies, Flora often moved on from their ideas, leaving students to disengage with Flora's pre-determined prompt. We also saw evidence of this in *episode four* when Flora listened for students to articulate the sun and hive as resources for communication. When students didn't state the resources, Flora kept asking students for other ideas. As a result, in the final discussion, the majority of discourse was spent on Flora re-articulating the rules of play instead of making scientific conclusions.

Chapter 5. Lily: A Student-Led Approach to Learning through Play

In this chapter, I present my analysis and findings of Lily as she led play lesson #2 in a student-led approach to play. Similar to the previous chapter, I drew from the roles of the teacher in guided play as well as research on student-driven instruction (Sengupta-Irving & Enyedy, 2014). This chapter will examine how Lily's role in the student-led condition impacted the flow of activities, influenced students' interactions in play, and shaped discussions.

While each of Flora's episodes had clear goals, Lily's episodes were often iterative. Due to Lily's more open approach to play, students shaped goals and ideas as play progressed. For this reason, students had opportunities to test, revise, and re-test ideas across multiple episodes. Because of the repetitive nature of Lily's interactions with students, I do not present every episode that I have analyzed. Additionally, the last two episodes of this lesson were essentially one elongated conclusion to the lesson. According to my definition of where to draw boundaries around an episode, I do not consider the conclusion as only one episode. For this reason, I combined the last two episodes into one concluding section.

In this lesson, Lily organized play around students' emerging ideas. For this reason, she did not orient the students towards specific prompts or goals as they played. The lesson began with an open-ended prompt. After playing in the space, students made observations and came up with ideas to try in the space. The cycle of student-driven ideas led to more opportunities for students to test ideas during play, leading this class to engage in six episodes of play and discussion.

Episode One: Introduction of the Lesson & Bumping into Bees

While Flora led with guiding questions and strategies that aligned with the lesson goal, Lily began the first episode with an open-ended introduction that dramatically highlighted the

role of being a bee. Although the goals of the lesson remained the same across classrooms, Lily approached the lesson with a more open, student-driven plan. Throughout the lesson, Lily tested and explored strategies based on student observations, interactions, and ideas. In this episode, Lily opened the lesson with a brief review of the conclusions students made about both the technology and science content. Lily then proceeded to co-play with students in the tracking space as they gathered nectar from different flowers.

1. Lily: So bee::s
2. *(Students are making buzzing noises as they are sitting down and listening to Lily)*
3. Lily: **Now** we made it back to our **space**. Right? **We're back** and I hear some of you buzzing and running to go off into the space
4. *(Students make buzzing noises)*
5. Lily: JUST a couple of reminders know that when YOU are umm **out** right? Looking? A::nd what were you looking for last week?
6. Students: Honey::
7. Students: Nectar
8. Lily: **Nectar** right? A::nd where did that nectar come from?
9. Willow: From **there!** *(Willow points to the screen behind Lily)*
10. Lily: Fro:::m the **board?** *(Lily points behind her)*
11. Cedar: From the flowers
12. Willow: NO from~from flowers
13. Lily: FLOWERS?!

Transcript 16.

Although Lily focused her review on the bee's jobs of gathering nectar, she led the introduction by relying on students' experiences in role-play. First, because she hadn't used any of the post-its to document learning, Lily relied on students' recollections of their experiences in play from the previous day. Second, Lily acknowledged and embraced moments of role-play that fell outside of the typical classroom participation structure. Students made buzzing noises as they walked into the room and sat down (Transcript 16, Line 2, 4). Instead of asking students to listen and follow a turn-taking discussion, Lily built on these moments. When she brought the class together, she addressed the students as bees (Transcript 16, Line 1). Students then responded with a buzzing noise (Transcript 16, Line 2). Instead of asking students to refrain from making

noises, she accepted the buzzing as a valid form of engagement and participation, “and I hear some of you buzzing and running to go off into the space” (Transcript 16, Line 3).

Throughout the unit, Lily continued to embrace and build on these moments of dramatic role-play. As the introductory review continued, these kinds of interactions occurred several times between Lily and the students. Just as she had when students buzzed in the space, Lily acknowledged and encouraged these moments that helped students role-play as bees.

14. Lily: A::H::: *so* today as bees because I do want to get you out there. **Remember** we are collecting nectar right? Now *bees* just a couple of reminders once you're out in space just be respectful of each other. Remember to bubble up and also bee::: respectful I mean not respectful but remember that if you're laying down can the camera read where you're standing or where you're sitting or where you're laying down?
15. Students: No
16. Lily: No you have to be up!
17. Willow: But we're ALREADY bees
18. Lily: Well you *are* but NOW
19. Watson: No
20. Lily: We want you to be bees in this space here
21. Watson: No cause we're not we haven't gone through the bee-o-matic 6000 yet
22. Lily: Oh OH it's the bee-o-matic 6000 that's right
23. Cedar: Yea that's right
24. Rowan: Bee-o-matic 6000

Transcript 17.

For both Lily and the students, the ritual of transforming and playing as bees was an important part of the introduction of every lesson. Watson exclaimed, “No cause we’re not we haven’t gone through the bee-o-matic 6000 yet” (Transcript 27, Line 21). Therefore, the act of walking through the prop became an essential part of becoming bees and interacting in the space (Transcript 17, Line 22, 23, 24). Although the students knew walking through the hula hoop wouldn’t affect their ability to become a bee in the tracking space, it is interesting to note how much both Lily and the students made the prop as an essential part of entering play.

These moments of dramatically and joyfully becoming a bee continued throughout the introductory discussion of this episode. While readying students for play, Lily, who was sitting

down during discussion, stood up to send students into the space. As Lily stood, the technology tracked and assigned her a bee with some nectar. This was a technical glitch. At the start of the lesson, I forgot to refresh and restart the technology. As a result, when Lily got up, the cameras read her as a bee with some nectar. In the following transcript, students reacted to Lily's bee and directed her in the space.

25. Lily: Are you ready?
26. Watson: You're in there! You're in there Ms. Lily!
27. *(Students are yelling out that Lily has a bee in the space with nectar)*
28. Lily: You know what..
29. Willow: Go to the hive
30. Lily: SHOULD I GO TO THE HIVE?
31. Willow: YEESS!!
32. Watson: YES
33. Students: YES
34. Cedar: You just drop off your nectar
35. Lily: What am I taking to the hive?
36. Cedar: You dropped all of it. Woaaaa
37. Watson: You dropped off your nectar
38. Lily: I dropped all of my nectar good.
39. Cedar: Why is it good?
40. Lily: Why? Well are you ready to go look for more what?
41. Cedar: How are you supposed to find the flowers and nectar?
42. Lily: Yeaaa umm so
43. Watson: Yea how are you supposed to find flowers and nectar *(asking the researcher)?*
44. Lily: I need **help** I can't be the only one out there looking for nectar.
45. Researcher: How do bees find flowers and nectar *(responding to Watson)?*
46. Willow: MM::!
47. Lily: So whose going to help me find some **nectar**?
48. Willow: M::E::!!
49. Students: M::E::!!!
50. Lily: Ok are you ready? Let's go ahead and I'm going to start with Heath. Ready? Ready? **Bu:::zz::** Next Violet? **Bu::zz::**
51. Violet: I:::M:: SECO::N::D:::!!!
52. *(Lily continues to invite students into the space one at a time through the hula hoop)*

Transcript 18.

In the moments leading up to play, Lily's accidental bee (with a tank full of nectar) led to another moment of drama and joy in play. When students noticed that Lily's bee had nectar, she didn't try to explain or address the event as a technical glitch (Transcript 18, Line 27, 28, 29, 30). Instead, she played along as students directed her to go to the hive. Lily matched students' tone

and dramatically asked, “SHOULD I GO TO THE HIVE?” (Transcript 18, Line 30). She then walked over to the hive and dropped off her nectar. Here, we saw another moment where Lily acknowledged an opportunity to build and joyfully and dramatically follow students’ excitement over play. In the buzzing of the students as they walked into the room, the necessity of walking through the bee-o-matic 6000, and Lily dropping off her nectar, Lily continuously matched the excited and dramatic tone students displayed throughout discussion. She also further acknowledged the importance of transforming into a bee by making “Buzz” noises for each and every student who walked through the bee-o-matic 6000 (Image 19; Transcript 18, Lines 50-52).

What is different about Lily’s interactions is how students were invited into the play space. Rather than focusing students’ actions to guide their thinking and discovery of science content, Lily provided minimal structure and guidance as students turned into bees. Cedar questioned and asked, “How are you supposed to find the flowers and nectar?” (Transcript 18, Line 41). However, when Lily answered she left the goal of the play activity open for students to develop on their own. Her reply was an open-ended objective to come into the space as bees to help find the flowers (Transcript 18, Line 44, 47). The following transcript occurred as students entered the play space.



Image 19. Students are “buzzed” into the play space one at a time by Lily

53. *(Violet, Heath, Bluebell, Lilac, Jasmine, and Poppy are walking in the space trying to find flowers as Lily "Buzz" students in one at a time)*
54. *(Violet walks around and finds the first flower in play)*
55. Violet: WAIT WAIT WHERE WHERE WHERE WHERE WHERE
56. *(Violet lands on the yellow flower)*
57. Cedar: THERE! THERE! THERE'S A FLOWER RIGHT THERE
58. Watson: IT'S LARGE:::::
59. Cedar: You have to go to places and find the flowers then they'll appear.
60. *(Lily is still buzzing each student into the space one at a time)*
61. Cedar: VIOLET YOU'RE FULL GO BACK TO THE HIVE
62. Lily: HELP! We need your help!

Transcript 19.

While Lily continued to invite students to walk through the bee-o-matic 6000, “HELP! We need your help!” (Transcript 19, Line 62), students in play began to walk around the empty field looking for flowers. Since Lily didn’t give specific directions on how to collect nectar, the students in the space walked around freely. As a result, students in Lily’s class walked around the play space with little guidance. As Cedar pointed out at the end of discussion, “How are you supposed to find the flowers and nectar?” (Transcript 18, Line 41). However, when Violet found the first flower in play, students were excited about the discovery. First, Violet yelled, “WAIT WAIT WHERE WHERE WHERE WHERE WHERE WHERE” (Transcript 19, Line 55). When Violet landed on the yellow flower, Cedar, who was waiting in the back, yelled out, “THERE! THERE! THERE’S A FLOWER RIGHT THERE” (Transcript 19, Line 57).

The discovery of flowers and the realization of how to gather nectar as bees was met with excitement by students. Instead of providing a specific strategy to test in play, Lily invited students by asking for help with gathering nectar. The overarching prompt was general, and it built on the excited students as they wondered how to find nectar and flowers by calling for help. Once the students discovered *how* to find flowers, they began to walk around the space looking for more.

After sending each student through the bee-o-matic 6000, Lily entered the space as a bee to help look for flowers and gather nectar. While Lily and the students played in the space, the familiar issue of crowding around flowers emerged.

63. Violet: SOMEBODY BUMPED INTO ME:.....!
64. *(Students are walking around find flowers)*
65. *(Lily and all students are in the space)*
66. Lily: Woa:::
67. Ren: Where am I
68. Lily: So what are we getting?
69. Willow: Jump on the hive!
70. *(Lily is at the yellow flower collecting nectar)*
71. Violet: Somebody bumped into me where am I?
72. Violet: Wait I wanna see me. Can I see myself?
73. Bluebell: DAR::N:: it
74. *(Students are talking over one another at once about not seeing themselves)*
75. Cedar: I can't get how to get
76. Violet: Whose got
77. Ren: I found myself! GO UP TO THE FA:.....LOWE:.....R
78. Lily: So which one are you going to Ren?
79. Ren: The flo::wer!
80. Lily: Which one?
81. Ren: Either I don't care
82. Lily: It doesn't matter?
83. Ren: NO! FLOWE:::R!!!
84. Violet: Ughh that wasn't me:::
85. Watson: Stop pushing me

Transcript 20.

When Lily began playing with students, she maintained a minimally guiding role as she helped collect nectar for the hive. First, Lily solidified her role as a fellow bee by following students in the space as they collectively gathered nectar for the hive. Once Lily entered the space, she shared students' excitement and said, "Woaaaa" (Transcript 20, Line 66). She then proceeded to collect nectar from the yellow flower that Violet first discovered and dropped it off at the hive (Transcript 20, Line 70).

