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Scaffolding Emergent Academic Language with ELL Children: Multi-Touch Tables in Preschool

by

Catherine Anne Miller

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

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of the

University of California, Berkeley

Committee in charge:

Professor P. David Pearson, Chair

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Scaffolding Emergent Academic Language with ELL Children: Multi-Touch Tables in Preschool

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Catherine Anne Miller

Abstract

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Professor P. David Pearson, Chair

Exposure to academic language in preschool classrooms has the potential to provide English language learners valuable practice in academic language registers, a precursor to later success in literacy. The purpose of this study is to evaluate the potential of a multi-touch table app as a setting for a teacher delivered conversational prompts for preschool students. In this study, forty-two preschool students participated in an experiment in which ELL oral language production was measured while at they were playing with a multi-touch table. The research design was a multiple baseline single-case design (SCD) with pre-post assessments. Proximal measures of change in the quality and quantity of case-study student language were measured through a qualitative analysis of transcribed video sessions and continuous vocabulary assessments. Distal measures of language change were measured pre- and post-intervention with The Boehm Test of Basic Concepts-3 Preschool, and the Preschool Emergent Literacy Indicators test (PELI).

Visual analysis of the SCD graph and proximal vocabulary measures provides reasonable evidence that the intervention likely accounted for the positive changes in the quality and quantity of student utterances. These changes in student language behavior did not transfer to the distal measures of general language skills.

The data corroborate previous research describing the generally non-verbal nature of student interaction with screen-based tools, like the touch-table, in a business as usual condition. Productive talk is apparent mainly when a skilled adult was present and active in encouraging student interaction. Data show that in the treatment phase, ELL student academic language production mirrored the baseline phase data of their high-language peers. In addition, ELL tier 3 vocabulary acquisition was strong into the maintenance phase of the study. Implications are that multi-touch tables have the potential to become a valuable setting for activities designed to scaffold emergent academic registers for ELL students.

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Chapter 1: Theoretical Framework and Review of the Literature

Knowing how to instruct students in reading comprehension is a persistent challenge. Since 1970, the US government has sponsored the National Assessment of Educational Progress (NAEP). NAEP produces the Nation's Report Card, an effort to inform the public about the academic achievement of elementary and secondary students in the United States. According to the 2011 NAEP, only 67 percent of fourth-grade students are reading at or above Basic, which NAEP defines as partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade (National Center of Educational Statistics, 2011). According to the NAEP, fourth grade student reading scores have not changed significantly from their 2009 levels. Correlational and longitudinal (Kieffer, 2012) studies link verbal skills as early as preschool to later reading comprehension, and those studies have focused on the relationship between oral language and SES find that low-income students begin school at a with lower levels of the critical cognitive and linguistic skills than their middle-income peers (Hart & Risley, 1995; Lonigan & Shanahan, 2008). The persistence of low reading scores in public schools is a clear indication that we have much to learn about how to teach children to read, especially in the area of comprehension.

Of particular importance is the reading gap between English language learner (ELL) students and their native English peers. My focus on ELL students stems from (a) the demonstrated need of this population for effective tools and developmentally appropriate instruction (Snow, Tabors, & Dickinson, 2001) and (b) a documented lack of skilled instruction available for this group of students (Smith & Dickinson, 1994; Snow, Burns, & Griffin, 1998; Wright & Neuman, 2014).

In the past 20 years we have learned a lot about how to teach early literacy skills that make a difference in short and long term student outcomes (less so for English learners) (Beck & McKeown, 2007; Dickinson, 2013; Dickinson & Smith, 1994; Thomas-Tate, Washington, & Edwards, 2004; Wasik & Bond, 2001). The success of read-aloud activities as a means to scaffold oral language skills in low SES students has been both well-documented and incorporated into regular preschool practice (Smith & Dickinson, 1994) though scaling up research successes has varied at the school and teacher level. We also know that the skills a young child brings to the classroom, especially their language skills, dictate what instruction he or she will be able to respond to. So how does our knowledge of instruction for low-income students transfer to a growing population of English-learner students within their ranks?

Complicating the picture are rapidly evolving digital tools. Digital tools such as e-books on tablet computers have made their way into the preschool classroom, adding their multi-modal affordances of sound, concrete objects, and interactivity to the instructional mix. How do we apply what we already know about oral language development with traditional classroom tools such as interactive read-alouds, small group activities, and playful but intentional instruction (Roskos & Christie, 2012; Wasik & Hindman, 2012; Dickinson, 2011; Dickinson & Smith, 1994; Heisey, 2009; Silverman, Crandell, & Carlis, 2013; Wasik & Bond, 2001) to emerging digital settings in preschool? This question is particularly important to answer for ELL students when we contrast their need for oral language development with the persistently non-verbal nature of digital tool use (Plowman & Stephen, 2007).

The purpose of this study was to understand the potential of a multi-touch table app to

enhance the quality of oral language production for English-language learner (ELL) preschool students. Specifically, this study investigated teacher use of interactive prompting to stimulate vocabulary and syntactic development as students' worked/played on a multi-touch table in small groups. My guiding hypothesis was that effective scaffolds currently used with traditional print texts, and instructional moves that support the use of problem-solving and exploration with digital tools, can be effectively combined to enhance emergent academic language skills of English learner students.

This is a study using a digital app to promote social interaction designed to influence the acquisition of oral language among ELL students from low-income families. The current study is grounded in several research literatures. Because the intervention is based on social interaction, a socio-cultural theory, and in particular activity theory, frames the logic of the intervention. The activity setting of the intervention is a technological tool, and evidence of the usefulness of this class of tools to support social interaction is reviewed here. Because the participants in this study are pre-school English learners, research on the relevance of developing particular types of oral language ability—namely the verbal skills used in school that predict later reading comprehension—are important to describe as the motivation for this work.

Socio-cultural Theory

Sociocultural theory, derived from the works of Lev Vygotsky (1978) describes people as having two kinds of mental development, the first, the level of mental development we have already attained as a result of previous developmental cycles and the second, the potential to grow, or the distance between our actual developmental, as determined by independent problem solving, and the level of potential development determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978). It is the second kind of development in which literacy teachers and researchers are most interested. When we think of the strongest instructional models we can devise, we are less interested in what children can do on their own than in what more they could do with the support of knowledgeable others with tools and artifacts to scaffold their learning (Brown & Reeve, 1985).

Socio-cultural theory suggests that (a) individual thought processes begin through social interaction and (b) mental processes share organizational properties in common with social situations from which they were derived (Wells, 1999; Wertsch, 1994). Vygotsky (1978) describes the construction of all deep conceptual development, or higher functions, originating as relations between individuals. For example, when teachers enact a learning environment, it awakens in the learner a variety of internal developmental processes that function only upon interaction with people in his environment and in cooperation with peers. That is to say, that the development of conceptual knowledge in a child occurs two times, first on the social, or interpsychological level and second on the individual, or intrapsychological level (Vygotsky, 1978).

It is strategic to take a socio-cognitive perspective when looking for principles to design digital tools to support comprehension instruction for early elementary children (Nelson, 1993; Engeström, 2001; Stahl, 2002; Koschmann, 2012). The goals of early elementary comprehension instruction include (a) introducing new learners to schooling contexts and academic discourses used in school and (b) developing background and conceptual knowledge in academic domains even as they learn to read (Snow, 2002). Sociocultural concepts provide tools to explain how

children develop the foundational abilities for comprehending conceptual knowledge through teacher/child and group interactions using mediating artifacts such as a printed text or digital tools to reach an objective (Brown & Reeve, 1985). The sociocultural perspective, particularly activity theory, which we will discuss next, delineates how cognitive tools or cultural artifacts mediate comprehension in an instructional context (Gavelek & Bresnahan, 2009), even for children who do not yet know how to read printed text (van den Broek et al., 2005).

Activity theory. Activity theory is an extension and refinement of Vygotsky’s sociocultural framework and contributes to our understanding of cognitive development (Engeström, 2001 Rogoff, 1990; Cole, 1996). This theory is grounded in the *situated* nature of learning; human thought emerges in the context of activities that are embedded in specific social and cultural settings (Engeström, 1999). From an activity theory perspective we see a structure of human activity in which an individual (subject) engages in a goal-directed activity (object) with the assistance of a mediating artifact in order to meet a need or desire. The interaction between the subject, object and mediating artifacts is synergistic; each component can mediate other components, thus shaping the entire activity (Cole, 1996).

Activity theory provides conceptual tools building on a sociocultural perspective in which conceptual knowledge is first externalized through dialogue between an expert and a student and then internalized as a way of knowing, driven by individual goals and mediated through artifacts such as text, resulting in negotiated and co-constructed forms of knowledge (Cole, 1996; Gutierrez, Baquedano-Lopez, & Tejada, 1999). Activity theory has evolved as a theoretical tool the help us understand (a) the role of interaction and learning artifacts, and (b) the function of dialogue, multiple perspectives, and entire networks of interacting activity systems. A network of interacting activity systems might look like small groups of students working on a goal-directed activity with a common mediating object (Engeström, 2001). Wells augments the activity theory diagram (see Figure 1.1) created by Engestrom to show that tools and signs of participants in joint activity are included but not necessarily shared. They contribute to the outcomes dynamically. He also mentions, but does not pursue, the evidence that non-verbal signals (para-language) contribute to the eventual outcomes (Wells, 2002, p 58).

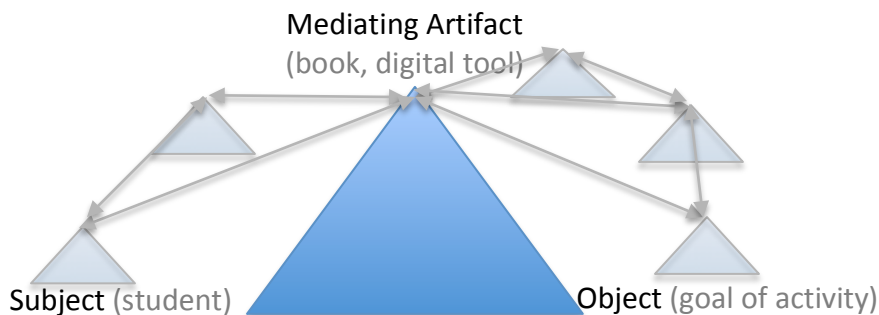


Figure 1.1: Activity Theory Diagram

Groups as subjects. As opposed to considering the subject of an instructional interaction as one individual, neo-Vygotskian theories posed that the subject can be construed more

flexibly. A network of interacting activity systems might look like small groups of students working on a goal-directed activity with a common mediating object (Engeström, 2001; Kaptelinin & Nardi, 2006). The socio-cognitive perspective states that the child and the social world are involved to an extent that precludes regarding them as independently definable (Flavel, 1994). People are special because we develop our cognitive abilities in situ with others, and that in fact it is the interaction with others that allows for cognitive development. In the socio-cognitivist view, this networking is a precondition for cognitive development. Rogoff (1990) describes socio-constructivism and the implications for cognitive psychology when she makes the case that socio-culturalism changes the unit a developmental psychologist studies, shifting from the individual to the group in activity.

The rationale of this study is based on the conceptual tools of activity theory, and I have structured the review of the literature to emphasize the role of the conceptual tools of subject, object and mediating artifact. I will review the rationale for positioning small groups as the subject, digital tools as the mediating artifact, and emergent academic language as the object of the instructional setting. After presenting the rationale for this structure, I explain and support the premise of the study through the empirical literature on language development and its connection to later literacy skills.

Software as a Mediating Artifact. Consistent with the model of activity theory, I propose digital technology in a classroom context as a mediating artifact (De Vries et al, 2002; Kaptelinin & Nardi, 2012). Like a book, software becomes the focusing point of dialogue and action and a means of representing elements in a discussion. Because this study is concerned primarily with social interaction as a means to support the acquisition of oral language, software is considered as a tool to support the meaning-making possible through face-to-face interaction. This perspective on technology in the classroom is consistent with the premise of sociocultural models of comprehension instruction taken from pre-digital classroom contexts. Specifically, this instruction is intended to support deep concept development and the situated practices of negotiating meaning-making within domains of knowledge through the use of mediating artifacts (Stahl, 2002).

Mediating artifacts in this case refers to technology, specifically as software designed to support the collaborative learning of those that use it (Kaptelini & Nardi, 2012). No matter the technology used, the relevant question is how does the teacher or expert in the classroom use it as a mediating artifact to support development of conceptual knowledge. For example, a computer simulation of the process by which hydrogen and oxygen form to make water would be a mediating artifact, or the text, that a group could use to discuss and with which to form questions in a science lesson. It is this conception of software creating a mediating artifact for meaning making that provides a promising approach for preschool oral language development. Teachers and students can use the alternative modes of conceptual representation possible with digital tools to support concept development in developmentally appropriate ways (Kendeou, Van den Broek, White and Lynch, 2007).

The role of software in promoting comprehension. In gathering studies for this review, I found several ways in which researchers have examined comprehension development in the context of technology tools. Most of these studies were conducted with older students, but they are informative when we consider what might be possible in oral language development with very young children. I examined studies that provided positive results for developing the

academic discourse used in comprehension instruction in settings using the computer as a mediational object.

Positive results were found for activities that used digital tools to scaffold student reflection (Puntambekar, 1995; Zhang & Son, 2011) and subsequently helped students retain more domain knowledge. For example, Zhang and Son (2011) conducted a study with 22 fourth-grade students focused on comprehension of science domain knowledge using *Knowledge Forum*, a networked collaborative knowledge-building environment. Content analysis of student portfolios, classroom videos and discourse analysis of student and teacher notes in knowledge forum showed deep cross textual comprehension. This comprehension was evidenced by reading practice along four themes: reading for the purpose of advancing community knowledge; as progressive problem solving; embedded in sustained knowledge-building discourse; and as dialogues between local understanding and knowledge in the larger world.

Positive results have also been found in changes to peer negotiated meaning-making (Zurita & Nussbaum, 2004; Lai & Law, 2006; Chung & Walsh, 2006; Wood, Littleton & Chiera, 2005; Lund, Molinari, Séjourné & Baker, 2007; Gomez et al., 2013). As an example of a study focused on the effect of digital tools on negotiated meaning with very young students, Gomez et al. (2013) explored the use of *Single Display Groupware* (SDG), which allows multiple co-located individuals, each with his or her own input device on the same machine, to interact simultaneously on a single communal display. This technology was intended to create an environment that required children to collaborate in order to reach a certain goal. The collaboration supported the simultaneous visualization of elements involved in the tasks. The study sample included 286 kindergarten students and used a quasi-experimental design with a control group to assess the intervention with children from a densely populated, lower-middle income area in Chile. It is worth noting that the experimental group had a performance inferior to that of the control group in the pre-test, and a superior performance to the control group in the post-test. Although both groups progressed, the experimental group's performance was clearly better than that of the control group with large and medium effect sizes respectively. The effect size of the intervention, which is a widely used index of the difference between improvement of the experimental and control groups, is 0.54, considered by convention (Cohen, 199x) to be a moderate effect size. Achieving common goals through collaboration on co-located single displays with tasks that centered on curricular contents contributed to the children's achievements in the intervention group. The implementation of the intervention highlighted the importance of offering settings where students in early childhood can share activities and develop collaboration while learning basic skills. It also highlighted the importance of careful teacher support during these activities to facilitate the collaborative interactions among children, and to strengthen the role of the teacher. Tools such as co-located single displays have been shown to support interaction when teachers integrate them into their regular work and mediating accordingly with the children.

Basic reading skills and digital tools. Digital tools could support basic reading skills for older students (Zurita & Nussbaum, 2004; Tsuei, 2011). In an exploration of *Electronic Peer-Assisted Learning for Kids* (EPK), an online tutor system for peer-assisted learning, on the quality and development of reading skills of 4th grade students, Tsuei (2011) conducted a quasi-experimental design with 46 students arranged in heterogeneous dyads split between face-to-

face and online pairs. The peer-assisted learning strategy was more effective when applied in the context of online participation. EPK provided instruction-guiding buttons, question-posing buttons and emoticons, which effectively facilitated students' interaction while learning activities online. His findings showed higher scores for the online tutoring group than the face-to-face group (small effect size = 0.178) in Reading Skills (building words and vocabulary) but not for higher-level language arts activities (making sentences longer or shorter by using adverbial clauses or other language skills). With these more global results in mind, we can turn to digital tools supporting basic reading skills with preschool students.

Digital tools in preschool. Literature reviews exploring the integration of comprehension instruction and technology, while finding modest positive results using educational technology in general (Kamil & Chou, 2009; Kulik, 1994; Reinking & Bridwell-Bowles, 1991) have not synthesized what we know about early elementary comprehension instruction using digital tools specifically. There is a striking lack of theoretical or practical knowledge about how digital tools function in place of more conventional mediating artifacts, such as hard-copy books, that they are rapidly displacing in the classroom. There is no shortage of enthusiastic endorsements that acknowledge the broad promise of multiple media to provide visual, audio and interactive experiences that link to literacy skills we want to learn (Plowman & Stephen, 2003). More cautious assessments of utility in the classroom arise when researchers drill down to find evidence of growth in skills that are associated with literacy, like vocabulary development, oral language and comprehension (Belo, McKenney, & Voogt, 2014; Radich, 2013). I agree with Korat and Shamir (2008), who present the multi-media affordances of ebooks as a possible support for emergent literacy with low SES students, though their data provide support for a constrained set of skills (word recognition and phonological awareness).

Digital tools such as programmable objects and video games have been linked theoretically to socio-cognitive theories of learning (Papert, 1980; Veenstra & van Geert, 2010). The overwhelming empirical evidence supports student gains in code-related precursors of reading (Neuman, Newman, & Dwyer, 2010; Roskos, Burstein, Shang, & Gray, 2014; Gee, 2004). These code-related gains, namely alphabet knowledge, phonological awareness and phonics, are linked to one another. The pattern of positive findings for code-related skills, but a lack of support for gains for oral language skills, may map on to the relative knowledge constraints required for each skill (Paris, 2005). Code based skills are mapped to what Paris labels the most-constrained side of a scale, meaning that there is an upper-end to the knowledge required to master that skills (i.e., naming the 26 letters of the alphabet for alphabet knowledge, or breaking a word down into phonemes for phonological awareness). Students generally learn code-based skills through games with known-answer questions (i.e., the first sound in *dog* is /d/), and repetition (i.e., the alphabet song), through introduction to the books in which the answers seldom change (the front of a book generally has the title, illustrations in the book generally relate the text, and text is read left to right, from the top to the bottom of the page). Once students learn these code-based rules, they seldom need to learn them again. And while mastery of these code-based skills preschool or kindergarten is a predictor of reading comprehension in early elementary, it describes only part of the skills picture that students need for success in school.

On the other side the constraint scale is oral language and vocabulary development, which Paris identifies as relatively unconstrained, meaning that there is no practical upper limit

of knowledge (i.e., people continue to learn new vocabulary and comprehend more language throughout their lives). Oral language and vocabulary in preschool are predictors of comprehension in upper elementary and beyond (Dickinson, 2013; Whitehurst & Storch, 2002).

Not only is oral language and vocabulary unconstrained, students generally learn comprehension development in very young children is cross-modal, meaning that children can learn equivalent comprehension skills through more established forms of technology like television. Kendeou et al. (2007) conducted a six-year study assessing the cross modal nature of comprehension. Researchers found evidence that narrative comprehension skills transfer across media and are highly predictive of reading comprehension once children begin to read. Vocabulary was related to both reading comprehension and non-text narrative comprehension. The important point here is that comprehension skills are not systematically related to foundational literacy skills like phonological awareness, letter or word identification (constrained skills). These two essential strands of knowledge develop simultaneously and in fundamentally different ways.

I think it is important, when construing skill development in a digital context, to pay close attention to the relative difference between constrained versus unconstrained skills. It is the constrained skills that are more ideal to program for digital tools in preschool when these tools are designed for individual student interaction independent of adult mediation. Students are exposed to and can play with sounds and letters independently and with positive results. Unconstrained skills, like oral language and comprehension, have long been supported through the responsive scaffolding of adult and peer interaction, often in settings that use multi-modal tools like those used in Kendeou's 2007 study with cross-modal media such as television, or at meal-time, in small group play with concrete objects, and of course during read-alouds when questions about a narrative or informational text are introduced and explored with the teacher and peers. In each of these settings, students are presented with immediate and authentic stimulus which they can either see, hear and/or touch. The new information is immediately understandable (not mediated through text, which they cannot yet decode), and in the most productive cases, scaffolded by an adult who introduces new vocabulary and facilitates the mediating object/student interaction in a productive manner.

We are still trying to understand ways to use digital tools to build oral language skills in young children from low-income families. Recall that ELL students often come to school needing oral language as the object of their instruction above and beyond that of their middle-income peers. However, my review of the literature provides no support for independent student use of digital tools as a scaffold for the oral language or vocabulary development that characterizes emergent skills in comprehension. It is plausible that digital tools supporting unconstrained literacy skills in preschool must accommodate interactive social settings for authentic communication scaffolding for students still mastering the register and knowledge demands of school-based communication. A multi-touch system, which provides immediately understandable information in the form of video, sound, and manipulation of concrete objects in a small group context, is one type of tool that might provide the multi-modal artifacts and (when used with a teacher and peers) accompanying social interaction needed for oral language and comprehension development with ELL students.

Multi-touch systems. Multi-touch systems (see Figure 1) allow simultaneous input from multiple users on a touch-screen (George et al., 2011). Previous screen technology used for

collaborative learning activities required students to share a mouse and keyboard or take turns with a touch-screen. The most recent studies on multi-touch screen technology take into account the small group structure of the table as an opportunity to combine both process and content, including the importance of an interactive peer-to-peer environment and the facilitating role of the teacher in a socio-cultural framework (Lee, 2012).

Research on the use of multi-touch tables as a collaborative context for both content and process providing “a socio-culturalist flavor” has been approached with caution (Vangsnes et al., 2012; Dillenbourg & Evans, 2011), with a focus on the components of the environments and their relative contributions to student outcomes including the design of the software (Higgins et al., 2011), the ability students bring to the user-interface, the strength of the link to pedagogical objectives, and the role of the teacher (Klien, Nir-Gal & Darom, 2000; Voogt & McKenney, 2007; McKenney & Voogt, 2008; Dillenbourg & Evans, 2011; Simon, Nemeth & McManis, 2013; Yelland, 2010). For example, studies of language and concepts development in the context of the tables have provided some data supporting broad positive outcomes for student participants (Higgins et al., 2012), including a positive relationship between use of the table environment for increased joint attention and activity for older students (Higgins et al., 2012), content-specific discourse and collaboration (Higgins, Mercier, Burd & Joyce-Gibbons, 2012; Mercier & Higgins, 2013), and the manipulation of ‘concrete’ objects that allow students to hear and interact using conceptual knowledge (Clements, 1999; Higgins et al., 2012). There is also evidence that multi-touch tables when used as an independent activity center evoke a qualitatively different kind of collaborative discussion in older students (Harris et al., 2009; Higgins, Mercier, Burd & Hatch, 2011), though there are no studies on oral discourse to date with younger students in these particular settings.

It is hypothesized that table-top technologies provide more accessible opportunities for young children who can use pictures and sounds to make meaning while interacting with peers and adults (Vernadakis, Avgerinos, Tsitskari & Zachopoulou, 2005). Multi-touch table apps designed for preschool students provides exposure to information-rich contexts (like tide pools or outer-space) paired with audio that provides contextualized content and sophisticated vocabulary. The small group format can accommodate an adult mediator to facilitate the activity for a language-rich experience. Multi-touch tables provide an activity setting that combines the predictable and information-rich content of informational books with the hands-on, albeit highly structured, exploration of the sandbox (Dillenbourg & Evans, 2011; Mercier & Higgins, 2013). These opportunities are especially valuable for ELL students who, more than students who speak English fluently, must often resort to using these multi-modal tools to make sense of the world around them.

Studies of computer technologies that support comprehension make the point that technology is not a new element in comprehension instruction (Kamil & Chou, 2009), and that this new wave of technological innovation in tool use has respectable precedent, for example, with the invention of the printing press in the 15 century. Computer technology is qualitatively different, of course, folding multiple affordances into a single platform and so providing quick and easy access to video, sound and images that might have instructional use in the classroom. But teachers already use these instructional tools. Certainly we have access to video, audio recordings, and images for quite some time, and have used these tools to spark discussion or as a reference for accuracy about a model in the classroom. The difference may be that digital

tools provide a new breadth of media flexibility, access, and ease of resource allocation that lends itself as a tool to use in small group interactions. But as always, what matters for instruction is how we make use of those tools to support student learning. In early childhood, students predominantly learn through interactions between teachers and peers with oral language. The breakthrough in learning with technology for younger children may be to find ways of incorporating the face-to-face scaffolding that is more characteristic of ordinary instructional settings.

