How Parents Support Early Numeracy Development During Shared Math Storybook Reading

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ABSTRACT
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Math storybook reading can be a beneficial activity in the home numeracy environment that facilitates children’s exploration and understanding of numbers. Parents play an important role in guiding and supporting their children’s math development through their joint engagement in the story. Exploring how parents and their children interact during home activities such as math storybook reading is crucial given strong associations between the home numeracy environment and later academic success. The primary goal of this study was to investigate how parents supported their children’s early numeracy development as they responded to children’s number mistakes and engaged their children in conversation about the number concepts present in the story. Observations of parent-child interactions (n = 47) while reading a math storybook and interviews with parents were intended to uncover how parents can use storybooks as a means of involving their children in math learning and guiding their understanding of numbers. The present study expands on the extant math storybook literature by examining the role of parental beliefs and home practices in shaping parents’ and children’s behaviors during math storybook reading. Results indicated that parents’ beliefs about the importance of early math learning and their role in helping their children learn math were associated with a lower frequency of children’s simple math mistakes, a greater degree of support parents provided in response to those mistakes, and a greater amount of simple math concepts parents discussed with their children while reading. Furthermore, children exposed to a greater frequency of home counting activities completed more of the math tasks in the storybook. Finally, three main factors that
appeared to drive parents’ selection and use of math storybooks were children’s interest, attention spans, and math abilities. These findings support the use of math storybooks as a potentially beneficial activity that can elicit positive parent-child interactions around number concepts and demonstrate that parents are intentional in how they use storybooks to guide their children’s math development. The results are discussed in relation to home support for early numerical development and contextualized within the math storybook literature.
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Chapter I
INTRODUCTION

Developing early math competencies has been linked to later reading and math achievement (Duncan et al., 2007), with number knowledge emerging as a particularly strong indicator of later success (Claessens, Duncan, & Engel, 2009). Studies have found that children’s proficiency in number sense tasks at school entry is strongly associated with their math achievement in first grade (Jordan, Kaplan, Locuniak, & Ramineni, 2007) and computational fluency in second grade (Locuniak & Jordan, 2008), underscoring the importance of developing a strong foundation in math skills. The foundation of early knowledge begins informally in the home environment as children interact with their parents during events and activities. Although math is increasingly acknowledged as a crucial early skill and parents are widely recognized as vital sources of math development, the ways in which parent-child interactions can support the development of early math skills in young children remains to be fully examined. The depth and breadth of research into the home literacy environment have informed our insight into how children acquire literacy skills and have led to empirically tested recommendations for home activities and practices. A similarly rigorous set of research studies still needs to be conducted on math learning experiences to comprehend better how math knowledge is acquired in the home environment.

The purpose of this study was to explore how parents support their children’s early numeracy development through math-related interactions during shared storybook reading. Observations of parent-child reading sessions and interviews with parents were intended to
uncover how parents can use math storybooks as a means to engage their children in math learning and guide their understanding of numbers. Variations in the ways that parents and children interacted while reading storybooks and differences in the degree and type of support parents provided were examined in the hope of making a contribution to the study of math storybooks as an aspect of the home numeracy environment.

This chapter is comprised of an overview of current research on the home numeracy environment, with a specific focus on math storybook reading and its role in children’s math learning. In particular, I review home activities that encourage math interactions, how parents provide guidance during those home activities that support their children’s development, and the influence of parents’ beliefs about the importance of early math learning. Although the focus of the current study is on one particular home numeracy activity, namely math storybook reading, there is a dearth of empirical studies that explore the potential benefits that math storybooks confer on young readers. Therefore, studies on other home numeracy activities, such as cooking and playing card games, are also reviewed. These studies are of interest because they demonstrate how parents can engage children in mathematical thinking at home and their findings may be applicable to the exploration of shared math storybook reading.

The Home Numeracy Environment

The home is the primary source of academic and social experiences for young children prior to entry into school. Parents play an important role in contextualizing their children’s math learning through organizing and structuring activities and interactions in the home numeracy environment (HNE) (Anders et al., 2012; LeFevre et al., 2009; Niklas, Cohrssen, & Tayler, 2016). Evidence has suggested that parental involvement in math learning at home is positively associated with mathematical performance in early childhood (Blevins-Knabe & Musun-Miller,
1996) and later math achievement in elementary school (Lefevre et al., 2009). A meta-analysis linking children’s academic, socioemotional, and attentional skills at school entry with later reading and math achievement indicated that early math skills were the strongest predictor of academic success, even when controlling for children’s cognitive ability, behavior, and other contextual influences (Duncan et al., 2007). This powerful finding underscores the importance of studying early math learning and understanding how parents can support their children’s math learning at home.

While some researchers have described the characteristics of the home math environment more broadly, numeracy is the focus here due to the goals of the study. Cross, Woods, and Schweingruber (2009) recommended that early math learning should be focused primarily on numbers than on other early math topics, although other math domains such as measurement, geometry, and spatial relations are also important for young children to learn. While children are born with some innate number skills and knowledge (Gelman & Butterworth, 2005), their experiences in their surrounding environment contribute to their math development (Geary, Berch, & Koepke, 2015) and enable them to acquire a deep understanding of numbers. “Understanding numbers” is a broad skill that encompasses several aspects, including comprehending quantity and the relationship between numbers, and the ability to execute simple operations (Cross et al., 2009). Counting is a basic ability that underpins other numerical competencies and involves the coordination of several abilities, such as making a one-to-one correspondence between a counting word and its referent object (Gelman & Gallistel, 1978). Once children can successfully count sets of objects, they can apply this knowledge to broader and more complex tasks, such as comparing two sets of objects to determine which set has more or less.
Three important aspects of the HNE that stimulate children’s early numeracy learning emerge across studies of home learning: (a) specific activities and materials that promote positive math interactions, (b) parent guidance during the activities that support children’s cognitive development, and (c) parents’ beliefs about the importance of early math learning and their role in helping their child learn math. Each of these three aspects is explored further in the following sections.

**Home Activities That Support Numerical Learning**

Parents support their children’s learning during shared activities, such as play and storybook reading, and engagement in these home activities has been associated with preschoolers’ math skills (Blevins-Knabe & Musun-Miller, 1996; LeFevre, Clarke, & Stringer, 2002; LeFevre, Polyzoi, Skwarchuk, Fast, & Sowinski, 2010; Skwarchuk, Sowinski, & LeFevre, 2014) and children’s later numeracy knowledge at age 5 and age 7 (Melhuish et al., 2008). Much of the research on the HNE has been derived from self-report questionnaires on the frequency and type of home activities, which is then associated with children’s math learning. In a survey administered by Missall, Hojnoski, and Moreano (2017), parents reported involving their children in math activities approximately three to five times per week, on average. However, comparing the frequency of home numeracy experiences across studies reveals a large amount of variation in math activities (Blevins-Knabe, Austin, Musun, Eddy, & Jones, 2000; Blevins-Knabe & Musun-Miller, 1996; Skwarchuk, 2009), with some families reporting greater engagement in literacy activities (Cannon & Ginsburg, 2008; LeFevre et al., 2009). In addition, parents’ self-reported responses to questionnaires should be interpreted with caution. Studies have indicated that sometimes parents do not recognize the math concepts present in the
activities they do with their children at home (Cannon & Ginsburg, 2008), so they could be underreporting the frequency of home early numeracy experiences.