In addition to gathering nectar alongside the students, Lily also asked students questions about their activity while playing in the space. These questions prompted students to voice and share their actions as bees. What is interesting about this participation structure is that students

continued to have agency despite Lily asking the questions. When Lily asked the class, “So what are we getting?” (Transcript 20, Line 68), students didn’t respond to her question. Instead of repeating her question or pausing play, Lily continued to collect nectar from the yellow flower. She also asked Ren, “So which one are you going to Ren?” (Transcript 20, Line 78). Ren answered that he was going to the flower (Transcript 20, Line 79), which led Lily to ask, “Which one?” (Transcript 20, Line 80). Ren responded, “Either I don’t care”. Lily then asked, “It doesn’t matter?” (Transcript 20, Line 82). What is important about this moment is how Lily asked questions to hear about students’ actions as bees. She didn’t ask Ren to meet a lesson goal by describing a strategy of collecting nectar or expanding on why it didn’t matter which flower he went to. Instead, Lily asked Ren to explain what he was doing and didn’t further engage or question him. She continued to co-play with students and provide space for them to discover and play on their own.

As play continued, students ran into a problem while gathering nectar from the flowers. Just like in Flora’s class, students found themselves bumping into one another while trying to collect nectar. Violet repeatedly stated that someone bumped into her (Transcript 20, Lines 63, 71) while Watson stated, “stop pushing me” (Transcript 20, Line 85). This concern caused students to approach Lily during play to share and discuss a solution.

These side conversations were a re-occurring and common phenomenon throughout all of Lily’s lessons. Perhaps because Lily was often in the play space, she was visibly and physically available for spontaneous conversation. What is interesting about these side conversations is how rich and reflective they are. Side bar conversations were student-initiated and led to observations, questions, and ideas being shared with Lily. This episode’s side bar conversation took place at the same time as the remaining ten students were playing in the space (Image 20). As a result, I

often found myself unable to hear the full discourse while the other students joyfully and loudly gathered nectar in the background. The following transcription captures how the side conversation in this episode began.



Image 20. Students approach Lily in side bar conversations during play

86. Bluebell: There's too much people
 87. Violet: **Where** am I?
 88. Lily: There's too many people **where** Bluebell?
 89. *(Bluebell approaches Lily and they are engaged in a private side conversation)*
 90. Bluebell: There's too much people we keep bumping into each other from behind
 91. Lily: What do you think we should do? Ohh You mean in terms of [inaudible because students are all talking]
 92. *(Heath joins the side conversation while the remainder of the class continue to gather nectar)*
 93. Willow: MINE~MINE~MINE'S FULL
 94. *(Heath is sharing an idea to Lily in the side conversation)*
 95. Watson: I'm going back to the hive!
 96. *(Lily is still engaged in the side conversation with Bluebell and Heath)*
 97. Violet: Down down down no this way
 100. Lily: AAHHH that's an idea so going along with what Bluebell said
 101. Violet: DEE DEE DEE DEE DUP DUP DUP DUP (0.1) DUP DUP DUP Hu:::h
 huuuuu
 102. Lily: **BEES** Bluebell has an idea she said why won't we separate into groups *(breaks from the side conversation)?*
 103. Willow: YE::A:::
 104. Lily: And do **what** in groups Bluebell?
 105. Bluebell: Umm [inaudible because students are talking over one another]
 106. Lily: Collect **honey**? Or what are we collecting? Nectar!
 107. Bluebell: Nectar
 108. Lily: So into how many groups or how should we divide ourselves? Two groups?
 What is that one group going to do?

109. (*Lily is now engaged in a side conversation with Ren, Bluebell, and Willow. They are talking about how to divide into groups*)

110. (*Meanwhile the other students are still gathering nectar and bringing it back to the hive*)

Transcript 21.

In the last few minutes of interacting in the play space, three students (Bluebell, Ren, and Heath) approached Lily to discuss the collective problem of crowding around flowers (Transcript 21, Line 89, 92, 109). We already saw several students, including Violet and Watson, having trouble in the space due to the crowded nature of the activity (See Transcript 20). As a result, a side conversation began with Lily. Here, we saw students make the discovery that there was a need for some sort of solution to prevent bees from running into one other while collecting nectar. While Bluebell was the first student to express this concern (Transcript 20, Line 86), both Ren and Heath eventually joined the conversation (Transcript 20, Line 92, 94, 109). Since the majority of the class continued to loudly gather nectar for the hive, several moments of the side conversation were inaudible. However, in the few turns when discourse was clearly heard, Ren, Bluebell, and Lily talked about dividing into groups in order to avoid bumping into one another. The significance of this interaction is what Lily did after engaging in the side conversation. When it was clear that an idea was formed, she announced and shared it to the rest of the class. In the following transcript, Lily paused play and began a discussion.

111. Lily: So Bluebell had an idea. Bluebell was thinking~Bluebell aaand Heath were thinking that you should divide into four groups
112. Ren: *I* thought that we should go into four groups
113. Lily: And ohh Ren thank you Ren so it was actually Ren, Heath, and Bluebell
114. Willow: Because there were four flowers every single person
115. Lily: So every group is gonna choose one flower to go to?
116. Students: No
117. Lily: Hmm
118. Willow: Maybe it's four~four maybe divide into four *persons* and then every person could go to a flower
119. Bluebell: No that won't be a good idea
120. Lily: Why?
121. Bluebell: Because we would literally be like oh which flower am I going to where it'll get too *crowded* there

122. *(Students all talk over another)*
123. Lily: What about? Violet?
124. Lily: Cedar come listen to our ideas. Yes?
125. Violet: What about we split our bees in half and then one could go
126. Cedar: THERE I AM
127. Violet: And then we send three or four people out and then we send and there they can only collect nectar once and come back to the hive and then we'll send out FOUR out again
128. Lily: Ahhh so shall we try that?
129. Cedar: YEA YEA YEA YEA YEA
130. Lily: Allright sooo still in groups aaaaand we're going to go **out** they're going to
131. Willow: Just ONE time?
132. Lily: Well Violet, they're gonna collect nectar and bring it in so does that mean only four bees will collect nectar?
133. Violet: And then you have another group come out
134. Ren: But you can only collect one time
135. Violet: Yea
136. Cedar: Only collect one time
137. Violet: But that would be
138. Willow: But that's not gonna be that more
139. *(Inaudible because students are all overlapping talk about sending bees out to the four flowers)*
140. Watson: Because that *(Watson walks up to the screen and points)* there isn't four flowers because that one up there is telling you go on it turns purple which means it's (0.2) out of nectar
141. Lily: Aahhh so some flowers are running out of nectar?
142. Students: Yea

Transcript 22.

By the time Lily shared the side conversation with the rest of the class, students had already achieved one of the lesson goals. Bluebell's idea to divide into groups was not only accepted by the rest of the class but was a consequence of crowding and bumping into one other in the space (Transcript 22, Line 111). As a result, the students concluded that they needed to come up with an organized system (of splitting into groups) to collect nectar. Not only was the idea that students needed a system for collecting nectar accepted, but students built and argued over how to split into groups. When Lily introduced the idea, Willow first suggested dividing into four groups (Transcript 22, Line 118). However, Bluebell interjected and went against Willow's idea, explaining that "we would literally be like oh which flower am I going to where it'll get too **crowded** there" (Transcript 22, Line 121). The importance of this discussion is that

although only a few students began thinking about the solution to the problem of crowding around flowers, Lily's role in sharing student ideas led to a longer and rich discussion that built and planned for the strategy of dividing into groups.

Throughout the episode, both Lily and the students were joyfully and dramatically engaged in play as bees. However, even with the dramatic tone and minimal guidance, students still discovered how to find flowers, identified a problem, and came up with ideas on how to solve it. Since Lily didn't begin the lesson with a specific question or strategy in mind (See Transcript 17, 18), students took time to play in the space and experienced and discovered a problem on their own. In other words, students entered the space with Lily's open-ended introduction and co-discovered the problem of crowding around flowers and bumping into one another. Because of this, students in the first episode were able to conclude on their own, in the first episode, that a strategy for collecting nectar was needed. While this was a technological limitation in the design of the curriculum, the lack of flowers led to a longer conversation about the need for organization. We saw this when Bluebell, Heath, and Ren gathered around Lily to voice their concern and come up with a plan to divide into groups. After listening to the three students, Lily wrapped up her side-bar conversation with Bluebell, Ren, and Heath to share their ideas with the rest of the class.

Episode Two: Dividing into Groups

In the second episode of the lesson, Lily organized the class to test the idea of splitting into groups. Although she maintained her role as a co-player, she began to connect students' ideas with the larger lesson goals. However, despite Lily providing more guidance, students still maintained their agency throughout play. The second episode began with Lily organizing and dividing the class into groups. After dividing the class, students began a play activity to test how

well groups remedied the problem of bumping into one another. The importance of this episode is not only how students' ideas shaped the lesson, but how Lily provided guidance to achieve lesson goals without impacting students' agency.

1. Lily: So why won't we do this. Why won't we divide ourselves into **groups** and we'll try one of those strategies out just like we do for math. Could we be (0.1) could it **work**? ┌ Possibly?
└ Or one at a time
2. Cedar:
3. Lily: Would we have to refine? **Probably.**
4. Lily: But wait you can stand up because you're all going to be in your **groups**
5. Ren: I know I'm tired
6. Lily: How many are we here today Cedar? We're 16 in the space? Let's number ourselves out ready? *(Lily then counts each student out loud)*
7. Lily: So we're fourteen **I'll** join one of the groups. So we're **fourteen** if we need to separate into **two** groups how many friends are there in each groups?
8. Cedar: Four~Five. Five and four
9. Lily: Five and four?
10. Cedar: Two 5s and one 4
11. *(Lily then divides the class in half. She places group 1 at the side of the room and group 2 at the back of the room)*
12. Lily: All right so NOW what do we do? Bluebell?
13. Bluebell: We go in and play and see which one goes first
14. Lily: So **this** group what flowers are you going to? *(Lily points to the first group)*
15. Ren: Uhh all of them
16. Watson: Uhh The big one
17. Lily: So you're just going to the **big** flowers?
18. Students: No:::
19. Bluebell: We take turns like
20. Lily: Oh so one person goes in at a time
21. Bluebell: No we take turns like one group goes first get nectar
22. Ren: WE GO FIRST
23. Cedar: We go first
24. Lily: Bluebell if your group comes first to collect nectar~well why won't we try it ok so **this** group we're going to go ahead and step out. We're going to give them the opportunity to collect nectar and we'll see the most efficient way.

Transcript 23.

In this discussion, Lily not only valued Bluebell's idea, but she *listened to the students* even if she didn't know if the idea would be completely successful. Not only did she mention that the students would probably need to refine their strategy, but there was a moment of disconnect towards the end of discussion (Transcript 23, Line 24). Lily originally thought the students wanted different groups to go to different flowers at the same time. For example, one

group would be assigned to the blue flower while the second group was assigned to the yellow flower. However, Bluebell corrected Lily and stated, “no we take turns like one group goes first then comes back” (Transcript 23, Line 21). It is unclear if Lily agreed or thought Bluebell’s idea would be an efficient strategy for collecting nectar, “Bluebell if your group comes first to collect nectar~well why won't we try it ok” (Transcript 23, Line 24). However, Lily decided to follow Bluebell’s idea and invited the first group to enter the play space while the second group waited for their turn, “We’re going to give them the opportunity to collect nectar and we’ll see the most efficient way” (Transcript 23, Line 24).

Although Lily went along with Bluebell’s idea and took the time to organize the class around this strategy, she also began to insert an agenda. Not only did Lily state that they would need to refine this idea (Transcript 23, Line 3), but she established the overarching goal of finding the most *efficient* way to collect nectar (Transcript 23, Line 24). Lily balanced the importance of students’ voice as well as the larger goals of the lesson to discover which strategy was most efficient and robust.

In the second episode’s play activity, students entered as bees in groups to gather nectar from flowers. The play activity began with the first group looking for nectar before the second group was invited to enter. Although Bluebell and Lily agreed to try the strategy of taking turns in order to find nectar, Lily did not heavily regulate this rule and the play activity eventually ended with all the students in the space gathering nectar. For the amount of time Lily spent counting and organizing students into groups, she didn’t pause or re-phrase the goals of the activity.

To clearly illustrate the variety of student interactions in the space, the discourse from students in group 1, who were playing in the space, is written in blue font.