Oral Language Development as the *Object* of Instruction

Once children begin school, language functions as the medium with which they learn all academic content. A large part of their mastery of this content, from storytelling to social studies, rests on mastering the linguistic resources required to understand and communicate the content. More than just the vocabulary terms they need to define and use, children must learn to vary the manner in which they organize their discourse according to the contexts they must speak in (Schleppegrell, 2004). The importance of early language experience is clarified by Hart and Risley's 1995 study, which found that by age 3, children develop a level of vocabulary growth and a pattern of interaction that mirrors their parents and is resistant to change without intervention. We care about this because in spite of interventions aimed at supporting the lowest achieving students who need a good education to move beyond their socio-economic status, these students often enter school without the necessary skills to learn to read and never catch up. Rather than attribute low achievement to heredity or a cultural attitude of not caring about schooling, researchers focused their attention more closely at what was happening in the home before the children got to school, before age 3. Hart and Risley found a qualitative difference in the type of parent/child interactions co-related to parent income and education level. Higher income parents interacted with their children in ways that prepared them for advanced education, including asking questions, giving positive feedback, and refining understanding of vocabulary. Lower income parents interacted with their children in ways that promoted socially acceptable behavior, including reinforcing politeness and conformity. These differences in home language practices amounted to a significant gap in words known between high and low income children by age 3. Many students make the transition between the language of home and the language of school smoothly. The ease of their transition is supported by early experience with the language of instruction (English), and the forms of talk similar to school-type talk. Early experience with language is especially important for low-income ELL students (Goldenberg, 2011; Hammer, Scarpino, & Davison, 2011), because low-income students begin school with less of the necessary oral language skills than their middle-income peers (Hart & Risley, 1995; Lonigan & Shanahan, 2008) and tend to have less access to the instruction that supports oral language development (Wright, 2012).

Low-income ELL students must learn the discourse of schooling in addition to learning the content of their academic subjects. For these students, the object of an activity can become not only the academic content, but mastery of the vocabulary and forms of discourse used to communicate that content. So let's take a closer look at oral discourse in instruction.

The role of interaction in activity. Wells (2002) cites oral discourse as an indispensable mediational means, "Although it is still an 'operation' deployed to achieve the goal of the action, and hence is oriented to the object of the action, it is the dialogue itself that constitutes the primary action." (p 61). This perspective has advantages when considering developmentally

appropriate instruction for low-income ELL students who must simultaneously master content and discourse skills. A focus on dialogue at the expense of a more concrete outcome (like a drawing or other concrete product) represents a shift in instructional goal that turns attention from a product, or what artifact was produced from an activity, to a process, or what happened in the course of the activity. This is especially powerful when oral language development plays the primary action with mediational artifacts playing a lesser role, (i.e., learning and practicing particular vocabulary and forms of talk in the context of constructing a pattern, rather than constructing a pattern). The activity becomes the meaning-making context in which language development occurs.

Oral language development. We know that oral language development is supported with lots of opportunity to talk, talking in the specialized register of schooling, and the exposure and use of a rich set of vocabulary in early childhood (Beals, De Temple, & Dickinson, 1994; Henrichs, 2010; Huennekens, 2013; Mohr & Mohr, 2011; Snow et al., 2001). As early as preschool, students develop the linguistic systems that will transfer to their later literacy development through their participation in formal and informal activities with teachers and peers (Connor, Morrison, & Slominski, 2006; Dickinson & Smith, 1994a; “Handbook of Early Literacy Research,” 2001; Sticht & James, 1984; Whitehurst & Storch, 2002). In a longitudinal study of Head Start preschool students, Beal et al. (Beals et al., 1994) documented the positive relationship between verbal interaction and later cognitive and linguistic skills through coding the number and quality of adult/child utterances in home and school settings, coding for cognitive challenge and finding a correlation between extended discourse at age 4 to story comprehension at age 5 ($r = .49$, $p < .005$). This relationship was stronger for vocabulary ($r = .60$, $p < .0005$).

Beal’s study underscores what other studies have found, that opportunity and content of talk drives a change in vocabulary and comprehension scores (Henrichs, 2010; Kieffer, 2012; Snow et al., 2001), especially for low-income and ELL students (Huennekens, 2013; Mohr & Mohr, 2011) who come to school with little if any exposure to the types of verbal interaction used in school settings. This lack of exposure is related to the institutional structure of schools; schools are organized and run by a set of values that closely mirrors the values of middle and high-income families, so children from these groups have a relatively seamless transition to school. Low-income ELL students begin school needing to absorb both content and cultural information embedded in language content and register of school-based talk. We have determined elements of school-based talk, and how to apply these elements in instructional interventions intended to help students from non-mainstream communities, like ELL students, learn the rules and ways of talking in school (Beck & McKeown, 2007; Dickinson, 2013; Hindman, Connor, Jewkes, & Morrison, 2008; Neuman & Celano, 2006; Wright & Neuman, 2014). The form of talk students need to succeed in a school context, or academic English, includes decontextualized and specialized language (Anstrom et al., 2010; Schleppegrell, 2002). This register of language, familiar to students who come from highly literate homes, and typically high to middle-income homes, is generally unfamiliar to children from low-income families who speak a language other than English.

Emergent literacy encompasses the pre-reading behaviors and skills that are the developmental foundations of reading and writing (Kendeou, van den Broek, & White, 2009; Whitehurst & Lonigan, 1998). The developmental foundations of reading include both code-

related and oral language skills (Whitehurst & Lonigan, 2013; Whitehurst & Storch, 2002). The form of talk, and the skill students develop with academic forms of talk, are necessary to participate in classroom instruction that lead to effective vocabulary and comprehension skills (background knowledge, context) this aspect of oral language is thought to be especially important in the school years preceding fluent text reading, or when children are reading especially difficult texts (Lawrence & Snow, 2011). Oral discourse is also an essential way to move from teacher modeling to student application in the gradual release of responsibility model (Pearson & Gallagher, 1991).

From a systemic linguistics approach (SLA), language is the product of social forces, organized by implicit behavioral norms adopted by communities (Schleppegrell, 2002). A central construct of SLA is the notion of language registers. A register is a setting-specific set of language competencies that shape and reflect the roles and relationships between individuals and the content they are interacting about. Registers are identifiable by their specific linguistic features. The development of this academic register is crucial for language minority students to acquire in school for later academic success (Carlo et al., 2004; Dickinson & Smith, 1994; Vasilyeva & Waterfall, 2011). The acronyms BICS and CALP refer to a distinction introduced by Cummins (1979) between basic interpersonal communicative skills and cognitive academic language proficiency. Children from low-income homes, for a wide variety of reasons, come to school with more of the everyday language (BICS) and less of the oral language skills associated with later success in reading comprehension (CALP) (Dickinson, 2013; Neuman & Celano, 2006; Wright & Neuman, 2014). The distinction between BICS and CALP was intended to draw attention to the very different time periods typically required by immigrant children to acquire conversational fluency in their second language as compared to grade-appropriate academic proficiency in that language. Conversational fluency is often acquired to a functional level within about two years of initial exposure to the second language, whereas at least five years is usually required to catch up to native speakers in academic aspects of the second language (Collier, 1987; Klesmer, 1994; Cummins, 1981). Failure to take account of the BICS/CALP (conversational/academic) distinction has resulted in discriminatory psychological assessment of bilingual students and premature exit from language support programs (e.g. bilingual education in the United States) into mainstream classes (Cummins, 1984). To a significant degree, mastery of the academic register predicts reading comprehension in elementary grades (Storch & Whitehurst, 1998). Academic settings that support the development and practice of CALP are essential for the success of low-income ELL students as early as preschool.

Academic English. While the critical importance of academic English is widely acknowledged, less clear is a how to conceptualize the construct. In a review of the literature, Angstrom et al. (2010) established a consensus among the wide range perspectives that (a) mastering an academic register is essential for children to do well in school, (b) essential features of this register must be taught, including vocabulary and discourse structures, and (c) that this instruction is particularly important to ELL students with limited backgrounds in academic English. I've adopted the broad definition of academic English developed from the Anstrom et al. 2010 review the literature, as a being *developmental with trajectories of increased sophistication in language use from grade to grade, with specific linguistic details that can be the same or vary across content domains* (p. 4). Anstrom's study is useful as a means to further contextualize the focus of the current study of *emergent* academic English in preschool

settings.

Emergent academic English. Defining the emergent academic register means grappling with similar issues of multiple research strands that both acknowledge the importance of the emergent academic language construct but differ in the approach to explain what that looks like in the classroom. Because this study is seated in the socio-cultural literature, I have adopted the social context perspective for my conceptual framework, with an eye and an ear toward the wider conversation and range of perspectives around emergent literacy and academic registers. With this in mind, emergent academic register is characterized by decontextualized language and specialized vocabulary in a discourse context that positions the interlocutors in positions familiar to classroom situations (asking for or providing knowledge)(Dickinson, Darrow, & Tinubu, 2008). Dickinson, in a longitudinal study of oral language development in Head Start, uses a systemic linguistics approach (SLA) to present the emergent academic register as extended discourse: talk that requires participants to develop understandings beyond the here and now, requiring several utterances to provide explanations, in narratives or pretend play (Snow et al., 2001). Researchers who study literacy and oral language development have found a positive longitudinal relationship between emergent academic language and later reading comprehension (Dickinson & Porche, 2011). Sharing stories, asking and responding to open-ended questions or attention to contextualized vocabulary all constitute contexts that support some form of emergent academic language (Henrichs, 2010; Snow et al., 2001).

Academic English is developed in social situations and requires ample opportunity for students participate in modeling from teachers and to practice with peers (Wolf, Crosson, & Resnick, 2005). Emergent academic English is developed in the classroom when teachers and students engage in a dialogue in which the teacher models an interaction focused on deepening student understanding vocabulary and/or concepts of text. Adult mediation techniques that elicit the highest levels of interactivity that look like emergent academic literacy development include sustained focus on vocabulary, focusing student attention on the content or activity, expanding on student comments, encouraging peer interaction and reflection on the text, and regulating student understanding (Beck & McKeown, 2007; Duke & Shedd, 2008). Activity settings that support the development of emergent academic language include engaging and content-rich artifacts (i.e. texts) nested within an interactive and participatory framework facilitated by an adult but providing ample opportunity for child-led meaning making (Rogoff, 1994). Conventional activity settings that have supported accelerated gains in emergent academic language for ELL students include read-alouds with rich narrative or informational text paired with skilled adult mediation (Beck & McKeown, 2007; Collins, 2010; Dickinson & Smith, 1994; Heisey, 2009; Kindle, 2010; Price, Bradley, & Smith, 2012).

Teachers can and do model academic registers in a wide range of preschool settings, most often in read aloud settings. In a recent study to identify the factors that shape language use in the classroom, Dickinson et al. (2014) examined language in Head Start classrooms in an effort to describe the nature of this teacher support for children's acquisition of academic language. The researchers analyzed teacher/student interactions at the level of utterance. Teacher language variables included sophisticated vocabulary, diversity of words used, number of words used and syntactic complexity (talk about vocabulary, concepts and skills). The researchers found a relationship between preschool settings (Book Reading) and the presence

of emergent academic language. This data on the central role of the activity setting, and the value of the read-aloud setting as a place to introduce and support emergent academic language in particular, is supported by a significant set of studies documenting language intervention strategies (McKeown, Beck & Blake, 2009).

Adult Scaffolding in Instructional/Digital Settings

When it comes to the topic of digital tool use in the classroom, most of us will readily agree that learning to use the tool is essential for the lesson to proceed, but not the object of the lesson itself. Where agreement usually ends, however, is on the question of the activities the teacher should engage in when a digital tool is in use. Whereas common knowledge might have us believe that children can master and use digital tools easily, some researchers maintain that the use of tools requires adult support (Fortus, Dershimer, Krajcik, & Marx, 2005; Plowman & Stephen, 2003). Adult support with digital tools has been described as guided interaction, “including gesture, touch, gaze and, sometimes, the emotional support that comes from the proximity of a familiar adult” (p. 17). There is a strong argument to be made for the importance of learning how to use tools in the classroom, especially in early childhood. Anyone familiar with how young children use digital tools should agree that guided interaction allows children to proceed through an activity with more space for the cognitive development potential of an activity. When students are new to tools used in educational contexts, guided interaction provides a framework for teachers to help students acquire tool use skills in the context of activities focused on more abstract objectives (e.g., learning new vocabulary or understanding number concepts)(Plowman & Stephen, 2003). A seemingly overlooked aspect of screen-based educational activities, however, is the non-verbal nature of the task. Observational studies conducted by Plowman and Stephens characterize screen-based technologies in the classroom as strikingly absent of talk. They found that while on their own, children rarely initiated talk with peers or adults for any reason. Their framework of guided interaction accommodates this focus on the screen with non-verbal supports such as gestures and gaze because, in their words, the screen focus “inhibits communication as it made eye contact difficult.” (p.17).

Plowman and Stephens provide ample evidence that guided interaction during the use of digital tools frees children’s attention for challenging cognitive tasks, but what happens when the cognitive challenge is the language that frames and guides the process of the activity? I believe the guided interaction framework can be expanded to include cognitive outcomes situated in activity *processes* as well as activity *product*. Taking an example from a non-digital context, the cognitive outcomes of read-aloud settings includes the language skills students gain when interacting with the teacher in the context of the book (process using an academic register), as well as any knowledge of how texts work (product of understanding concepts of print) or content knowledge (i.e., product of content development) gleaned from the book itself. This emphasis on the desired outcomes of an activity residing partially in the interactional process harkens back to the argument by Wells (2002). Wells invokes and then extends the mediating artifact in joint activity from tools to cognitive gains acquired through dialogue. In activity theory, then, the subject includes all participants in a joint activity who work toward the same object. The mediating artifact is a tool, such as a text or in this study, an app. But mediating tools and semiotic signs (language, gestures) play different roles in the activity. For some activities, says Wells, the object and the dialogue may be one and the same. In the case of this study, the tool (app) and signs (adult/child interaction) are simultaneous and

complementary. This argument convinces me that guided interaction is an essential but not sufficient framework to use when language development is the objective of an activity including digital tools.

Adult mediation with digital tools. Studies focused on the relative contributions of context in the use of digital tools in the classroom found a significant effect for the role of the teacher (Vangsnes, Økland, & Krumsvik, 2012; Yelland, 2010). Adult mediation of student discussion and collaboration has consistently appeared as a confounding variable in efficacy studies assessing language skills development (Voogt & McKenney, 2008; Eagle, 2012; Klien, 2000; Rochelle & Teasley, 1995). Yelland (2010) makes the case that while digital environments can evoke a playful setting, play does not assume learning. Her review of the data on educational technology environments provides evidence that playful technologies require adult mediation to push learning by, among other things, listening to and responding to children's talk, questioning children in order to extend learning, and working alongside children to model skills and the use of key vocabulary. For example, Vangsnes, Økland, and Krumsvik's 2012 study on the use of educational computer games in the classroom found that student dialogue took place only when the teacher was present. My point is not that children are unable to gain valuable cognitive skills through screen-based technologies, but that what seems to be the intrinsically non-verbal nature of these technologies matters when a key skill a child needs to develop is oral language.

Having established that guided interaction is essential but not sufficient for young children to develop oral language skills in the context of screen-based technologies, let us turn our attention to evidence of language development with screen based technologies albeit with slightly older children from middle-class families. In a quasi-experimental study examining the characteristics of effective adult-child interaction with Israeli kindergarten children in a computer learning environment, Klein (2000) found evidence supporting adult behaviors that resulted in pre- post test gains in vocabulary and abstract reasoning skills. These findings, emphasizing the role of expanding on child talk, verbal encouragement, paralinguistic communication expressing affect, align with research on interventions in more traditional settings (i.e., shared reading and meal-time settings), that find the quality of talk in a setting a more powerful predictor of student oral language gains than any specific setting (Beals et al., 1994; Dickinson & Porche, 2011; Huennekens, 2013).

Touch-tables are promising settings for oral language development. Using interaction and play with digital objects might be a powerful means to teach emergent academic language indirectly through authentic communication and concrete activity. For example, there is some support that children learn verbs indirectly, though listening to adult conversation or conversation with peers (Kaefer, 2012). This could mean that a multi-touch table could contribute to emergent academic language by the design of the activities and interactions between the adult and peers. The activity design in the app used for this study is much like a narrative text; there is a beginning, middle and end of each short activity. Children are engaged to solve a problem within a thematic context (i.e., outer space or a shopping mall). Kaefer makes the point that children learn during interaction because there is an emphasis on actions to push the activity forward, "As compared to object labels, for example, there are fewer natural pedagogical situations in which verbs can be directly taught to children. Verbs tend to be used to refer to impending or completed actions rather than ongoing actions." (p.7),

“Therefore learning new words may be a function of children’s ability to observe and interpret contingencies in the real world.” Kaefer surmises that children may use syntactic framing in a sentence to deduce verb meaning, using the structure of the language in context to deduce new word meanings, particularly new verbs. The narrative structure of the touch-table activities provide a likely setting to 1) accommodate multiple players around a single narrative while 2) authentically producing and using this syntactic framing.

Eliciting academic language in touch-table settings requires applying what we have learned in conventional settings. Understanding the use of guided interaction in concert with adult mediation helps to tease apart the moves that elicit particular responses in group interactions. What is clear is that both frames are essential for this learning context. Because use of the tool is not the object of the activity, adult mediation is required to provide the cognitive challenge and language development associated with later literacy acquisition. Adult mediation is more active in the use of linguistic cues than the guided intervention model proposed by Plowman and Stephens (2008), and the use of these linguistic cues can be challenging to provide. Consistent with what we have learned about scaling up read-aloud interventions (Wasik & Bond, 2001; Wasik & Hindman, 2011), table-top intervention studies that controlled for adult mediation found that untrained adults had difficulties in interacting with students in ways that modeled and encouraged the use of academic registers of language (McKenney & Voogt, 2008; Voogt & McKenney, 2007). We know skilled teachers who employ specific instructional moves in a learning setting successfully elicit academic language from students in diverse settings.

Bridging From the Literature To The Current Study

The premise of this study is that students from low-income families benefit from hearing and practicing certain types of talk in preschool. This premise rests on a strong research foundation that first categorized types of interactions based on family income and education, investigated preschool environments for types of talk associated with later academic success (Layzer, Goodson, & Moss, 1993; Smith & Dickinson, 1994; Wasik & Hindman, 2011; Wasik, Bond, & Hindman, 2006), and finally designed interventions to increase the types of talk associated with later literacy skills (Kaiser et al., 2011; Wilson, Dickinson, & Rowe, 2013).

The fundamental question of the current study is whether teachers, by augmenting the affordances of a technology tool designed to promote interaction and academic register with the very sorts of scaffolding that they use in ordinary small group face-to-face settings, can promote greater acquisition of both ordinary and academic language among English learners in a preschool setting. If it can be shown that a simple augmentation (teacher guided talk) to a digital tool with great potential can increase its effectiveness for this key population of English learners, it would provide important guidance for designers of digital tools and for teachers who use these tools in their classrooms.

Chapter 2: Methods

In this study, preschool students from ages 3.5 to 5 participated in an experiment in which English-language learner oral language production was measured while at they were playing with a multi-touch table. The research design was a four-phase (baseline, intervention, return-to-baseline, and maintenance) single-case study design (SCD) with pre-post assessments. The role of the baseline data collection was to measure ELL language production in a “business-as-usual” condition. It provided a benchmark against which production in the later intervention condition could be indexed. In the intervention phase of the experiment I used verbal prompts as language scaffolds to elicit an academic register from the case-study students. Return-to-baseline and maintenance phase data informed questions about behavior transfer and internalization of vocabulary. Proximal measures of change in the quality and quantity of case-study student language were measured through a qualitative analysis of transcribed video sessions and continuous vocabulary assessments. Distal measures of language change were measured pre- and post-intervention with standardized and criterion-based assessments. Three groups participated in the study, (a) case study students, (b) exposure-only students, and (c) test-only students. Group two provided data on exposure to the touch-table without the intervention, and group three provided data on maturation effects, both measured through the pre-post distal language measures.

In this chapter I will provide an overview of the study design and intervention procedures, modifications required to the initial intervention as the experiment unfolded, and a description of the equipment required to conduct this experiment.

Participants

The Population and Sample Characteristics

The participants were 42 Head Start pre-school students in a medium sized city in the Central Valley of California (age range 3.5-5). All students received parent-permission to participate in this study, though day-to-day participation rates varied by individual student inclination (see Group Construction for more details). No incentive was provided for any of these students to participate in the assessments. All research activities took place in the preschool classroom. The goal was to include as many English Language Learners as possible, especially for the treatment group.

Case study students. Originally I assigned 12 students as case study students. All case study students had to meet 3 criteria: (a) speaking Spanish at home and English at school, (b) achieving a low percentile ranking on the Boehm, and (c) receiving a recommendation from the preschool teacher as being ready for this type of group activity. As it turned out, 2 students out of the original 12 were dropped because of time limitations (not enough time for 6 group sessions in the pre-school day). As the study progressed, 2 of the remaining 10 were dropped because even though they met the criteria, they did not have the combination of attention skills and language skills to participate meaningfully in the group activities at the table. Of the remaining 8, 5 were assigned to the treatment condition and 3 were designated as control students (which meant that while they did not receive, either directly or indirectly, any

language scaffolding while they worked at the tables).¹ Of those three, only one, Yvonne, was able to sustain participation in the unscaffolded table activities. The others were dropped because their patterns of participation yielded too few data for meaningful analysis.² In the final analysis, 6 of the original 12 students completed the study.

Exposure-only students. Each small group intervention (see section on forming table groups in the procedures section) included two other types of students who, while exposed to the scaffolding provided by me to the case study students, did not receive any direct scaffolding. As a group, I refer to these students as exposure-only students.

High language peers. Each case study student was matched with a high language peer who tested in standardized assessments as within the average or above-average range of oral language development for the age group. These students helped to establish a high water mark for utterance quality and quantity in the context of the activity setting.

Incidental participants. In addition to high-language students, other students in each intervention classroom participated at the table, at their own volition, when the case study students were receiving language scaffolding from me.

Test-only students. Originally 16 students from another classroom (without a touch-table) at the same school served as a completely untreated control; that is they no opportunity, direct or indirect, to benefit from the intervention. They mirrored the language skill range of the two classrooms. This group will also allowed me to address questions about magnitude of change in the distal measures, specifically, *“what is the change in oral language development independent of the activity setting, due mainly to maturation?”*

Outcome Measures

Materials used for this study included video that was transcribed and coded, a researcher-developed vocabulary assessment of context-specific expressive and receptive vocabulary, an assessment of conceptual language, the Boehm preschool assessment, and an assessment of emergent literacy skills, the Preschool Emergent Literacy Indicators (PELI). All language assessments were administered pre- and post-intervention. Context-specific vocabulary was continually assessed throughout the intervention phase as well. Pre-assessment data was collected in the first week of the study. Students were taken to a quiet part of the preschool classroom and assessed 1:1. This took about 10 minutes per assessment, and I broke the assessments up into two separate sessions so students did not get too tired answering questions. Students did not have a lot of experience with taking assessments, and at times it was difficult for them to stay on task. In a number of instances the child being assessed would inform me that he or she was ‘done now’, and would walk away. In the first week, I also collected baseline data on language use at the multi-touch table. What follows is a description of each assessment.

¹ While it is not necessary to have control groups to establish the experimental criterion in a single-case design study, preschool students present such a wide range of language and social skills that for this context it was useful to include additional controls to reject a null hypothesis.

² I could have used their data, but it is largely non-verbal activity (e.g., moving objects, taking things from others, responding with movements to my guidance, and occasionally making an utterance that more likely than not was unrelated to the game). The one student who remained, Yvonne, provides the best case scenario for participation as a control student.

Proximal Measures of Vocabulary Acquisition

Proximal measures of vocabulary included a researcher-designed expressive and receptive vocabulary assessment consisting of words encountered in the context of the activity. The use of a researcher-designed assessment as opposed to a standardized assessment of expressive and receptive language is appropriate for the objectives of this study. The vocabulary assessment is a proximal measure, intended to measure growth in individual student vocabulary derived from participation in the study treatment, not general vocabulary growth.

Content-specific vocabulary assessment. The receptive vocabulary assessment was made up of tier 3 (Beck & McKeown, 2007) words that the students were exposed to in their interaction with the three themes (Outer Space, Forest, and Tidal Pools).

The full set of vocabulary words (n = 35) selected from scripts was used for pre- and during- intervention assessments in the six weeks of the baseline and intervention stages of the study. These were also the words selected for explicit instruction in the context of the intervention activity. All five case study students had an opportunity to learn the words and were continuously assessed in the context of the intervention. Case study data sheets recorded their assessment data on session by session basis. A random selection of these words were used in the maintenance phase of the study (see Appendix A for vocabulary used in this study).

Assessment protocols. The administrative protocols for the receptive assessment are adapted from the PPVT-4 (Dunn & Dunn, 2007), in which children are shown a set of three images (an image of the target vocabulary, an image phonetically similar to the target vocabulary, and a pleasing distracter image). The teacher asks the child to point to the image of the target vocabulary word with the prompt, “point to the _____”. The expressive vocabulary assessment is made up of the same tier 3 vocabulary words used for the receptive vocabulary assessment. The protocols were adapted from the CELF-Preschool 2 assessment (Wiig, Secord, & Semel, 2004), in which the teacher presents an image to the child and asks, “What is this called?”