While some researchers have proposed a unidimensional model of the HNE, in which all math-related activities are considered to contribute equally to children’s number knowledge (e.g., Kleemans, Peeters, Segers, & Verhoeven, 2012; Missall, Hojnoski, Caskie, & Repasky, 2015), other researchers have classified activities into several categories. For example, Skwarchuk et al. (2014) developed a framework that conceptualizes the HNE based on the home literacy model of Sénéchal and LeFevre (2002), which is comprised of home activities, parental behaviors, and parents’ beliefs. The home activities were categorized as either formal or informal and each type of activity is thought to have a different impact on children’s math development. Parents engage their children in formal learning practices, such as writing numerals, with the intention of directly teaching numeracy skills. In contrast, informal activities, such as playing card games, may provide incidental math learning, although the primary goal is not to teach mathematics. LeFevre et al. (2009) tested whether direct (formal) and indirect (informal) math activities were differentially associated with children’s performance on numeracy measures. While both formal and informal activities were related to children’s math fluency scores, only informal home numeracy activities—such as playing board games with dice—were positively associated with children’s math knowledge. In contrast, Huntsinger, Jose, and Luo (2016) found that the amount of time spent doing formal math activities was the strongest predictor of early math and reading skills, while the frequency of informal math activities negatively predicted math scores.

These disparate results reveal a lack of consensus on the relation between home numeracy activities and children’s developing math knowledge. Additional factors of the HNE—
such as parental support and parents’ beliefs—may influence how children develop math knowledge during shared home activities. These factors are considered in subsequent sections.

Although several studies have examined the frequency and type of math activities parents and children engage in at home and how these activities relate to children’s mathematical achievement, few of those studies have focused on storybook reading. Although the idea of integrating children’s literature into mathematics teaching and learning has been popular since the 1960s, there is a scarcity of empirical studies examining the effectiveness of this approach (Flevares & Schiff, 2014). The results of the few studies that have been conducted suggest that storybooks are one type of home activity that has the potential to impact young children’s math learning and engagement positively (e.g., Ginsburg & Seo, 2000; Hong, 1996; van den Heuvel-Panhuizen, Elia, & Robitzsch, 2014; Young-Loveridge, 2004).

**Benefits of math storybook reading.** Children enter school with real-world experiences in quantities, counting, sharing, and other topics that prepare them for formal instruction in mathematics (Moyer, 2000). Math teaching should naturally arise from these experiences, drawing on children’s wide range of prior knowledge and skills. Children’s literature does precisely this: it presents themes that connect more readily to their lives than examples from textbooks, facilitating the connection between abstract mathematical concepts and their concrete meaning in personal experiences (Murphy, 1999). Storybooks present the opportunity to connect novel ideas or events to prior experiences, thereby expanding and elaborating on children’s knowledge of the world, including their mathematical knowledge. Not only are young children casually acquainted with many early math topics, but they are often already familiar with reading storybooks as well. Embedding math instruction in this well-known context makes learning more engaging and meaningful because it is presented in a familiar structure (Moyer, 2000).
Researchers distinguish between two types of math storybooks: those that present math content *explicitly*, in which the text and images are intended primarily to teach math, and those that present math content *implicitly*, in which the math is incidental and secondary to the narrative (Marston, 2010; van den Heuvel-Panhuizen, van den Boogard, & Doig, 2009). Whether the content is presented explicitly or implicitly, storybooks have the potential to stimulate mathematical thinking and reasoning in a number of ways. The engaging quality of stories draws children into the plot, allowing them to become active participants in solving mathematically-related scenarios that naturally unravel throughout the story (Moyer, 2000). Therefore, storybooks can be used as a starting point to engage children in conversations and investigations of various mathematical domains, such as geometry, spatial thinking, data, and measurement (van den Heuvel-Panhuizen et al., 2009), as well as shapes, number combinations, and classification (Hong, 1996). In particular, Hong (1996) found that after listening to a math-themed children’s story, young children demonstrated advanced thinking by showing an affinity for working with larger numbers, a greater range of numbers, and multiple classifications when presented with number combination and classification tasks.

Storybooks have various features—such as the illustrations, text, and problem-solving scenarios—that provide an opportunity for the development of mathematical knowledge. Concepts such as number, size, and shape can be clearly represented through the narrative and illustrations, which reflect situations that children might encounter in their everyday lives. The illustrations support the words on the page, provide a visual anchor for understanding complex ideas—such as one-to-one correspondence in *Goldilocks and the Three Bears* (Marshall, 1998)—and provide a concrete, appealing representation of math ideas for young learners (Murphy, 1999). The pictures are representations that usually denote objects or events in the real
world. These books may also include diagrams and charts that can illustrate an idea clearly without the need for words (Murphy, 1999). Moreover, literature presents opportunities for children to construct mathematical knowledge by listening, reflecting, and communicating about math topics (Moyer, 2000). As children express their ideas and practice using mathematical language to describe the scenarios in the story, it helps them to connect their informal oral language to the formal symbols used in mathematics (Hong, 1996). Finally, storybooks can present math concepts amid problems that unfold throughout the story. Storybooks such as *Max’s Math* (Banks, 2015) present a context for problem-solving and higher-level thinking that motivates young children and captures their interest. Children can also learn the language associated with mathematics by conversing about the story and engaging in problem-solving processes.

Using an experimental approach, van den Heuvel-Panhuizen et al. (2014) tested whether an intervention using storybooks in kindergarten classrooms contributed to children’s math performance. Three hundred and eighty-four children from nine schools in the Netherlands were divided into a control and experimental group. In the experimental group, teachers read 24 storybooks to their class over the course of 3 months that were focused on either numbers, measurement, or geometry. A pretest and posttest were administered to each child that consisted of multiple-choice questions addressing each of these three math domains. Results indicated that the difference between pretest and posttest scores was 27% higher for the experimental group than for the control group. This demonstrated that reading math storybooks had a significant impact on kindergarteners’ mathematics performance. However, these conclusions should be tempered by the fact that the researchers were unable to routinely monitor whether the teachers in the experimental group were correctly following the storybook reading protocol and what
other types of mathematics activities they employed in the classroom may have increased students’ test scores. In addition, the researchers were unable to parse out particular qualities of the storybook reading interactions that led to gains in math scores.

In addition to the cognitive benefits afforded by shared storybook reading, various developmental and social-emotional outcomes also result from reading with children. For example, Lam, Chow-Yeung, Wong, Lau, and Tse (2013) reported that parents who read with their children experienced greater self-efficacy in helping their children learn to read and experienced an improved relationship with their offspring. Children in the study benefitted by becoming more motivated to read. Lastly, shared storybook reading was found to increase children’s real-world knowledge and improve interpersonal connections between parents and their children (Haden, Reese, & Fivush, 1996).

In summary, storybooks can serve as a useful tool to engage children in mathematical thinking because they present mathematical problems, illustrate mathematical ideas in a visual format, and provide language in the text that helps children communicate their thinking (National Council of Teachers of Mathematics [NCTM], 1989). Research has suggested that storybooks can promote children’s mathematical development by increasing their engagement and interest in the subject (Jennings, Jennings, Richey, & Dixon-Krauss, 1992; Langford, 1994), promoting meaningful mathematical conversation (Anderson, Anderson, & Shapiro, 2004, 2005; Hojnoski, Columba, & Polignano, 2014; Moyer, 2000), and helping students relate mathematical concepts to their everyday lives (Shatzer, 2008; Thatcher, 2001; Zanger, 1998).