Image 21. Students split into groups as a solution for crowding around flowers

25. *(Group 1 is in the space while Lily and group 2 are watching from the back of the room)*
26. Cedar: There's a flower that's already out of nectar
27. *(Group 1 is still collecting nectar and bringing it to the hive)*
28. Cedar: My bee wings will not fly Ms. Lily look
29. *(Cedar is playing with his bee wing costume as he is sitting down)*
30. Cedar: Ms. Lily! *(points to screen)* you were collecting nectar
31. *(Students from group 1 are still walking back and forth collecting nectar for the hive)*
32. Lily: Why won't we have (0.2) they're collecting nectar so what do you think? Should we try helping them collect some nectar?
33. Students: Me!!
34. Cedar: Me! I wanna go
35. *(Lily enters the play space and asks the first group in the next line)*
36. Lily: Can we help you collect some nectar?
37. Students: No::
38. *(Lily goes back to group 2)*
39. *(Students are talking over one another as they collect nectar)*
40. *(Juniper has a side conversation with Lily)*
41. Lily: A::hh
42. Willow: Can I go?
43. Violet: BEE::::
44. Willow: Can I go?
45. *(Some students from group 2 are now in play. There is a lot of overlapping talk in play)*
46. *(Juniper is still in a side conversation with Lily)*
47. Watson: THE HIVE IS FULL THE HIVE IS FULL
48. *(Lilac, who was in the first group stops playing and goes to Lily)*
49. *(Lilac, Juniper, and Willow are now in a side conversation with Lily)*
50. *(Cedar is playing with his wings by himself in the back of the room)*
51. Violet: BEE BEE BEE BEE BEEEE BEE BEE BEE BEE BEE UU:::::HH::::::::::
52. *(Most of the students are now in play and are all talking over another)*
53. *(A few of the group 2 students are still sitting while Lily is still in the side conversation with Lilac, Juniper, and Willow)*
54. Lily: So why won't we have this group *(points to the remaining students waiting)* stand up why won't we go and help them collect some nectar?

Transcript 24.

Although the class established the rules of the play activity (for one group to go first before the second group received a turn), Lily didn't follow through with the plans made during discussion. While the first group gathered nectar in the space, the second group sat down in the hive and watched. Lily, who was standing in the back with the second group, also observed the first group as they collected nectar (Image 21). When students from the second group began to ask if they could go into the space, Lily finally invited the rest of the class to gather nectar. However, what is crucial about this moment is that Lily did not organize or direct students according to Bluebell's plan. Although the strategy was to take turns, Lily didn't follow and enforce the rules that were discussed. Instead, when the second group entered the space, Lily didn't ask the first group to come back into the hive (Transcript 24, Line 55). Thus, the turn taking aspect of the strategy was not enforced. This is interesting given that part of the reason why students wanted to split into groups was because of the crowding in the space. In the end, when the second group joined to collect nectar, all students were together in the space again.

This episode ended shortly after students and Lily joined group 1 in play. As we also saw in *episode one*, students continued to engage in side conversations with Lily that marked the ending of play as she shared students' ideas and observations (Transcript 24, Line 41, 47, 50, 54). Similarly, the ending to this episode came quickly after a side conversation took place. After all students and Lily started to collect nectar in play, Juniper approached Lily and pointed out the flowers that were running out of nectar. This led Lily to stop play, and announce Juniper's observation of the flowers without nectar to the class, concluding this episode.

Episode Three: Looking for a Sign

As she had done in the previous two episodes, Lily gave space for students to share and listen to ideas. She did this by providing minimal guidance, engaging in side conversations with

students during play, sharing students' ideas by announcing them to the class, and helping organize student ideas during discussion. It is also important to note how Lily guided and shaped students' thinking towards the lesson goals. In *episode one*, she began the lesson with an open-ended agenda for the play activity. The goal of the play activity was to help find flowers and collect nectar. Towards the end of *episode one*, Lily began to use students' observations to highlight and shape future interactions. When Bluebell stated that they were too crowded, Lily shared Bluebell's observation, which initiated the second episode of splitting into groups. Once again, towards the end of the last episode, Juniper approached Lily and shared her observation about the purple flower running out of nectar. As part of our design, when flowers ran out of nectar they turned a translucent purple color. The students in Flora's class perceived the color as "grey" while students in Lily's class called it "purple".

In this episode, Lily used students' actions and observations to further inquire and build towards the lesson goals. Although Lily increasingly inserted lesson goals in the remainder of the lesson, they were always built from students' ideas and actions in play. Lily also used students' ideas for play regardless of how productive they were in achieving the lesson goals. As we saw in *episode two*, Lily displayed a moment of hesitation over Bluebell's idea. However, she quickly stated that they would still try her idea and possibly refine it.

In the following transcript, Lily began the episode with a discussion around students' ideas. The discussion that took place after the end of *episode two* focused on why flowers ran out of nectar and what to do once students found a flower in the space. Violet suggested that they refrain from moving around and stand still on a flower until the nectar was collected. Violet also proposed that students should only move away from the flower once the bee tank was filled with

nectar. Lily tried to initiate another play activity around Violet's idea. However, Watson soon added to the conversation and asked why Bluebell had lost her nectar when he bumped into her.

1. Lily: **We're** going to try to look for flowers that have **nectar** and once you find that flower you're going to **stand** there without **moving** and Violet is trying to say if~that's we're trying to figure out if that's a **quicker** way of finding nectar Violet?
2. Violet: Yes
3. Lily: Ok so you're standing on a flower without moving. Watson? (*Watson has his hand up in front of Lily*)
4. Watson: I have a question. Why every time like say I'm umm walking around trying to get to a flower and Bluebell was coming back to the hive and then I accidentally bump into her bee then why cause she loses all her nectar in the like I walk I accidentally bump into her and then she loses all her nectar.
5. Lily: Did that happen?
6. (*Students all talk at once*)
7. Watson: I bumped~I~bumped into her tank
8. Lily: So Watson what can we do to **ensure** that a bee that's full of nectar doesn't move his nectar?
9. Watson: So they don't bump into anything **and** another thing is **I** always stay to the side because the researcher said the Eagle is gonna come and surprise I always stay to the side but the Eagle
10. Lily: If you stay to the **side** are you collecting any nectar if you stay on the side?
11. Watson: Because like this flower is on this spot (*Watson shows the flower on the side*)
12. Lily: Ok here's we heard a couple of strategies one we're going to go out into space and we're going to collect nectar from the flowers that **still** has nectar Violet said we're going to stand still whenever we find a flower that still has nectar you're going to **stay** there without moving and then you're going to take that nectar back to the hive BUT Watson said when we're taking the nectar back to the hive what does everyone else have to do Watson?

Transcript 25.

We see in the opening of this episode that Lily continued to use conversations to organize student-driven ideas that could be tested during play. Although Violet shared her ideas on finding flowers, Watson also had an opportunity to share his experience, turning it into an idea to test in play (Transcript 25, Line 4, 9, 11). These two student-driven ideas (standing still on flowers and avoiding bumping into one another) did not explicitly move towards the lesson goal of discovering the need for a dispersed communicative system of collecting nectar. However, Lily continued to give students space in discussions to contribute and suggest testable ideas in play.

In the play activity that followed discussion, students continued to engage in playful and joyful discourse while Lily observed students as a co-player. Although the activity was supposed to focus on trying Watson and Violet's strategies, Lily didn't remind students of these rules. Once again, instead of enforcing and regulating the two ideas from discussion, Lily continued to interact and co-play as a bee while gathering nectar. She also maintained her minimally guiding role as she occasionally made observations and asked students what they were doing instead of reminding them of the assigned task.

13. *(Students are talking over one another and collecting nectar and trying not to bump into one another)*
14. Student: THE HIVE IS ALMOST FULL
15. Cedar: I found that flower!
16. Watson: This is NOT A NEW MAP
17. Ren: IT'S **FU:::ULL**
18. *(Lilac is getting nectar while Lily is standing next to her)*
19. *(Rowan approach Lilac as she fills up)*
20. *(Lilac leaves the flower she was on and goes to the hive)*
21. *(Rowan goes to the flower Lilac was on)*
22. Lily: Ohh are you taking turns?
23. *(Students are still talking over another while gathering nectar)*
24. Willow: This is not a new map
25. *(Students are all talking in the space while gathering nectar)*
26. Student: I'm fu:ll:::
27. Willow: I'm full!
28. *(Bluebell approach Lily for a side conversation. Inaudible audio due to students talking over her)*
29. *(Rowan is running in the back to drop off his nectar)*
30. *(Students are talking over another while collecting nectar)*
31. Willow: THE HIVE IS FULL THE HIVE IS FULL!!!!!!
32. Lily: It's **full!**
33. Student: The hive is full!
34. *(Juniper approach Lily in another side conversation. Inaudible audio due to students talking over them)*

Transcript 26.

A significant moment in play in this episode was when Lily observed and commented on Rowan waiting to collect his nectar (Transcript 26, Line 18, 19, 20, 21). Although Lily made comments and asked questions in earlier episodes, she largely followed students' ideas that were

shared with her in either side conversations or discussion. In the first episode, it was Bluebell who first noticed and stated the need to organize into groups in order to avoid crowding around flowers. This led to the realization of a need for organization in order to efficiently gather nectar without crowding and bumping into one other. Although Lily brought this to everybody's attention, it was Bluebell, Ren, and Heath who first made the observation and shared it out loud. What's different about the interaction in this play activity is that this was the first time *Lily* made an observation and shared it to the class (Transcript 26, Line 22). In the upcoming discussion that will be presented in Transcript 27 below, Lily shared her observation from play.

Lily began the discussion by asking how well Watson's strategy worked. Once again, she didn't regulate or remind students of either Watson's or Violet's strategies during play. Although she gave directions to students in the beginning of the episode, Lily didn't heavily guide the class towards testing the ideas in play. Instead, Lily moved to share with the class what she observed Rowan doing during play.

35. Lily: All right so:: did **that** help not bumping into each other?
36. Students: NO!!
37. Students: YES!
38. (*Students are in discussion in the play space. Some are sitting down and some are standing up with Lily*)
39. Willow: Some people keep doing it
40. Ren: Yea people keeps on **doing** it
41. Lily: So~what we're still noticing a couple of things some of you what I started to notice was **Lilac**. (*Lily walks over to where Rowan and Lilac were during play and recreates it*) Lilac was standing on a flower and she collected all her nectar and Rowan was standing right here and Rowan just sta:::ed wa:::ited for Lilac to collect nectar. Once Lilac was taking her nectar back to the hive what did you do Rowan?
42. Rowan: I went on that flower (*pointing to the screen*)
43. Lily: YEA! He **went** on that flower so
44. Willow: Good idea! (*Willow gives Rowan a thumbs up*)
45. Lily: Was that a good idea?
46. Rowan: Because~because MY strategy was that first someone tests it out and then if it doesn't have any I don't go to that
47. Lily: A:h::: so you were looking for a **sign** right? So he waited and said well let's see if Lilac collects any nectar and if Lilac collect nectar then **I'm** going to that flower. Did anyone else do that?

48. Students: Yea
 49. Students: No
 50. Lily: You did that too Cedar?
 51. Cedar: Somebody was waiting at a flower that orange one and I was behind them and it was like it was black so I went to the flower right there
 52. Lily: Ahh so you also waited. So you were waiting for a sign
 53. Ren: I did it~I did it on Lilac after
 54. Lily: You did? So you were waiting for a sign right huhh. So think about it as you're moving into space many of you are being observant and watching each other and then following that move. Do you think that's something *bees* do?
 55. Students: Yes
 56. Ren: Yes and then they show people where the flowers are that has nectar
 57. Lily: So BEES *show* where flowers
 58. Ren: In the hive they do this sort of dance to show where the flowers that have nectar (*inaudible*)
 59. Willow: They make the hive where they're flowers
 60. Lily: So Ren now if we wanted to communicate to friends *look*~this~flower has nectar *how* would we do that?

Transcript 27.

Lily immediately moved on from Violet and Watson's ideas and started to share her own observations from the earlier moment with Rowan during play. She recalled the series of events and shared it with the rest of the class (Transcript 27, Line 41). This observation was not another student's idea that Lily re-voiced. Although it was a student's behavior that was shared, it was Lily, not another student who made known the observation. Therefore, not only did Lily listen to students' ideas and observations, but she watched and shared students' actions from play to highlight and lead discussion.

Although the students seemed to conclude that gathering around one flower was not an efficient method, they had yet to discover the need to *communicate* in order to spread out to different flowers. Up to this point in the lesson, students in Lily's class continuously observed and stated that they kept bumping into one another. Throughout the discussions that took place in these episodes, students offered solutions and ideas to remedy this problem. When students kept bumping into one another, they responded by splitting into groups. By splitting into groups, a

smaller number of bees would be dispersed in the space, thereby reducing the chance of bumping into one another and losing nectar. While this idea became a universal issue that needed to be addressed, the need for communication had not yet been identified.