The administration of the content-specific vocabulary (both receptive and expressive) was continuous, meaning that children were taken aside a few minutes before they began the table activity to take the assessment, and were asked to respond only to words they would encounter on the table in the upcoming session. This was the continuous part of the pre-assessment, in contrast to a pre- post-assessment that is administered before an intervention phase and then again after the end of the intervention phase. The ‘during’ assessment took place a few minutes before the table activity began. Once the table activity began, I would introduce and provide direct instruction on the target vocabulary as we encountered them in the context of the game. Throughout the course of the activity (which lasted on average 3.5 minutes), I would attempt to elicit the vocabulary word from the target student by asking he or she to name it or point to it when it appeared on the tabletop. Students who independently used the vocabulary were assessed as having known the word in the intervention phase of the study.

To make this process transparent, I will provide excerpts of these instructional and assessment moves in the context of the activity. In the example, Angel, the case study student, understands the idea of a mommy deer, but is learning the label “doe.” I reinforce the more sophisticated, or academic, label for the object that she and I have already explored at the start

of the activity.

Teacher: [showing a picture of a faun and a picture of a doe] This is a doe and this is a faun, and did you know that a faun is a baby deer? This is a faun and that's the mommy, the mommy is called a doe. Isn't that neat? [I put the activity on the screen] You guys want to play with some deers and fauns?

Angel: We've got to get the mommy deer!

Teacher: The mommy deer is a doe.

Once the target objects for vocabulary instruction were named, I prompted Angel to independently identify them either non-verbally or out loud. In all cases, if a student did not provide a correct response, a high-language peer or myself provided the correct response. I would ask all students to echo the target vocabulary word, and then I would repeat my request to the case study student to identify the target object. The example illustrates this manner of hinting and modeling follow up after explicit instruction of the word "doe." The students do not take the phonetic hint I provide, so I provide the word, and Camron, the high language student, goes on to provide more information by both pointing to and naming the objects.

Teacher: [pointing to the doe] That's called a [short wait] the mommy's called a /d/

Angel: /d/

Teacher: Doe

[Both echo]: Doe

Camron: Hey, there's two does!

Once the case study student provided a correct response (Angel, in this instance), I assessed expressive vocabulary first in a non-explicit manner by asking students questions designed to elicit the target word without a hint from me. For example, I would ask, "What do we put here?" or "What are you looking for?" In the example, Angel is the case study student, and the other group members (Camron and Abigail) are high-language peers. The activity requires them to sort four different types of forest animals into separate piles. The interaction between myself and her peers modeled the language register and content that Angel eventually produced, the target word "beetle," in the context of the activity. Once she independently produced the correct label for "beetle," I marked her case study form for that word on expressive contextualized vocabulary. I next encouraged her to use the word again so she would become comfortable and confident with the new vocabulary.

Angel: [pointing to a beetle] Spider.

Teacher: There's a beetle!! That's a tiger beetle! Where does it go?

Angel: Tiger beetle?

Teacher: Where does the tiger beetle go?

Angel: Right here. [indicating the correct place]

Teacher: [pointing to an elk] What's that called?

Angel: Beetle.

Teacher: That's an elk! [pointing to a beetle] And that's a beetle.

Angel: [pointing to a beetle] A spider.

Teacher: You got a tiger beetle! Where's another tiger beetle?

[Abigail leans forward and touches a beetle that needs to be sorted]

Teacher: Hey, Angel, I think they are trying to give you something! What are they trying to give you?

Angel: A beetle.

Camron: Beetle beetle beetle beetle beetle.

Angel: They are giving me a lot.

Teacher: Wow! What are they giving you?

Angel: A lot.

Teacher: A lot of what?

Camron: Beetles.

Angel: Beetles.

Because of the iterative and instructional nature of the intervention/assessment, students could sometimes provide correct responses to expressive vocabulary assessment prompts before they could provide correct responses to receptive vocabulary assessment prompts. Some assessment data, therefore, show a dip from baseline to intervention receptive, only to rise in the intervention expressive assessment. This is consistent with what we know about how children learn declarative knowledge through play (Van Reet, 2010).

Maintenance Assessment. Seven weeks after the end of the intervention, case study students were assessed on a randomly selected set (n=12) from the total set of vocabulary words. Subsequent analyses of growth from pre- to during- to post-intervention were conducted only for this set of words. I then back-mapped their data on these words from student case study data sheets from the first two phases of the study.

Measuring emergent academic utterances. The major proximal index of student language change is the rate of total and emergent academic utterances over time for the case study students. These data were compiled from the verbatim transcripts of the video recordings of the case study groups. From these transcripts, the quality and quantity of student utterances were counted. Utterances were coded for qualities of emergent academic language. As is the convention for single-case study designs, counts of the target behavior, in this case the total and emergent counts of student utterances, were then graphed onto a table for visual analysis.

The logic of visual analysis. Visual analysis is possible because of the nature of the intervention effects desired through single-case research, namely overt behaviors that can be counted in the context of the intervention. For example, in the context of this study, the desired behavior is student talk, measured at the level of utterance. Student utterances should rise quickly at the introduction of the intervention, demonstrating what Kazdin (2011) describes “clear and potent interventions demonstrating reliable effects.” (p. 286) that can be readily seen. Like statistical analysis, visual analysis helps to avoid the chance of a Type 1 error (concluding the intervention produced an effect when the results could be due to chance).

Visual analysis uses four characteristics of the data related to **magnitude** and **rate of change** across phases. Magnitude is related to mean and level. Rate of change is related to trend and latency. Changes in *mean* refers to a shift in the average number of utterances. Consistent changes in means of utterances across the baseline to intervention phase and then in the return to baseline phase helps to determine if participants are responding to the intervention. Change in *level* refers to the shift in performance from the end of one phase to the start of the next phase. The change of level is independent of the change in mean. Changes

in *trend*, or *slope*, refer to the tendency of the data to rise (accelerate) or fall (decline) over time within a phase. A horizontal trend is referred to as having 'no trend.' (for an example of a 'no trend' table, see Yvonne's baseline graph in Figure 3.1). A visible change in slope conveys that something happened that is reliable and change from the predicted pattern conveyed by the slope of the previous phase. *Latency of change* refers to the time it takes for a change in performance to appear between phases. The less time it takes for an effect between the termination of phase and the onset of the next, the clearer the intervention effect. In the case of this study, the immediate change of behavior desired is an increase in quantity of student utterances as well as an increase in the proportion that meet the "emergent academic language" criteria. This is related, but not directly descriptive, of the longer-term desired change of vocabulary and fluency in an academic register. Single-case research provides a means to measure behaviors related closely to interventions. In the case of this study, these oral language behaviors in preschool predict desirable behavior for later cognitive development. Another component of visual analysis is the amount of overlap between data points and phases. The characteristic of *non-overlapping data* refers to the finding that the values of the baseline phase do not approach the same level as the intervention phase.

While each element of the study is important, Kazdin (2011) reminds us that it is essential to look at all the parts together (See Figure 8 for all-participant picture). If there are changes in the means, levels, trends, and latencies and the data do not overlap, "there is little to quibble about whether the changes are reliable and meet the experimental data criteria." (p. 293).

An independent coder reviewed twenty percent of the activity transcriptions to check for number of (a) total utterances and (b) proportion that fit the criteria of EA. The level of agreement between the myself and the independent coder was calculated by dividing the number of agreements on the occurrence of utterances during each observational interval by the total number of agreements plus disagreements, times 100 percent. We achieved 98 percent agreement on total utterances and 73 percent agreement on the proportion coded for EA.

Measuring extended interactions. Throughout the enactment of the intervention, I encouraged groups attached to the treatment case study students to engage in extended conversations by (a) posing open-ended questions, (b) asking students to talk about target vocabulary, and (c) repeating and extending student responses to questions from myself and peers in the activity group. Many times students would respond to my prompts non-verbally (see the example of the open-ended questions), but a conversational interchange was coded only if there were two or more back-and-forth exchanges (or, if you prefer, four interactive turns) between myself and a student, or between peers, on a particular topic. The relevant outcome measure was a simple count of the number of interactions segments between that met the criterion for an extended interaction. Examples 1-3 illustrate interactions that meets the criteria for an extended conversation.

- Open-ended questions

Teacher: Where do you think this goes? [I point out a jellyfish]
Domenico [He puts a jellyfish into the pattern]
Teacher: Domenico, look what you did! You put a starfish, sea...
Samaira: [Answers for Domenico] ...horse

Teacher: You put a starfish, seahorse...what comes next?

Domenico Jellyfish.

Teacher: A jellyfish!

- Asking students to talk about vocabulary

Teacher: What did you find?

Angel: [Hesitates] Can you call it?

Teacher: Yea, it's a ladybug!

Angel: Ladybug!

- Repeating student utterances

Teacher: My favorite forest animals is an owl.

Angel: My favorite is bunnybears.

Teacher: Bunnybears?

Angel: And cockroaches and bunnies.

Social validity measure. Last, as is conventional in single case study design, a measure of social validity was administered to the teachers in the form of a survey (Appendix E) at the end of the study. The survey provides data to evaluate how important and appropriate this study was to the classroom, and to guide any changes that should be made if the study were to be replicated. Social validity procedures ensure behavioral research is socially significant and carried out in an ethical manner. For this study, questionnaires to teachers provided information on the perceived social significance of the goals, the appropriateness of the procedures, and the importance of the effects (Wolf, 1978). Teachers, who have contact with the students everyday, will determine the level of significance in behavior changes by completing the evaluation questionnaire.

Distal measures of emergent literacy indicators.

I used three distal measures of growth in emergent academic learning—the Boehm Test of Basic Concepts and five subtests of the Pre-school Emergent Literacy Indicators (PELI).

The Boehm Test. The final receptive vocabulary assessment is the Boehm Test of Basic Concepts-Preschool Version. The Boehm Test of Basic Concepts-3 Preschool is a norm-referenced test. This test measures relational concepts in preschoolers, such as size, direction, position in space, time, quantity, and classification. The concepts are important for children's understanding of the relationships between objects and for following directions. The assessment is designed to measure a child's knowledge of 26 basic relational concepts considered necessary for achievement in early elementary.

The Boehm served as the measure of emergent academic language instead of the more commonly used PPVT. While the PPVT is a standard measure for preschool oral language development, there is some question as to how appropriate it is for dual-language preschool students. Using the PPVT, which has a high number of developmentally appropriate items for young children (based on what children are familiar with at home), will likely provide an under-estimation of ELL participant vocabulary knowledge. Studies focused on validity for dual language preschool students argue that ELL children are more likely to know the names for objects and activities used at school in English, but not those objects and activities used at home (Garcia, McKoon, & August, 2006). Everyday objects are typically learned in a student's first language. Therefore, using a conceptual assessment in English was intended to capture the academic language I am interested in, without misinterpreting student language skills. The

Boehm Test of Basic Skills provided a measure of change over time in student's concept-oriented vocabulary they would likely have learned in an academic context.

Preschool Early Literacy Indicators (PELI). The PELI assessment (Kaminski, Abbot, Bravo-Aguayo, Latimer & Good, 2014) is a story-based assessment of emergent literacy skills (alphabet knowledge, phonological awareness, vocabulary/oral language, and listening comprehension) intended to provide teachers with ongoing criterion based data to support literacy instruction. Story-based assessments are designed as low-stress and authentic settings for young students who likely are unfamiliar with testing. The assessment is untimed, and the assessor provides models and a series of prompts to encourage children's performance. The vocabulary and oral language section of the test assesses children's ability to name and describe common objects. The listening comprehension section of the test assesses the child's ability to make predictions and inferences, to answer comprehension questions on a simple story, and to complete missing words in a story in a cloze task.

The entire PELI was administered by myself to all students in the two classrooms as a pre-assessment before the baseline phase of the study. In the maintenance phase I administered the vocabulary and oral language assessments, and the listening comprehension assessment which included the five subtests that had relevance to my study. The subtests included two vocabulary measures: (a) expressive vocabulary, and (b) tell about pictures, and three listening comprehension measures: (a) inference and prediction, (b) retelling, and (c) a cloze activity.

Expressive vocabulary. The expressive vocabulary subtest is designed to assess children's ability to name common objects. The assessor provides some time for the child to explore a colorful image of a common setting, like a playground or a bedroom. Next the assessor prompts the child to provide names for objects she points to with the prompt, "Here are some pictures of things you might see [on the playground, in the bedroom, in the kitchen, etc.]. I will point to the picture and you tell me its name." Students gain one point per picture they accurately name.

Tell about pictures. Tell about pictures is designed to assess a child's ability to describe common objects that he or she may or may not be able to name for the expressive vocabulary subtest. The assessor points to and then names a picture (i.e., This is a _____.) before asking the child to tell about it. The suggested prompt is, "Now I want you to tell me everything you know about some words. My turn first. I will tell you everything I know about a mirror. A mirror is made of glass and you can see yourself in it. Now it is your turn! Tell me everything you know about a _____." Students gain zero to five points based on their response pattern. Student response patterns are rated by their inclusion of sentence elements, including (a) subject, (b) verb, (c) object, and (d) descriptors.

Inference and prediction. The inference and prediction subtest assess the child's ability to make predictions about a story. After exploring the cover of the book, the assessor prompts the child with, "What do you think this story will be about?" As the story is read, the assessor prompts the child to make inferences based on the storyline with a prompt (i.e., How do you think Carla feels? Or What do you think Joey found under the bed?).

Recalling. Recalling poses who, what, when, where, and why questions to assesses listening comprehension of the child. Once the assessor has read the story to the child, a series of prompts guides a child's recall of the story (i.e., what was the story about? When did the story happen? Why was Carla excited to make dinner?, etc.).

CLOZE. The Cloze test assesses the child’s ability to recall the story with support. A series of pictures from the story are displayed within the book for the child. The assessor re-reads an abbreviated version of story and prompts the child to fill in the blanks with the prompt, “Here are a few pictures from the story. I am going to read the story again and when I stop, you tell me the words that go in the story.”

Reliability. Assessment in single-case design is commonly measured with individualized scales designed to take into account observable behavior at the time of an intervention, in this case for a ‘type’ of student identified in advance with standardized assessments. Measures are designed to assess target behavior, in this case, the quality and quantity of oral language produced with and without adult mediation. A reliable, consistent measure is one in which the observations are attained consistently, that is to say, *how consistently do different observers rate the same student’s behaviors?* The assessment should be a function of who is being assessed, not who is doing the assessing (Kazdin, 2011). Inter-rater agreement is the measure for the reliability of study measures for single-case designs (Kratochwill et al., 2012). In this study, interrater reliability was achieved by

Implementing the Intervention within a Single Case Design Framework

An experimental, single-case design (SCD) using multiple baselines across participants with pre- and post-intervention measures was implemented to measure the effects of interactive read-aloud techniques on student vocabulary and emergent academic language in a non-traditional multi-touch table center. The design for SCDs includes four main criteria: (a) the independent variable must be systemically manipulated, 2) the outcome variable must be systemically measured over time and by more than one assessor, 3) the study must include at least three attempts to demonstrate an intervention effect at three different points in time, and 4) each phase of data must include at least three data points to establish a convincing trend or slope of time-ordered data (Kratochwill et al., 2012). While replication is usually considered the most important feature of an SCD to establish causal inference, the three-demonstrations of an intervention effect is based on professional convention; no ‘gold-standard’ for the number of replications exists. In this study, the replication criterion is met with three or more demonstrations of the desired behavior.

Independent variable

The independent variable for this study was adult mediation in the context of the multi-touch table activity center. Adult mediation, defined as the application of interactive scaffolding adapted from read-aloud techniques designed to elicit emergent academic language with preschool students, was implemented by me in the classroom in the course of the regular preschool day.

Dependent variables

Change in student emergent academic register was assessed by measuring proximal and distal measures of oral language skills, including the use of academic register conventions and vocabulary development (see earlier section for detailed description of the dependent measures and their administration). The proximal dependent variables in this study were defined as quantity of emergent academic utterances, receptive vocabulary, and expressive vocabulary that emerged from the intervention itself (i.e., language related to the touch-table activities and themes). The distal dependent variables included receptive conceptual vocabulary (measured by the Boehm preschool assessment) and vocabulary and listening comprehension

(measured by the PELI). Quantity of emergent academic utterances was continually assessed in the course of the intervention with an observational rubric applied to transcribed video sessions. Receptive and expressive vocabulary was continually assessed with researcher-designed assessments for content vocabulary. Pre- and post-assessments of conceptual language were measured with the BOEHM Preschool assessment. General vocabulary knowledge was assessed pre- and post-study with the PELI vocabulary/oral language measure. Listening comprehension was assessed pre- and post-study with the PELI comprehension measure. These measures are described in more detail later in this methods chapter.

Variable control conditions

Two-group studies used within single-case designs help to establish (a) norms of the target behavior from the non-intervention population and (b) magnitude of change in the intervention students (Kazdin, 2011). While not necessary to establish the experimental criterion of the single-case design, it does describe the magnitude and rate of the dependent variable (oral language skills) which in the case of this study is not yet developed enough in the research literature to supply benchmark criteria for desirable outcomes. That is to say, we do not know how many emergent academic utterances describe an at-risk or high-functioning student in this activity setting. This study used two control groups, an in-class control group of high-language students and a test-only control group of like students in a remote classroom. It makes good sense to incorporate pre- post testing from both of these group as I am interested in understanding the magnitude of change by using social comparison (Kazdin, 2011) to establish benchmarks.

Study phases

There were four phases to the study for students in the treatment groups: (a) variable baseline phase, consisting of interaction with the touch-table with access to guided interaction until at least 3 data points on vocabulary and emergent academic language have been collected. (b) intervention, consisting of as much time it took to gain at least three positive data points on the targeted behavior. This phase lasted three days. Each week I measured transfer effects by administering alternative activity topics to check for generalization of behavior change, (c) a return to baseline condition to further establish experimental validity, and (d) long-term follow up, or maintenance phase, consisting of two sessions of testing taking place seven weeks after the end of the return to baseline phase. In the maintenance phase, data were collected only to assess the retention of vocabulary from the intervention setting (the touch-table topics) and the general language assessments.

In single case study designs the rationale for the baseline is to establish normal behavior in a particular activity setting for the case study student before the intervention begins. I adopted the standard of what constitutes a stable norm of behavior from Kazdin (2011) in which normal behavior patterns are established after several (in his case days, in my case, several activities) instances of the activity without the intervention. This is necessary because the case study student acts as his or her own control. In case study designs, as opposed to two-group studies, controls are established by the conditions set up in the experiment.

In the baseline condition, each group within classrooms with access to the touch-table was introduced to the table environment and I provided guided interaction to show them how to use the table effectively (for example, the students first needed to learn how to touch the table in a gentle manner to move the objects in the activity) by modeling and practicing with

the students. In the baseline condition I used guided interaction to guide student group use of the table, and posed comprehension questions to the case-study participant in the context of the activity. All activities were videoed and transcribed, and the transcripts were coded for receptive and expressive vocabulary, as well as the number of emergent academic utterances by case study students.

The baseline became the phase in which I found which students had the skills to participate in the study and which students did not have the prerequisite skills to participate in the study. All case study students were initially chosen because of their home language background and literacy assessment scores. Four of the students, the 3 1/2-year-olds for the most part, demonstrated an inability to focus on the activity with the group for an entire session. In the treatment condition these same students were not able to respond to any comprehension questions nor did they respond to any peer-to-peer interaction. I decided that these students needed more conversational English skills in order to benefit from the language-building activities specific to this experiment at the table. So I excluded them from any analyses and replaced them with others who had been relegated, for a short period of time, to the incidental participant group. The net result of these replacements were that I was forced to include students who did not fully meet all of the criteria I had originally used to select case study students.

Procedures

Ongoing data analysis. SCDs require ongoing assessment to determine first, if a child has met the data benchmark in any particular phase and second, to inform ongoing modifications to an intervention. To that end, I created a data collection form to document the vocabulary words and response to conversation prompts from each activity in the treatment (see Appendix G). These data were entered each day into a database program and analyzed for variability in the rate and volume of student vocabulary acquisition, as well as for a tally of student utterances within the activities. I used these data to inform my modifications to the mediation scripts as well.

Fluid group construction. Each session began with the construction of the small group of students to work together at the activity center. I began group construction by asking the case study student if he or she were ready to play with me on the table. If the student was ready, I recruited other members of the small group to join us.

When asking students to participate in the activity, there were some additional considerations, beyond willingness to play to be taken into account. There were times when some children do not get along with other children. If they came to the table together and they were not “friends,” their interpersonal problems flowed out into our activity. I found it important to stay aware of the interpersonal dynamics between the children. Because of this, after asking if my case study student was ready to come play with me, I asked, “are you friends with (student’s name)?” And the child responded yes or no. If yes, we invited him or her to join us, if no, I continued to ask about individual students until we had at least two children for the group.

In order to make sure that the groups were approximately equal in skill level, despite the rather liquid group construction, I made sure that the case study student was always paired with a student designated as a ‘high-language’ student (determined by language level on the standardized assessments, and willingness to engage in talk with me and the other students).

Students in the study were broken up into achievement level bands in the original grouping. I choose from this selection of students when I asked a child who he or she was friends with at the time.

Implementing the phases of the study. Each phase of the study entailed somewhat unique procedures because of the role that I played or did not play in supporting student language use.

Baseline phase. In the baseline phase I monitored (but did not interact with) student groups at the technology center during center time using the conventions of guided interaction (Plowman & Stephen, 2007). Each group spent an average of 2.85 minutes at the table in the baseline condition.

Intervention Phase. Students spent an average of 3.5 minutes in intervention activity sessions. In the intervention phase I continued to use guided interaction to support student progression through the activity and I added mediation in the form of oral language scaffolds to encourage the development and use of emergent academic language in the case study students. This was the only change between the baseline and intervention conditions, and students in the control group continued to receive guided interaction without adult mediation for the duration of the study.

In activity mediation. I mediated the activity through verbal prompts asking for information the student had access to, and providing it explicitly if students could not provide the information in the following ways,

- Comprehension checks: in the context of the activity I encouraged listening to digital narrative instruction with physical gestures (i.e., cupping a hand to my ear and leaning toward the screen) and prompts asking for immediate recall of the script (mute the screen and ask student what we just heard). If the student has no response, repeat what we just heard and ask the student to tell someone else in the group.
- Learning Vocabulary and During Activity Assessment. I asked student to identify specific objects from the vocabulary list for that game. If the student did not respond, identify the object and ask the student to repeat the name of the object after me.
- Asking students one detail about an object highlighted in the activity (i.e., starfish have five arms, but can have up to twelve). If the students cannot give the detail, provide the detail for the student.
- Asking a relational question (Where is the biggest animal? Can you find the closest starfish?) If the student did not respond, I identified the asked for object.
- Asking students to interact with the rest of the group (i.e., Explain to _____ how to move an object, Explain what the group should do next, Show where an object is on the screen). If the students did not respond, I provided the answer and encouraged the student to mimic my answer.

All interventions sessions were scripted, though as the intervention phase progressed I improvised on the script with additional language scaffolds in an effort to elicit the target behavior. These improvisations were captured in video transcripts, and the scripts were adapted as the intervention phase progressed to accommodate my own learning about eliciting academic language with preschoolers.

For example, while I had planned to use prompts to elicit student listening comprehension of the narrative audio (i.e., What do they want us to do?"), it became apparent

that students would not listen to the narrative audio for directions. I made modifications to the script with these constraints in mind. My first script modification was to repeat the directions verbatim from the audio (i.e., “we have to touch the starfish at the same time! What are we supposed to do?”). This strategy was not effective, and even the high language students did not pick up on repeating to me the directions for the activity, which included matching, taking turns, making patterns, or uncovering specific types of objects. In another example, the prompt, “turn to your neighbor and tell him what you would like to do if you were a scuba diver,” was met with silence and apparent confusion. It seemed that this type of task was either too difficult, requiring a fund of vocabulary and language skills the preschool students had not yet acquired, or was to apparently inauthentic for the students to engage in.

In an additional twist affecting my scripted mediation, the students quickly lost interest in the table once an activity was completed on the screen. Additional questioning about what had happened in the context of the activity, “Can you tell us what we just did?” was met with silence or with the children deciding it was time move on to another activity somewhere else in the room. I learned to ask comprehension questions that were concrete (i.e., “What did you find?”), prompt students with authentic cues intended to solve immediate problems, (i.e., “Camron, can you use your words to tell Angel what to do?”), and move swiftly through activities to hold student interest. In fact, the average time spent in each activity was much shorter than I anticipated, with an average of 3.37 minutes per session in the intervention phase. Once I realized these were factors in the multi-touch table environment, I shifted my mediation to quick and direct instruction of the target vocabulary in the game context and to eliciting target language behavior through modeling, echoing, and posing open-ended questions before the activity was complete.

My final modification to the scripted mediation was to introduce each activity with a brief scenario intended to elicit student prior knowledge for content vocabulary and to structure a question/response behavior indicative of an academic setting. For example, before an activity on matching forest animals, I presented each group with an introductory comment, “My favorite forest animal is an owl. What is your favorite forest animal?” Students responded with a variety of animals from horses to bunnies (or in one case, with the color pink). Once each student had a chance to share, I said, “Let’s play with some forest animals! What do you see?” and the activity would begin.