Parental Support of Early Number Knowledge

Adults play a vital role in guiding their children’s understanding of both math and literacy concepts, and help shape the home learning environment through the activities and
language they use with children. The sociocultural view of learning suggests that children gain knowledge by participating in culturally significant and developmentally appropriate activities with others who guide learning (Vygotsky, 1978). According to Vygotsky’s (1978) sociocultural theory of learning, learning is considered to be a social activity with language as its focal point. Many educators and researchers in the field of mathematics have adopted this sociocultural theory and view mathematics as a set of social practices embedded within larger cultural and social practices in society. A child is enculturated into mathematical processes primarily through conversation with a more skilled person, such as a parent or teacher, who leads the child in acquiring the knowledge (Sfard, Nesher, Streefland, Cobb, & Mason, 1998). Vygotsky (1978) described the metaphorical space through which the adult guides the child as the zone of proximal development, or the difference between what the child can accomplish without support and what the child can achieve with adult guidance. Reflecting a sociocultural perspective, storybook reading can be considered a socially constructed situation, with conversation playing a key role as adults guide their children through mathematical concepts and problems that occur in the narrative. Parents provide guidance and support for early numeracy by creating learning opportunities that encourage their children to engage in mathematical thinking.

As noted in the previous section, studies using survey data have demonstrated that parents engage their children in a variety of math-related home activities. Observational studies of parent-child interactions have augmented survey data and elucidated the manner and degree to which parents inject mathematics into shared activities. For example, parents ask children about size relationships in the illustration during storybook reading (Anderson et al., 2005), model how to count the number of spaces to move a counter while playing a board game (Vandermaas-Peeler, Ferretti, & Loving, 2012), or help the child measure out the amount of liquid while
cooking (Vandermaas-Peeler, Boomgarden, Finn, & Pittard, 2012). These types of home activities create a meaningful social context for children to receive guidance and support from a more skilled adult.

An increasing number of studies have begun to explore how parents of young children address the mathematical content found in storybooks while reading with their children. For example, Anderson (1997) recorded the frequency of math events as families interacted with multilink blocks, a storybook, blank sheets of paper, and worksheets. All four activities generated math events and parents tended to engage children in those math events through verbal interactions. The three most frequent math concepts across activities fell within the domain of numbers (counting, naming numbers, and recognizing numerals), demonstrating the prevalence of number-related activities in contrast to other math domains, such as shape and measurement. In a study focusing on storybook reading, Anderson et al. (2005) recruited 39 linguistically-diverse pairs of parent-child dyads in Canada and videotaped the dyads reading two implicit math storybooks, *Swimmy* and *Mr. McMouse*. Their subsequent qualitative analysis revealed that all the families engaged in mathematical conversation during the storybook reading sessions, although the amount of mathematical talk varied among dyads. Size was the most common math topic discussed, followed by number and, far less frequently, shape. Interestingly, most of the math talk centered on the pictures in the storybook, not the text, which supported previous findings from studies of non-math storybook reading (Ezell & Justice, 1998; Shapiro, Anderson, & Anderson, 1997) and highlighted the unique role that pictures may play in shaping parent-child conversations about the story.

Other studies have found that parents support their children’s math development during cooking (Vandermaas-Peeler, Boomgarden et al., 2012), board games (Bjorklund, Hubertz, &
Reubens, 2004; Vandermaas-Peeler, Ferretti, & Loving, 2012), puzzles (Ramani, Rowe, Eason, & Leech, 2015), block play (Anderson, 1998), and other play interactions (Vandermaas-Peeler, Nelson, & Bumpass, 2007). However, in many observational studies of the home numeracy environment, parents were cognizant that the researchers intended to study math interactions. This awareness may have influenced the amount and nature of math support provided to the child. Some studies have examined the impact of making math learning an explicit goal by encouraging or training parents to infuse mathematics in their home activities. For example, Vandermaas-Peeler, Boomgarden et al. (2012) suggested ways that parents could guide their children’s learning by incorporating numeracy concepts in a cooking activity with their children. When the researchers explored the influence of parental guidance of numeracy, they found that children whose parents had been trained to incorporate math concepts during cooking solved more math tasks correctly than the control group. Similarly, a group of parents were provided with a list of suggested simple and complex number tasks they could embed in a board game, while a control group of parents played the game without the list of activities (Vandermaas-Peeler, Ferretti, & Loving, 2012). Parents who were given the suggested number tasks embedded about twice as many simple and complex number activities in the board game sessions compared to parents who did not receive a list of activities. Children who were asked more questions about number concepts produced more correct answers but also made more mistakes. Vandermaas-Peeler, Ferretti, and Loving (2012) also found that all of the children correctly responded to the majority of simple number tasks, such as basic counting. However, children whose parents incorporated more number tasks in the board game sessions accurately solved a greater percentage of the complex math tasks, such as addition, compared to the control group. These findings endorse the sociocultural perspective that children can achieve more with the guidance
of a skilled adult, particularly one who is given suggested ways to support math learning, than they can achieve independently (Rogoff, 1990, 2003; Vygotsky, 1978).

**Complexity of math talk and activities.** Another way that parents contribute to children’s early learning during home activities is through their use of math-related talk, which has been correlated with children’s math development (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006; Pruden, Levine, & Huttenlocher, 2011). For example, Levine, Suriyakham, Rowe, Huttenlocher, and Gunderson (2010) found that the overall amount of number input parents provided at home when the child was 14 to 30 months of age predicted children’s cardinal number knowledge at the age of 46 months. Gunderson and Levine (2011) further explored the influence of certain types of number talk and found that more complex talk relating to counting or labeling large sets of four to 10 objects predicted children’s later cardinal-number knowledge, controlling for talk about smaller sets of fewer than four items and socioeconomic factors. Moreover, Elliott, Braham, and Libertus (2017) found that parents’ use of numbers larger than 10 when playing a variety of games with their 5- and 6-year-old children was associated with children’s overall numerical ability score on the Test of Early Mathematics Ability, 3rd Edition (TEMA-3) (Ginsburg & Baroody, 2003). Together, these results indicated that more advanced number talk involving larger sets of items may bolster children’s number knowledge.

In addition to differences in number talk at home, questionnaire data have revealed differences in the complexity of home math activities. Blevins-Knabe and Musun-Miller (1996) surveyed parents of 3.5- to 5.5-year-old children and found that parents of older children reported doing more complex number activities than parents of younger children, demonstrating that the child’s age may be a significant factor related to the complexity of activities. Skwarchuk
(2009) examined factors related to the frequency of basic math practices (e.g., counting objects, reciting numerals) and complex math practices (e.g., adding and subtracting sets of objects, counting by twos). Interestingly, involving children in more basic math activities was related with lower numeracy knowledge, although engagement with more complex math was associated with higher numeracy knowledge. Likewise, research on math talk indicated that caregivers’ use of advanced math talk about arithmetic, ordinal relations, and cardinal numbers predicted children’s advanced number skills (Ramani et al., 2015). Shared storybook reading may be particularly conducive to promoting complex conversations. Studies have found that both the parents’ and children’s language was more advanced during storybook reading than during other activities such as mealtimes and playtime (Hoff, 2010; Lewis & Gregory, 1987; Sorsby & Martlew, 1991). Thus, an environment rich in complex math talk and opportunities to practice advanced number skills may play a crucial role in the development of children’s number competencies.