To move the lesson forward, Lily introduced terms and fine-tuned students' ideas. In the discussion following play (Transcript 27), Lily made reference to Rowan's actions in order to guide students in a new conversation about signs. After sharing with the class, Willow added, "Good idea!" (Transcript 27, Line 44). This led to Rowan, the student whose actions Lily had shared, to recount and explain his strategy, "MY strategy was that someone tests it out and then if it doesn't have any I don't go to that" (Transcript 27, Line 46). When Rowan explained his actions, he clarified that what Lily observed and shared to the class was a *strategy* (Transcript 27, Line 46). It was not a random moment in play that Lily happened to see. When Lily recounted Rowan's play, she didn't describe his actions as a strategy. It was Rowan who clarified that his actions were a strategy. Rowan's actions during play was an active strategy in which he waited for information by letting another bee test it out to see if it had any nectar. Rowan made clear that his strategy was based on the *quantity* of nectar to determine if he should also visit that same flower.

What unfolded in this discussion was the progression from Lily's observation in play, towards a co-constructed conversation around a strategic method of collecting nectar. After Rowan expanded on his strategic actions, Lily continued the conversation with a formalized summary of Rowan's strategy, "so you were looking for a *sign* right?" (Transcript 27, Line 47). Here, Lily introduced the term "sign" to the students as a way to formally make sense of Rowan's strategy. The conversation continued to build as Cedar also shared that he did something similar in play (Transcript 27, Line 51). Therefore, Lily's observation of students'

actions in play, which she shared to the class in discussion, led to a co-constructed discussion of a strategy that looked for a *sign*.

Throughout this discussion, Lily inserted formal terms around Rowan's strategy. She linked his strategy back to the larger lesson goals. We saw this final shift in the discussion as the episode came to a close when Lily asked, "many of you are being observant and watching each other and then following that move. Do you think that's something *bees* do?" (Transcript 27, Line 54). Here, Lily built on Rowan's idea to look for a sign by tying it back to role-playing as bees. Lily transformed Rowan's strategy into a sign that bees perform and look for in order to efficiently gather nectar. We also saw Lily add the term "communicate" when Ren stated that bees "show people where the flowers are that has nectar" (Transcript 27, Line 56). In this moment, Lily linked Rowan's strategy to a sign, and then a form of communication for finding flowers. As a result, this episode, with Lily's guidance, unpacked the importance of communication when collecting nectar through strategic signs.

The ideas behind this episode that helped students come to this conclusion was co-constructed by both students' actions in play and Lily's guidance in formalizing and transforming ideas. The importance of this discussion is that Lily's didn't introduce an idea on her own. She observed students in play and used their interactions to bring attention to concepts that could further her lesson agenda. For this reason, even when Lily was more heavily guided and shaped the conversation in this episode, students were still engaged and had a voice in validating and furthering Rowan's strategy. Lily used students' discourse to attach formal meaning to them. After Cedar and Rowan shared their strategy, Lily introduced the term "sign". When students agreed that bees used signs in the real world, and that they showed the locations of flowers, Lily introduced the term "communicate". Therefore, this episode marked a shift in

both Lily's role and students' understanding of bees in play. As Lily provided more guidance and formalization of students' understanding, students began to think about the need for communication.

Episode Four: Communicating flower locations using hand motions

While the discussion at the end of *episode three* illustrated the importance of communication, this episode centered around *how* and *what* bees communicated in order to find flowers for nectar. The fourth episode began when the discussion moved towards students co-constructing a form of communication to share location of flowers. In the following discussion, students were led by Lily as they tried to come up with hand motions to direct and share flower locations to other bees. As the discussion progressed, Lily asked how students could communicate each piece of information. Students and Lily then entered the play space as co-players to use and test hand motions to communicate flower locations.

1. Violet: Wait let's do { **hand** motions
2. Lily: } So **let's**~oh hand motions?
3. Violet: So this can be up (*pointing both fists together up to the sky*)
4. Lily: So this would be our communication?
5. (*Ren and Violet are doing the up sign*)
6. Ren: Up down side to side (*Ren wiggles his hand down side to side*)
7. Lily: A::h::::
8. Violet: That's more harder
9. Lily: So Violet is saying here's how we're going to communicate to each another that **we** had found nectar
10. Violet: Up down side side (*Violet moves her hands up and down, then side to side*)
11. Lily: **So** if all of you were in the hive and **I** found nectar what **sign** would I give you? Violet?
12. Violet: You would say I found nectar like this (*Violet bumps and waves her fists together for the I found nectar sign*)
13. Lily: So this is **I** found nectar (*while doing the I found nectar sign of bumping and waving her fists together*)
14. Violet: And then you would have to tell us where to go!
15. Lily: So how would I tell you?
16. Violet: You could do a hand motion for up down side to side (*Violet rolls her arms together, then moves her up, down, then side to side*)
17. Lily: Aa:h:: so if you're in the hive I would say **this** (*Lily rolls her arms together in the air*) which means come **up** and **then** what?
18. Violet: And then this means come down
19. Lily: Oh so come **down**?

20. Bluebell: That's too complicated
 21. Student: No it's not
 22. Lily: So let's think about this if **I** do this (*Lily moves and waves her fists and thumbs up in the air*) I found nectar I found nectar!
 23. Willow: And WHAT~about **I** got nectar
 24. Lily: Oh
 25. (*Students are talking one another*)
 26. Lily: So I could give you a signal this way **you** know **come** here I found nectar
 27. Willow: I found nectar i'm going to the hive
 28. Lily: Oh::::::

Transcript 28.

In the first two minutes of this episode, Lily led a discussion with students to determine the hand motions that conveyed important information about finding nectar. It began when Violet suggested the use of hand motions to communicate to other bees (Transcript 28, Line 1). Lily continued to build on Violet's suggestion as Ren joined the conversation (Transcript 28, Line 6). Violet suggested the "up" hand motions, while Ren suggested the "down" and "side to side" hand motions (Image 22). This conversation helped construct how students would communicate where and how within the "flower field" bees could find flowers. Following Violet and Ren's suggestion, Lily asked, "**So** if all of you were in the hive and **I** found nectar what **sign** would I give you?" (Transcript 28, Line 11). Violet continued to build on the use of hand motions by suggesting a thumbs-up motion that indicated that a bee had found flower (Image 22).



Image 22. Violet and Ren construct signs (left) and Lily does "I found nectar" (right)

These components, which were defined by hand motions in the discussion, represented the information bees needed as they systematically collected nectar. As part of the curriculum design, the goal of this lesson was to discover the need for a dispersed communicative strategy of collecting nectar. Honeybees are unique because they go to different flowers and share the location of flowers to other bees in the hive. Recall, the information honeybees share in the hive (in the form of a waggle dance), is an intricate and complex form of communication that illustrate distance, direction, and quality of nectar. In the discussion, Lily led students in co-constructing hand motions for 1) “I”, as a bee, found nectar and 2) where the flowers were located “up, down, then side to side”. By using “up, down, then side to side”, students began to brainstorm how to communicate the *direction* of flowers.

Lily also started to guide the students into thinking about the larger cycle of gathering nectar; that it is not enough to find flowers, but that bees should also share where they were located and when they were bringing nectar back to the hive. In this discussion alone, we saw students and Lily co-constructing pieces of information that bees needed in order to share and gather nectar. As the discussion progressed, Lily continued to refine the hand motions and organized the students to re-enter play by summarizing the goals and job while playing as a bee.

In comparison to previous episodes, Lily’s role in discussion began to shift towards the inclusion of more guidance and structure as she built and co-constructed ideas with students. In *episode one* and *episode two*, she largely re-articulated, highlighted, or organized the class around students’ observations and ideas. In the *episode one*, Lily invited the students into play by inviting the students to come help find nectar. In *episode two*, Lily invited the students into play to try Bluebell’s strategy of splitting into groups. In *episode three*, Lily also invited students into play to try both Watson and Violet’s strategy. She also refrained from interrupting play and did

not fully enforce and regulate play despite taking time organizing the students in discussion. However, in this episode, Lily sent students into play with a clear set of directions that illustrated how the students would interact in the space. Instead of sending students out with general ideas or observations to further try and observe, Lily displayed a clear stance that students needed to follow her directions and refrain from using words and direct a friend to a flower using signals. Even though Lily provided more guidance in this episode, she continued to build the rules from students' play, discourse, and interactions.

Due to the short time students played and ended this episode, I will summarize the remainder of the episode in this section. Following discussion, Lily co-played with students as they tried the hand signals in play. In the short amount of time both Lily and the students were in play, several students found flowers and practiced using the signal for "I found nectar" (Image 23).



Image 23. Lily and students used signs to share information while playing

The play activity that took place after this long discussion only took two minutes because many of the flowers on the screen didn't have enough nectar.. Due to the fact that students were quickly and efficiently collecting nectar, the flowers ran out of nectar within 2 minutes. This

caused both Lily and the researchers to stop play, and quickly gather the students in the back of the room to re-set the technology and provide students with a new flower field.

Episode Five & Episode Six: Epilogue

In the final two episodes, Lily concluded the day with two more opportunities of play and discussion as students continued to use hand signals to communicate flower locations. The discussions that Lily led in *episode five* was a continuation of the previous episode as students were organized and reminded to communicate where to find nectar during the re-set of the technology. Similar to the ending discussion that took place in *episode four*, Lily provided more structure and guidance as she organized the students for play.

Unlike previous episodes where Lily gave a minimal amount of directions and structure, students were paired up and reminded to move when a bee gave directions. While we saw a similar level of organization in *episode two*, the difference here is that it was not student-initiated. In *episode two*, Lily only organized students into two groups because of Bluebell's idea. After organizing students into groups, Lily invited students to play in pairs. In the following transcript, I capture the last few moments of play that led to a discussion.

—Play—

1. Ren: Bee:: buh beh byeea::: (*As he walks back to the hive with his arms spread out like a bee dropping off his nectar*)
2. Rowan: Go where that flower is (*pointing to a flower for Alder*)
3. Student: Go back!
4. (*Lily is engaged in a side conversation with Willow and Watson*)
5. Ren: WHY IS THERE A FLOWER RIGHT IN FRONT OF THE HIVE?
6. (*Students are still playing in the space. Some are giving directions, but most are just collecting nectar*)
7. (*Lily is at the side of the room in a side conversations with Lily, Watson, Willow, and Heath. Discourse is inaudible because students are still playing in the space.*)
8. Lily: Aa:h::::: (*As Lily walks away from the side conversation, into the play space*) Bees can I have your attention? Bluebell can I have your **attention**? I::::f can we pause it?
9. (*Students who are playing in the space slowly gathers around Lily in the hive*)

—Discussion Begins—

10. Lily: So umm a couple of things if I could bees if I can have your attention. So

Watson just can you share um with the class what you were just saying
Watson?

11. (*Watson walks up to the front*)

12. Lily: Well why won't you face them

13. Watson: Should I tell them my question?

14. Lily: Well you can pose your question and then what you think yes

15. Watson: I had a question why does the hive fill up so fast? And then I answered it because *I* think it's because we are doing our job correctly and we're doing it fast enough that it's filling up really fast.

Transcript 29.

Despite providing further organization and guidance in these last episodes, students continued to engage in side conversations that led to new observations and discussions. During play, Lily continued to refrain from heavily regulating the rules of play and engaged in several side conversations (Transcript 29, Line 4). After Watson posed his question, Lily paused the play activity to share their interaction (Transcript 29, Line 10). Once play was paused, Lily gathered the students in a brief discussion to share Watson's conclusion on the class successfully gathering nectar. Students stopped gathering nectar in the play space and turned their attention to Watson and Lily. This conversation was important because it illustrated how Watson eventually came to the conclusion that they were doing an efficient job of filling the hive. In the previous episode, the researcher had to reload the technology due to the quick success students had in filling their hive. Watson made note of this and concluded that the class must be doing an efficient job of collecting nectar if the hive was filling up this quickly.

In *episode six*, Lily first led a discussion that reflected on the hand signals before inviting students to play for the last time in the lesson. The discussion that took place after Watson's conclusion centered around the complicated nature of signs. Students concluded that bees must do a very complicated dance to communicate information. Lily used this conclusion to invite students one last time to think about how they could use their bodies to communicate like bees. In this last play activity, students ran back and gathered nectar for the hive while Lily continued

her roles as a co-player in the space by engaging in side conversations and making observations about students' play. After a few minutes of playing in the space, the Eagle came out and swooped into the screen, causing students to scream while they tried to get nectar for the hive.

16. *(Students huddle in the hive to escape the Eagle)*
17. Ren: Guys **when** you're dead go to the yellow mat and come back and you're back alive
18. Rowan: AH IT GOT ME
19. *(Students are screaming and dodging the Eagle)*
20. Ren: OR YOU GO ON A FLOWER
21. Watson: WOAA EE::: (*Watson runs back to the hive where Violet is*)
22. Violet: Are you okay?? (*Violet hugs Watson in the hive*)
23. Watson: Yes
24. *(Students are walking back and forth gathering nectar for the hive)*
25. Student: STOP THE EAGLE::
26. *(Students are screaming as they try to collect nectar around the Eagle)*
27. Rowan: Oh god it's too much

Transcript 30.