This shift in the scripted mediation had the desired effect of eliciting some language from each participant immediately, and, unexpectedly, the children would usually imitate my language model, “My favorite forest animal is a _____.” This shift also provided a model for the children to talk about what they were encountering in the forest environment of the app., as they responded to my general question “What do you see?” with a full sentence that used an emergent academic language register, (i.e., “I see a lizard!”)

Equipment and Training

The multi-touch table. Equipment required for this study is a multi-touch table with an app designed for preschool-aged children (See Image 1, below). The multi-touch table allows for simultaneous use for up to four children at a time. The table used in this study included the Hatch app called We Play Smart, best described as a game-based set of activities designed for preschool aged children. The activities were designed to elicit the types of knowledge and skills appropriate for young children, including activities for matching, sorting, uncovering, putting

puzzles together, voting, cooperative play, making choices and sharing. The activities are accompanied by on-screen modeling and an audio narrative in English. Student groups can vote on a randomly selected set of activities, but the table program will choose for student groups that cannot collaborate in a reasonable timeframe.

In addition to the activities for children, the table has microphones embedded within the frame (see the blue inserts visible on the frame in Figure 2.1). The microphones turn on for short periods of time to record student utterances when students are using the game. This feature is designed to support preschool teacher assessment requirements for student academic and social progress throughout the year.



Figure 2.2 *Multi-touch Table.*

I had no formal training in how to use the multi-touch table prior to the study. Once access to the classroom was obtained and before the start of the study, I spent three weeks in the classroom playing with children on the table to familiarize myself with the app and to resolve ongoing connectivity problems the site had with the hardware. At the start of the study, the teachers at the site had stopped using the table because they did not know how to use it, and the students regularly crashed the program when they used the app independently from the teachers. Consequently, the students and teachers were fairly new to the equipment at the start of the study, and the first training in how to use the table with the students was provided by me once the table was back online.

The app was programmed to provide a random set of activities to the students when they logged into the table. For the purposes of the study, I needed to access particular activities chosen in advance for their vocabulary content. The Hatch company provided me with a set of scripts from all of the programmed activities. I used these scripts to identify appropriate activities that demanded behavior (cooperative) and comprehension skills that matched the instructional intervention goals of the study, as well as to pre-planned vocabulary assessments and instruction in the course of the activity. The Hatch company also provided a back-door into the app that allowed me to pick a particular activity for the students to engage in. This backdoor, designed to troubleshoot the table mechanics, did not include every activity for

which I had a script. Consequently there were occasions when a planned activity was not available for the study and a similar but not planned activity had to be chosen. In those cases, I followed the intention of the original planned activity to the best of my ability, though some vocabulary words that were pre-selected were not available for in-activity instruction. Those missing vocabulary words were left out of the final list included in this study, and only the student emergent academic utterances from the session were included.

Recording the interactions. As students played in small groups at the multi-touch table I wore a chest harness with a GoPro camera attached to video-record all sessions.

Chapter 3: Results

A brief summary of the design elements that inform the results chapter is now in order. This single-case study employed a multiple baseline across participants design to investigate the research questions. Data for single-case designs is gathered by manipulating an independent variable across different phases of a study. For this multiple-baseline design, I used a traditional three phase design, (a) a baseline phase in which I gathered data on typical and unassisted behavior of the children in the context of the multi-touch-table, (b) the intervention phase, in which I consecutively teach and prompt student verbal skills to the children, and (c) the return-to-baseline phase, during which I stop the intervention and, as I did in the baseline condition, simply guide student use of the multi-touch-table using the conventions of guided interaction. Evidence of change in behavior is documented by a rise in student talk, academic utterances, and the use of the target vocabulary from the app, as well as maintenance of the change in behavior once the intervention is removed (in the case of this study, seven weeks after the final return to baseline session). Using multiple participants in single-case research allows for a replication of the intervention effects at different points of time, with multiple baseline data supporting an analysis that the intervention is the most constant condition that changes between phases. The experimental criterion is met by determining whether performance shifts when the intervention is introduced to a participant. If the behavior is maintained once the intervention is removed, it is evidence that the behavior has become a part of the students' repertoires; if the behavior returns to baseline levels, it is evidence that the behavior is not likely to occur in the absence of the intervention, which in this case is teacher scaffolding of verbal interactions.

In this chapter, results are organized by the various classes of dependent measures used. First I report what those who use single subject design methods call visual analysis, where I offer full reports on each of the case study students, including the control student, Yvonne. Second, I report results across the case study students on those measures that emerged from the intervention itself—utterances, extended conversations, and vocabulary acquired, including a social comparison of average utterances between case-study and high-language students. Third I look at aggregated data including trends in social comparison between two groups, the case study students and the high language students. I then conduct an across-participant visual analysis and last review the results of pre- post distal measures of general language from the Boehm and the PELI to evaluate whether there was any transfer from what might have been learned during the intervention to measures that bear any resemblance to the intervention. In Chapter 4, the results will be discussed, not by dependent measure but by research question.

Analyses Conducted at the Individual Level

The interactions held by the case study students while I was scaffolding their conversations were examined to assess growth across the three phases of the intervention for (a) average utterances per minute (UPM), (b) emergent academic utterances (EA), and (c) extended conversations. The analytic tool used to assess the power of the intervention is called visual analysis. Visual analysis refers to the use of graphs for an overall image of overt behaviors in the course of an experiment. The UPM and EA are graphed into a linear chart describing the progression of the participant through various experimental phases, providing a

means to evaluate the magnitude and rate of their behavior change. The experimental criterion is met by determining whether language performance shifts when the intervention is introduced to a participant. If the target behavior is maintained once the intervention is removed (in return to baseline), it is evidence that the behavior has become a part of the students' repertoires; if the behavior returns to baseline, it is evidence that the behavior is not likely to occur in the absence of the intervention. One participant's data provides some evidence of change, and I, as is typical for SCD studies, apply lessons learned in the first participant's intervention phase to succeeding participants. In this way, the intervention is refined and multiple participants replicate the experiment in rapid succession (for the logic of visual analysis, see the Methods chapter).

The tool used to assess the relative level of language behavior change compared to peers is called social comparison. Social comparison refers to the use of the peer group of the students who share demographic and other variables but differ in performance on the target behavior or characteristic (in this case, oral language skills). Members of the peer group are students who are considered to be functioning at a good level of the target behavior, determined by placement in percentile ranges from normed language assessments. Normative data are gathered to evaluate the level and change of behavior of the case study participant. In the case of this study, in which the practice and use of EA language is known to support later literacy skills [cite], but the knowledge of the number of desirable utterances has not been developed, benchmarking from peers by comparing standardized data on linked skills, such as receptive academic language or criterion-based vocabulary and comprehension assessments, provides a way to determine progress on the lesser developed utterances benchmark. That is to say, the average utterance rate of high-language (HL) peers acts as a high water mark to gauge how many utterances are reasonable to expect from students of the same age but of lower oral skills in the novel instructional setting of a touch-table app. For each case study student, I provide a social comparison with a high language (HL) student to give the reader some perspective of what children this age are capable of if they have the chance to develop their oral language skills.

Examining the Trajectories of the Case Study Students

First, I examine the data from the control student and the five case study students for evidence of change in their language indicators as well as their standardized scores from the distal measures.

Yvonne. The control student, Yvonne, establishes what these data look like when a student proceeds through the study without the intervention. Yvonne remained in the baseline condition throughout the study, acting as an additional control to the SCD study design. Yvonne is an active and socially positive 5 year-old who has been in Head Start from the start of the school year. She had good attendance at the site, was positive and social and she worked well with her group, but I have not included a transcript excerpt as there is very little verbal data to share. Yvonne's language skills are described in part by her general language scores. She placed in the fifth percentile of children her age on the Boehm, and obtained a 0 and a 4 on the PELI vocabulary and comprehension measure, respectively. Yvonne began as one of three ELL control students in this study. She was randomly selected into the control condition after being matched with Angel by her Boehm score.

Typical participation exemplar. Yvonne was naturally talkative going into the study, and as it turned out, she was the only control student to yield sufficient verbal data for analysis; the other two were not sufficiently cooperative to generate data useful enough to compare with the case study students. She did quickly catch on to what was required to move through the activity sessions using the guided interaction I provided, though most of her activity was non-verbal, which was typical of the baseline verbal behavior of the case study students. The excerpted transcript illustrates a typical baseline interactional sequence.

In this activity, students watch a demonstration on the screen illustrating how forest animals should be sorted to their respective homes in the corners of the screen. Four types of forest animals appear floating randomly between the students on the screen (bears, owls, snakes and salamanders, four of each animal). In these transcripts, the label, digital audio refers to what was broadcast by the app itself. I am the teacher, and each student who participated is named. Non-verbal action is denoted with brackets [].

Digital Audio: *Now it's your turn to help me sort the animals.*

Sureah: I don't like snakes

Teacher: Remember gentle touches, right you guys? Soft.

Yvonne: [drags an animal to the other side of the table] Right here.

Zahmari: No those are mine [to Sureah]

Yvonne: Gimme [she takes a bear and quickly sorts it]

Zahmari: That's mine

Sureah: No that's mine.

[Students quickly complete sorting the rest of the animals without taking and then leave the touch-table.]

This excerpt is a transcript of the whole activity, and took the three students 1.42 minutes to complete from start to finish. As you can see, the interactions focus on concrete objects that assume the interlocutors share a line of sight (words like 'those' and 'gimme' imply the hearer can see what the speaker is referring to and can comply with a request for action related to the object), the language register is what might be characterized as everyday language with no use of specific object labels that might signal an emergent academic register (i.e., "Gimme *that bear*," or "Those are my *salamanders*.".) The transcript is also characterized by the lack of spoken language; what you see is the only talk that took place for the 1.42 minutes that the students matched objects at the touch-table. This lack of spoken language illustrates what we consider typical language behavior with digital tools: Students work quietly on individual projects without interacting with each other. In this case, we see that the lack of language persists even in the context of a touch-table designed circumvent the screen silence characteristic of single-user apps on tablets and computer screens. Yvonne's transcript is a typical example of interaction representative of case-study student baseline language behavior. This baseline excerpt from Yvonne helps to contextualize the interactions that we'll explore from case-study students in the intervention and return to baseline conditions.

Trends in utterance performance. Yvonne stayed in the baseline condition throughout the study, for a total of 10 sessions. Her session time averaged 2.31 minutes per session, with an average UPM rate of 2.48, with 47 percent coded as EA. As a visual inspection of figure 3.1 suggests, her trend line slightly accelerates for UPM and slightly declines for EA throughout the study. Notice also that her UPM is only slightly higher than her EA (see Figure 3.2). She

stabilized at a low rate and stayed in that same range throughout the study. Magnitude and rate are not calculated for Yvonne as she stayed in the baseline for the duration of the study.

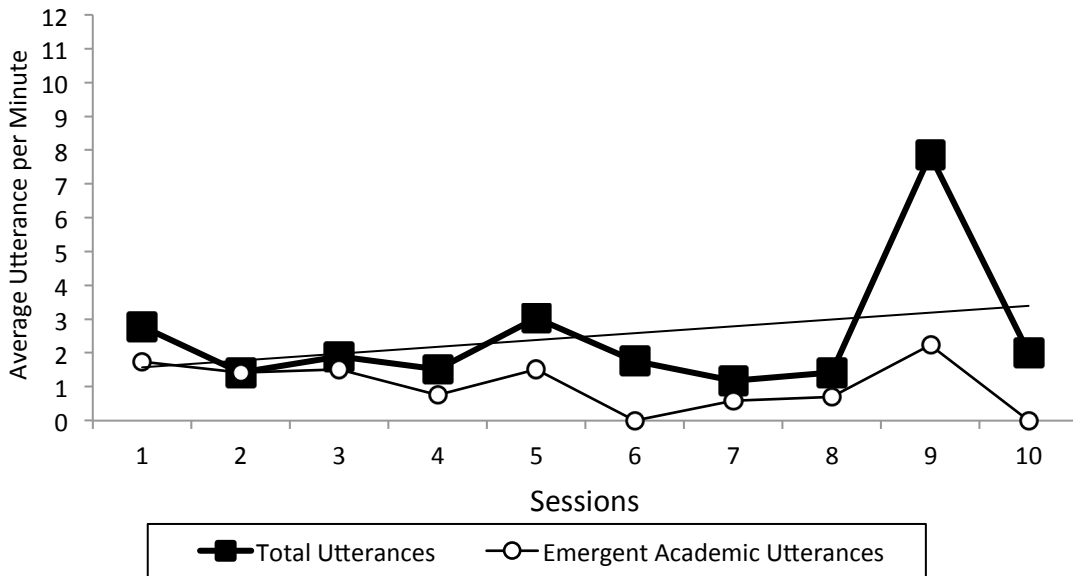


Figure 3.3. Average UPM and Proportion of EA per Phase for Yvonne (Control Student). UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

General language measures. Tier 3 vocabulary measures were not collected for Yvonne, but she did participate in the general language assessments of the Boehm and PELI. Her Boehm pre-assessment placed her in the fifth percentile of students her age, and her post-assessment at the maintenance phase of the study fell to the third percentile for her age group (her raw score fell by -6 points). Her pre-assessment PELI scores on vocabulary and listening comprehension rose from 0 and 1, respectively to 11 and 14 on vocabulary and comprehension.

While it is unfortunate to withhold the active teacher prompting included in the intervention phase for Yvonne, her data are helpful for a visual inspection of the graph to determine if the intervention had any obvious effect on those who participated in the intervention phase of the research. Yvonne’s profile is a canonical example of the sort of flat profile we expect from a participant who does not have access to an intervention. As such, she provides an ideal benchmark, in addition to the individual baseline controls characteristic of SCD studies, against which the profiles of the target children can be compared.

Angel. Angel engaged in the intervention with me for the most sessions. Yvonne and Angel were matched at the start of the study on language ability (Angel placed in the first percentile, and Yvonne placed in the 5th percentile on the Boehm), so the contrast between them is particularly telling. Angel was four and a half years of age when we started the baseline phase of the study. She had good attendance at the site, and was present for every session in all three phases of the study, including the follow-up phase. Angel was quiet in her participation in small group or whole group activities in the regular classroom, and her classroom teacher

and the para-teacher had made a note that she did not talk a lot in class. Her characteristic non-verbal behavior was not, as you can see from the excerpt, due to a lack of curiosity. Angel's initial verbal skills are further described by her Boehm scores, which placed her in the 1st percentile of oral language skills for her age. Angel scored a 5 in comprehension and a 9 in oral language/vocabulary on the PELI. As a way of comparing her skills with her peers, Camron, an English-only boy of the same age and her regular intervention partner, scored in the 65th percentile on the Boehm, and a 21 and 9 on the PELI vocabulary and listening comprehension assessment, respectively. Angel represents the specific type of student I hoped to work with in this study, a willing and interested child who needed more oral language in order to participate in the academic activities of the classroom.

Typical participation exemplar. First I offer an example of a typical transcript for Angel during the intervention phase of the study—to give readers a more vivid feeling for the nature of her participation in the intervention. In this activity, students are asked to make a pattern of sea creatures by dragging them into the center of the screen. Students are grappling with (a) identifying objects by their names and (b) fulfilling the requirements to make a pattern.

Digital audio: *use your fingers to line at the starfish jellyfish and seahorses on the dock*

Teacher: Hey look, it's a pattern! There's a pattern! Seahorse, jellyfish, starfish. Seahorse, jellyfish...[pointing to a starfish] What is that one?

Angel: [points to starfish on the screen] That's a [looks at me]

Teacher: [stops to help her] What's that? That's a ... [pause to give her a chance to fill in the word] starfish

Angel: [echoing me] Starfish. [points to another starfish] That one is...[looks at me to help her]

Teacher: Jellyfish

Angel: No...

Teacher: [points to seahorse] That one's a...[pause] do you remember?

Angel: Jellyfish.

Teacher: That's a seahorse. [points to jellyfish] Here's a jellyfish.

Angel: No! That's a jellyfish over here. [pointing to another jellyfish]

Teacher: Yes, that's a jellyfish over there.

The transcript illustrates a typical session in which Angel has opportunities to learn new vocabulary in the context of a pattern activity. Making a pattern is a new skill for most, if not all, of the students in the classroom, and in this session structures the activity's purpose (we want to make a pattern). Angel quickly understands that I want her to tell me what the objects are on the screen so we can call out the pattern together. She typically looks at me to tell her what an object is called, but as you can see, she is eager to use her new words as soon as she is able to. She is not successful at making the pattern, but this episode is a good example of Angel using an EA register, as she has an extended conversation with me about objects that we are both looking at and trying to manipulate. This is also a typical example of explicit instruction and immediate assessment of tier 3 vocabulary (starfish, jellyfish, seahorse).

Trends in utterance performance. In the analysis of the data, I first present Angel's language behavior in each of the three study phases. Next, I describe the magnitude and rate of change between the three phases with the logic of visual analysis. The intention of this method of analysis is to describe a relationship between Angel's language behavior changes and the

implementation of the intervention. Angel participated in three baseline sessions over three days, with an average session time of 2.88 minutes per session. She was the first student to enter the study, and so she had the longest time in the intervention phase (11 sessions over 4 weeks) with an average session time of 3.88 minutes. She was willing to engage in learning with me and the small group at the touch-table, and quickly adopted the academic language routines of responding to known-answer questions and responding to tone and other paralinguistic cues that encouraged echoing language and behavior molded first between me and her peers. As a result, her overall UPM increased in the intervention (see table 3.1). In the return to baseline, Angel had an average session time of 3.00 minutes. Once I removed my scaffolding in the return to baseline phase, Angel continued to talk at the same rate, though the quality of her talk declined.

Visual analysis of the intervention phase suggests an *immediate increase* in level of UPM and EA, and an *accelerating* trend after each intervention session, with *low* overlap between the baseline and intervention conditions, and no trend in the return to baseline mean utterance level, but with a declining trend in EA utterances (see Figure 1). The *magnitude* of behavior change between the baseline and intervention phase was determined by a mean change level between phases (+3.57) indicating a positive change in overall talk, and an immediate level change of 35 percent of emergent academic utterances from onset of the intervention. The *rate* of change (determined by the trend and latency of change) was determined by a declining trend of the data (See Figure 3.2) in the intervention condition and no latency of change between the introduction of the intervention and the change in participant behavior.

Once all case study students had entered the intervention phase, the intervention was terminated and all case study students entered the return-to-baseline phase (phase three). In Angel’s case, she participated in four return to baseline sessions over two days, with an average session time of 2.60 minutes. The visual inspection of her trend line indicates no trend in overall talk, with a magnitude of change determined by the mean level change between the intervention and the return to baseline phase (+.08), though the overall change in EA represented a decline from the intervention phase but an overall modest improvement from the baseline rate of EA (+ 4 percent).

As a means to contextualize this level change in language behavior, a social comparison with Camron, Angel’s main partner at the touch-table, is helpful. Camron is four and a half years of age, and designated a high-language peer by a combination of his agreeable and talkative nature, his regular attendance to school, and his pre-assessment Boehm score placing him in the 65th percentile for children his age (see Table 3.1).

Table 3.1
Social Comparison of UPM and proportion of EA between Angel and Camron.

Student		Baseline	Intervention	Return
Angel	Mean UPM (SD)	1.93 (1.02)	5.50 (2.11)	5.58 (2.26)
	EA (proportion)	.41	.76	.45
Camron	Mean UPM (SD)	5.13 (2.26)	3.97 (1.64)	4.19 (0.00)
	EA (proportion)	.68	.79	.44

Note. Mean UPM= mean utterances per minute, EA (proportion) = proportion of utterances coded as emergent academic.

Social comparison between Angel and Camron provides some basis for determining what might be a reasonable and desirable benchmark to aim for in UPM for Angel. I did not aim to elicit a certain number of UPM from the case study students, but it is interesting, in terms of the goals of the intervention, that Angel’s intervention UPM and EA rose to Camron’s benchmark UPM and EA in the baseline. As you might expect, in the return to baseline her EA declined, but her UPM continued to rise.

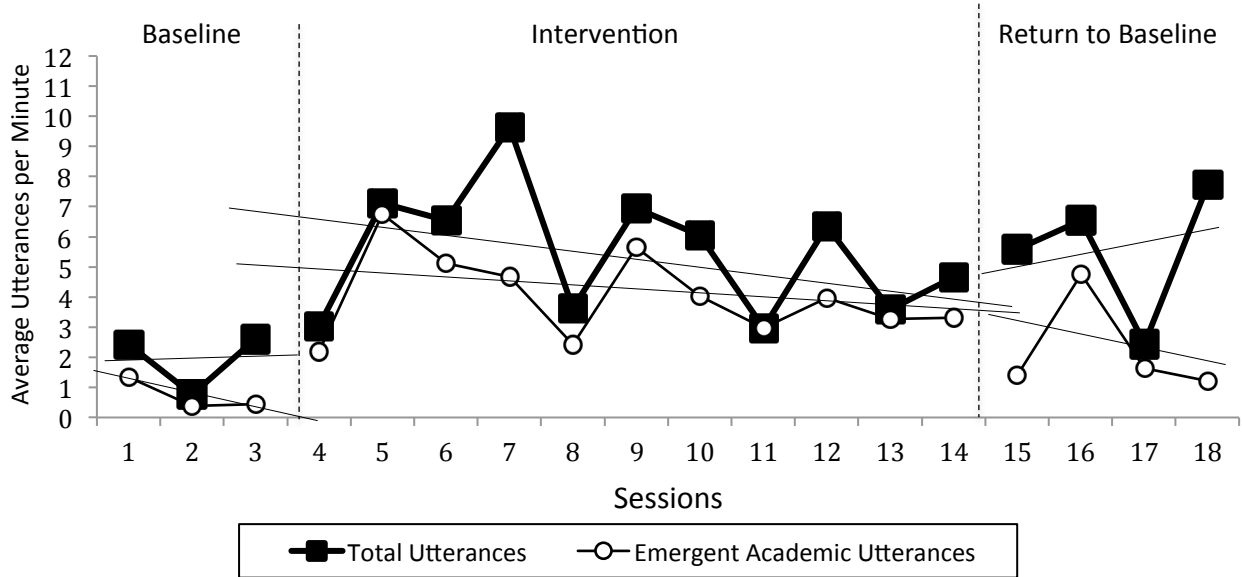


Figure 3.4. Average UPM and Proportion of EA per Phase for Angel.

UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

Tier 3 vocabulary. Recall that because Angel was in the intervention longer than anyone else, she had the most time to learn and practice the set of tier three vocabulary I highlighted in the touch-table app (these were the content words in each app—words like starfish, doe, fawn, turtle, beetle). As a reminder, at the start of this study Angel was mostly non-verbal and scored the lowest on all general language measures (see Appendix C). These general language skills seemed to be reflected in her pre-intervention performance of the tier three words (see table 3.7). Remember that I explicitly taught all the students the tier 3 words in the context of the intervention, and then immediately assessed their receptive and expressive knowledge with those same words before we left the table. In the context of the touch-table, Angel’s receptive scores fell in the intervention condition (down 36 percent). By contrast, in expressive vocabulary she gained 25 percent in the words she could use to identify and name pictures, Angel surpassed herself in the maintenance phase of the assessment, showing a 53 percent gain from the intervention of receptive vocabulary and maintaining her 25 percent gain in expressive vocabulary 25 percent.

Distal measures. Finally, pre-post language assessments showed that the gains made in

the proximal measures did not transfer to the distal measures of language development on the Boehm and the PELI. Compared to her pre-test scores, she showed little, if any, improvement. Her Boehm scores placed in her the first percentile of children her age (no change from the pre-test), though her raw score rose slightly (+ 12). Her PELI scores decreased in both vocabulary (5) and comprehension (0), a change of -4 and -5, respectively (See Appendix C).

Summary. Looking across these various proximal and distal indicators of Angel's trajectory from the beginning to the end of the study, we encounter two different trends—a positive trend for the intervention on the proximal measures and no trend on the distal measures. The visual analysis of Angel's magnitude and rate of change show a positive response to the intervention, with some skills in talk remaining in the Return to baseline phase of the study. Her quantity of talk surpassed her high-language peer, Camron, and her EA register shows that with scaffolding she could obtain a mean level of EA language almost indistinguishable from Camron in his business-as-usual condition. In addition, Angel's maintenance of tier 3 words long after the end of the study (maintenance data were taken seven weeks after the end of the return to baseline phase), demonstrate her deep level of vocabulary acquisition. Overall, Angel's data imply that the setting and the intervention bootstrapped her language skills to the level of a high-language student, Camron, with some enduring gains once the intervention was withdrawn.