**Reaction to number mistakes.** Another way that parents can support their children’s developing number knowledge is by providing help when the child makes a mistake. A number of studies have examined the amount and type of parental guiding behavior in reaction to a child’s numerical errors during home math activities. Vandermaas-Peeler and Pittard (2014) analyzed the support parents provided while playing a math board game and doing an explicit math activity with their children, while also collecting reports of numeracy and literacy home activities and children’s math performance. Six types of numeracy interactions were coded together with six types of parent responses when a child made a counting error. Results indicated that prompting children to count was the most frequent type of numeracy support provided by parents across both activities, followed by number recognition. Counting errors were the most
frequent type of error, with an average of 6.22 per board game, compared with an average of only 1.72 number recognition errors. The more support parents offered, the fewer counting errors children made. When a child did make a counting error, parents responded most frequently with physical hints (30%) and disaffirmation without a prompt (27%). Using physical hints meant pointing to each object one at a time as the child counted them and disaffirmation without prompt referred to when a parent said “no” without explaining why the child was incorrect.

In a similar study analyzing the relationship between kindergartners’ arithmetic strategy use and parents’ guidance behaviors while playing Chutes and Ladders and answering math fact questions, Bjorklund et al. (2004) found that parents provided a greater amount of supportive behavior during the explicit math activity (answering math fact questions) than during the board game. These researchers also analyzed the amount of support parents provided to low-ability as compared to high-ability children, as measured by their pretest scores. While they hypothesized that parents of low-ability children would provide greater support, the results in fact demonstrated that high-ability children received more guidance. This suggested that parents of highly skilled children may be more attuned to their children’s needs during board game play and better able to provide them with appropriate math scaffolding than parents of less skilled children.

Parental Beliefs

In addition to the frequency of math activities and support that parents provide during the activities, parents’ beliefs and attitudes about early math learning have been evaluated in a number of studies (e.g., Musun-Miller & Blevins-Knabe, 1998). These include parents’ ideas about the importance of incorporating early math learning into their children’s everyday life and beliefs about their role in helping their children learn math. Closely related are parents’ feelings
of efficacy and confidence in supporting their children’s early math learning. Parents’ beliefs and attitudes have been shown to impact both the frequency of math activities (Blevins-Knabe et al., 2000; Skwarchuk et al., 2014) and the degree of support parents provide to their children during home activities (Saxe et al., 1987; Starkey & Klein, 2008; Vandermaas-Peeler, 2008), underscoring the important role that parental beliefs play in understanding and conceptualizing the HNE.

In questionnaires and interviews, parents have indicated that they believe exposure to early math concepts is both developmentally appropriate and important for their children’s later academic success (e.g., Cannon & Ginsburg, 2008, Missall et al., 2015; Skwarchuk, 2009). However, parents have also reported that learning literacy skills and social skills is more important than math skills for preschoolers (Cannon & Ginsburg, 2008; Musun-Miller & Blevins-Knabe, 1998) and they tended to express more positive attitudes about reading activities than math activities (Blevins-Knabe et al., 2000). Furthermore, parents mentioned that they did not set explicit goals for their children’s math learning and also expressed uncertainty about the particular math concepts their children should learn and how to support those skills (Cannon & Ginsburg, 2008). However, in a later study, Missall et al. (2015) found contrasting results. Parents in their study did not endorse the belief that it was more important for their children to develop early literacy skills than early math skills. Missall et al. (2015) attributed their findings, in part, to the increased national focus on and awareness of academic success in the fields of science, technology, engineering, and mathematics, which may influence parents’ beliefs about the importance of early math learning.

In Missall et al.’s (2015) study, parents expressed confidence in their ability to help their children learn math and demonstrated self-efficacy in supporting their children’s developing
number knowledge. Their positive attitudes about their own skills were significantly related to the frequency of involvement in home math activities and beliefs in the importance of early math learning. This suggested that parents who felt confident about helping their children learn math also believed that their children should practice math skills at home and therefore they engaged their children in many home math activities (Missall et al., 2015). Other studies have found a significant relationship between parents’ math anxiety and their children’s math anxiety, which impacted the child’s math achievement (e.g., Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Therefore, it is important to examine and support parents’ feelings of efficacy and confidence.

In summary, the home is an important environment that provides the space for young children to explore their surroundings and grow their math knowledge, along with guidance from parents and caregivers. The HNE consists of activities and materials that promote math investigation, math language that arises from these tasks, and the support children receive from parents while engaging in these activities and materials. Parents’ values, experiences, and beliefs related to early math learning influence their interactions with their children and contribute to the conceptualization of the HNE (Street, Baker, & Tomlin, 2008). Shared storybook reading is one particular home activity that has the potential to both promote parent-child interactions and stimulate math conversations (Anderson et al., 2004, 2005; Ginsburg & Seo, 2000; Moyer, 2000). However, few studies have observed and reported specific ways that parents support their children’s math learning during storybook reading and how parental beliefs and the frequency of other home activities influence interactions around storybooks, which is the focus of the current study.
Research Questions and Hypotheses

The primary goal of this dissertation was to understand parent-child interactions involving number concepts that occurred during shared storybook reading. In particular, this study investigated the way that parents used math storybooks as a tool to develop their children’s number knowledge and how they responded to number mistakes. This section lists the specific research questions in the study.

The first two research questions addressed children’s number mistakes and how parents respond to those mistakes. The following three research questions focused on the factors that impact how parents select and use storybooks to help their young children engage in math thinking.

Research Question 1

Are there significant differences in the frequency and type of simple and complex math mistakes children make while reading a number book? Which child, parent, or household factors are associated with differences in the frequency of simple and complex math mistakes? Children were expected to make a greater number of mistakes when attempting complex number tasks in the context of the story. As children’s ages increased from 36 to 60 months, they were predicted to make fewer simple and complex mistakes. Likewise, a higher level of math proficiency was expected to be associated with a decrease in the frequency of simple and complex math mistakes.

Research Question 2

Are there significant differences in the support parents provide in response to their children’s number mistakes? Which child, parent, or household factors are associated with differences in parents’ supportive responses? Substantial variation in the type and degree of parents’ responses to their children’s math mistakes within the context of storybook reading was
expected. Parents were predicted to vary their support based on both child-level and parent-level characteristics. In particular, it was expected to see parents decrease the amount of support they provided as the children’s ages and math abilities increased. Moreover, it was expected that parents who held strong beliefs about the importance of early math learning would provide a high level of support when their children made a number mistake.

**Research Question 3**

How much of the math content in the storybook do parents discuss with their children? Which child, parent, or household factors impact the extent to which parents address the simple and complex number concepts in the storybook? Parents were expected to differ widely from one another in the amount of the math they discussed while reading the storybook based on parent characteristics. In particular, it was predicted that parents who engaged their children in more home math activities and held stronger beliefs about the importance of early math learning would address more of the number concepts in the book. In addition, the child’s age was expected to influence the extent to which parents addressed the math in the storybook. Parents of younger children were expected to discuss more of the simple math concepts while parents of older children were expected to discuss more of the complex math concepts presented in the story.

**Research Question 4**

Do parents or children complete more of the math tasks during shared storybook reading? Moreover, which child, parent, or household factors are associated with the amount of the math tasks that children complete? It was expected that the children’s ages would play a significant role in determining who did more of the math thinking. When parents read the storybook with younger children, the parents were expected to complete more of the number tasks than the
children. However, when parents read the storybook with older children, the children were expected to complete more of the number tasks than the adults.