The importance of this last moment in play was how students interpreted the predator. When the Eagle swooped in, it influenced the students' play in two ways. First, the Eagle caused students to engage in very dramatic interactions. For example, when Watson almost got eaten by the predator, Violet, who was safely in the hive hugged him and asked if he was ok (Transcript 30, Line 22). Second, the Eagle was a collective problem that students wanted to solve in play. For example, Ren tried to think of strategies to survive the predator by screaming out ideas to his friends as they tried to gather nectar (Transcript 30, Line 17).

Shortly after the Eagle swooped in, Lily paused play, gathered the class in the back, and ended the lesson with a short debrief of what students learned.

28. Lilac: Willow was saying that so I agree with her because maybe at the same time you have to get away from the Eagle so you can't just run you could stay there and do signs and then it could be like a dance.
29. Lily: So Lilac is saying you just can't run into the space you need to have like a strategy in mind you need to know where you're going. So maybe there is a dance that communicates that so this way you're not being attacked by the predator.

Transcript 31.

In the final discussion, Lilac included the Eagle's role in her conclusion by stating that while we needed to do the hand signals, we also had to be wary of the predator (Transcript 31, Line 28). Lilac's conclusion was interesting because although the Eagle made the interactions in play look chaotic, it was actually a part of figuring out where and how they would gather nectar safely. In other words, the Eagle was part of the play narrative. Students incorporated the Eagle as a problem in play and needed to think about how bees would communicate with one another to avoid getting eaten. Immediately after Lily's comment in line 29 (Transcript 31), the class ran out of time and ended the lesson.

Conclusion of Chapter

In this chapter, I presented my analysis on how Lily structured play with an open approach to inquiry. This lesson had a total of 6 episodes. Throughout the lesson, Lily provided the space for student generated ideas to be organized into play activities. In the first few episodes of the lesson, Lily focused on observing, co-playing, and dramatically introducing role-play to students. However, in the final few episodes of the lesson, Lily began to organize and more heavily provide structure as students tested the hand motions during play.

Lily's two groups of film and film restricted groups had subtle differences in interactions. To avoid confusion, I will name the two groups of students. The group of students without film restrictions, that I have detailed in this chapter will be Group A while the group of students with video restrictions will be called Group B.

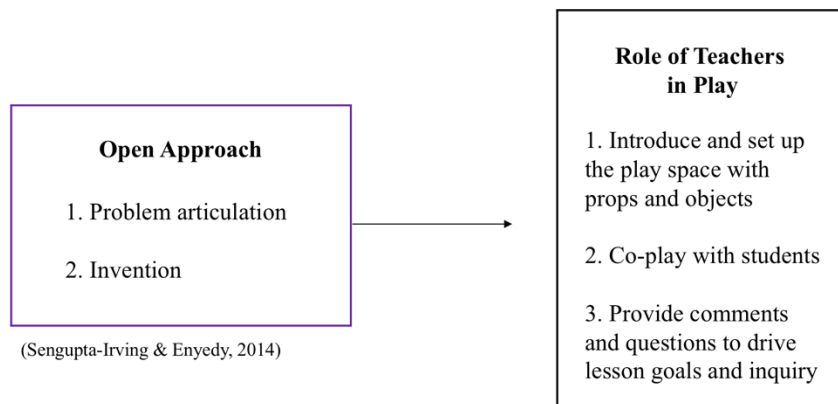


Figure 5. Analyzing teacher roles in an open approach to play

I draw once more from my literature review on the three roles of teachers in guided play as well as Sengupta-Irving & Enyedy’s (2014) principles of open approach instruction (Figure 5). In the remainder of this chapter, I first summarized my findings and then cross-referenced my findings to the group of students with film and video restrictions (Table 3).

Table 3.
Lily’s Open Approach in Play

Role of Teachers in Play	Lily’s Roles in an Open Approach of Play
Introduce and set up the play space with props and objects	<ul style="list-style-type: none"> • Introduce play by dramatizing the props and tools in the space • Match the students’ dramatic and excited tone • Invite students into play with an open-ended prompt
Co-play with students	<ul style="list-style-type: none"> • Co-play with students and make observations during play • Co-play and ask students to share what they are doing in play • Engage in side conversations in the play space

Provide comments and questions to drive lesson goals and inquiry

- Share the observations made from watching students in play (& organize play around observations made from play)
 - Share side conversations with students to the rest of the class (& organize play around ideas from side conversations)
 - Question students to share their ideas and observations in play
 - Organize class around students' ideas and strategies
-

Open approach of introducing and setting up play. Lily introduced and set up play by dramatically engaging in roles, matching students' tone of excitement, and providing time and space for students to construct a problem in play. In group A, Lily dramatically built on the hula hoop, the bee-o-matic 6000, by "buzzing" and taking the time to invite each and every student to transform through the prop (Table 3). Although students knew that walking through the hoop wouldn't impact the technology's ability to turn them into a bee, the students made the prop an essential part of entering play. Lily's interpretation of the bee-o-matic 6000 was important to the students in group A because it set up the tone and level of drama that was acceptable in this space. It not only helped students transform into their role as a bee, but it supported and validated the kind of dramatic and exploratory nature that is unique in play.

Lily also matched the dramatic tone of students in group A as they readied to enter the space (Table 3). When students first entered the space, Lily called the students "bees", which prompted students to make buzzing noises as they sat down. Lily then acknowledged their buzzing and built off their role-play as she began her introduction. What is important about this teacher role is that Lily built and validated students' excitement of turning into a bee as an

important part of interacting in play, which focused her introduction of the lesson on building excitement, drama, and exploration for students.

In addition to dramatically interacting with the hula hoop prop, Lily also introduced the students in group A into the space with minimal structure and prompts (Table 3). Instead of requesting students to enter role-play with specific jobs and goals in mind, Lily gave the students in group A the time and space to first play as bees before organizing and transforming their observations and ideas to meet lesson goals. For example, in *episode two*, Lily used Bluebell's observation of bumping into other bees to pause and set up the next play activity around a solution to the students' emergent problems. Since Lily didn't provide students with specific questions in the introduction, students in group A discovered problems, like bumping, as they interacted in the play space. After sharing with Lily their observations, Bluebell, Ren, Willow, and Heath offered an inventive solution to this problem by dividing into groups. Although Lily provided minimal guidance and no overarching prompt related to lesson goals, students played, explored, and came up with problems and solutions.

Group B. The level of importance the hula hoop had in Group A also held in Group B. For example, in Group B, Lily "buzzed" each student into the space and accepted their excitement as a valid form of participation in the space. Similar to Group A, students in Group B made buzzing noises while they stood up to enter through the hula hoop. Lily matched the tone of students in group B and responded to the buzzing noises by encouraging the students to get ready to stop being a human being and to "have fun" (Table 3).

Lily's open-ended prompt in the introduction of the lesson not only held across both groups but influenced students in similar ways (Table 3). After Lily invited students into the space, students in group B engaged in the side conversations similar to the interactions I have

presented in group A. In these side conversations, students occasionally shared an observation or idea to Lily during play.

In group B, students also articulated the problem of the best way to collect nectar. Due to Lily's open prompt, students' observations and ideas that were shared in discussion became the root for upcoming strategies or ideas to test in play in both groups. Similar to group A, the discussions that took place around each play activity were based on student's side conversations with Lily, that were then shared with the rest of the class.

Open approach of co-playing with students. Throughout group A's lesson, Lily largely remained inside the play space as a co-player. Not only did she play as a fellow bee gathering nectar for the hive, but she also followed students around as they shared with her their ideas and observations (Table 3). We also saw students in group A approach Lily in side conversations as she gathered nectar for the hive in the play space (Table 3). Due to overlapping talk, it was often difficult to hear these side conversations. However, the students' ideas impacted the flow of the entire activity. Since Lily followed students' ideas to organize play, the topic or purpose of each play activity relied on students. This caused students in group A to have a high amount of agency in the ideas being tested during play. For this reason, the number of episodes in Lily's group A class was high (six episodes). The students had the opportunity to control the flow of ideas and activity, resulting in multiple opportunities and episodes to test in play.

Group B. Similar to Group A, Lily's students in Group B continued to engage Lily in side conversations as she walked around the play space. The students' ideas that were shared in side conversations continued to mark moments for Lily to share and begin a new play activity (Table 3). In group B, students debated the best way to gather nectar; only collect nectar from flowers with three hearts or go spread out to the different flowers. Lily's decision to co-play with

students in group B also led to multiple side conversations, where students shared their ideas and observations in the space. As a result, the ideas that were tested, the repetition and revision of those ideas, and how many ideas got tested varied across group A and group B. While group A had six episodes, group B had 5 episodes. Despite the difference in the number of episodes, my finding in group A, where Lily led activities based on students' ideas held across both groups.

Open approach of providing comments and questions. Lily also provided a variety of guiding comments and questions throughout play that gave students in group A more control of the flow of discourse and activity (Table 3). What is most unique about her comments and questions are the lack of a clear prompt or question (Table 3). In group A, Lily often left students in play with overarching invitations or general observations from play. She refrained from heavily organizing the rules and roles of play until students tried to address the emergent problem with ideas. For example, in group A, students quickly identified the issue of bumping into one another in *episode one*. This collective problem emerged while playing in the space. Once the problem was identified and shared in a side conversation, Lily stopped the class to organize and try Bluebell's idea of splitting into groups.

What is also unique about Lily's questions and comments is how it shifted as the lesson progressed. While the students in group A began the lesson with a very open-ended invitation to play, Lily progressively added more guiding comments and questions for students in play. However, what is most important about how Lily carried out this role was her decision to provide more structure, organization, and guidance when students in group A were ready to try an idea. The timing of Lily's structure came towards the middle and end of the lesson when students had established a problem and had moved towards finding and articulating a solution.

Group B. The lack of prompts and pre-determined goals similarly influenced students' interactions in group B. The main difference between the two groups were the ideas that were tested in each episode (group A had six episodes while group B had five episodes). Similar to group A, the students in group B had agency over the exploration and articulation of ideas. The students in group B also played with an open-ended prompt before discovering a problem while playing (Table 3). In group B, the students' collective problem was deciding on which flower gave the best and most amount of nectar. Throughout the entire lesson, students worked to find solutions to this particular problem. Although the problems and ideas that were tested in group A and group B differed, the importance of this difference is that Lily gave students enough agency for each group to observe and play for their own emergent ideas and problems.

In addition to the lack of prompts in play, Lily also focused her questions and comments around emergent student ideas and observations in group B (Table 3). Instead of inserting the lesson goals into their interactions early on, Lily continued to follow students' ideas like she did in group A. In group B, Lily also co-played with students in the space and continued to give students the opportunities to come up with observations and ideas on their own. Similar to group A, after students had a chance to articulate a collective problem, Lily began to provide more guidance as the students tested specific ideas and strategies. However, these interactions were rooted in the ideas articulated from students in group B, resulting in continuous engagement and agency as Lily organized the class for play.

Summary of student agency, engagement, and discussion. In summary, Lily followed an open approach to play, where she dramatically introduced and maintained a student-driven play activity. This resulted in students gaining agency and control over the flow of the lesson.

Each episode was not assigned or given a specific idea to meet lesson goals. Instead, Lily gave students the opportunity to share and organize ideas in both discussion and play.

Lily's dramatic approach also led to multiple layers and types of students discourse during play. Due to the volume and amount of overlapping talk in the play space, most of the time Lily's students were in play, were inaudible. While I was able to hear individual or groups of students who occasionally talked near the microphones, the level of engagement of the activity produced simultaneous interactions at the same time.

Additionally, Lily's role also made an impact on students' agency and engagement in discussion. Throughout discussion, Lily didn't prompt or ask questions that directly led to the articulation of lesson goals. This resulted in students not only sharing multiple ideas but led to conversations that built on one another's observations. For example, in group A, students built off of one another's ideas in discussion when Rowan shared his strategy of collecting nectar (which led to Violet's suggestion to use hand motions). Similarly, in group B, students were engaged in multiple disputes throughout all five episodes on how bees visited flowers using the quality of nectar. As a result, students were not only engaged in dramatic play, but engaged in overlapping talk, side conversations, and debates on how to best collect nectar.