Bianca. Bianca was 3.5 when we started the baseline phase of the study. She had good attendance at the site, and was present for every session in the first three phases of the study. She was sick in the maintenance phase, and while I eventually obtained post-intervention assessment scores for her, the data at the delayed post-test phase did not appear to reflect her actual ability. Bianca was assertive in her participation in small group and whole group activities. Her classroom teacher and the para-teacher have made a note that she likes to respond with “no” when asked to participate in group activities, though she willingly participates if not given a choice (i.e., “Bianca, please come and play with me.”). At age three and a half, she was the youngest child in the case-study group, she but scored at the 25th percentile on the Boehm assessment, demonstrating a level of conceptual receptive language second only to Emmelia who was a full year older at four and a half. Bianca scored 15 and 8 on vocabulary and comprehension for the beginning of year PELI. As a way of comparing her general language skills to a more skilled peer for perspective, Alice, an English-only girl slightly younger than Bianca at age three, scored in the 85th percentile of the Boehm, and scored a 13 and 6 on the vocabulary and listening comprehension test of the PELI.

Typical participation exemplar. It was difficult to locate a transcript that “typified” Bianca's verbal behavior during the intervention, primarily because there was so much unpatterned variation in her participation at the table. The transcripts illustrate a progression in Bianca's use of EA between the first intervention session and the fourth intervention session. Remember that in the intervention phase, I provided additional language scaffolding for the case study student (in this case, Bianca).

First intervention session with Bianca. In this activity, students are supposed to match marine animal babies (orca, manatees, walrus, and tadpoles) with their mommies. The babies float around the screen between the students, who must ‘catch’ them and drag them to the right mommy. If a student mismatches a baby to mommy, the baby pops away and begins to float around in the center of the screen again.

Teacher: Ok, here is a walrus
 Bianca: That one goes to there! [to Peyton, who has dragged a walrus to the walrus mommy]
 Teacher: That one goes to the walrus. Bianca, say walrus.
 Bianca: Rarus
 Teacher: Walrus! Very nice. [Bianca grabs the orca baby to drag to the orca mommy] That one goes to the orca. Bianca, say orca.
 Bianca: Orca.

Forth intervention session with Bianca. It is informative to take a look at Bianca's progress in EA register after a few sessions of adult mediation have passed. In this transcript of the forth intervention session with me, students are supposed to match forest animals to their homes. Four different types of animals float around on the table for students to catch and drag home, elk, newts, beetles, and swans. The two HL students, Patty and Martin, are quickly sorting and matching animals in the activity. Bianca is a bit younger and is having a hard time competing with them in grabbing animals as they float by.

Bianca: [to me] I want to do one!
 Teacher: [I drag a newt to Bianca] Where are you going to put him?
 Bianca: [silently drags into the newt box]
 Teacher: With all the other newts! Hey, did you guys do it?
 Bianca: Yeah!
 Mellious: I got two.
 Bianca: Me it picked it got two.
 Teacher: You got the [pausing and pointing to beetle box] beetles
 Bianca: [she gives her own label] Spiders
 Teacher: And the newts, and the [pointing to swans]
 Bianca: Fishes
 Teacher: The swan
 Patty: Swans
 Teacher: And the [pausing to look at Bianca as a cue for her to respond, but Mellious beats her to the reply]
 Martin: Reindeer
 Teacher: The elk. What are these called? [points to beetle box for Bianca, but Paige beats her to the response]
 Patty: Beetles
 Teacher: Hey Bianca, what are these called? [points to newt box] /n/
 Bianca: Nicks
 Teacher: Newts
 Bianca: Newts
 Teacher: Newts.

We can see that between the first and forth intervention session, Bianca has become more aware of the cues and language expectations when playing at the touch-table. One of the register norms she adopts is repeating a new word when prompted by a look or a tone from me, as she does when I pause to let her finish my sentence while pointing (“...you got the...”)
 She provided a different label, spider, instead of echoing my model of ‘newt,’ but the fact that

she tells me what she thinks the object is called is a marked change from her first session. Another emergent register norm she adopts is responding to known answer questions, as she does when I ask her tell me what an object is called (newts). While Bianca’s participation was variable, she did adopt her own interpretation of what I wanted her to do.

Trends in utterance performance. Bianca participated in 3 baseline sessions over three days, with an average session time of 3.76 minutes per session (see Table 3.2 for a complete description of Bianca’s UPM and EA results across all study phases).

Bianca was the second student to enter the intervention phase, which lasted for 8 sessions over 3 weeks for her, with an average session time of 2.50 minutes. Visual Analysis of the intervention phase suggests an *immediate increase* in level and an *accelerating* trend after each intervention session, with 25 percent overlap between conditions (see Figure 3.3). Visual Analysis of the return-to-baseline phase suggests *low and stable* trend to the UPM, and a *low and declining trend* of EA utterances. The magnitude of behavior change between the baseline and intervention phase was determined by a mean change in UPM of 2.92, indicating a positive change overall, and a level change of 3.71 UPM at the onset of the intervention. The rate of change (determined by the trend and latency of change) was determined by a declining trend of the data (See Figure 3.3) in the intervention condition and 0 percent latency of change between the introduction of the intervention and the change in participant behavior.

In the return-to-baseline condition, Bianca participated in 3 sessions and recorded an average time of 2.39 minutes per session. Visual analysis of the return to baseline phase shows an accelerating and stable trend to the UPM, and a low and stable trend to the EA utterances. The magnitude of behavior change between the intervention and return to baseline was determined by a mean change level in total utterances, declining by 1.58 UPM, and a declining proportion of EA utterances by 22 percent from the intervention.

I was not able to establish a consistent social comparison peer for Bianca because of variable attendance and shifting friendship alliances. Even so, Alice (who I used as a comparison for Bianca’s general language skills) was the best match for in terms of age and joint participation opportunities. Table 3.2 provides the rate (UPM) and academic utterance (proportion of EA responses) showing a social comparison between these two young students.

Table 3.2
Social Comparison of UPM and proportion of EA between Bianca and Alice.

Student		Baseline	Intervention	Return
Bianca	Mean UPM (SD)	1.61 (0.86)	4.52 (2.23)	2.98 (0.27)
	EA (proportion)	.59	.73	.37
Alice	Mean UPM (SD)	1.08 (0.61)	3.26 (0.58)	2.23 (.00)
	EA (proportion)	.66	.30	.20

Note. Mean UPM= mean utterances per minute, EA (proportion) = proportion of utterances coded as emergent academic.

In summary, the data provide some support for Bianca responding to the intervention treatment with a significant rise in talk, with a modest portion of that talk falling within an academic register. When the intervention was withdrawn in the return to baseline condition, Bianca’s verbal behavior declined, but her total talk remained higher than her baseline.

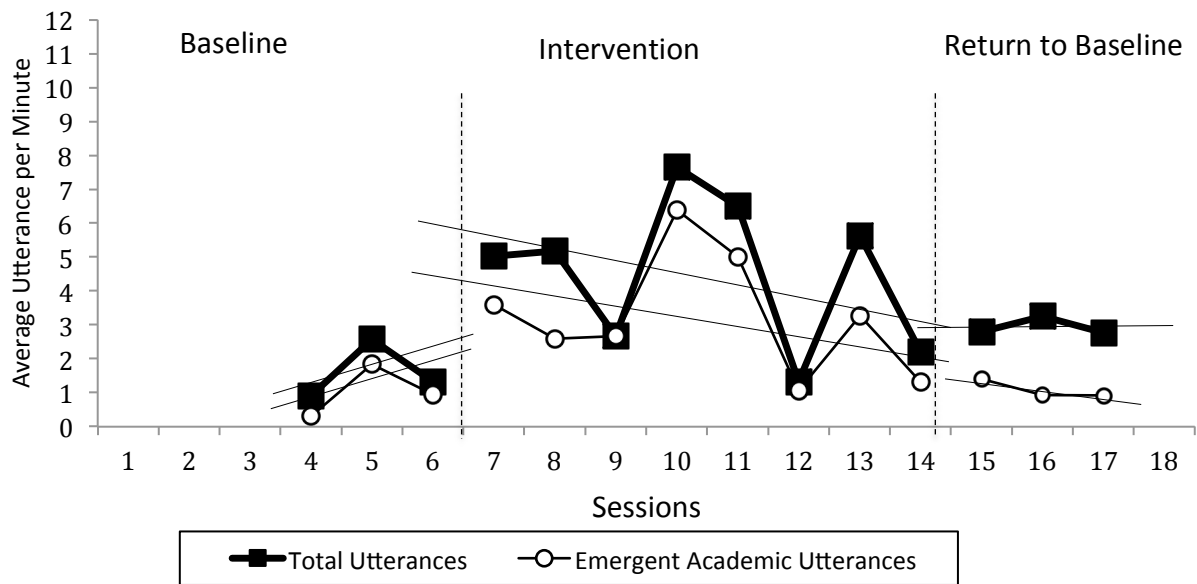


Figure 3.5. Average UPM and Proportion EA per Phase for Bianca.

UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

Tier 3 vocabulary. Bianca's tier 3 vocabulary knowledge was likewise strong going into the study (see table 3.7), and she showed a modest positive gain of 8 percent over the pre-assessment condition on both receptive and expressive tier 3 vocabulary at the maintenance phase of this study.

Distal measures. Her Boehm scores fell from the 25th percentile to the 1st percentile in conceptual language. Bianca's PELI scores rose to twenty in vocabulary and thirteen in listening comprehension, a change of +6 and + 3, respectively. Her positive response to the PELI, as opposed to her decline on the Boehm, is perhaps because of the non-stressful and story-book format of the PELI assessment.

Summary. While Bianca's intervention data follow the pattern of the other study participants (increase in number of academic utterances during the intervention), it is not clear that her standardized assessment scores or the pre- during- maintenance-vocabulary assessments reflect her actual level of knowledge. Bianca fell very ill for a month in the winter, which took her out of class for some time. At the same time, her home routines were disrupted when her mother took custody of her after a long absence, disrupting Bianca's home routines. Remember that Bianca was a mere three and a half years of age at the time of this study, and even an older and more experienced student would find these two events disruptive. Bianca became resistant to assessment when she came back to the school site, expressing no interest in participating with me in the assessment activities. Her disinterest is reflected in a drop her maintenance phase scores on general (Boehm and PELI) language assessments. It is important to note that for most of these students, this is the first formal type of assessment they have participated in.

Emmelia. Emmelia was a positive and socially adept four and a half year-old at the

beginning of this study. She made close friendships with some of the high-language students in the preschool, and helped the youngest and children who had the least amount of English with their verbal interactions when playing with me at the touch-table. She was the same age as Angel, the first case study student, but she began the intervention much farther advanced in her language skills, demonstrated by both her interactions with me and her teachers as well as her Boehm and PELI scores. She scored at the 30th percentile of children her age on the Boehm, putting her at the highest language skill of the students in the case study group. In contrast, Angel, who matched her in age, scored in the first percentile of the Boehm for her age group. In the emergent literacy assessment, the PELI, Emmelia scored 18 on the vocabulary and nine on the listening comprehension. Once again contrasting with her age-mate Angel, Emmelia scored nine points higher than Angel (who scored a 9) on the vocabulary, and 4 points higher in listening comprehension. While Emmelia started the study as the highest language case study student, she was still below her high language peers in the class. For example, Teagan, an English-only student six months younger than Emmelia, placed in the 85th percentile on the Boehm pre-assessment, and had PELI scores of 23 and 15 in vocabulary and listening comprehension, respectively.

Typical participation exemplar. Before delving in the quantitative data, I've provided a typical example of Emmelia's language behavior in the return to baseline phase to contextualize her study results. Her transcript demonstrates the mentorship role she frequently adopted with younger ELL students, like Jenny. In these cases, she became the high-language student for her less fluent peers, modeling how to use the table and encouraging participation.

Digital Audio: *Work together to find word cards beginning with the letter a. Touch them at the same time.*

Emmelia: [Taps different cards, finding several that chime] Jenny, esta! [She indicates with her chin where Jenny should touch and then glances at me].

Emmelia: She (*referring to Jenny*) has to talk in both Spanish and English.

It is clear from her transcript that Emmelia can nimbly navigate a range of registers in the setting, moving from mentoring Jenny, who has little language and most of it in Spanish, to contextualizing her behavior for me, the teacher.

Trends in utterance performance. Emmelia was the third case study student, meaning that she was third in line to begin the intervention, after first Angel and then Bianca demonstrated three data points responding to the intervention.

Emmelia's social comparison student is Andrea, a four and a half-year old English-only child who, despite her pre-assessment Boehm scores (25th percentile), quickly established herself as a high-language peer by way of her natural talkativeness and her playful good nature. During the course of the study Emmelia and Andrea became fast friends, and they made a point to play at the table together during the intervention and return to baseline phase of the study. I assumed, after observing her behavior at the touch-table setting in the intervention phase with Emmelia, that her low Boehm scores was a product of her inexperience with assessments rather than a lack of language skills or knowledge. Andrea's baseline phase UPM was 63 percent lower than Emmelia's, but her baseline EA was moderately higher (see Table 3.3) than that of Emmelia. In fact, Andrea's EA continued a slight acceleration throughout the study phases, gaining 8 percent from baseline to return to baseline, while Emmelia's EA declines by

31 percent in the return to baseline phase.

Table 3.3
Social Comparison of UPM and proportion of EA between Emmelia and Andrea.

Student		Baseline	Intervention	Return
Emmelia	Mean UPM (SD)	3.59 (3.62)	3.00 (1.78)	7.01 (2.41)
	EA (proportion)	.79	.78	.47
Andrea	Mean UPM (SD)	2.96 (2.03)	5.19 (3.74)	4.36 (3.11)
	EA (proportion)	.86	.90	.94

Note. Mean UPM= mean utterances per minute, EA (proportion) = proportion of utterances coded as emergent academic.

Visual analysis of the baseline trend line suggests an *accelerating* trend for total utterances and an *accelerating* but *variable* trend for emergent academic utterances (See Figure 3.4). Emmelia’s intervention condition spanned 5 sessions, with an average session time of 3.35 minutes. A level change (the immediate effects of a change in condition between the last session of one condition and the onset of the new condition) in UPM between the end of baseline and onset of her intervention was -5.60, with an increase in EA 32 percent. So Emmelia spoke less in the intervention, but when she did speak, she used a higher proportion of an emergent academic register.

Emmelia’s intervention data trended in a *declining* direction, though the percentage of utterance coded for EA showed no trend. The latency of change was immediate, and one baseline data point exceeded the highest level of the intervention data. Overall, the mean change level (-.59) indicated a negative effect. The high PND (percentage of overlapping data) between the baseline and intervention, and the stable trend of utterances coded as EA, make conclusions about the effects due to the intervention unclear with a visual analysis alone.

Intervention effects are further complicated by the subsequent rise in utterance rate once the intervention was withdrawn in the return-to baseline phase. Emmelia’s average UPM exceeded her highest utterance rate in the intervention condition by 3.99 percent, and dropped by 31 percent in EA. Her rate of change, calculated by the accelerating trendline of the data over all conditions, suggests a *stable* change in verbal behavior sustained after the intervention was withdrawn, and a drop in proportion of her emergent academic language, consistent with the other case study students who declined in EA language once the scaffolding was withdrawn. The latency of change was immediate, with a level change of + 3.08 UPM and a drop in EA of 19 percent. Emmelia is a student for whom the intervention appeared to work; with one exception (the 4th return to baseline session), she performed at a high level even after the intervention ceased.

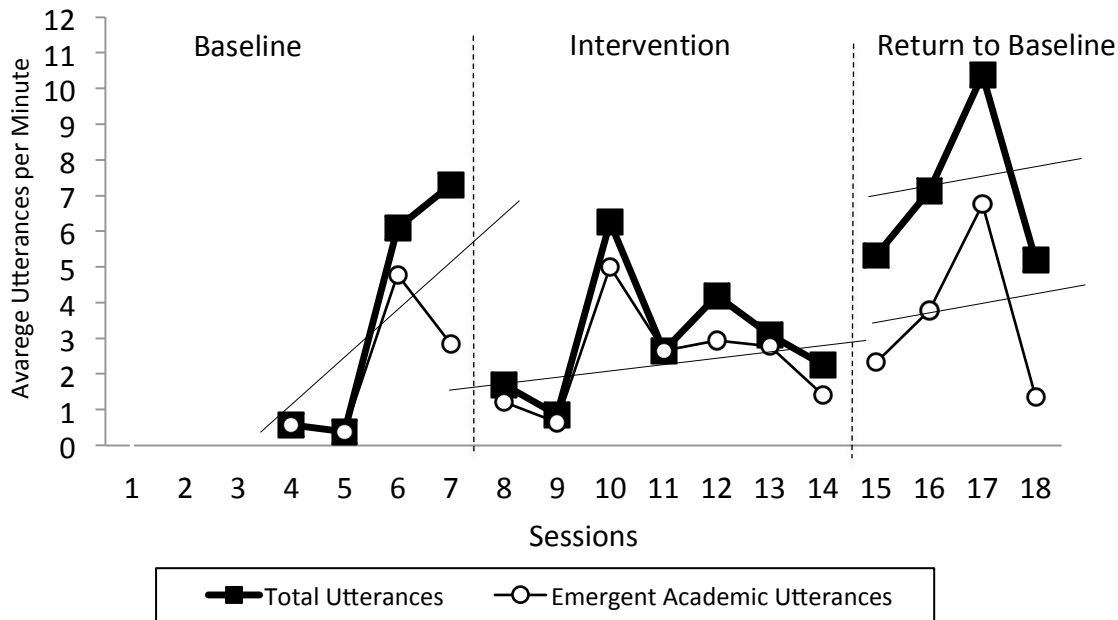


Figure 3.6. Average UPM and Proportion EA per Phase for Emmelia.

UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

Tier 3 vocabulary. Her language ability was also shown in the proximal measures of vocabulary (see table . Before the start of the intervention, Emmelia could identify 50 percent of the receptive vocabulary at the pre-assessment, and 92 percent of the maintenance phase assessment (+ 42). She gained the same amount in expressive vocabulary (+ 41).

Distal measures. Emmelia obtained the highest language scores of the case-study group in the pre-assessments for the study. On the Boehm, she placed in the 35th percentile of children her age at the pre-assessment, and rose to place in the 75th percentile of children her age by the post-assessment in the maintenance phase. On the PELI, Emmelia obtained an eighteen on vocabulary and nine on listening comprehension on the pre-assessment of the PELI, and in the post-assessment she obtained a seventeen on vocabulary (-1) and 15 on listening comprehension (+6).

Summary. The visual analysis of Emmelia’s magnitude and rate of change show a negative response to the intervention, with a positive rate change once the intervention is withdrawn. Her baseline average utterance rate was comparable to a high-language student, though unlike the high language students in this study, her rate declined at the onset of the intervention. In the time taken up by the study, Emmelia experienced a rapid growth in both her vocabulary and her emergent literacy skills. It may be that her level of language skill at the start of the study, and her friendship with Andrea, who exhibited one of the highest levels of EA register in the study, combined to accelerate her skills. It could be that her language skill level describes a the type of student who can benefit from using that table with only her peers, and not with a teacher providing language support. Without my support, she had the space and ability to adopt an expert role and practice it in a fun and playful setting. Her initial language

skills profile may describe the ceiling level of language skills that respond to the intervention in this study.

Domenico. Domenico was the fourth child to begin the intervention phase. He was four years of age at the start of the study. Domenico was an enthusiastic participant at the touch-table setting. His initial language skills are on par with Yvonne, our control student; he placed in the third percentile on the Boehm, and obtained a 0 on both PELI measures (vocabulary and oral language). Domenico was an active and verbal boy who observed and echoed responses from Norman during the intervention. Both Domenico and Norman kept up a good-natured competition on completing activities and responding to questions during the course of the study.

Typical participation exemplar. Before we look at Domenico’s utterance data and language measures in each phase of the study, we can take a look at a typical peer learning activity between Norman and Domenico. In this activity, the students are asked to make a pattern from sea creatures. As you can see, Domenico quickly picked up on how to negotiate instructional settings, and echoed the response Norman provided without prompting from me.

Teacher: Do you guys know what a pattern is?
 Norman: Yeah.
 Teacher: Can you tell me? What’s a pattern?
 Norman: You can do....you, you...[slides his arm to indicate the screen] this is a pattern.
 Teacher: Yeah.
 Domenico: This is a pattern [mimicking Norman, sliding hand over screen]
 Teacher: Here’s a pattern, let’s see how it goes. It goes, seahorse, jellyfish,...what’s that [pointing to the next object]?
 Domenico: seahorse, jellyfish, starfish. Seahorse, jellyfish, starfish.

Trends in utterance performance. Domenico’s baseline condition spanned four sessions. His average session time was 3.34 minutes. His baseline data show an *accelerating* trend (see Table 3.4) and are *variable*. (see Figure 3.5). Domenico had 8 sessions in the intervention condition, an average session time of 3.10 minutes. Going by the rising rate of UPM and the stable proportion EA, Domenico increased his quantity of talk while maintaining his already high level of EA utterances. Domenico showed a positive response to the intervention.

Table 3.4

Social Comparison of UPM and proportion of EA between Domenico and Norman.

Student		Baseline	Intervention	Return
Domenico	Mean UPM (SD)	1.27 (.86)	5.81 (2.84)	n.d.
	EA (proportion)	.72	.71	n.d.
Norman	Mean UPM (SD)	3.29 (1.80)	4.86 (0.53)	5.20 (0.94)
	EA (proportion)	.74	.96	.85

Note. Mean UPM= mean utterances per minute, EA (proportion) = proportion of utterances coded as emergent academic. n.d.= no data.

Assuming all other variables were constant across conditions, the primary variable that changed was the introduction of my adult mediation for interaction. The magnitude of

Domenico's change was evidenced by a mean change between his baseline and intervention phase of UPM, +4.54, and no level change of UPM at the start of the intervention, though his EA utterances had a 60 percent rise at the onset of the intervention (See Figure 3.5). The intervention phase also showed no change in trend direction (accelerated in both baseline and intervention), though the slope shows an initial burst and then a drop in the acceleration trend during intervention. No immediate change occurred with the introduction of the intervention, though the *latency of change* was only one session. The mean change level indicated a positive change overall, though the lack of average level of change in EA utterances, combined with the lack of an obvious trend change and a high percentage of overlapping data make it difficult to draw conclusions about the effect of the intervention for this participant with a visual analysis alone. In addition to the lack of level change, Domenico was absent for the return-to-baseline phase, so we do not know if his behavior would have reverted to a lower number of utterances once the intervention was removed. Even so, his response to the intervention suggests that even a student who began with a moderately high level of interaction skill (compared to the other target children) can benefit from teacher scaffolding.

Calculating the percentage of non-overlapping data (PND) for Domenico indicated that 60 percent of his responses in the intervention condition exceeded the highest correct response obtained during the baseline condition.

By way of comparison, his oftentimes intervention partner, Norman, also placed low on the Boehm (10th percentile, but like Andrea, his high verbal behavior belied his Boehm scores), but Norman displayed a high level of emergent literacy skills measured by the PELI; he obtained a 22 on vocabulary and 12 on listening comprehension at the outset of the study. When we look table 3.4, we see that his UPM is barely higher than Domenico in the baseline phase of the study, but perhaps in reaction to the scaffolding I am providing for Domenico in the intervention phase, Norman reveals his ability to use an EA register. His data show almost all of his UPM are coded as EA in the intervention phase, and are higher than Domenico's by 25 percent. Domenico was absent for the return to baseline phase, but I have included the data for Norman, taken from a different set of return to baseline sessions, to show his pattern of response once the scaffolding is taken away, is like that of other HL students, who decline only modestly in their rate of EA.

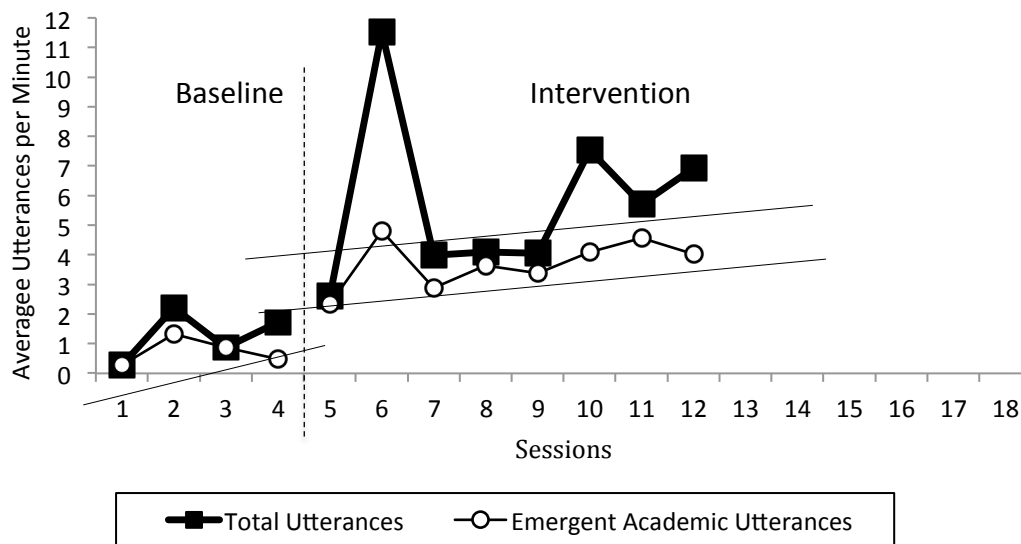


Figure 3.7. Average UPM and Proportion EA per Phase for Domenico. UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

Tier 3 vocabulary. Domenico did demonstrate increased mastery of the tier 3 vocabulary. Domenico demonstrated his mastery of the tier 3 vocabulary by the end of the study (see Table 3.7). In the pre-assessment taken immediately before each activity session, Domenico had 50 percent of the receptive, and 42 percent of the expressive vocabulary for this assessment. By the maintenance phase of the study, he gained an additional 50 percent of the receptive vocabulary assessment, though his expressive vocabulary assessment score dipped by 9 percent).