**Research Question 5**

How do parents select math storybooks to read with their children? Which aspects of a storybook (e.g., the math language in the text or math ideas portrayed in the illustrations) do parents find beneficial in fostering their children’s math skills? While studies have repeatedly found that math storybook reading can be an advantageous home activity, no studies to date have explored how parents evaluate and choose the storybooks they read with their children. Therefore, this aspect of the study is exploratory and no predictions were made about particular ideas that parents might mention.
Chapter II

METHOD

Participants

This study included 47 pairs of parents and their children, with ages ranging from 3.0 to 5.0 years. The researcher sent flyers to preschools and parent groups in the New York City region to recruit participants. Flyers were intentionally distributed to preschools in neighborhoods with varying ethnicities and income levels in an attempt to recruit a diverse sample, although this was not entirely successful. Additional participants were recruited through a snowball sampling technique.

The adult sample included 39 Caucasians, four Hispanics, three Asian/Pacific Islanders, and one African American. Of the adult participants, 40 were mothers and the remaining seven were fathers. Parents ranged from 20 to 47 years of age ($M = 33.21, SD = 5.54$). The 28 male and 19 female children ranged in age from 36 months to 60 months ($M = 44.15, SD = 6.47$). Approximately half (47%) of parents reported their household yearly income to be under $60,000 and the remainder reported earning more than $60,000. The highest level of education achieved by parents was variable: four parents had a high school degree, 18 had some college experience, 15 had earned a college degree, and 10 had earned a graduate degree. Families received a free copy of a math storybook in exchange for their participation in the study.

Procedure

The observational study took place in participants’ homes and consisted of four parts: (a) parent-child math storybook reading, (b) administration of the Test of Early Mathematics
Ability-3, (c) parent questionnaire, and (d) parent interview. Each session took approximately 1 hour to conduct. Interactions between the parent and child while reading a math storybook were videotaped or audiotaped, transcribed, and coded at the sentence unit. The parent interviews were audiotaped, transcribed, and entered into the NVivo coding software for later analysis.

The Storybook and Measures

Math Storybook

A researcher-created math storybook, *Monster Birthday Surprise*, was used as the primary instrument in the study. *Monster Birthday Surprise* was based on an interactive electronic storybook of the same title (Ginsburg, Cerf, & Creighan, 2016). In the story, a monster named Ziggy goes shopping to buy items for his sister Nona’s sixth birthday party. The print version of the story was carefully designed to present particular math concepts in the text and illustrations to elicit parent-child conversation around the concept of number. In particular, the book was designed with eight opportunities to recognize written numerals, 10 opportunities to count small sets of five or fewer items, 14 opportunities to count large sets of six or more items, one opportunity to compare the magnitude of two sets of items, and one opportunity to subtract. Appendix A contains a copy of the storybook pages.

At the beginning of the study, parents were given a copy of *Monster Birthday Surprise* and told that the researcher was interested in studying how parents read math storybooks with their children. Parents were then asked to read however they would normally, and they could choose to be audio recorded or video recorded.

TEMA-3

Following the storybook reading, the primary researcher administered the Test of Early Mathematics Ability, 3rd Edition (TEMA-3), developed by Ginsburg and Baroody (2003). The
TEMA-3 is a standardized test appropriate for 3- to 8-year-old children that uses manipulatives, images, and verbal questions to measure children’s informal and formal number knowledge. Each age interval has an internal consistency alpha equal to or above 0.92. Children earn one point for each correct answer and the sum of the points produce a raw score, which can be converted to age-based standardized scores with a mean of 100 and a standard deviation of 15.

Children’s standardized scores on the TEMA-3 ranged from 73 to 124 ($M = 93.66, SD = 11.10$). A t test revealed that female children ($M = 98.74, SD = 12.26$) scored significantly higher than male children ($M = 90.21, SD = 8.90$) on the TEMA-3, $t(45) = -2.76, p = .008, d = .80$.

**Parent Questionnaire**

Parents were asked to complete a three-part questionnaire while the primary researcher administered the TEMA-3 to the child. The first two sections came from the Early Math Questionnaire (EMQ), developed by Missall et al. (2015). The first section (“Activity Items”) includes 36 questions that measure the frequency of home activities. These items were intended to be distinct and unique daily activities that are easily measurable and appropriate for preschool-aged children. Missall et al. consulted both the NCTM’s (2000) early math standards and Clements and Sarama’s (2009) developmental trajectories to create the items. Participants responded on a 5-point Likert scale ($0 = $not at all, $1 = $once or twice a week, $2 = $3 to 5 times a week, $3 = $about once a day, $4 = $more than once a day). In the second section (“Belief Items”), Missal et al. (2015) consulted extant instruments and theoretical perspectives—such as Bandura’s triadic reciprocal causation—to create 13 questions that focus on values and beliefs, personal experiences, and self-efficacy. The questions in the second section are rated on a 4-point Likert scale ($1 = $strongly disagree, $2 = $disagree, $3 = $agree, and $4 = $strongly agree).
The final section of the questionnaire asked demographic questions, including questions on age, gender, income, and the highest level of education attained.

**Factor analysis on the EMQ items.** An exploratory factor analysis (EFA) was conducted in SPSS as a means of dimension reduction for the activity and belief survey items on the EMQ. Although the first section of the EMQ measures the frequency of home activities covering number and operations (19 questions), geometry (nine questions), measurement (five questions), and algebra (three questions), only the 19 questions regarding number and operations were included in the EFA in this study. In their original study, Missall et al. (2015) grouped all 36 activities questions together to create a singular measure of home math activities, but this produced insufficient fit indices (Tucker-Lewis index [TLI] = .608, comparative fit index [CFI] = .630, root mean square error of approximation [RMSEA] = .126) and a large Cronbach’s alpha score (\( \alpha = 0.96 \)), indicating the possibility that the items were overly correlated. According to Hu and Bentler (1999), the following indices are recommended to indicate acceptable model fit: TLI > .95, CFI > .95, and RMSEA < .06. In addition, the sample size of 47 in the current study is too small to run an EFA adequately with all 36 activity items and 13 belief items. Therefore, the number and operations items were chosen and the remaining math domains were excluded in the EFA because the current study involved parent-child interactions while reading a storybook about number and operations.

An initial screening of Pearson correlations resulted in removing items A16, B7, and B9 for high correlations with other items and removing items A6, A15, B2, B3, and B11 for poor correlations. Results of the EFA on the remaining items (principal components extraction with varimax rotation) suggested a 3-factor model with items A2, A3, A4, A5, A9, A11, A12, A13, A14, A17, A18, and A19 loading onto factor 1; items A1, A8, and A10 loading onto factor 2;
and items B1, B4, B5, B6, B8, B10, and B12, and B13 loading onto factor 3. An analysis of the fit indices in SPSS AMOS yielded the following fit indices, $\chi^2 (206) = 247.67, p = .03$, TLI = .922, CFI = .931, RMSEA = .066, with a confidence interval of .026 to .095.