Chapter 6. Save the Bees! Making of a Pollinator Paradise

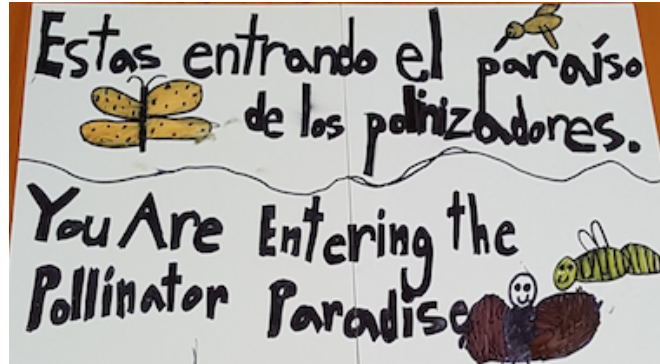


Image 24. Entrance to the Pollinator Paradise

A month after the completion of the play unit, when I visited Lily and Flora's classrooms for a post interview, I found that students showed a sustained and growing interest in the importance of pollinators. This interest was expressed through art. Lily and Flora's classrooms are located next to one another and connected by a large middle room. As a result, the two classrooms share a space that physically connects them together. In this middle room, the students created a "Pollinator Paradise" (See Image 24 and Image 25). The Pollinator Paradise was filled with a collection of art produced by the students. Even after completing our science unit on bees and pollination, students continued to explore the important role of pollinators.

Students learned that without the help of pollinators like bees, we would lose a significant number of our food sources. After completing the unit on bees, students began to question whether other insects were also responsible for pollinating plants. This led students to research other pollinators and their roles within our ecosystem. After learning about the decreasing population of bees, students began to create art pieces and statements that represented their stance on pollinators. They used these to create the Pollinator Paradise, a representation of what the world would look like if we sustained and cared for our ecosystem. It also represented the

importance of pollinators and why the human race must do a better job of preventing the disappearance of bees.

“What is a pollinator paradise and they said it’s a paradise because this would be a space where all the pollinators could be free from and they started talking about pollution. They would be free from and everything they were affecting what they were researching that was affecting pollinators. And so this was the one safe space for the pollinators that they were creating and you know three dimensionally and so they called it pollinator paradise because this is you know how beautiful life would be if we just took care of our pollinators and you know cared for them.” (Lily, Post-Interview).



Image 25. Pollinator Paradise

The students in both Lily and Flora’s classrooms made a variety of art pieces and statements for the Pollinator Paradise that not only represented what students learned, but also how they felt after learning about the importance of bees. While some of the art pieces stemmed from the play unit, most grew out of further investigation and research on pollinators. The larger art pieces students made were large pollinators (a bee, a bat, a hummingbird, and even a butterfly) that were hung from the ceiling over large flowers with pollen and nectar (Image 26). In one corner of the room, students also created a bee hive that was made out of hexagonal pieces of paper (Image 26). In another corner, a handful of signs made by students asked readers

to take care of our ecosystem and help our pollinators. Many asked readers to stop using pesticides while others called attention to the need for planting more pollinator-friendly plants.



Image 26. Students created giant pollinators (left) and a bee hive (right)

Although students showed excitement and engagement throughout the play unit, I was still surprised to witness how *long* they had sustained their level of interest in bees. In previous chapters, I analyzed students' interactions and found that across both classrooms they were engaged and excited while pretending to gather nectar. However, I didn't anticipate students to *remain* engaged in role-playing as bees and flowers long after completing the lesson and unit.

After asking both Lily and Flora how the conversations and art making process were shaped, the teachers revealed that students in Lily's classroom led the creation of the *Pollinator's Paradise* after the last play lesson. After returning to class from the last day of the play unit, Lily's students continued to talk about pollination and led the two classrooms throughout the art making process that lasted until the end of the school year. This led me to wonder: *What was unique about Lily's final play lesson that began this longer student-led exploration on the importance of pollinators and inspired the creation of the Pollinator Paradise?* To investigate the impact of the last play lesson on Lily's students, I interviewed Lily to understand not only when but how the play lesson contributed to the Pollinator Paradise project that lasted until the

end of the school year. After confirming with the teachers that Lily's students led the creation of Pollinator Paradise, I asked her during the post interview to describe how play impacted students.

“So by the time that last session came, they were so invested and you know having played the role of a bee I think helped too. For them to really be you know we always put ourselves in the shoes of that character and that's exactly what they did. They were so invested so excited about you know yes I'm a bee and then in that last session where, but look at what's happening to the bees. Look how important they are. That I think for some students it resonated with them in the sense like wow I was having so much fun being a bee and all of a sudden that's what's happening to bees. That could easily happen to me or you know and that's when they started making these deeper connection. That after that last session after the comments that were made it just took off we need to do something about this. We need to save the bees not only bees but all pollinators. And they wanted to research more well is the same thing happening to other pollinators. Is the same thing happening to and they started to research. They wanted to know more about other pollinators other insects and the research just grew and grew. They wanted more they had a lot more questions but their questions were so focused.” (Lily, Post-Interview).

Throughout Lily's interview, she continually referenced the last session as the most impactful moment for students. In this last play session, Lily thought that students were beginning to make deeper connections and develop more questions about pollinators. While role-playing as a bee helped students engage and invest in their character's roles, Lily believed the last session also helped students think about *why* bees were so important. More specifically, Lily saw that students began to question the level of impact and importance of bees as pollinators: “after that last session after the comments that were made it just took off we need to do something about this. We need to save the bees not only bees but all pollinators.” As a result, “they wanted to know more about pollinators other insects and the research just grew and grew” (Lily, Post-Interview).

Learning Pollination through Dual Affect

In this last session, the lesson goal was to discover the inter-dependent relationship between plants and pollinators. Some students took on the role of bees and others took on the role of flowers to explore and discover how pollination occurs in the real world. For pollination

to occur, in the simulation, students playing as bees had to bring pollen from one flower to another flower of the same type. If there were no other same type flowers to collect pollen from, that flower would not grow. For example, if students wanted to make a yellow flower grow, they had to bring pollen from different yellow flowers (Image 27). However, if there was only one blue flower, and no other blue flower to bring pollen from, the blue flower would eventually wither and die on the screen.

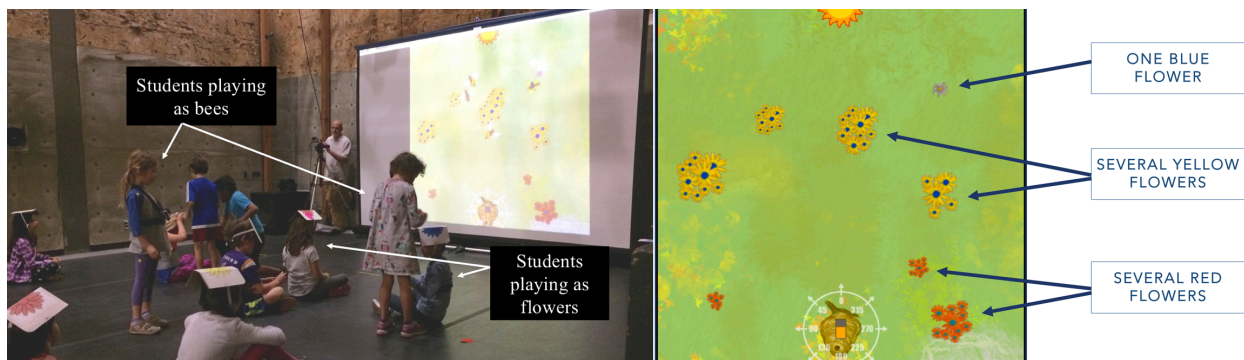


Image 27. The pollination play lesson

In addition to the technology feature of flowers growing, we also incorporated physical props for students playing as flowers. To represent the sticky pollen, we gave each student playing as a flower a roll of dot stickers (Image 28). For example, if a student pretended to be a yellow flower, they had a roll of yellow stickers that would then be transferred to each visiting bee. As a result, students playing as bees had a variety of dot stickers (blue, yellow, and red) all over their face and bodies, just like real bees do when they visit flowers. In addition to students playing as flowers sticking pollen on visiting bees, we also provided small heart post-its (Image 28). These heart post-its represented the nectar that students playing as bees needed to gather and bring back to the hive. Therefore, students pretending to be bees would gather heart props (nectar) while flowers stuck dot stickers (pollen) all over their bodies.



Image 28. Props used in the pollination lesson

In the last play activity, while playing as various flowers, students' discovery of pollination led to a dramatic conversation around the importance of bees. During Lily's interview, I asked if there was a specific moment in the conversation that she attributed to the larger connection seen in Pollinator Paradise.

“What really resonated and helped make that link that connection was that one last experience with you guys when towards the very end you could see it it was very clear. Students started making connections to the bigger picture right? And the impact of how important pollinators are. Now that we know their purpose and how they function and what bees do but wow you know I mean they are important and without bees this is what would happen. What happened that day they made that connection I think what ummm. Cedar said at the very end wow we need to in his words you know in other words what he was trying to say is we need to be their voice you know we need to help these bees. We need them they're important and it's like he's thanking them he's thanking the bees. And then you know also like wow like they're so important we need to do something about this you know about really protecting and saving bees and allowing other students know how important they are” (Lily, Post-Interview).

The conversation Lily referenced in her interview took place in the last few moments of play lesson #6. This specific interaction was a discussion that occurred after multiple opportunities of play within the lesson. Before my analysis of the dramatic conversation that Lily attributed to the inspiration for the Pollinator Paradise, I present the preceding interactions that led up to the final discussion.

In this play activity, students playing as flowers began as wilted flowers and could only grow within the technology when bees brought same-type pollen. The following students played as flowers: Ren (blue flower), Bluebell (yellow flower), Watson (yellow flower), Jasmine (yellow flower), Lilac (yellow flower), Juniper (yellow flower), Cedar (red flower), Violet (red flower), and Heath (red flower). Since Ren was the only blue flower in the field, no matter how many times student bees visited him, he never grew. As a result, while all the other flowers grew, Ren remained wilted and “dead” (Image 29).



Image 29. Ren, the only blue flower

After students played in the space, Lily led a discussion and asked students why Ren didn't grow. When students concluded that Ren would never grow due to the absence of a second blue flower, Lily continued the lesson and engaged in a series of play-discussion activities. Just as in previous sessions, Lily provided guidance throughout the play and discussion, and led with students' observations and ideas.

What is interesting about the play interaction that followed the discussion is the amount of drama Ren displayed throughout play. Although the class had already concluded that Ren would never grow due to the absence of other blue flowers, Ren continued to emote dramatically

to illustrate and highlight his dying flower. The following transcript took place within the final few minutes of the play lesson. This was the very last play activity for Lily's students.

1. *(Willow runs to Ren)*
2. *(Willow stand in front of Ren trying to help him grow)*
3. Willow: I can't help you
4. Ren: EVERYBODY I'M ONLY GIVING NECTAR BUT I'M NOT GROWING
5. Willow: I'm trying to help you
6. *(Willow walks away)*
7. Ren: NO GO TO ME
8. *(Willow walks back to Ren and tries to help him grow)*
9. Lily: What's happening to those red flowers bees?
10. *(Willow goes to Jasmine)*
11. Willow: I'm helping you gro:::w::
12. *(Many flowers are saying "thank you" as bees fly to them)*
13. Ren: EVERYBODY I'M ONLY GIVING NECTAR
14. *(Willow runs back to Ren and tries to grow him again)*

Transcript 32.

Although Ren knew that he would never grow, he continued to display dramatic discourse throughout the entire play activity by asking Willow to visit him. The importance of this interaction is the level of drama Ren displayed as Willow came to help him. When Willow first approached him, she even stated that, "I can't help you" (Transcript 32, Line 3). Still, when Willow walked away, Ren shouted after her, "NO GO TO ME" (Transcript 32, Line 7). Despite knowing Ren wouldn't grow, Willow listened to Ren and continued to visit him three times in this clip. Here, both Willow and Ren carried out their roles as bees and flowers despite knowing as students that Ren wouldn't grow. What is important about Willow's actions is how she continued to visit him no matter what she learned and concluded with the class. It didn't matter that Ren wouldn't grow because Willow was a bee, and bees visit flowers for nectar. Therefore, although Ren the blue flower never grew, Willow always visited him to gather his nectar. For students, the needs of the dramatic role-play were often the important part of their interactions during play.



Image 30. Ren shouting at Willow to help him grow

In addition to Ren and Willow’s decision to continue carrying out their roles in play, Ren also displayed moments of dual affect. Vygotsky described dual affect as when children simultaneously “weeps in play as a patient, but revels as a player” (Vygotsky, 1976 p. 549). Several times in this clip as well as in the remainder of the play activity, Ren shouted out to the class that he was only giving nectar and would never grow. This is an interesting moment because, as the class had already concluded, Ren needed the pollen from another blue flower in order to grow. The flower field used in the previous play activity was the exact same field used in this clip. Nothing was new, and nothing had changed since the students last played. The students knew that no matter what, Ren would remain wilted. Yet, Ren fully embraced his role of a dying flower and continued to shout for help from Willow (Image 30). He accepted the dying flower role and dramatically announced and narrated his demise throughout play. Therefore, as Lily stated in her post-interview, *“So by the time that last session came, they were so invested and you know having played the role of a bee I think helped too for them to really be you know we always put ourselves in the shoes of that character and that’s exactly what they did.”* (Lily, Post-Interview). The investment in and acceptance of playing the part of the dying flower was an important part of Ren’s interactions during play. Although his character was suffering, he as a student was fully engaged and invested in the play activity. To draw a clearer parallel to

Vygotsky's notion of dual affect, Ren reveled as a player and wept as a dying blue flower. His sadness and cry for help to Willow were emotions and actions that dramatically illustrated his *character*.