Distal measures. Domenico’s verbal skills, which showed plainly in the visual analysis, were also evident in his scores on the general language assessments (Boehm and PELI). Domenico’s language scores on the Boehm were quite low initially, in the 3rd percentile for students his age, and rose to the 30th percentile by the maintenance phase, a raw score change of +14 words. His PELI scores rose as well. His PELI pre-assessment scores were 0 and 0 for vocabulary and comprehension, rising to 10 on vocabulary and 11 on comprehension by the maintenance phase.

Summary. The visual analysis of Domenico’s magnitude and rate of change show a positive response to the intervention. The transcript illustrates his typical uptake in AE register modeled from his peers; un-prompted by me. In addition, his mastery of the tier 3 vocabulary sample and his corresponding rise in the general language measures provided some evidence that Domenico was a child for whom the intervention worked. It was a serious loss to the efficacy of this study that Domenico was not present for the return to baseline phase because in some ways the change he experienced from baseline to intervention was among the most promising of all of the case study students on the criterion of response to the intervention.

Jordan. At 5 years of age, Jordan was the oldest child of the case study students at the start of this intervention, but had only been in Head Start for three weeks. He exhibited strong social skills and had befriended a high-language student, Norman, who was his partner during

many of the intervention sessions (Norman was also a frequent partner with Domenico, the fourth case study student). Jordan was the last child to join the study, and he started preschool later than the other children in the study as well. Because of this, his baseline condition spanned just five sessions, though this was long enough to obtain the requisite three data points establishing a pattern of response to the touch-table app.

Typical participation exemplar. In the transcript, Jordan is helping the two young members of the class, Alice (three years of age) and Ann (three-and-a-half years of age) put patterns of forest animals (does and fauns) together. While both Ann and Alice are significantly younger than Jordan, they are both verbal, cooperative and interested in playing at the table despite the activities being a little beyond their skill level. Alice acts as the high-language peer for this session (her Boehm scores at the pre-test placed her in the 85th percentile for her age group). This is Jordan's second session in the intervention condition, and he is just getting used to my prompting him to talk more. He responds to my prompts mostly non-verbally, but his actions show he understands the concepts. Much of the action in the transcript is non-verbal, which I've indicated by placing brackets [] around the text.

- Teacher: Ready? Let's play! What do we see? [the demo shows up on the screen.] I see does [pointing] and I see fauns [pointing]. And it's in a pattern, too. You guys want to say them with me? [we chant the pattern. Jordan keeps his mouth hidden in his sleeve so I can't tell if he's chanting, but he points to each image as we say them.] Let's mix them up and see if you guys can put them back together again. You guys ready? [the demo ends and I unmute the audio]. Common, let's put them together. [I begin to chant the pattern while tapping each image] doe doe, faun faun, doe...what comes next?
- Jordan: [places a doe in the line]
- Teacher: That's a doe, what comes after doe doe, you guys? What do you think comes next? [Ann has a tile but is uncertain where to put it. It is a faun and comes next in the pattern. Jordan reaches his hand toward her tile to take it] Will you show her what to do with it, Jordan?
- Jordan: It goes right here [places tile]
- Alice: This is too hard for me!
- Teacher: Is it too hard? Well Jordan is going to show you. Show her how to do it
- Jordan: [Takes her tile and places it next in the pattern].
- Teacher: What does she do next? Can you use your words? Where does she put it, Jordan? [Jordan places the last tile to complete the pattern]
- Teacher: Here's let's do it, [we all chant the pattern. Jordan chimes in about half-way through and says the words with us.]

The excerpt shows Jordan acting as an expert in the activity for the younger students, though the younger students provide most of the dialogue. This is the first time Domenico had participated with confidence in the pattern chanting. He was not always accurate, saying faun for the final doe, but he corrected himself and talked out loud, not covering his mouth.

Trends in utterance performance. Jordan had an average of 3.07 minutes per session in the baseline phase and the visual inspection of the trend line shows no trend. (See Figure 3.6).

Because he was the last child to join the intervention phase, he had the fewest number of intervention sessions, four total, and he obtained a modest increase in UPM (+6) , with a significant increase in the proportion in an EA register (+ 49). The visual inspection of the trend line for direction shows a stable trend for utterances and an accelerating trend for emergent academic utterances, with a latency of change of one session. Jordan’s number of total utterances was a modest improvement from the mean of the baseline, though the shift to EA for a high proportion of those utterances demonstrated student improvement given the objectives of the study.

Table 3.5
Social Comparison of UPM and proportion of EA between Jordan and Norman.

Student		Baseline	Intervention	Return
Jordan	Mean UPM (SD)	2.17 (.67)	2.23 (2.22)	3.47 (1.34)
	EA (proportion)	.24	.73	.59
Norman	Mean UPM (SD)	3.29 (1.80)	4.86 (0.53)	5.20 (0.94)
	EA (proportion)	.74	.96	.85

Note. Mean UPM= mean utterances per minute, EA (proportion) = proportion of utterances coded as emergent academic.

Jordan’s rate of change was evidenced by a positive change in trend direction (See Figure 3.6) and a latency of change of one session. The magnitude and rate of Jordan’s change in utterances indicates a positive change overall, with a one-session delay between the introduction of the intervention and the change in his verbal behavior.

Jordan also showed a change in behavior in the return-to-baseline phase of the study. He had four sessions in the return-to-baseline phase, which averaged 2.10 minutes per session. If we look once again at the magnitude and rate of change, we see that *magnitude* of change was positive (+1.24) for total utterances, and negative (-14 percent) for proportion of EA language. Despite this decline, both metrics are positive in relation to the underlying purposes of the study, as Jordan accelerated his magnitude of verbal behavior, and had a higher proportion coded for EA than the first baseline in the series. Jordan’s *rate* of change was evidenced by the accelerating trend in the intervention being maintained in the return to baseline condition. The latency of change was 0 percent, as an immediate change in verbal behavior occurred with reintroduction of the baseline.

In addition to the overall positive (but variable) response to the intervention, when calculating the percentage of non-overlapping data (PND) we see that 33 percent of the responses in the intervention condition exceeded the highest correct response obtained during the baseline condition.

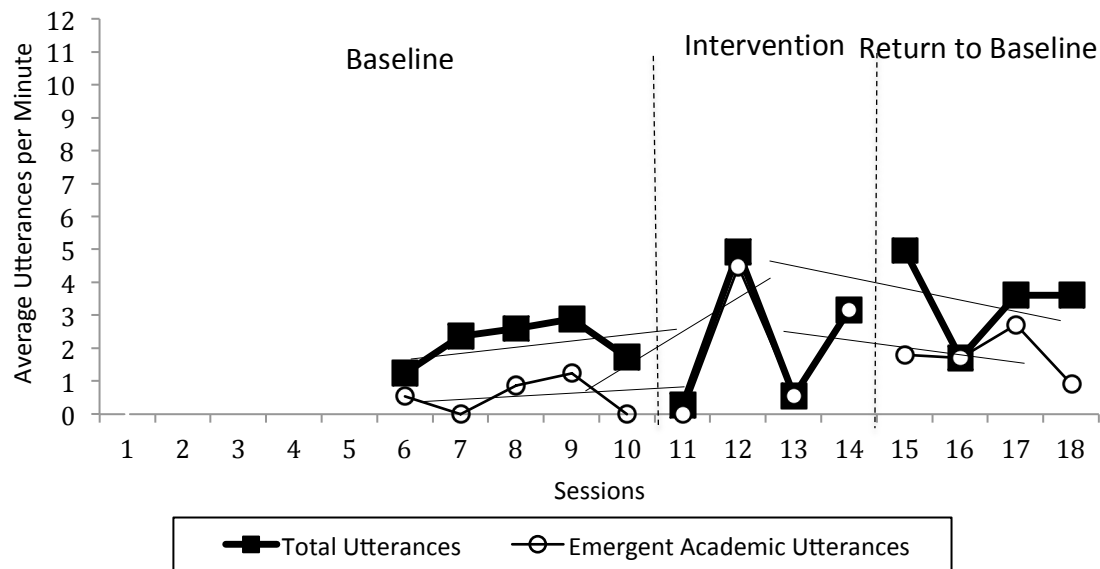


Figure 3.8. Average UPM and Proportion EA per Phase for Jordan.

UPM=Utterances per minute. Total Utterances = Utterances per minute per session. Emergent Academic Utterances = the proportion of session average UPM coded as emergent academic.

Tier 3 vocabulary. For tier 3 vocabulary, Jordan had modest gains; pre-intervention receptive vocabulary scores were 58 percent, rising to 83 percent in the maintenance phase, for a +25 percent gain overall. Jordan’s expressive vocabulary followed a similar pattern. His pre-intervention expressive vocabulary was 33 percent, rising to 42 percent in the maintenance phase, for an +8 percent gain overall (see Table 3.1).

Distal measures. Jordan’s Boehm scores were lower than both Bianca and Emmelia, placing him at the 15th percentile in the pre-assessment, and at the 25th percentile at the maintenance assessment. His PELI shows pre-assessment scores at fourteen for vocabulary/oral language, and ten for listening comprehension, while his post-assessment scores in the maintenance phase are thirteen and fourteen for vocabulary/oral language and listening comprehension, respectively (see Table 3.6 for a breakdown of PELI subtests).

Summary. Magnitude and rate changes from the visual analysis indicated a positive effect from the intervention overall, as the mean of the return to baseline phase is higher than the baseline phase. That said, it must be acknowledged that session to session variability in both intervention and return to intervention phases is the most striking characteristic of Jordan’s verbal interaction behavior. If the intervention phase had been prolonged for him, as it was for Angel who had eleven sessions (to Jordan’s four sessions), perhaps this variability would have smoothed out. Even in the few sessions Jordan had for the intervention, his UPM and EA utterance data on Table 3.5 look quite similar to that of Angel. Overall, Jordan’s data helps to establish a stable trend in the case study student response to the language scaffolding at the touch-table. We now go to the aggregated data, which further helps to establish cross-case study trends in response to the intervention.

Aggregated Data Analyses

In this section, I turn from a focus on individual students to an examination of the data when it is examined across the students. Parallel to the section on individual students, the first

set of analyses focuses on embedded language measures and the second considers distal measures.

Embedded Language Measures

Utterances. In the previous section, I focused on the data showing the change in the dependent variable, quality and quantity of language, between study phases for each of the case study students. In this section, I will revisit the utterance evidence in two complementary analyses. First, instead of conducting a visual analysis of the patterns of performance across the 3 phases for each individual, I'll conduct a visual analysis of the six cases (Yvonne and the 5 case study students) as a composite. Second, the low numbers notwithstanding, I will examine their aggregate data of the 5 case study students in comparisons to how their high-language (HL) peers (all 9 of the social comparison students) used language in the very same setting as the case study students.

Composite visual analysis. Figure 8 displays the number of UPM and EA utterances collected from each child³ during the baseline, intervention, and return to baseline phase evaluated within the multiple baseline across participants design. UPM and EA utterances increased for all participants during the intervention period and decreased in the return-to-baseline phases for most students. However, it is clear from looking at the graph that all four criteria for visual analysis are not met in each graph. Across five of the participants (excluding Yvonne, who remained in the baseline phase for the duration of the study) the UPM and EA mean changes from baseline to intervention. As for changes in level, (discontinuity at the point of intervention for each participant), participants 1, 2 and 3 show changes in level. As for changes in trend, each participant shows a change in trend, excepting the baseline-only participant, Yvonne. The characteristic of latency (amount of time between the onset of the intervention and rise of utterances) is immediate in participants 1-3, and delayed by one session in participants 4 and 5. From this variation, it is clear that the criteria apply differently to different children. Looking at the overall graph, it is reasonable to conclude that the intervention likely accounted for the changes in quantity of UPM and EA utterances, as each participant's behavior changed between the baseline and intervention condition. Further evidence of the effect of the intervention is provided from the return to baseline condition.

Student engagement in the activities during the baseline condition was low. While they were initially excited to begin playing on the table, for the most part they did not understand how to operate the games. While this study is not an exploration of how to redesign the game, the lack of mediation on how to interact with the game and how to proceed through the game between the adults and the students became slightly problematic when the students did not want to complete an activity because they were bored. Their boredom was displayed by their wandering attention and their gradual walking away from the touch-table.

The differentiated criteria evident between participants is analogous to between-group differences in two-group studies that show significant differences between groups on some measures but not on all measures. One path to interpreting these differences is to look at the language assessment data gathered pre- and post intervention from these students.

³ The fourth child, Domenico, missed the return to baseline phase so his data is missing. He was absent during this period of class, but returned to school for the post-intervention assessments.

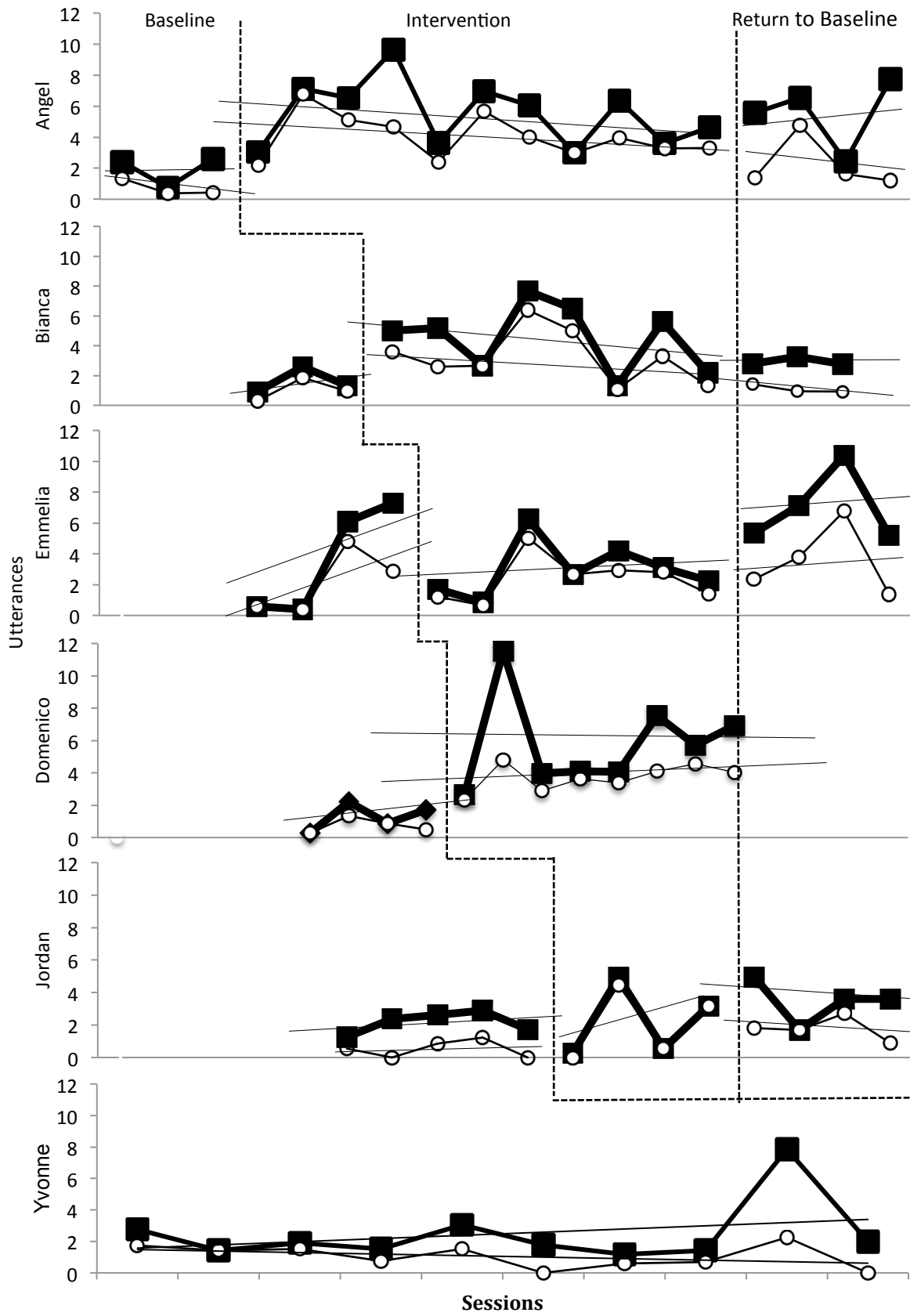


Figure 9. Whole Group Visual Analysis Chart.

Social comparisons across phases. Table 3.6 compiles the average utterance data to show larger trends between the case-study students and the HL students who received exposure to the touch-table without the benefit of direct language scaffolding.

Table 3.6

Comparison of the Utterance Patterns for the Case Study Students and their High Language Peers across Phases

Student Group	Baseline		Intervention		Return to Baseline	
	<i>N</i>	UPM (range)	<i>N</i>	UPM (range)	<i>N</i>	UPM (range)
CS (n=5)	19	2.15 (.28-7.30)	38	4.55 (.28-11.52)	15	4.87 (1.70-10.38)
<i>Proportion EA</i>		.54		.74		.48
HL (n= 8)	27	3.26 (.28–6.96)	23	4.20 (.50–11.79)	9	3.93 (.55- 7.97)
<i>Proportion EA</i>		.75		.85		.88

Notes: CS = Case study students, HL = High language students. n = # of students, *N* = the number of sessions included in the sampled average. UPM= average utterances per minute across sessions. *Proportion EA*=proportion of total utterances coded as Emergent Academic language.

The data show an average change in the quality and quantity of talk between study phases for case study and HL students. During the baseline condition (phase 1), case study students lagged in total average utterances (-1.11) behind their HL peers, as well as lagging behind HL students in EA (-.21). Not only did the case study students talk less than their HL peers in the baseline condition, but when case study students did talk, their language was characterized by an assumption of a shared line sight, less sophisticated vocabulary, and fewer extended conversations.

This balance between the case study and HL student groups shifted quickly in the intervention condition (phase 2). With the support of my language scaffolds and direct instruction of relevant tier 3 vocabulary, case study student language took on quality and quantity language characteristics of the HL students from phase 1. Case study quantity of talk increased, the average total utterances from case study students rose by 2.40 words per minute, outstripping the HL baseline utterances average by 29 percent. Case study student quality of talk, measured by the proportion of utterances coded EA, rose from their baseline proportion by + .36, coming close to matching the phase 1 HL student EA of .73. Looking at Table 3.6, the case-study phase 2 data looks strikingly similar, if not better than, the HL phase 1 data.

As anticipated, once I removed the scaffolding in the return to baseline condition (phase 3), the gap between the student groups reasserted itself, though with an interesting nuance between the two groups. Case study students spoke even more than in phase 2, but their quality of talk decreased, while HL student spoke less than in phase 2, and their quality of talk increased. In phase 3, the rate of total utterances from case study students rose in comparison to phase 2 by 32 percent. While case study students increased their rate of talk per minute

from phase 2, their quality of talk shifted from EA back to a non-academic register by -.26, sinking below their phase 1 EA. This is in contrast to HL students who, though talking less than case study students, and talking even less than their own average in phase 2 by .94, accelerated their proportion coded for EA by +.03.

Tier 3 vocabulary. Students were continually assessed on receptive and expressive content-specific vocabulary in the intervention and maintenance phases of the study. Recall (see Methods chapter) that these assessments were based on a randomly selected set of words from the various themes (Tidal Pool, Forest, and Outer Space). Data points for each student include three time periods, (a) before each intervention session (pre), (b) during, and as a seamless part of, the intervention session (during), and (c) 7 weeks after the study ended, in the maintenance phase (maintenance). While student responded to only two or three vocabulary words during any given pre or during assessment, they responded to a randomly selected set (see Appendix A) for the maintenance assessment in a single sitting. To create a fair comparison across the three time points (pre, during, and maintenance), I limited the data used for the pre- and during-assessments to only those 12 words that were included in the maintenance. As is evident in Table 3.7, the data for the pre- and the during- assessments are puzzling, especially for the receptive vocabulary. Why would know more of these words before the activities than after they had encountered them during the activities? The only explanation that seems plausible is that there was something odd about my asking them to point to an object as we encountered them “on the fly” during the activities. Clearly, these case study students knew these words in the maintenance phase, implying that learning had taken place during these sessions at the table. The expressive vocabulary trajectory seems more plausible in the magnitude of the changes from pre- to during- to maintenance phases.

Table 3.7
Tier 3 Vocabulary Results Before, During and After the Study

Student	% Receptive (n=12)			% Expressive (n=12)		
	Pre	During	Maint	Pre	During	Maint
Angel	58	22	75	0	25	25
Bianca	50	17	58	42	17	50
Emmelia	50	50	92	17	42	58
Domenico	50	50	100	42	42	33
Jordan	58	8	83	33	17	42
<i>Mean</i>	<i>53.2</i>	<i>29.4</i>	<i>81.6</i>	<i>26.8</i>	<i>28.6</i>	<i>41.6</i>

Note: Maint=Maintenance phase

Extended conversations. Group transcripts were coded not only for utterances, emergent academic language and receptive and expressive tier 3 vocabulary, but also for evidence of extended conversations. Evidence of an extended conversation with the case-study students consisted of talk sustained for two or more interchanges on the same topic between peers and/or between me and child (for examples of talk coded as extended conversations, please see the Methods chapter). Change in number of conversational interchanges is presented in table 3.8. The data send a pretty clear message: with the exception of Domenico, extended

conversation did not occur among the students at the table when left to their own devices. It was only when I intervened that some of the students (Angel, Domenico, and Jordan) accepted my invitation to extend the conversation. And when I withdrew the support during the return to baseline, these conversations could not be sustained among the students.

Table 3.8
Extended Conversations Across Phases

Student	Baseline	Intervention	Return to Baseline
Angel	1	14	0
Bianca	1	2	2
Emmelia	1	1	0
Domenico	5	7	n.d.
Jordan	1	5	0
Yvonne	1	3	0

n.d.= no data

Social Validity Outcomes

All teachers and para-teachers participated in the social validity questionnaire (see Appendix E). As a reminder, the social validity questionnaire serves to inform the researcher on the sustainability and practical usability of their research. Their responses were positive. All of the teachers and para-teachers felt that the study did not intrude on their regular classroom routines; it was easy to accommodate and it fit into their regular schedules. They also strongly agreed that the study taught important skills to the students and was suitable given the classroom culture; it improve the student’s oral language skills and they strongly agreed it would have lasting positive effects. They strongly agreed that they would recommend this kind of study to other teachers, and most of the teachers felt they would be able to do the same intervention I modeled in my study on their if they needed it.

Distal Measures: Standardized Assessments of Language

The aggregated data presented thus far suggest that the proximal measures show a change in student language behavior (students spoke more and with a higher proportion coded as an emergent academic register) and vocabulary knowledge (measured by the proximal vocabulary measures shown in table 3.7). The distal measures of general language skills tell another story. As a reminder, our distal measures are the Boehm and PELI. The Boehm assessed conceptual vocabulary (i.e., up, over, across). The PELI included 2 subtests of vocabulary/oral language (a) expressive vocabulary and (b) Tell about pictures, and 3 subtests of comprehension (a) inference and prediction, (b) retelling, and (c) CLOZE (you can find a full description of these subtests the Methods chapter).

For these analyses, I used three groups of students: (a) the five case study students who received the scaffolding, (b) the 24 exposure only students—those students who were at the table with the case study students but did not receive any direct scaffolding, and (c) the 13 test-only students—students from a comparable classroom without the touch-tables present. The results of the analysis of covariance (see tables 3.10 for pre- and post-test means), standard deviations and f values), examining average post-test vocabulary and listening comprehension scores among the three groups, controlling for pre-test scores. The Boehm ANCOVA used

standardized T-scores (M=50 and SD =10). The PELI ANCOVA used raw student scores. The analysis shows that there is no statistically significant effect of group, after controlling for student's pretest ability. Apparently growth from pre- to post-test on general language skills measures did not differ across the 3 groups on these transfer measures of vocabulary and language performance. Whatever it is that students acquired in the intervention was specific to the content and processes enacted within it.