In summary, results of the factor analysis on the EMQ survey items yielded three distinct factors. The *number and operations activity* factor (items A2, A3, A4, A5, A9, A11, A12, A13, A14, A17, A18, and A19) addresses the frequency of number and operations activities parents and children undertake at home ($\alpha = .94$). The *counting activity* factor (items A1, A2, A7, A8, and A10) addresses the frequency of counting activities parents and children undertake at home ($\alpha = .77$). The *math beliefs* factor (items B1, B4, B5, B6, B8, B10, B12, and B13) represents the degree to which parents believe in the importance of early math learning and in their ability to influence their children’s math skills ($\alpha = .90$).

Table 1 presents the factor loadings for the activity and belief items included in the final model along with the eigenvalues and percent variance of each factor; Appendix C contains the means and standard deviations for all 36 activity items and 14 belief items.

**Parent Interview**

In the final part of the study, the researcher interviewed parents about which aspects of math storybooks they found most beneficial in fostering their children’s math development and how they selected storybooks to read at home. Appendix B lists the interview questions. The interview protocol allowed for additional follow-up questions for parents to clarify and elaborate on their responses to the initial set of questions.
Table 1

*Factor Loadings of the Early Math Questionnaire Activity and Belief Items (n = 47)*

<table>
<thead>
<tr>
<th>Item</th>
<th>Eigenvalue</th>
<th>Percent explained variance</th>
<th>Factor loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number and operations activities</strong></td>
<td>6.49</td>
<td>27.04</td>
<td>.768</td>
</tr>
<tr>
<td>A3. Count by 2’s, 5’s, or 10’s—something other than by 1’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4. Write numbers</td>
<td></td>
<td></td>
<td>.586</td>
</tr>
<tr>
<td>A5. Match printed numbers with group size or a collection</td>
<td></td>
<td></td>
<td>.601</td>
</tr>
<tr>
<td>A9. Estimate a small number for small groups and a large number for large groups</td>
<td></td>
<td></td>
<td>.763</td>
</tr>
<tr>
<td>A11. Distinguish between one-digit and two-digit numbers</td>
<td></td>
<td></td>
<td>.654</td>
</tr>
<tr>
<td>A12. Compare groups of objects to identify <em>more, less or same</em></td>
<td></td>
<td></td>
<td>.622</td>
</tr>
<tr>
<td>A13. Identify numbers as more or less</td>
<td></td>
<td></td>
<td>.808</td>
</tr>
<tr>
<td>A14. Match equal groups of objects</td>
<td></td>
<td></td>
<td>.852</td>
</tr>
<tr>
<td>A17. Add and subtract using objects</td>
<td></td>
<td></td>
<td>.728</td>
</tr>
<tr>
<td>A18. Recognize how parts make a whole</td>
<td></td>
<td></td>
<td>.781</td>
</tr>
<tr>
<td>A19. Create equal-sized groups from a larger group</td>
<td></td>
<td></td>
<td>.848</td>
</tr>
<tr>
<td><strong>Counting activities</strong></td>
<td>3.22</td>
<td>13.45</td>
<td>.818</td>
</tr>
<tr>
<td>A1. Count out a number of items from a larger group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2. Count using his or her fingers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A7. Count backward</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A8. Read numbers</td>
<td></td>
<td></td>
<td>.634</td>
</tr>
<tr>
<td>A10. Count the number of objects in a group</td>
<td></td>
<td></td>
<td>.807</td>
</tr>
<tr>
<td><strong>Math beliefs</strong></td>
<td>5.11</td>
<td>21.30</td>
<td>.692</td>
</tr>
<tr>
<td>B1. When I was growing up my family valued math</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4. Young children should learn about mathematics in the preschool setting</td>
<td></td>
<td></td>
<td>.785</td>
</tr>
<tr>
<td>B5. Mathematics is important for daily living</td>
<td></td>
<td></td>
<td>.802</td>
</tr>
<tr>
<td>B6. Even very young children can learn about mathematics</td>
<td></td>
<td></td>
<td>.884</td>
</tr>
<tr>
<td>B8. I can influence my child’s math skills</td>
<td></td>
<td></td>
<td>.813</td>
</tr>
<tr>
<td>B10. I feel comfortable teaching math skills</td>
<td></td>
<td></td>
<td>.760</td>
</tr>
<tr>
<td>B12. It is as important to develop early math skills as it is to develop early reading skills</td>
<td></td>
<td></td>
<td>.750</td>
</tr>
<tr>
<td>B13. I have good math skills</td>
<td></td>
<td></td>
<td>.722</td>
</tr>
</tbody>
</table>
Coding

The audio or video recordings of each parent-child reading session were transcribed, and the transcriptions then underwent three iterations of coding. The primary researcher served as the master coder and coded 20% of the data with a research assistant to establish inter-rater reliability. Upon demonstrating adequate inter-rater reliability and resolving any coding discrepancies, the primary researcher coded the remainder of the data independently. The kappa score or percent agreement for each measure is reported individually in the sections below. In addition, examples of parent-child dialogue are included to illustrate each behavior that was coded.

Type of Numeracy Mistake

Cross et al. (2009) described the teaching-learning paths for number and operations and highlighted particular skills that children acquire at various stages of early development. They identified five number competencies that can be categorized either as basic skills or complex skills. Basic skills included counting small sets and numeral recognition, while complex skills included magnitude comparison, counting large sets, and subtracting small sets. The five competencies in the two categories can be seen in Table 2. Each statement the child made that involved number—whether independently or prompted by the parent—was coded as one of these five numeracy skills and recorded as either correct or incorrect. The inter-rater reliability for this measure across two coders using Cohen’s kappa was .96.
Table 2

*Simple and Complex Numeracy Skills*

<table>
<thead>
<tr>
<th>Skill</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple number skills</td>
<td></td>
</tr>
<tr>
<td>Counting small sets</td>
<td>Counting a set of 1 to 5 items</td>
</tr>
<tr>
<td>Numeral recognition</td>
<td>Identifying written numerals, e.g., 1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Complex number skills</td>
<td></td>
</tr>
<tr>
<td>Magnitude comparison</td>
<td>Comparing small sets of items to determine which set has the greater or fewer number of items, such as comparing a set of 3 items versus a set of 5 items</td>
</tr>
<tr>
<td>Counting large sets</td>
<td>Counting a set of 6 or more items</td>
</tr>
<tr>
<td>Subtraction</td>
<td>Subtracting small sets of items, such as 6 minus 1</td>
</tr>
</tbody>
</table>

The following three examples are taken from the transcripts of the storybook reading sessions to illustrate different simple and complex math mistakes children made while reading *Monster Birthday Surprise.* The type of coded mistake is identified in parentheses following the child’s mistake. The text and page number from the story are included at the beginning to contextualize the parent-child conversation. In the following examples, children made a variety of mistakes while solving both simple and complex number tasks in the story.

**Story:** “Whoops!” Ziggy said. “I took too many!” She let one balloon fly back. (p. 5)
**Parent:** She let one balloon fly back, so how many balloons are left?
**Child:** One balloon. *(subtraction: complex number mistake)*
**Parent:** One flew away. How many she has now? Can you count them? Count them.
**Child:** Three.
**Parent:** Three green and how many purple?
**Child:** Eight, nine balloons. *(counting small sets: simple number mistake)*

**Story:** Next up was Snozzleberries. Ziggy put each Snozzleberry in her cart slowly, one at a time, as she counted them. (p. 8)
Child: Two, three, two, seven, eight. (*counting large set: complex number mistake*)
Parent: Good counting!
Child: Two-
Parent: We’ll count together.
Both: One, two, three, four, five, six, seven.