While I found Lily's interactions in the pollination play activity to remain consistent with my findings from the previous chapter, I also found evidence of dual affect that contributed to the concluding conversations. In the final discussion following play, Ren and Willow continued to display dramatic discourse and moments of dual affect as the class concluded their lesson on pollination. In this finale, Lily embraced students' emotional connections to role-play and built on their responses and discourse in her conclusion to the unit.

15. Lily: Bee::s bee::s. **Flowers** what do we say? This time you WERE growing well **some** of you.
16. Ren: But **I** wasn't
17. Cedar: I was HUGE
18. Lily: Yellow and red bees I mean yellow and red flowers what do you say?
19. Cedar: Thank you bees for letting me grow I'm HUGE now I'm the biggest red flower
20. Lily: So the flowers are saying **thank** you **bee::s**
21. Ren: BUT WHAT ABOUT ME I'm saying **no** thank you bee you~guys~are the~worst bees [in the world
22. Willow: BUT I WAS **HE::LPING** YOU I WAS TRYING TO **HE::LP**
YOU
23. Ren: But I'm dead
24. Watson: Cause you're ALWAYS DEAD
25. Lily: Ren
26. Ren: I **cast** you bees
27. Willow: No but Ren I was trying to he::lp you
28. Lily: But the bees were trying to he::lp
29. Ren: Then why am I not growing?
30. Lily: But did they collect the correct~the right pollen to take over to you?
31. Students: No::
32. Lily: No::
33. Ren: There is no other blue flower I was only **giving** nectar

Transcript 33.

In the final discussion of the play activity, students in Lily's class not only displayed moments of dual affect but also built on the emotional conclusions from play to come up with solutions to help bees. Within this discussion, two major events occurred that shaped and paved

the path towards the creation of Pollinator Paradise. First, Ren continued to display evidence of dual affect throughout the entire first half of the ending discussion. When Lily opened the discussion, Ren immediately commented on how he was unable to grow (Transcript 33, Line 16). Meanwhile, Cedar, who was a red flower, grew into a large bunch. As a result, Cedar thanked the bees for letting him grow. When Lily said to the class, “So the flowers are saying *thank* you” (Transcript 33, Line 20), Ren dramatically and loudly shouted out to the class in Line 21. Not only did Ren call his friends the worst bees in the world, but he then proceeded to “cast” the bees (Transcript 33, Line 26). What is interesting and important about this discussion is Ren’s reaction to his death as a blue flower. As mentioned earlier in this chapter, students played with the same roles and same flower field twice. Not only did Ren know he wouldn’t grow, but he also knew *why* he didn’t grow. Yet, in discussion, he asked, “Then why am I not growing?” (Transcript 33, Line 29). Here, Ren dramatically brought attention to his dying role as a blue flower in discussion. He accepted and embraced his role as the dying flower. As a result, when Lily opened the discussion, he acted out his flower’s emotion. Despite asking why he wasn’t growing and dramatically exclaiming and announcing his death, Ren knew why he would never grow. When Lily asked in Line 30 (Transcript 33) if bees collected the right pollen, Ren correctly responded, “There is no other blue flower” (Transcript 33, Line 33). Drawing from Vygotsky (1976), Ren was engaged and excited as a student pretending to be a dying flower. However, within the play space, he maintained the emotion and response of his role as the dying blue flower. Thus, in discussion, Ren displayed his frustrations towards his friends as a flower, not as a student.

34. Lily: Any last thoughts because we're getting ready to go back to~to:: class. Cedar?
 35. Cedar: I just want to give the bees a thank you cause this (*Cedar points to his red flower that grew*) is the big~this is the in all this wee::k umm this is the biggest I've gotten
 36. Lily: You know Cedar? Thank you. Thank you for sharing that and I think it is

important that we take a minute to really thank bees. Not just *these* bees (*Lily gestures to the students who played as bees in the activity*) that were here today but all the bees in general.

37. Ren: I'm *sad* now
38. Lily: You're still sad?
39. Watson: Why cause you're *dead*?
40. Willow: You're not growing
41. Lily: Thank you Cedar for sharing that. Bluebell?
42. Bluebell: We could plant some flowers in our house so bees could come and try to help them umm in~in our gradens
43. Lily: That's a really good idea
44. Bluebell: And we'll tell them the people help please
45. Lily: To help you know and I as we get ready to umm go off on spring break I want you to think about
47. Ren: WE SHOULDN'T MAKE A FLOWER PARADISE ONLY WE SHOULD TRY TO MAKE A BEE PARADISE
48. Lily: Ahh so what would a bee paradise look like? Think about it during spring break. But for now friends, we have to get ready to go back to class.

Transcript 34.

As Lily detailed in her post-interview, the second significant moment in this discussion occurred when Cedar thanked the bees for helping him grow. This comment was what Lily remembered most about this last session (Lily, Post-Interview). Interestingly, Cedar actually thanked his friends twice within this discussion. He first thanked the bees for helping him grow in Line 19 (Transcript 33). Lily, who heard his comment, repeated his comment and said, “So the flowers are saying *thank* you” (Transcript 33, Line 20). However, Cedar restated and expanded on his gratitude when Lily asked for any last thoughts. He clarified that he was thankful for the bees because, “this is the biggest I’ve gotten” (Transcript 34, Line 35). Lily responded to Cedar’s second thanks and she expanded on his gratitude as an important take away from this lesson, “Thank you. Thank you for sharing that and I think it is *important* that we take a minute to really thank bees. Not just *these* bees that were here today but all the bees in general” (Transcript 34, Line 36). This then led to students sharing ideas and thoughts to the class. Bluebell expanded on the importance of bees and suggested that they plant flowers and tell other people to help the bees (Transcript 34, Line 42, 44). Lily agreed in Line 45 (Transcript 34) and was about to

encourage the students to continue thinking about it during the school break when Ren interrupted her, “WE SHOULDN’T MAKE A FLOWER PARADISE ONLY WE SHOULD TRY TO MAKE A BEE PARADISE” (Transcript 34, Line 47). While the discussion marked the end of the play unit, it also marked the beginning of the longer conversation around why bees were important. What was important about this last lesson was how affect both led discussion and impacted how students viewed bees as an important part of our ecosystem.

The connection made between students’ emotional experiences and the real world struggles of bees is illustrated in this last play lesson. This connection led to the idea of creating the Pollinator Paradise. We saw this movement taking root when the drama of dying and surviving was applied to the perspectives of the real bees and flowers in the world. The purpose of the Pollinator Paradise, to create a safe space for the pollinators in our world, stemmed from the concluding remarks made in this discussion. Once Cedar displayed his thankful stance on the bees, Lily both acknowledged and built on the importance of his statement.

Not only did Lily thank Cedar for sharing his thoughts, but she extended his comment to both the bees in the space (students) as well as the bees in the world. This was a critical moment because once Lily applied students’ responses to the real world, students began to think about the emotions of dying and growing in the context of real bees and flowers. This then led to Bluebell’s suggestion that they tell other people to plant a garden. Bluebell’s idea represented both the response of needing to help in reaction to the dramatic death of Ren as well as moving towards a solution. Her solution was to help the bees by planting a garden and letting other people know. Finally, Ren excitedly shouted out in the end that the class should create a Bee Paradise. Lily encouraged Ren to continue thinking about what a Bee Paradise would look like.

In her words, the concern and need to raise awareness about bees was what began the longer student-led investigation and eventual creation of Pollinator Paradise.

“We want to research with the intention of figuring out if the same thing was happening to other pollinators. Like what's happening to bees. And it was because they you know they wanted to bring awareness to what was happening to bees and it's like well if we're going to bring awareness to bees we need to bring awareness to other pollinators. And that's where this whole idea of you know really thinking about you know service learning project but from their lens from their perspective it's we need to bring awareness around bees and this is what we want to do this is where you know we really want to inform our audience or just everyone in general how important our bees are which was really really cool” (Lily, Post-Interview).

Conclusion of Chapter

In this chapter I investigated an unexpected turn of events—the sustained engagement of students that lasted past the end of the lesson. The teacher attributed the impetus for this to this specific play activity, and my analysis supported Lily’s inference. What stands out in this particular lesson of my study was that the dramatic role-play and affective engagement was more pronounced. The question of that this chapter then investigates is: what exactly about the drama and emotional reactions during play and discussion sustained and engaged students till the end of the school year?

It is worth noting that although the planned lesson focused on the death of flowers in order to learn pollination, the sustained engagement was focused on saving the bees (and other pollinators) from dying. It is not particularly surprising that after six days of becoming a bee that the students would return to that perspective in their independent investigation. However, the common denominator between the dramatic role-play of flowers dying and saving the bees from dying was death.

I argue that it was the death of Ren and the gratitude towards bees that both sustained engagement past the end of the lesson and transformed their inquiry into a desire for action. Specifically, the dual affect of the joy of playing and the sadness of dying, became intertwined

and embedded within the conversations about the elements and relationships within this complex system. The emotional investment first lead students to want to work through the complexities of a complex system. Later it was the emotional investment that makes students want to move beyond understanding and do something to help the agents within the system that they have begun to personally identify with.

In a sense I argue that emotion enhances learning in much the same way that emotion often motivates any theatrical performance where the goal of the story and acting is to understand why people do the things they do, what they do when confronted with different situations, and how actions and actors affect one other. Emotions and emotional crises motivate the inquiry of theater. We become invested in the characters and want to explore and see the resolutions of their emotional crisis and make sense of it all. I believe the same is happening with the dual affect present in the Ren's death. The students see the affect that arose from Ren and Willow's interaction and are drawn into it. The affect character of the interaction motivates the students' sustained engagement around questions to understand why bees do the things they do, what bees do when confronted with different situations, and how the actions of bees affect the lives of flowers in this interdependent relationship.

Chapter 7. Discussion

This study examines how teachers structure and use play as part of a science curriculum, and the impact engaging in play has on students’ agency, engagement, and discussions. In what follows, I describe and discuss the differences of how Flora and Lily structured and integrated play into the science curriculum according to my study design. To better capture the differences across findings in both conditions, I also present Table 4 to illustrate how Flora and Lily practiced each defining teacher role in play.

Table 4.
Comparing Teacher Roles in Guided and Open Play

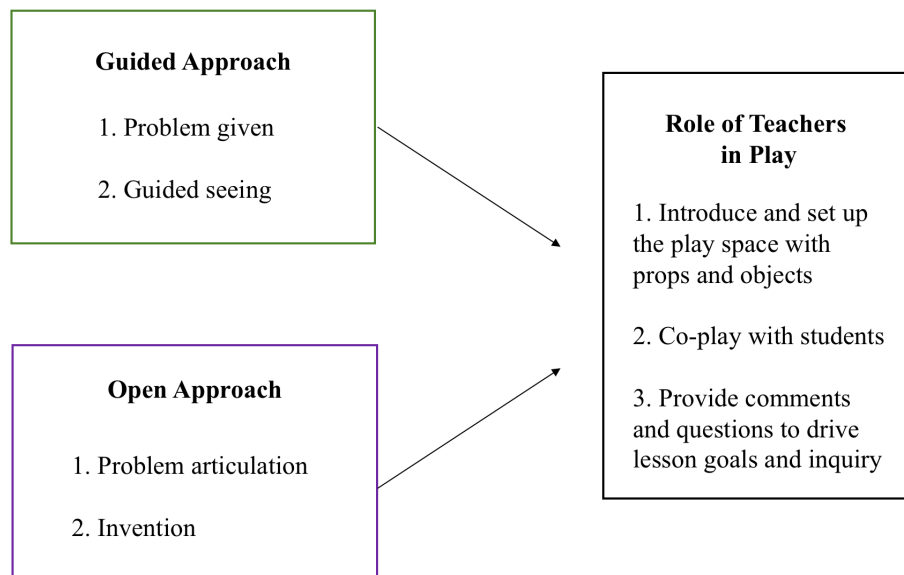
Role of Teachers in Play	Flora’s Roles in a Guided Approach of Play	Lily’s Roles in an Open Approach of Play
Introduce and set up the play space with props and objects	<ul style="list-style-type: none"> • Introduce play by using the documentation as a resource to organize students’ ideas • Uses props to prompt the goals of the lesson • Articulate the goals of play by clarifying the jobs of being a bee • Prompts the problem that students needed to think about during play 	<ul style="list-style-type: none"> • Introduce play by dramatizing the props and tools in the space • Match the students’ dramatic and excited tone • Invite students into play with an open-ended prompt
Co-play with students	<ul style="list-style-type: none"> • Co-play to help students make conclusions on scientific ideas 	<ul style="list-style-type: none"> • Co-play with students and make observations during play • Co-play and ask students to share what they are doing in play • Engage in side conversations in the play space

Provide comments and questions to drive lesson goals and inquiry

- Comments are made to re-articulate the goals of the lesson
- Comments are made to highlight resources in the play space
- Questions in play re-position student actions towards the goals of the lesson

- Share the observations made from watching students in play (& organize play around observations made from play)
 - Share side conversations with students to the rest of the class (& organize play around ideas from side conversations)
 - Question students to share their ideas and observations in play
 - Organize class around students' ideas and strategies
-

Recall in chapter 2 in the literature review, in guided play, teachers can introduce activity by setting up the space with props, co-play with students, and provide comments and questions to help shape activity. As part of our study design, we structured how each of these three teacher roles in play could be implemented differently to reflect a guided or opened approach (Figure 6).