Table 3.9
ANCOVA and Distribution of scores by Group

Source	SS	df	MS	F	p
adjusted means	63.38	2	31.69	0.39	0.68
adjusted error	3027.43	37	81.82		
adjusted total	3090.81	39			

Table 3.10
ANCOVA and Distribution of Pre- and Post-Treatment Scores by Group

PELI	Case Study (n=5)	Exposure (n=20)	Test-Only (n=13)	F	p
	Mean (SD)	Mean (SD)	Mean (SD)		
Expressive Vocab					
<i>Pre</i>	2.20 (1.48)	3.47 (2.50)	3.46 (2.37)		
<i>Post</i>	6.40 (2.61)	6.89 (2.54)	6.85 (3.31)	.14	.86
Tell About Pictures					
<i>Pre</i>	9.00 (5.79)	9.50 (7.31)	8.62 (8.11)		
<i>Post</i>	6.60 (3.51)	9.50 (5.48)	11.69 (7.67)	2.55	.09
Infer & Prediction					
<i>Pre</i>	3.20 (1.92)	3.95 (2.01)	3.62 (2.43)		
<i>Post</i>	4.20 (2.68)	5.05 (2.28)	3.85 (2.54)	.86	.42
Retelling					
<i>Pre</i>	1.00 (1.41)	2.30 (2.25)	3.00 (2.94)		
<i>Post</i>	4.80 (2.77)	5.25 (1.86)	4.54 (3.43)	1.47	.24
CLOZE					
<i>Pre</i>	2.20 (1.79)	3.25 (1.59)	2.62 (1.66)		
<i>Post</i>	1.60 (1.82)	2.50 (1.61)	1.77 (1.59)	.36	.69

Note: Values of F interaction between groups, and ANOVA two-way repeated measures. SD= standard deviation, Infer = inference.

Summary of Results

As suggested earlier, these results reveal two different scenarios. In general, the story from the analyses of the individual journeys of the case study students is that they responded to the intervention through a rise in their quantity (UPM) and quality (EA) of talk. Granted the effect of the intervention was not as dramatic for some students as it was for others, and there were important differences across students in the durability of the intervention, but in general,

the conclusion one would have to draw from the case study data is that the scaffolding supported a change in the quantity and quality of talk, especially academic talk.

But the story from the standardized assessments is completely different. There were no apparent transfer effects to the general language assessments. Either the intervention would need to continue on for a longer period of time to show up on general language assessments, or the content of the intervention would need to be specialized to emphasize the conceptual language and the thematic content of the PELI to show up after the intervention.

Chapter 4: Discussion and Implications

Set within a sociocultural framing of the ways in which language and literacy are acquired, the premise of this study was that low-income preschool students can realize enduring academic benefits from a focus on their emergent academic language skills in the context of new digital tool use. Academic language production in preschool is a strong predictor of emergent literacy skills in the near term (in K-1) and, of reading comprehension skills in the longer term (in grades 2-3) (Wilson, Dickinson & Rowe, 2013; Dickinson & Smith, 1994). Teachers and researchers have found multiple academic settings and activities that are both effective for developing these skills and developmentally appropriate for preschool students. Most of these studies focus on commonplace classroom settings (whole group, small group, and center settings and activities) to scaffold emergent literacy skills through oral language prompts that model and elicit the forms and content of emergent academic language (Huennekens, 2013). In this study, I investigated the impact of infusing a focus on language production and reception in a new digital setting, specifically a touch-table that provided developmentally appropriate activities with multiple media, to preschool students who were already using the tool to investigate worlds of words and ideas—tidal pools, forests, and outer space—rife with opportunities to make meaning. In these virtual worlds they encountered sound, images, and manipulative objects with easy access to peer interchanges (another source of meaning making). The multi-touch table app used in this study exhibits many of the affordances we know help students gain knowledge and make meaning in the world in a playful environment.

Multi-touch tables in preschool are fairly new on the instructional scene, and we are still learning how to use them productively. And while there is some evidence of emergent literacy constrained skill development (e.g., letter knowledge, phonological awareness) in the context of using digital tools, no studies to date have explored how to use digital tools for the development of the unconstrained skills (see Paris, 2005), such as the development of the sophisticated vocabulary and register associated with academic language. The purpose of this study was to examine the beneficial effects of adult mediated academic oral language scaffolding on the production of English learner's emergent academic language in the context of a multi-touch table setting.

The exploration of an unknown tool and my interest in a specific type of student (low-income ELL students who have enough conversational English to participate in instructional activities) led to the choice of using a single case study design (SCD) for this study. My study used a multiple-baseline SCD with pre- and post-assessments. In a multiple baseline single-subject design, each student's baseline condition served as his or her own control, and the intervention (teacher scaffolding of talk at the table) served as the experimental condition. Students were inducted into the intervention sequentially across different time points. Once the first student demonstrated a positive response to the intervention prompts in three episodes (a 1-3 minute interaction with the table content), the next student was inducted into the intervention condition while the first student continued to receive it, and so on, until 5 students were active in the intervention. After the fifth and last target student achieved the three-response criterion, all students were returned to the baseline condition, i.e., participation at the table with guided interaction (how to use the tool), but without academic-talk

scaffolding, as the sole type of teacher scaffolding. The key question is to what extent students respond to the intervention, and how that response is replicated as each succeeding student enters the intervention phase. Behavior change was measured with visual analysis of magnitude and trend-lines that indicate the strength of the intervention, and how student behavior changed once the return to intervention phase was begun. I used the SCD design to answer the fundamental question of whether adult mediation can provide just the optimal level of support that enhances students' acquisition of the academic register (Kratochwill et al., 2012) within a digital learning environment.

In this chapter, I interpret the results of the single-case study data in light of that fundamental research question. I also explain the theoretical and practical consequences and contributions of the results in the context of that research question. I conclude with a set of limitations, including threats to internal and external validity, implications for curriculum and pedagogy, and some thoughts about future research steps that move beyond this preliminary question of efficacy.

Research Question: Does multi-touch software used with adult mediation support various indices of academic language development?

This broader question is better conceptualized as three related but more specific questions, each reflecting a different set of dependent measures:

- (a) Does adult mediation in the multi-touch table setting support a greater quantify of talk and, in particular, an increase in emergent academic language?
- (b) Does adult mediation support the learning and use of the tier 3 vocabulary embedded in the program?
- (c) Does adult mediation support more extended conversational interchanges?
- (d) Does participation in the program at various levels of exposure to adult mediation influence growth on more distal indices of academic language?

These questions stem from what we know about role of opportunity to talk and in acquiring deep vocabulary knowledge as a part of the overall development of emergent literacy skills. We know that students who have more opportunities to talk in an academic register will develop stronger skills in communicating in that register (Mohr & Mohr, 2011; Smith & Dickinson, 1994; Snow et al., 2001) We also know that vocabulary is a predictor of later reading comprehension skills. In building on this rich tradition of emergent literacy research, the aim of this study was to evaluate scaffolds designed to increase the opportunities to talk in an academic register and to develop tier 3 vocabulary in the context of the app. To this end, case study students were encouraged to talk through a range of scaffolds that I provided: modeling, asking students to echo my words, drawing out specific responses through direct questioning, and repeating and extending student utterances to elicit conversations with and between them. Sophisticated vocabulary was taught and reinforced explicitly in the context of the activity by first identifying and naming objects, asking students to name objects, eliciting the names of objects in the natural progression of the activity (i.e., "What did you find?") or asking high language peers to name objects as a model for case study students. In short, I did everything possible to encourage greater amounts of talk, especially of the sort privileged in school settings.

The evidence used to answer all aspects of the question comes from several analyses:

- (a) a visual comparison of the average number of utterances per minute (UPM) and the proportion coded for meeting the criteria for emergent academic utterances

- (EA) provided by the case study students in each phase of the study (with a control student who participated at the table but without teacher intervention),
- (b) a pre-, during-, and post-test comparison of the number of tier 3 vocabulary terms acquired by students across the duration of the intervention plus a maintenance assessment seven weeks after the intervention was withdrawn,
 - (c) an analysis of the number of extended conversations across the three phases of the intervention,
 - (d) pre-post comparisons on several distal measures of language performance—the Boehm, and the vocabulary and listening comprehension subtests of the PELI.

The data from items a, b, and c in the list involved only the 5 case study students and the control student, Yvonne. The comparisons for the more distal measures (d) involved three groups: (a) the case study students (those who had direct benefit from the scaffolding) (b) the exposure-only students (those who might have received an indirect benefit from the scaffolding because they were at the table at the same time as the case study students), and (c) the test-only students, (those who were in classrooms without any of the touch tables).

The simple answer to question 1 overall is yes, but the answer varies depending on the particular dependent variable. A visual analysis of the talk that emerged at the table and the trends evident in proximal assessments of vocabulary provide evidence that adult mediation has a positive impact on talk and vocabulary acquisition. The case study students demonstrated a rise in their overall utterances, the proportion of utterances that were classified as emergent academic language, and their acquisition of tier 3 vocabulary, and even (albeit more modestly) their engagement in conversational interchanges during the intervention phase of the study. These gains in register and vocabulary did not carry over to the distal measures of language skills, the Boehm and the PELI.

The visual analyses. The visual analysis across the three phases of this study (baseline, intervention and return to baseline) shows an effect for adult mediation on average number of utterances per minute as well as the proportion of EA utterances. While the magnitude and rate of change varied by individual student, the typical pattern in the data shows a rise in emergent academic utterances during the intervention phase of the study. Adult mediation of student language likely accounted for the changes in quantity of emergent academic utterances, as each participant's behavior changed between the baseline and intervention condition. Further evidence of the effect of the intervention is provided from the return to baseline condition, in which individual students either continued to show a rise in average number of academic utterances per minute, or a drop (from intervention to return to baseline) in utterances that was nonetheless stabilized at a higher level than during the initial baseline.

Embedded vocabulary. Evidence of change in UPM, EA utterances, and tier 3 vocabulary learning was collected from two sources, coded transcripts of child utterances and pre-post assessments of tier 3 vocabulary. As a reminder, the tier 3 vocabulary assessments were the proximal indicators of student vocabulary learning of sophisticated, context-specific words (names of animals, space objects, tidal pool organisms and the like) in the context of the activity. Coded transcripts showed that case study students had gains in expressive and receptive vocabulary in the intervention phase, demonstrating that students gain vocabulary with support in the activity context. Even the data on a maintenance of tier 3 receptive and expressive vocabulary given seven weeks later demonstrate that these vocabulary gains

endured over time. While progress was made on proximal measures of tier 3 vocabulary, there is no evidence of transfer to distal vocabulary measures (Boehm and PELI assessments). This finding is consistent with as previous studies that show gains that might be attributable to preschool language interventions on distal measures are not immediate, with vocabulary gains showing up at the end of kindergarten (Dickinson & Smith, 1994a).

Conversational interchanges. Evidence of a rise in conversational interchanges was collected from coding transcripts for talk sustained for two or more interchanges on the same topic between peers and/or between the teacher and child. The data show a rise in conversational interchanges in the intervention phase, and a falling off of conversational interchanges in the return to baseline condition (see Table 3.8). The interest in this questions stems from studies that provide evidence of the number of conversational interchanges a child can sustain as co-related to later literacy skills. Not surprisingly, Angel, who had the highest number of session with me, had the highest number of conversational exchanges as well. While Angel did not experience a rise in her distal language measure, the Boehm, she did begin to exhibit the behaviors and characteristics that we associate with later literacy skills, including engaging in asking questions and sustaining conversation on a single topic. While the content of her conversation was limited and often off-topic, it may be that if she gets more opportunity to engage in these emerging academic conversations, she will adopt a more active and inquisitive norm in educational settings that lead eventually to literacy expertise.

A closer look at the visual analysis. If we take a close look at the visual analysis, the data actually show two patterns of responses to the return to intervention condition, a continued rise in average UPM, or a drop in UPM (in comparison to the intervention phase) that was nonetheless stabilized at a higher mean than the initial baseline. These two patterns are perhaps attributable to the initial oral language skill of case study students. Emmelia, one student whose average UPM continued to rise in the return to baseline condition, was assessed in the 30th percentile of the Boehm in the pre-intervention assessment, and the 75th percentile in the post assessment. In the return to baseline condition, when I stopped providing the language prompts that encouraged student participation in the activity and the accompanied language exchange, Emmelia showed evidence of having adopted EA language forms without the presence of, or the need for, a model. The excerpt below involves three students in a single table episode during the return to baseline phase, Andrea is the high language peer with whom Emmelia was most often paired, Emmelia is the case study student, and Jenny is a low language student who tested too low to be in the study as a target student but still had fun when she participated. The activity is set in a bubble-bath, and students move bubbles out of the way to uncover objects in the bath. The objective classification, students are asked to find bath toys with letters on them and drag them to the center of the tub. Interspersed with the bath toys with letters are other objects, including bath toys with numbers.

Digital Audio: *Help me find the bath toys with letters on them.*

Emmelia: Try to find duckie!! Duckie duckie!

Andrea: I found a star.

Jenny: ah...mine mine!

Emmelia: Here's octopus. Hippo! I found...

Jenny: eh-tah! Me got

Emmelia: Hippo! I found a hippo!

Andrea: I found a seal!

Emmelia's rise in language ability and her adoption of some conventions of academic language (e.g., turn taking, language that does not assume a shared line of sight) is unlikely to be attributable solely to the study intervention. There might be some connection between her relatively high scores on the Boehm, and her facile adoption of the language forms of the intervention.

Angel is a good example of a student representing the other pattern of data in the return to baseline phase, in which her average UPM decreased in comparison to her intervention phase data, but showed an overall rise in mean UPM as well as EA from her initial baseline phase data (see Figure 3.5). Her pre-intervention Boehm assessment placed her in the 1st percentile of children her age, and while her raw score rose from 5 to 9 words between the baseline and the return to baseline phase of the study, she remained in the 1st percentile of the Boehm when given at post-test. Her general language behavior in the intervention, however, somewhat paralleled that of Emmelia. Angel, like Emmelia, demonstrated an increase in overall oral language in the return to baseline phase of the study. However her language in the return to baseline is more reminiscent of BICS than CALP, that is to say, she adopted the behavior norm of talking in the intervention, but was not as successful in producing the academic forms of language when I withdrew the intervention support. This excerpt illustrates the difference in language forms produced in the return to baseline phase between Emmelia and Angel. In the transcript, Angel keeps up a steady narrative that is only sporadically related to the task she is completing with Jenny, a low language student. I have numbered the academic utterances in the transcript. Out of a total of thirteen utterances in this transcript, two meet the criteria of EA utterances.

Angel: [to Jenny] You don't know how to play this. You don't know how to play this. You don't know how to play this. You, you...that's mine. [To me] I miss my mom. Do you miss your mom? I miss my mom. Do you have a mom? Where is your mom? At the house? [to Jenny] (1) That's yours. (2) You put yours right there [indicating a space in the puzzle].

While the data show a high level of language production from Angel (a striking change from her baseline language behavior), this is everyday rather than academic language. Angel's increased everyday language production is contrasted to Emmelia, who started out with a higher proportion of her utterances coded as EA. The proportions of everyday to emergent academic language are similar for Emmelia and Angel in the intervention phase (.78 for Emmelia and .76 for Angel), and in the return to baseline phase (.47 for Emmelia and .45 for Angel) but the quantity of talk is different, with Emmelia talking more overall (7.01 utterances per minute) than Angel (5.58 utterances per minute). Both students adopted the behavior of talking in the context of the game, a positive outcome based on the underlying objectives of the study. But their ability to use an academic register with only a few weeks of intervention seems to depend on their initial language skills going into the experiment (Remember that Emmelia was the third student in line for the intervention phase, and so received fewer intervention sessions than Angel). The implications for transfer and the enduring nature of the language behavior from students may vary by student prior language skills. Future studies might investigate the value of using a standardized measure of expressive language, such as the Boehm assessment, as a covariate for predicting and explaining academic register uptake by

students; it might be the case, for example, that only students who begin an intervention with a certain threshold level of academic language ability are able to benefit from the sort of scaffolding I provided.

Key Issues Emerging from this Study

Several issues, some anticipated and others surprising, emerged as the study unfolded, but all of them are worthy of discussion in light of the findings from this attempt to increase the academic language experiences of young English learners. Three, in particular, seem especially salient: adult mediation, peer mediation, and readiness to benefit from the intervention.

Adult Mediation

Socio-culturalists recognize the role of expert others to provide cultural apprenticeships in the rules and language school for young learners. The structure of this study was based on the assumption that an expert other would provide models and scaffolds to novices in the learning setting, and that the technological tool would act as an artifact with which to frame conversation, problem posing and content presentation. The socio-cultural approach to the intervention design is important; the logic of the intervention stems from our understanding of how rules and values differ between social groups, especially between different income groups. The culture of school mirrors middle and high-income group values, ensuring a smooth transition to school cultures for children who grow up in these groups. We know that low-income ELL students do not have the same language rules and resources at home to draw from when they are introduced to school. Low-income ELL students instead depend on schools to scaffold for them the ways of talking, acting and thinking that are specific to the academic context. These are the fundamental tools students must gain in order to communicate effectively in schools. This intervention was designed to support student gain in academic concept and knowledge development, but also to support student gains in cultural fluency through short and playful apprenticeships in academic language use. Consistent with what we know about how children learn subtle moves that indicate cultural fluency, the data show strong gains when the teacher and the peer provide language scaffolds to the novices, and ELL students mimicked and adopted the academic language register and content knowledge (vocabulary) needed to act in this setting.

To what extent should we attribute the gains made by case study students to the teacher scaffolding versus the technology by itself? Certainly the case of the one control student, Yvonne, for whom we had sufficient data, suggests that the technology by itself doesn't result in any appreciable change in the incidence of either overall or emergent academic language. While there are few, if any, other experimental studies of pre-K students using touch-table technology for emergent literacy skill development, the results of using adult mediation in an activity setting to support academic language development compare favorably with other studies with the same aim, albeit with different tools (Klein, Nir-Gal, & Darom, 2000). The finding that adult mediation explicitly for oral language development support the quality and quantity of student talk is consistent with other studies on oral language development in preschool that show it is not necessarily the setting that matters (read-alouds, mealtime or touch-table activities in this case), but the adult/child interactions that support construction of oral language forms (Snow et al., 2001; Wasik & Bond, 2001). Other experimental studies have focused on the read aloud setting as rich and productive for oral language development with students (Beals et al., 1994; Beck & McKeown, 2001; Dickinson &

Smith, 1994a; Silverman et al., 2013). For example, the value of the read aloud setting comes from first, the resource of academic language and rich varied vocabulary that lies within the books chosen for read-alouds, and second, the teacher/student interaction in an academic register. This type of language, not generally present in everyday conversational interactions, is easily accessed through the pages of a book. Some parallel might be made with the content of a touch-table, which in the case of the app used in this study was rich with vocabulary, images and concepts not generally found in everyday conversation or easily set up in conventional activities (M. M. Neumann & Neumann, 2014).

But it is not simply the content or the conceptual frameworks presented through the touch-table app that seems to hold value for oral language development. Like read aloud studies that cite the quality of teacher/child interaction as driving the change in student outcomes, so it should be for the interaction between adults and children in the touch-table setting. Adult prompting that employs the oral language scaffolds we know support literacy development (Mohr & Mohr, 2011) did elicit more academic utterances than adult prompting that supported the technical and inter-personal functioning of the setting, a finding consistent with prior studies on oral language development with young children (Dickinson, 2011).

In addition to the oral language scaffolds, the multi-touch table allows for the use of paralinguistic cues between the experts and the novice learners. Paralinguistic cues include many of the guided interaction moves that support the technical progress of students through the activity, such as pointing, facial expressions, and modeling with the table objects. As I expected at the outset of the study, these cues were also helpful in encouraging ELL students to experiment with and eventually adopt decontextualized language. All student participants benefitted from multiple opportunities to describe and explain what they were doing at the time, first non-verbally, then verbally. This affordance, the face-to-face small group interaction facilitated by the multiple participants and the small size of the table, requires skilled facilitation much like that in a read-aloud, but unlike a read-aloud, students can manipulate concrete objects, direct the progress of the 'narrative' to some extent, and as the HL peers demonstrated in this short study, provide peer-to-peer oral language scaffolds that do not generally occur in read-aloud settings. This language intervention had multiple avenues for authentic and contextualized communication unique to the multi-touch table setting.

While the audio affordance of the table did not show a clear benefit in this study, audio has been shown to support comprehension skill development in other studies using multi-modal technology with pre-decoding students. There seems to be a promise in audio to provide models of language for ELL students, though this particular app did not provide models that the students responded to in any discernable way. Perhaps a study controlling for audio might tease out the contribution of this affordance to overall student language gains.

The data from this study, at least from the perspective of increasing low-income English learners' uptake of emergent academic language and content specific tier 3 vocabulary, suggest that technologies like multi-touch tables will likely require, or at least benefit from, scaffolding for the conceptual content (matching, making patterns, solving puzzles), technical skills (moving objects with one finger or twisting objects with two fingers), and linguistic skills (sharing information, naming objects, participating in academic forms of language). And, consistent with comprehension instruction in other educational settings, as children gain expertise in any of the areas listed above (conceptual, technical or linguistic), scaffolding can be eased in a gradual

release of responsibility from the expert to the student (Pearson & Gallagher, 1983). It is possible that some of this sort of scaffolding can be programmed into the tool, just as directives for playing the game are now, but that has not yet been done. Moreover, it is hard to imagine how any digital environment or tool, even the friendliest of avatars, can be responsive to the particular journeys of student language in the way a live and responsive teacher can be, especially for students who are unfamiliar with the rules and content of school-based language, the same rules driving the audio script of the program in this case. For low-income students, then, language scaffolding from an expert other is a required addition for productive use of a tool of this type.

In terms of implications for classroom use, the key message is about how teachers should position and regard a tool like a touch-table in order to take advantage of an asset that can assist them. Based on the experiences in this study, when choosing and using digital tools as a support for oral language development with preschool students, the student/tool interaction should not be considered a communication scaffold. Adult mediation is required as a scaffold for building the language and conceptual understanding required for true collaboration. The student/tool interaction might be considered in the same way we think of texts. Texts don't teach, but they can enhance the repertoires of teachers; so too it should be with touch-tables, at least until we have new and more convincing evidence. With touch-tables, as with texts, an adult mediator should be present to model, structure, and elicit the desirable register of language from the participants. Successful and independent use of a digital app designed to support oral language might be described as a demonstration of expert performance, much like successful reading of a text is described as an expert performance for reading (Kintsch, 2004). I do not mean to imply that student cannot gain important cognitive skills by playing independent of an adult at a touch-table app like the one used in this study. I think students can gain knowledge of content and conceptual skills independently from an app such as this if their language skills are strong enough for the listening comprehension task; very much like students can gain concept and content knowledge from books once they have adequate literacy skills matched to the text they are reading.

Granted, there are limitations to these trends that stem from both the experimental design and the participant selection process (c.f., Limitations later in this chapter), but the trends in the data from the individual cases are encouraging in that they demonstrate that teacher scaffolding during the intervention has both a pretty clear immediate effect and stable if less impressive residual effect after the intervention has been removed.

Peer Language Influences in the Activity Setting

An essential design element of this study was the intentional matching of high-language and case-study students in all groups. This matching was based on the conclusion from many studies of English learners, which conclude that the presences peer models of exemplary language use is essential for ELL's overall and academic language growth (Lee, Quinn, & Valdes, 2004; Valdez, 2004; Wong Fillmore, 1992). Some patterns of high-language peer influence emerged in all of the groups. The high-language peers provided syntactic (forming a complex sentence which was then echoed by the case study student) and pragmatic (responding to implied questions, echoing teacher language), as well as vocabulary support (filling in for the case study students when a vocabulary word was asked for). These peer responses may have had the effect of demonstrating the implied behavior I was trying to elicit for the case study

students, as evidenced by the fact that more often than not the case study students echoed or mimicked this behavior immediately afterwards. For example, in this interchange between me, Mellious and Bianca in a finding activity. Students are supposed to find and then tap certain objects in a tidal pool (in this case, a pincushion urchin). I address my requests to Bianca, who remains silent. Mellious jumps in and Bianca mimics his actions in the activity.

Teacher: [To Bianca] What are we supposed to be looking for? [Bianca is silent]

Mellious: These [Tapping a pincushion urchin]

Teacher: Those! Good! Bianca, can you show me a pin cushion urchin? [Bianca is silent, Mellious answers for her again]

Mellious: This is a pincushin urchin [tapping an urchin]

Teacher: Yes it is. [Bianca mimics Mellious and taps her urchin]

In addition to language modeling, the high-language peers provided models for how to complete some of the conceptual puzzles posed by the activities, including attempting to explain the concept of patterns or matching. In this example of a baseline condition activity, Domenico is the case study students and Norman is the HL student. The activity requires the students to sort objects by their classification of recycling, compost or into a canoe in the center of the screen. If an object is incorrectly sorted, it pops back onto the screen. Domenico cannot get his objects to stay where he puts them, and Norman helps Domenico complete the activity.

Digital Audio: *Now it's your turn to work together. Help clean up. Please help me find all the cans, bottles, food scraps, and lost and found items. Then sort them by dragging them to the recycling bin, compost pile, or canoe.*

Domenico: [Pointing to the canoe, from which all of his objects pop out] Why is this one not working?

Norman: Because you need this things [sic] [Norman pushes the right object towards Domenico at the opposite side of the table] Take this.

Domenico: [Domenico takes the object, a paddle, that Norman is passing to him. He drags it to the canoe.]

Norman: Catch it! Touch it!

Domenico: [Domenico successfully put it into the canoe.]