Story: “Hmm,” she said. “I wonder if there’s more chocolate cupcakes or strawberry cupcakes?” (p. 11)
Parent: Which cupcake had more, honey?
Child: Strawberry cupcakes.
Parent: Strawberry cupcakes. Let's count how many strawberry.
Child: One, two, three, four, five, six, seven, eight, nine. (*counting small set: simple number mistake*)
Parent: Five. And let’s count how many chocolate there are. One...
Child: Seven, eight, nine, ten. (*counting small set: simple number mistake*)
Parent: Look, just count while I’m pointing. One-
Child: One, two, three, four. (*counting small set: simple number mistake*)
Parent: There’s three chocolate cupcakes.

**Parental Response to Numeracy Mistake**

Parents’ responses to each child’s numeracy errors were considered supportive behaviors and coded based on the system developed by Bjorklund et al. (2004) and Ramani, Siegler, and Hitti (2012). Table 3 provides a description of each supportive parental behavior. Level 0 represents the “lowest” level and indicates that the parent did not respond to the child’s number mistake. The “highest” level is 5; this level indicates that the parent modeled a correct strategy in response to the child’s number mistake. However, the range of levels is not intended to represent quantitatively increasing levels of quality. Level 5 does not indicate a superior response as compared with the prior levels. Instead, it indicates the amount of intervention a parent provides when the child makes a number mistake. It was expected that parents would intervene in different ways based on various factors. For example, it may be appropriate for a parent to provide less support when a younger child makes a more complex math mistake because the child may not yet be developmentally ready to attempt the complex number task. Furthermore, an older child with more advanced math skills may only need a reminder to try again (Level 3:}
Verbal prompt) and may not benefit from a higher level of support because the child can complete the task independently. This study was meant to uncover variation in the ways that parents support, or intervene in, a response to a child’s math mistake and evaluate factors that influence the degree to which they intervene without suggesting that certain types of support are better than others.

A supportive behavior was coded for every parental response to a mistake that a child made on one of the five number skills listed in Table 2. Parents sometimes provided multiple supportive responses to a single mistake; in such a case, only the highest level of support observed was scored for that mistake. For example, if the parent told the child, “No, there’s six balloons. Watch as I count them: one, two, three, four, five, six,” the parent is demonstrating a disaffirmation (Level 0), providing the answer (Level 1), and modeling how to count a large set of items (Level 5). Therefore, the parent’s response to this child’s mistake would be coded as Level 5. Total scores for each participant across the entire book were averaged to create a single score for each participant, ranging from 0 to 5; this score represents the degree of support provided to the child. The inter-rater reliability for this measure across two coders using Cohen’s kappa was .90.

The following two examples are taken from the transcripts of the storybook reading sessions to illustrate how parents reacted to their children’s number mistakes while reading Monster Birthday Surprise. The type of coded response to mistake is identified in parentheses. The text and page number from the story are included at the beginning to contextualize the parent-child conversation. The parent provided a variety of supportive responses in each example, although the first example demonstrates more instances of providing the answer and the second example demonstrates more instances of modeling.
<table>
<thead>
<tr>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0: No response</td>
<td>The parent does not respond to the child’s number mistake and therefore no support is provided.</td>
</tr>
<tr>
<td>Level 1: Disaffirmation</td>
<td>The parent corrects the child and indicates the child gave an incorrect answer by using a negative response, such as an explicit <em>no</em> (e.g., “No, you’re wrong.”)</td>
</tr>
<tr>
<td>Level 2: Provide answer</td>
<td>The parent names the correct answer for the child (e.g., “There are really five bears.”)</td>
</tr>
<tr>
<td>Level 3: Verbal prompt</td>
<td>The parent suggests that the child tries once more (e.g., “Are you sure? Do you want to try again?”)</td>
</tr>
<tr>
<td>Level 4: Instruction</td>
<td>The parent explicitly suggests the use of a specific counting strategy (e.g., the parent reminds the child to count each bear slowly, one at a time).</td>
</tr>
<tr>
<td>Level 5: Modeling</td>
<td>The parent models a counting strategy for the child to observe and mimic (e.g., the parent counts the five bears with one-to-one correspondence).</td>
</tr>
</tbody>
</table>

Story: Ziggy took some balloons and counted to make sure she had the right amount. (p. 4)

Parent: Okay do you remember she made a list? How many balloons did she need?

Child: One.

Parent: One, two, three, four, five, six. *(provide answer)*

Child: Six.

Parent: Let’s count. How many balloons does she have?

Child: One, two, three.

Parent: Oh my gosh, let’s try again. *(verbal prompt)* One, two, three, four, five, six, seven. *(provide answer)*

Child: Seven.

Parent: Uh-oh, does she have the right amount of balloons?

Child: Yeah.

Parent: She does? *(verbal prompt)* No. *(disaffirmation)* She has one too many. *(provide answer)*

Story: Time to buy cupcakes! Ziggy checked her list so she could tell the baker how many cupcakes she need. (p. 9)

Parent: What number is that?
Child: Eight.
Parent: Okay. That maybe tells us that there could be eight cupcakes. Let’s count them, right?
Child: One, two, three, four, five, six, seven, eight, nine.
Parent: Well, it tells us that there is eight. (provide answer) So, let’s try again. (verbal prompt)
Child: One... You help me.
Parent: I will. I put my finger there, and you say the number, okay? (modeling)
Child: One, two, three, four, five, six, seven, eight, nine, ten.
Parent: No. (disaffirmation) You stop saying the numbers when you put your finger on the last one. (instruction) Like this, watch: One, two, three, four, five, six, seven, eight. (modeling) And that's the same number as that, right? Eight. Because I know you can count really high, but you stop at the end. (instruction) Okay?

Amount of Storybook Utilized

*Monster Birthday Surprise* was designed with 18 simple math concepts and 16 complex math concepts embedded throughout the text and illustrations. The extra-textual statements parents made involving number concepts were categorized as either simple or complex regardless of their illocutionary form (e.g., question or comment). Table 2 showed a description and definition of each simple and complex number concept. The frequencies of statements were converted into percentages that represent the number of simple and complex concepts parents addressed throughout the story. The inter-rater reliability for this measure across two coders using Cohen’s kappa was .89.

The following example taken from the transcripts of the storybook reading sessions illustrate some of the simple and complex math concepts a parent addressed while reading *Monster Birthday Surprise*. The type of coded math concept is identified in parentheses. The text and page number from the story are included at the beginning to contextualize the parent-child conversation. In this example, the parent progresses from discussing a simple math concept by asking the child to count small sets of cupcakes to asking the child eventually to compare the two sets of cupcakes, which is a more complex skill.
Story: “Hmm,” she said. “I wonder if there’s more chocolate cupcakes or strawberry cupcakes?”

Parent: Strawberry are the pink ones. Let’s count those ones. *(counting small sets: simple math concept)*

Child: One, two, three, four, five, six, seven.

Parent: Nope, see, you only count the pink ones, see? One ... *(counting small sets: simple math concept)*

Child: Two, three, four.

Parent: Five.

Child: Five.

Parent: There you go. And the brown ones are the chocolate. Let’s count those. *(counting small sets: simple math concept)*

Child: One, two, three.

Parent: Three. So, what's more? Five or three? *(magnitude comparison: complex math concept)*

Child: Three.

Parent: No, five is more, silly goose.

Child: Five.