(Sengupta-Irving & Enyedy, 2014)

Figure 6. Analyzing teacher roles in the guided approach and open approach to play

Summary of the Comparison of Teacher Roles in Play

While I did not set out to assess student learning, an unexpected finding was the relationship between the conditions of play and classroom interactions. The two conditions of play, the open approach and the guided approach, led to obvious differences in teacher-student and student-student interactions. In this section, I discuss key moments that illustrate differential teacher approaches, and the subsequent impact on classroom interactions. Key moments include introduction of play, teacher co-play with students, and use of prompts. Additionally, I answer my research questions by comparing how differential teacher roles impacted students' discourse and interactions in play and discussion.

Research Question #1: What are the different ways that teachers structure and integrate play as part of science curriculum? What types of structure do they provide?

Research Question #2: How does the variation of structure in teacher guided play shape and impact students' inquiry? How does it shape students' agency, engagement, and discussion?

Introduction of play. While both Flora and Lily used the hula hoop as part of their daily interaction, Lily incorporated the prop in a way that engaged students in the drama of being a bee. The hula hoop was an important part of both conditions in all groups of students. However, there was a level of excitement and investment in the prop that was more visible in Lily's classroom (Table 4). We saw this difference when Lily buzzed each student into play one at a time. She called each student to walk through, making buzzing noises to indicate that students were transforming into bees. I found this magical because there was a sense of delight and excitement as students pretended to be something else. Lily invested time and energy to transform students' experience of walking through the hula hoop. She matched students' tone and excitement of the bee-o-matic 6000 and took care in giving value in the prop in the way

students wanted. This led to students entering the play space with a sense of value in pretending to be a bee and embracing their roles.

In contrast, while Flora also took the time to invite students into the space with the prop, she also gave a direct use or goal for walking through the hoop (Table 4). In Flora's class, walking through the hula hoop was also an important part of entering the space. However, Flora focused students on the lesson goals that prompted and shaped the remainder of the lesson. This included how Flora introduced the lesson with the hula hoop. For Flora, the hula hoop was used as another resource to structure activity around lesson goals rather than a way to engage students in embodying and being a bee. Instead of transforming students to discover their roles as bees, students turned into a bee so that they perform certain pre-set investigations.

The differences in how Flora and Lily introduced the activity was one of the most important factors that impacted students' engagement and agency throughout the remainder of the lesson. When Lily introduced the lesson with an overarching invitation to explore as bees (Table 4), students engaged in overlapping discourse and side conversations to share observations and ideas, and were excited as they found flowers in the field. This led to students discovering and articulating problems after having a chance to play as a bee. In comparison, Flora's students had a lack of overlapping discourse, and engaged in typical classroom participation structures during play. Flora's students were given the problem as part of the pre-set goals of the activity (Table 4). While Lily's students were sharing ideas and observations, Flora's students were mostly quietly following directions and collecting nectar. We saw evidence of this in *episode one*, when Flora gave students the opportunity to test the strategy of spreading out.

In conclusion, the way teachers set up and introduce play activities with props impact the level of discourse students have during play. This included both overlapping excited discourse and side conversations, where students felt engaged in the exploration of being a bee and sharing those ideas with Lily. Lily's dramatic tone that matched the joy of turning into a bee through the bee-o-matic 6000 also helped sustain that level of excitement and discovery of finding out how bees found flowers in the field (Chapter 5, Episode One).

Co-playing with students. Although both Flora and Lily co-played with students, Flora used her role as Queen Bee to guide students towards articulating and making scientific conclusions in order to move the lesson forward (Table 4). In Flora's condition, she co-played as Queen Bee in *episode two* of play lesson #2. Here, she used the setting of play to interact with students by taking on a role. At the same time, Flora's role as Queen Bee had a purpose, and it was used to clarify to students which strategy of collecting nectar worked best.

This characteristic of guided play found in the literature review was perhaps one of the more surprising and interesting findings of my data. While designing both conditions, I hypothesized that if teachers co-played with students, it would make the play activity more open and exploratory. However, as we saw with Flora's Queen Bee strategy, this was not the case. Although Flora did dramatically enact the roles of the Queen Bee, the role of the Queen heavily guided the students in both groups of the class (Table 4). This, of course, was decided to help illustrate that the spreading out or dispersed strategy of collecting nectar worked best. However, by clearly guiding students towards this conclusion, Flora's students lost agency as she directed which bees would forage for nectar.

What is significant about this level of guidance was the misalignment that developed over the course of this episode in my data. When Lily co-played with students, she was positioned as

a figure with whom to share ideas and observations with. This led to side conversations that occurred during play with different students sharing observations and ideas in *every* episode (Table 4). However, when Flora began to sharply focus on the articulation of which strategy worked best, students began to disengage from her prompts and questions, as students were increasingly worried about crowding flowers. This issue came up in three out of the four episodes in Flora's lesson. However, Flora explained this issue as either a technical glitch or an invalid concern because in the real world, there are many more flowers.

In conclusion, how teacher co-played in the space also influenced students' engagement and agency over the course of the lesson. The lack of agency and engagement was particularly visibly when students developed and articulated an emergent problem that didn't align with lesson goals. This impacted the discussions and conversations that occurred throughout the final two episodes. As Flora tried to re-direct and engage students in the new problem of how bees communicated, the discussions in *episode three* and *episode four* were mostly Flora re-articulating and re-stating the rules of play instead of sharing and discussing ideas around how bees communicated. This led to Flora walking up to the sun and hive, heavily hinting and eventually giving to students the type of response she was looking for.

Prompts and questions during play. Both Flora and Lily also provided guiding comments, prompts, and questions in play lesson #2. However, the difference between the two conditions is not *if* teachers provided guidance or structure. Instead, the difference between Flora and Lily was *when* the prompts and questions were used to guide and structure students in play. Recall in *episode three* when Lily began to more heavily organize and guide students in the set-up of play. This was because she wanted students to test the idea of signs and communication. As Lily began to shift and transform the students' ideas into activity goals, she provided more

organization and structure during discussion. However, because she gave time and space for students to articulate a problem and invent solutions and strategies, students' agency and engagement were not impacted in the same way as Flora's students (Table 4).

In Flora's guided approach condition, the level of guidance and structure was higher than Lily's from the start of the lesson. This level of guidance worked at first when both students and Flora aligned on the activity goals. Since both Flora and students wanted to test the strategy of spreading out, Flora's guidance and structure didn't impact students' agency and engagement in the way it did in later episodes. As the episodes unfolded, students began to articulate an ongoing problem of crowding around flowers. In an attempt to re-engage students as they grew more interested in the issue of crowding around flowers, Flora reminded students throughout both play and discussion the goals and rules of each activity. This led to a final discussion that felt incomplete because Flora spent most of her time re-articulating rules and emphasizing the use of the sun and hive as resources.

Importance of Play and Affect in Learning Science

One of the most unique and powerful effects of this study was the creation of the Pollinator Paradise. Pollinator Paradise illustrated the impact play had on learning, as well as the importance of designing opportunities for students to experience affect. In what follows, I expand on Jaber & Hammer's (2016) work on the importance of affect while doing science, and argue for the inclusion of the dramatic aspects of play.

In chapter 6, I presented my analysis and findings on the impact of dual affect as part of the inquiry process. The display of affect in the ending conversation illustrates why students sustained their interest, agency, and engagement. This was an important finding because the dramatic and affective parts of play supported student thinking about different perspectives.

When Ren couldn't grow, his dramatic display of sadness and frustration opened up the conversation for students to think about the importance of bees. Without bees, flowers like Ren would die while flowers like Cedar would grow. By taking on the perspective of a dying flower, a hungry bee, or even a thankful flower, students empathized with their roles and deeply reflected on the importance of them in our ecosystem. This was visible throughout the pieces of art, as well as the culmination of the Pollinator Paradise that was created and displayed until the end of the school year.

Like Lily, I also attribute the level of sustainability and lasting engagement students had to the final play lesson. In my literature review, I expanded on the importance of emotions, or affect in both play and science education. I believe the role of affect in both play and learning should be one of the defining characteristics, and most important motivating factors, in engaging and sustaining student agency.

While Lily's open approach of implementing play was part of my study design, her introductions to play lesson where she matched the dramatic, joyful, and excited tone of students was her decision alone. Lily's tone through the lesson not only matched the excitement students had while learning through play, but she added her own drama and interpretation to the lesson. For example, her decision to buzz each student in was not scripted or pre-planned as part of our study design. Lily buzzed each student through the bee-o-matic 6000 on her own.

Lily's role in dramatizing the learning experience for students is important because it set the stage for students to perform these dual affective responses. When Red died in the last lesson, both Ren and Willow were screaming dramatically at one another. While this volume of speech is usually not accepted in classrooms, these interactions were part of dramatic play, making these emotional displays an acceptable form of learning.

In conclusion, I argue that while play can engage students in learning science, it is the dramatic and affective characteristics of play that led to sustained student engagement and agency. The emotional involvement while imagining themselves as bees and flowers led to dual affect. Play is unique in that it provided students with a space for dual affect to emerge. In particular, the perspective taking aspect of play encouraged and welcomed students to think deeply about the interdependent nature of pollinators and plants. It is also important to connect Lily's roles as the teacher in play to the dramatic interactions in play. Throughout play, Lily continued to follow students' ideas and accepted students' dramatic and excited tone as a valid form of participation.

Implications

My dissertation sought out to examine the different ways teachers can implement and structure play for teaching science. I have found that while the guided approach worked well for moments when students and Flora were aligned, students' agency and engagement were impacted when teachers over-guided play. This was most present when students grew interested in emerging problems and ideas as play progressed, leaving little room for students to explore and test their own ideas and conclusions.

Additionally, I found that the open approach sustained student agency and engagement not only throughout the play unit, but long after the lessons ended. I also want to draw attention to the importance of affect in Lily's class, both displayed by students and Lily in the last discussion. The role of affect, specifically dual affect, brought students perspective and opportunities to emotionally connect with the world. This led to a deeper conversation and connection to the importance of bees in sustaining plant life. We saw this in chapter 6 when Ren "cast" the bees and Willow shouted back that she was helping him. This interaction, of students

shouting loudly at one another was not only accepted by Lily, but Lily matched a sympathetic tone when Ren displayed distress.

For the reasons I state above, I argue that in addition to the three roles of teacher guided play (introduce play with props, co-play, and provide comments and questions), there needs to be a fourth characteristic that encompasses the teacher's role in matching the affect of students' play. This included the examples of Lily buzzing each and every student into the space, her sympathetic tone as Ren died, and her excited and happy tone as Cedar grew.

Further work. In addition to the implications and impact on student engagement and agency, further work is needed to understand how play and affect can impact other core scientific practices. The National Science Teachers Association identified eight practices: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information (National Research Council, 2012). Findings from this study can be used to further investigate how play and affect can provide a place for students to engage in the other practices identified by the NRC (2012).

While this study aimed to examine and argue for the inclusion of play for learning, it is important to also clarify that this work does not replace free, unguided play outside the classroom. Rather, I view this work as an extension or further use of play in elementary classrooms. In short, I argue that schools should make room for more play, both in and outside the classroom as part of a longer learning process for students. While further work is needed in understanding how we can implement play for learning, it is important for teachers to make room for these dramatic experiences that engage students long after the lesson ends.

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