In another example Jack, a high-language student, began to simply match a case-study student's objects for her, perhaps as a demonstration. I asked Jack to use his words to explain, so Jack walked over to Jennifer's space at the touch-table and matched one of her animal babies with the correct animal mommy on the screen.

Teacher: Jack, did you want to use your words help Jennifer do it?

Jack: Yep.

Teacher: You did? How do you use your words?

Jack: Like this [demonstrates touching and dragging an object across Jennifer's line of sight and then explains what he is doing to her] You take this and bring it to that mamma [pointing to the octopi on the other side of Jennifer.]

Case study students willingly used information from both the teacher and peers. At times, the peer would quickly respond to a comprehension question posed to the case study student, in which case the case study student would echo their response. The trust the students

had in each other consistently trumped my authority of providing declarative knowledge. For example, peers sometimes provided incorrect information that case study students accepted more readily than the alternative (and accurate) information from the researcher. For example, Camron, a HL student, rejected my label when I presented him with the unfamiliar image of a newt. Camron linked the newt image to what he was familiar with, a lizard. When I corrected him, he consented to say “newt,” but then continued on to say, “I gotta call it a lizard.” Angel went back and forth between the two words (lizard or newt). Angel’s confusion might have been based on the selective trust strategy she used (Carrow, Cowell, Doebell, & Koenig, 2012), preferring the testimony of a familiar informant to that of a relatively unfamiliar one. She and Camron had developed a trusting relationship over time in preschool, while I was a fairly unknown entity.

Readiness to Benefit from Tools and Scaffolds

One of insights that presented itself to me early on in this study is that students varied dramatically in the language skills they brought to the instructional environment in which I was going to ask them to work—so much so that I knew students would have to achieve some minimal level of conversational English in order to participate meaningfully in the activities presented by the touch table, and perhaps more importantly, to benefit from the conversational scaffolds that I would provide.

This question of the level of language skill a student brings to a learning setting is not new to those who study English language development. In fact, it stems from an understanding that English language development in early childhood spans a wide range of abilities that can quickly change (as evidenced by Emmelia’s rapid language growth between the start and end of the study). While I hoped all students would be able to participate in the study, it was clear from the outset that some students had such low language skills that they would not be able to engage in productive talk in the context of the activity. Evidence of prerequisite skills were collected from an analysis of student language and social skill characteristics matched to their baseline data after the study was underway. I found a minor constellation of data that described, at least with this small set of students, essential skills for this study, including first an ability to sustain interest in a cognitive task, like responding to all 52 questions on the Boehm assessment or participating in an expressive vocabulary assessment, and second an ability to respond to conversational questions with plausible responses (i.e., question: What did you play with on the playground? Possible response: rode bikes).

We know that age and language skills have an effect on uptake of challenging cognitive tasks in preschool read-aloud settings (Wasik et al., 2006; Wasik & Bond, 2001), with younger children (ages two and three) more readily taking up oral prompts in the context of a read alouds than their older peers who might be decoding already (and so drawing on a wider set of information resources to make sense of an activity). We also have some evidence that students who are at risk of language delays, like ELL students who score in the lowest percentiles of the Boehm preschool assessment, may not have the prerequisite skills necessary to process the high cognitive demands of beginning to make inferences, predictions, and connections between texts (or touch-table app content) and their personal lives. Fortunately, for the sake of evaluating the role of the intervention, I was able to find enough students (i.e., the five case study students and Yvonne, the control student), who were optimally suited for the intervention in the sense that while their academic language skills (i.e., the Boehm) were

weak, they exhibited enough everyday conversational skills to participate in the table talk activities and respond to the probes I offered in the intervention. But in truth, I had to assess a large number of ELLs in this setting to secure enough students for the intervention. And even then, I made some errors in judgment. Recall that I could not use the data on two of the students originally serving as control students (similar to Yvonne) because they just didn't say enough to merit analyses of their verbal data.

What might children gain from the table interaction? Learning with screen media has been likened to learning with picture books, providing children younger than six years of age avenues to comprehension development even before they can decode text (Neuman, Pinkham, & Kaefer, 2013). The images and narrative structure of picture books, alongside modeling in talking and interacting with peers and teachers as they explore these books, are easily within the developmental skill level of most young children in preschool. Some of the growth students demonstrate in their comprehension includes new ways of acting in the world (Pinkham, 2012) through their mastery of procedures such as solving problems and paying attention to materials. Young students also show comprehension development through their peer relationships, which we observe when they begin to listen to each other and take cues from each other on how to act in academic settings (like answering questions posed by the teacher about a story, exploring picture books independently, or paying attention to a story narrative from start to finish). Like picture books, screen media can provide accessible audio and visual material accessible to pre-decoding children.

But there are additional benefits screen media might provide beyond what we are familiar with in picture book settings. Screen media, specifically touch screens, provide a multitude of virtual environments and objects to explore in ways that are not available for direct experience (Neuman et al., 2013). In the case of the app used in this study, for example, students were able to explore tidal pools, forests and outer space through sorting, matching, and categorizing objects directly linked to the environments. Another additional benefit not available in conventional picture-book settings was the exacting nature of skill demonstration. Students were required to demonstrate accurate choices in the placement and selection of objects for matching or making patterns (to name just two examples) in order to progress through an activity. The gentle and playful environment of this particular app seems like an ideal setting to explore through trial and error concepts like making a pattern, or putting a puzzle together, or matching an outline to an object. Students were provided with unambiguous responses in the app, and if student trial and error was combined with modeling from a teacher or peer, students seem likely to obtain mastery of the concept in question (i.e., making a pattern means you repeat objects over and over) which might transfer to settings outside of the app activity.

Design Directions

Student group construction. There is some question about the optimal number of students to include in a learning session at the table. While the table accommodates four students, the number should vary according to learning objectives and student skill. For example, students who have strong listening comprehension skills might very well be able to navigate some activities independent of a teacher and in cooperation with their peers. However, students who are still developing listening comprehension skills, as is typical for preschool students, might benefit from using the table with one other child and an adult. Students

who have shown some level of competence at different conceptual puzzles, such as making a pattern or matching objects, might benefit from more independent practice at the table with peers, with the challenge objective set as cooperating with their peers by sharing and taking turns rather than the challenge objective set as solving a pattern puzzle. Students groups should be set according to skill level and lesson objective.

Audio refinement. As I've stated previously, the audio in this intervention did not have a clear contribution to the students' progress. A design shift with ELL students in mind would enable students to hear an object label when the object was touched (i.e., touching a starfish would produce the sound, "starfish"). Another design shift would reduce the amount of audio instructions provided, as students, for some reason, did not pay any attention to them. Replacing the audio with silent demonstration would be a possible refinement to address ELL student needs. Overall, the app provided too much constant audio for a teacher to talk over. In many instances I muted the audio in order to talk quietly with the students in the progress of the game. The volume of these apps should be taken into consideration when they are designed for a preschool classroom, where many sounds compete for attention during small group time, or when the table could be used for a small group during the relative quiet of whole group lessons. Relying on visual cues and selectively providing audio support for desirable language skill development would be a welcome refinement in the app.

Content Accuracy. The app provided thematic settings (outer space, forest, tidal pools, are some examples). These themes provided a useful narrative introduction that I used to my advantage in encouraging students to talk, in the same way we introduce a text. By talking about forest animals that I like, for example, students responded by sharing their own favorite forest animals which led us to exploring these animals by building patterns, matching babies to mommies, constructing puzzles, etc., primed with vocabulary that we repeated over and over again in the context of that theme. I found this to one of the most valuable affordances of the app; talking about and then playing with objects that fit into thematic categories. For students who are busy building their vocabularies, learning words that fit into thematic categories like the tier 3 words pulled out for explicit instruction in this study, supports their long-term memory development for the vocabulary, for logical connections made between objects in the category, and for their conceptual understanding about the thematic construct. In this way, the app in the touch screen setting operates as an informational *text*. Care should then be taken when these thematic contexts are constructed for content accuracy. When the context is outer space, for example, objects can include planets, stars, the milky-way, craters, the moon, etc. providing not only a corpus of vocabulary but also the rudiments of classification systems. Young children have proved themselves adept at learning and retaining tier 3 vocabulary. The context of the touch-table is a playful and applied setting to provide a wide range of carefully selected objects that have logical relationships. This has implications for STEM learning as well, as providing ample and clearly categorized objects for student exploration will support their eventual reading comprehension on the topics when they are decoding in later grades.

Limitations

Sampling issues. One key limitation of this study is the varied level of initial oral language skills of the case study students. Single-case design research is designed to investigate changes in *types* of students, and in the case of this study, the case *type* was preschool students

who speak Spanish at home and English at school, and no control was made for student age. Floor levels of language were discovered in the baseline phase of the study, when some students initially chosen for the study were found to not have enough oral language in English to productively participate in the intervention.

A second major limitation was that I lost two of the five students originally assigned to a control condition, along with Yvonne. As I suggested earlier, the original judgment I made about their fitness for inclusion was overly optimistic at the very least. Had I been able to keep those students in the study, I would have been able to expand the evidence pool to support the inference that without teacher scaffolding, low language students are not likely to increase either the quantity or the quality of their discourse in the touch-table environment. Perhaps what I might have done was to add a sort of performance pre-test in the touch-table app so that I could add some sort of “capacity to work in the environment at some minimal level of competence” as a criterion for participation in the study as a case study or a control participant.

The app. There were certainly limitations to the app itself that made my focus on oral language development more challenging. The app was not designed to support this sort of instruction, and I had to use an extensive amount of backdoor manipulation to conduct the study. For example, the table audio narrative was consistently ignored by all of the students, and contributed to a lot of what turned out to be distracting background noise I had to compete with. I solved that problem by muting the audio to the table, but this meant I also turned off any beneficial audio (for example, in a forest themed activity, when a jaguar was sorted correctly the student heard a jaguar roar). In addition, the assumption of independent student use meant that no matter what the students were doing, the activity would progress. This had two problematic outcomes for my study. First, I could not pause the progression of the activity to have a brief check in about vocabulary with the students during the activity itself. This meant that once a pattern was completed, for example, it quickly disappeared from the screen before we had a chance to chant the object labels or talk about the content or qualities of the task we had just completed (the way one might review a story just read with a group of students with comprehension questions such as, “What did we just learn about jaguars?” or perhaps, “What did we just learn about patterns?”). Second, the illusion of student choice and any benefits it may have imparted were quickly dispelled when the program itself began filling in responses after an absence of interaction from the students.

External validity issue. A major limitation, at least from the perspective of external validity, is also a limitation of the single case study methodology: to examine trends carefully for individuals, one sacrifices on the generalizability criterion. It is hard to know how other students from the same, let alone, different, population may respond to the same scaffolding in a similar setting.

Internal validity. An internal validity issue was the researcher made tools, which have unknown measurement characteristics. There should also be a better way to understand and improve the peer effect. I had some success with measuring quality and quantity of language and its change between study conditions, but there is more to understand if tools like this, designed to capitalize on the socio-cultural advantages of learning inherent in joint problem-solving and play, are to take off and be successful in low-income classroom contexts. Even when peer collaboration worked in the context of the touch-table, as was the case in activities with Camron and Angel, or between Domenico and Norman, would that collaboration transfer

to (a) other situations and activities, or (b) even in the context of the game itself without my presence?

It is not clear to what extent I was able to capitalize on the medium itself given my oral language scaffolding goals. Certainly the topics (forests, outer space, and tidal pools) and the conceptual goals (patterns, matching, sorting, categorizing), set within a colorful set of images that students could trade with (or more often, take from) each other, provided rich, dynamic, and most of all entertaining grist for interaction. The problem-based activities provided an authentic purpose for interactions, and the content itself was developmentally appropriate for the students. But could these interactions have taken place with the more conventional set of manipulatives native to preschool classrooms (blocks, home play settings, clay, etc.)? The answer is, of course, yes, so the relevant question becomes what did the touch-table medium contribute in and of itself to the interaction? One possible answer lies in the characteristic exacting nature of the environment; patterns were required to be in straight lines, matches to images were required to be placed exactly in the center of a 'bucket,' and categories of objects (i.e., summer versus winter clothes, or numbers versus letters) were unforgiving of mistakes (inaccurate placement choices generally turned red and returned to the active screen of objects. This is characteristic of a programmed digital environment, and might hold some value with the exploration of concepts, as the activity doesn't end until patterns are successfully placed. One possible avenue to explore in this area is how the exacting digital environment contributes (if at all) to accelerated conceptual development.

Suggestions for Future Research

This study is a scratch on the surface of a dynamic learning setting. A more robust study might explore the contribution of activity *type* to student interaction and learning outcomes. It became clear after several different groups went through the same activities that patterns of interactions emerged that lent themselves to different oral language goals (i.e., quality versus quantity of talk, or conversational exchanges versus tier 3 vocabulary development). For example, the task of making patterns provided students time and repetition with a limited number of objects that lent itself to learning and using new tier 3 vocabulary, and the same could be said of the matching activity. This time and repetition opportunity of patterns and matching was in contrast to the categorization activity (sorting letters from numbers, finding winter versus summer clothes) that provided a broad array of generally familiar objects. Categorization was an activity that lent itself to developing conversational interchanges (evidence of this is most noticeable for Angel, who had the longest time in the intervention condition). Future research might include a design that fixes the task across the content groups (matching in all themes, forest, outer space, etc.). The collaborative potential of the touch-table itself could be further explored in by using different apps with a similar student sample.

Building off of the variable outcomes for different students in this study, future research might explore ways to individualize this type of scaffolding for children at different language levels. Certainly all students, no matter the language level (except for Emmelia) had higher average UPM in the intervention condition. Understanding the gains that students with higher oral language skills might have with tiered scaffolding in small groups would be a productive avenue for future studies.

Concluding Statement

Looking across all of the issues, analyses, interpretations, conclusions, and limitations of the current work, three things stand out as the most likely legacy of this work: the familiar nature of cutting edge tools, the positive results of tier 3 vocabulary acquisition, and the swift uptake of language registers by ELL students.

Regarding the familiar nature of cutting edge tools, working with new technologies looks and feels familiar, and the pedagogical moves we use to support oral language with texts easily transfers to screen modalities, but just as we would not sit a preschool child down with a chapter book and expect her to learn from it, we should not expect to sit her down in front of a screen filled with unfamiliar vocabulary and cognitively challenging tasks and expect her to learn from it. In each case, a skilled adult must step in and provide the kind of scaffolding that allows the child some toe-hold of understanding and engagement with the material. This is good news, because we already know a lot about how to scaffold understanding and engagement with non-digital tools, and it looks like the pedagogical principles transfer easily into settings using digital tools. Which brings us to our second point, that students learn and retain tier 3 vocabulary in the applied context of the table. This is good news for teachers who work with ELL students, who come to school with fewer words than then English-only peers. The table provides access to a wide range of specialized thematic vocabulary in an accessible format for pre-decoding students. With some refinement, I think the touch-table app could become a powerful tool for vocabulary development for students playing both with a teacher and on their own (if design modifications were made, see Design Directions). Last, this tool provides a learning environment that accommodates a socio-cultural setting ideal for language learning. With an expert other in place and the table acting as a mediating artifact, ELL students swiftly take up an emergent academic register they need to prosper in school. This study showed that emergent academic registers can be rapidly adopted by very low language ELL students with multi-touch tables with the right scaffolds.

And in the final analysis, we must not forget the issue and the goal that this effort was trying to address—the development of language registers, vocabulary, and other literacy related skills that are most likely to improve the capacity of young English learners to negotiate this experience we call schooling in ways that increase their opportunities and sense of self-efficacy both in and out of school. The hope is that the current work contributes in some small way to that effort.

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Appendix A – List of Vocabulary Words

This is the full set of vocabulary words selected from scripts and used for pre- and during-intervention assessments in the six weeks of the baseline and intervention stages of the study. These are also the words selected for explicit instruction in the context of the intervention activity. All five case study students had an opportunity to learn these words and were continuously assessed in the context of the intervention. Case study data sheets recorded their assessment data on session by session basis. A random selection of these words were used in the maintenance phase of the study.

ant	manatee	star
beaver	monkey	starfish
beetle	newt	swan
black bear	octopus	tadpole
clown fish	orca	tang fish
crack	owl	tree frog
doe	planet	turtle
dragonfly	ring	turtle
elk	salamander	walrus
faun	scuba diver	wasp
gorilla	sea snail	whale
jellyfish	seahorse	
leopard	snake	

These words were randomly selected from the total set of context specific vocabulary words used in the study.

ant	jellyfish	beetle
tadpole	starfish	octopus
faun	walrus	seahorse
doe	turtle	
newt		

Students were assessed in the maintenance phase of the study on both expressive and receptive knowledge of these words. I then back-mapped their data on these words from their case study data sheets from the first two phases of vocabulary data collection (pre- and during-activity) of the study.

Appendix B: Sample Images for Tier 3 Vocabulary Assessment

Target words were drawn from the vocabulary included in the touch-table activity scripts. All words were rated for their relative importance to teach using two scales: The tier scale described by Beck and McKeown (1998), and the rating scale developed by Biemiller (2010). Tier 3 words, those words that are relatively rare and discipline specific, were identified

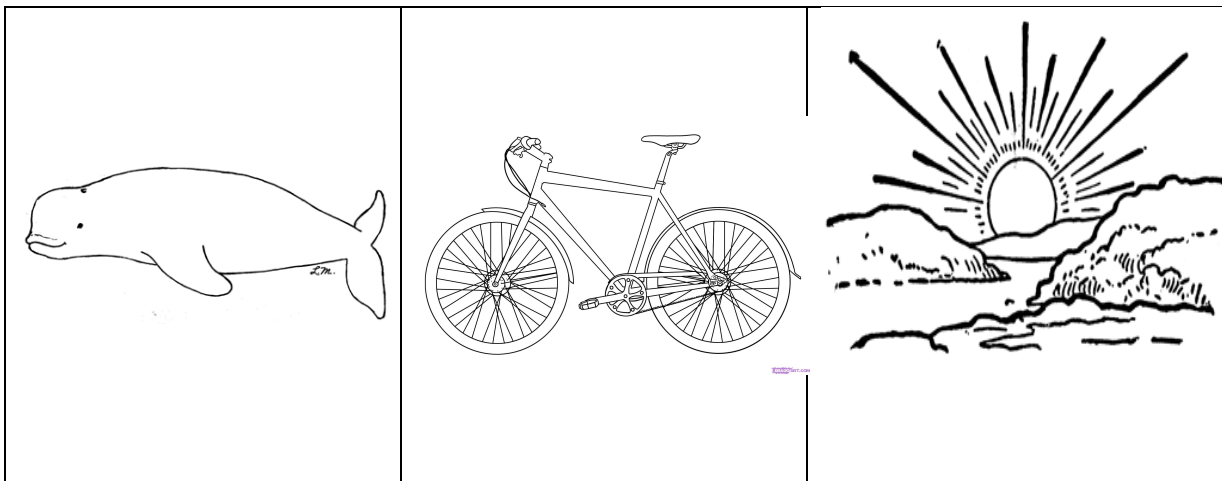
Receptive Language Assessment

The assessment protocol proceeds with the researcher showing the series of three pictures and asking the student to point the _____. All student responses are accepted without indication of accuracy.

Example:

Prompt: Point to the beluga whale

Sheet with images below shown to student



Appendix C: Distal Measures of Language Skills by Case Study Student

Student	Boehm		PELI				
	Score	% Rank	EV	TP	Infer	Retell	Cloze
Angel							
Pre	4	1	2	7	4	0	1
Post	16	1	4	1	0	0	0
Bianca							
Pre	31	25	4	11	4	2	2
Post	0	1	10	10	7	5	1
Emmelia							
Pre	43	30	3	15	5	0	4
Post	48	75	8	9	6	6	3
Domenico							
Pre	29	3	0	0	0	0	0
Post	43	30	4	6	4	7	0
Jordan							
Pre	41	15	2	12	3	3	4
Post	45	25	6	7	4	6	4
Yvonne							
Pre	35	5	0	0	1	0	3
Post	29	3	4	7	5	5	4

Notes: Boehm Score = Raw scores, % Rank = Percentile ranking. PELI EV = Expressive Vocabulary, TP = Tell About Pictures, Infer = Inference and Prediction.

Appendix D: Adult Mediation Basic Criteria
(Klien et. Al., 2000)

Definition of Criteria

Focusing (intentionality and reciprocity)

Any act or sequence of acts of an adult that appears to be directed toward affecting a child's perception or behavior. These behaviors are considered reciprocal when the infant or child responds vocally, verbally or nonverbally

Affecting (exciting)

An adult behavior that expresses verbal or non-verbal excitement, appreciation, or affect, in relation to objects, animals or values

Expanding (Transcendence)

Directed toward expansion of a child's cognitive awareness, beyond what is necessary to satisfy the immediate need that triggered the interaction

Encouraging (mediated feelings of competence)

Any verbal or nonverbal behavior of an adult that expresses satisfaction with a child's behavior and that identifies a specific component or components of the child's behavior that the adult considers contributive to the experience of success

Regulating (mediated regulation of behavior)

Adult behaviors that model, demonstrate, and/or verbally suggest to the child regulation of behavior in relation to the specific requirements of a task, or to any other cognitive process required prior to overt action

Appendix E: Social Validity Questionnaire
Fall 2014

Building emergent academic language with language-minority preschool children

Thank you for taking this social validity survey on the multi-touch table intervention study. This survey will help us evaluate how important and appropriate this study was in your classroom, and guide any changes that should be made if we wanted to do this study again. Your everyday interaction with the students makes you one of the few people who can determine significant changes in their behavior. You also are the best person to determine if the way the study was conducted interfered with your normal classroom routine, and if, in your professional opinion, the methods we used were practical and easy to replicate on your own.

Directions: Please indicate your level of agreement with the following statements.

This study...	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Fit into my regular schedule					
Taught important skills					
Was suitable given the classroom culture					
Was easy to accommodate					
Improved the students oral language					
Was acceptable to other students					
Will have lasting positive effects					
Is one I can do on my own when I need it					
Is one I will recommend to others					

Appendix F: Coding for Emergent Academic Utterances

My unit of coding was by the utterance. Utterances of the child were defined as units of speech containing a single meaning proposition. Previous studies of preschool children focused on oral language development found that the number of utterances to be the factor with the strongest effect on later development (one year) on the PPVT (Dickinson & Smith, 1994). In this study, academic language was defined as functional and abstract (Schleppegrell, 2012). I developed an age-appropriate coding scheme to evaluate utterances that qualified as emergent academic language. The following categories made up my coding at the utterance level:

- Responses to comprehension questions (i.e., a response to the question, *Can you tell us what we're supposed to look for?*)
- Student questions related to the activity (*What is this?*)
- Echoing language modeled by the teacher or a peer
- Echoing language heard from the audio in the program
- Describing actions or visuals related to the activity (*I found a jellyfish!*)
- Explanations using a verb tense related to time.

Excluded Utterances

Children's utterances which were repetitions, off-task, largely inaudible, and exclamations of excitement were excluded.

Examples of excluded utterances:

- Repetitions (counted as one utterance): *I did it! I did it!*
- Off-task: *Want to go to the park with me?*
- Exclamations of excitement: *yeah!*

Coding for Conversational Interchanges

In addition to coding at the utterance level, I coded transcripts for conversational interaction in the course of the activity. Conversational interaction was defined as any interchange of two or more turns by any two individuals in the context of the activity.

Examples of conversational interactions:

Example 1

Teacher: What did you find?
Angel: [hesitates] Can you call it?
Teacher: Yea, it's a ladybug!
Angel: Ladybug!

Example 2

Teacher: My favorite forest animals is an owl.
Angel: My favorite is bunnybears.
Teacher: Bunnybears?
Angel: And cockroaches and bunnies.

Appendix G: Sample Case Study Data Form

This is a sample sheet, and does not contain all of the questions and guides used in any given activity. This sheet is used for the pre-vocabulary check as well as the during activity mediation. The pre- vocabulary check takes place immediately before playing the activity and results are recorded in the “Pre” column on the sheet. The during-vocabulary check takes place in the context of the activity (see prompts below) and results are recorded in the “during” column below. Adult mediation also takes place in the context of the activity. Student responses are recorded during the activity by the researcher in the during column with a “+” or “-”.

Student ID: Alligator3

Date: 10/29/14

Vocabulary	Prompt	Mediation if no response or incorrect response:	Guided interaction	Correct response	Pre (-,+)	During (-,+)
Sea horse	Where is the sea horse?	There is the sea horse! Say sea horse.	Model or guide finger to sea horse	Points to sea horse		
Starfish	Where is a starfish?	Here is a starfish. Say starfish.	Model or guide finger to starfish	Points to starfish		
Octopus	Where is an octopus?	Here is an octopus! Say octopus.	Model or guide finger to octopus	Points to octopus		
Sea horse	What is this called? (indicate seahorse)	Sea horse! Say seahorse.		Sea horse		
Starfish	What is this called?	Starfish! Say starfish.		Starfish		
Octopus	What is this called?	Octopus! Say octopus.		Octopus		
	Can you tell us what we do next?	Explain what to do next		Touch the _____ at the same time		
	Can you tell him what we are looking for?			Seahorses/starfish/octopus		
		Say what we are looking for				