Parent: You see how there are more pink than brown? *(magnitude comparison: complex math concept)*

Child: Yeah.

**Individual Completing the Math Task**

Each instance of one of the five numeracy tasks occurring as the parent and child read the storybook was coded according to the individual completing the task. Either the parent, the child, or both the parent and child were coded as performing the particular math task, whether prompted or unprompted. For example, if the child counted the number of balloons in the picture, the task was coded under *child*. On the subsequent page, if the adult calculated how many balloons remained after one was released, the task was coded under *parent*. If the parent and child later counted the number of Snozzleberries in tandem, the task was coded under *both*. The total number of tasks was divided by the number of numeracy tasks that the child performed to create a percentage that represented the degree to which the child had autonomy over doing the math during storybook reading. Instances when the parent or child repeated or mimicked
what the other individual just said were not coded in this analysis. The inter-rater reliability for this measure across two coders using Cohen’s kappa was .86.

The following two examples are taken from the transcripts of the storybook reading sessions to illustrate instances when the parent or the child is completing more of the number tasks while reading *Monster Birthday Surprise*. The text and page number from the story are included at the beginning to contextualize the parent-child conversation. In the first example, the child is completing more of the math tasks on the page. This is contrasted with the second example, in which the parent is doing more of the math tasks on the page.

**Story:** Ziggy needed to buy some things for Nona’s birthday party. She looked at her list. First on the list was balloons. (p. 2)

**Parent:** So this is her list, just like you made a list with mom last night.

**Child:** Can I count?

**Parent:** Sure, count it.

**Child:** One, two, three, four, five, six.

**Parent:** Six balloons. And then she needs ... I think these might be bags, maybe. Or packages, I don’t know. How many are there?

**Child:** One, two, three.

**Parent:** Yeah, three, and that says three. And then she needs some stars. She needs stars too but I don’t know how many stars there are.

**Child:** I can count.

**Parent:** Thanks.

**Child:** One, two, three, four, five, six, seven.

**Parent:** Seven, yeah. See, there’s seven and that’s seven, it starts with S. And then this is your favorite number, you told me. How many cupcakes?

**Child:** One, two, three, four, five, six, seven, eight.

**Parent:** Eight. Eight still your favorite number?

**Child:** Yeah.

**Story:** Can you help Nona find groups of six things? (p. 16)

**Parent:** Can you help Nona find groups of six? Are the balloons groups of six? Let’s make sure. One, two, three, four, five, six. Yep, six balloons. What about the Monster Mix? Is there six Monster Mixes? Let's see. One, two, three, four. Oh, there’s not six, there’s only four. What about the Snozzleberries? One, two, three, four, five, six. Is there six of them?

**Child:** Mm-hmm.

**Parent:** And candles? One, two, three, four, five, and six. We have six candles.
Parent Interviews

Transcriptions of the 47 parent interviews were coded within NVivo, a qualitative data analysis software. Coding categories were created using both a top-down and bottom-up approach. A code was defined as a meaningful statement that reflected parents’ ideas or feelings about selecting and reading math storybooks with their children. Some codes were based on a priori themes in the storybook reading literature, and other ideas eventually became codes as they emerged from the data. For example, prior studies have found that parents pay particular attention to the illustrations when reading storybooks with their children (Anderson et al., 2005; Ezell & Justice, 1998; Shapiro et al., 1997); therefore, a code referencing the math present in the illustrations was established prior to coding. One unexpected code that emerged during an initial analysis of the parent interviews was attention—parents frequently mentioned how their children’s attention span influenced their selection of storybooks and how they engaged their children during storybook reading.

A subset of parent interview transcripts was first carefully reviewed to establish coding categories. Parents sometimes expressed multiple ideas in a series of phrases or sentences, and hence the codes were not mutually exclusive. Once an initial set of codes was developed, the remainder of the data was examined to revise and refine the codebook. Any codes that did not appear in at least 40% (19) of the transcripts were discarded. Finally, related codes were grouped into broader themes. For example, parents discussed various factors they considered as they read, such as asking questions, maintaining the child’s attention, involving the child in the story, attending to the complexity of the math on the page, and reinforcing the child’s current skills. These topics were related to the process of reading and therefore grouped into one theme: reading process.
The primary investigator and research assistant each coded 20% of the data set (nine transcripts) to establish reliability. The two coders reached at least 80% agreement for each of the nine transcripts, and they reached consensus on their disagreements.
Chapter III

RESULTS

This section presents the results of the quantitative and qualitative analyses for each of the research questions. In each of the statistical models described below, the researcher conducted preliminary analyses to check for violations of the assumptions of linearity, normality, independence of errors, collinearity, homoscedasticity, or a combination of the above. No violations of assumptions were present, unless otherwise stated in the analysis.

Hierarchical regression analyses were conducted to explore which child, parent, or household factors were associated with children’s number mistakes, parents’ responses to those mistakes, the amount of the simple and complex math in the storybook that parents addressed, and the degree to which children solved the math tasks in the story. Predictor variables were entered in the same order for each analysis: child-level factors in step 1 because it was hypothesized that parent behaviors would be strongly affected by their child’s characteristics, then parent-level factors in step 2 and household factors in step 3 to test whether the addition of these variables would contribute significantly to each model. Due to the small sample size, a limited number of predictor variables were included in the model. The relationship between each potential predictor variable and dependent variable was explored individually to determine which factors to include. Child gender and parents’ age had low and non-significant correlations with many dependent variables and were thus excluded from the analyses. Yearly household income and parents’ highest level of education were significantly correlated, \( r = .652, p < .001 \), and thus income was excluded from the model. Level of education was included in the model instead of
income because studies have found that parents’ educational attainment was associated with differences in young children’s cognitive and academic outcomes (Downer & Pianta, 2006), parents’ attitudes towards math and frequency of reading with their children (LeFevre et al., 2010), and the amount of math talk at home (Susperreguy, 2013). Parents’ highest level of education was converted into years of education (high school degree = 12 years, some college = 14 years, bachelor’s degree = 16 years, graduate degree = 18 years) and these years were included in the analyses. Finally, the household characteristic of interest in the present study was the frequency of home numeracy activities. Results of the factor analysis yielded separate factors for activities related to number and operations and activities related to counting, which were moderately correlated ($r = .65$, $p < .001$). Due to the small sample size, both factors were not included in the model. In the parent interviews, many parents explicitly named the skills associated with the counting activities as important for their children to learn. These included counting the number of items in a group and reading written numerals. Therefore, the factor representing the frequency of counting activities was included in the analyses instead of the factor representing the frequency of number and operations activities. The results of each analysis are described below.

**Research Question 1**

The focus of Research Question 1 was to understand differences in the types of number mistakes that children made and which factors were associated with those mistakes. Eight children did not attempt any number tasks while reading *Monster Birthday Surprise*, and thus they were excluded from the analysis. These eight children were compared to the remaining 39 and did not vary across any of the measured characteristics, including child’s age, gender, TEMA-3 score, parent’s highest level of education, and household income. Evaluating transcripts
of their shared storybook reading sessions revealed that the parents of these eight children made few extra-textual comments or questions beyond what was printed in the book; in doing so, the parents limited the number of opportunities the children had to engage in math thinking. The analyses reported below came from the data of the remaining 39 children.

Overall, there was a great deal of variation in the number of mistakes children made across the entire storybook, ranging from 0 to 24 mistakes ($M = 5.55, SD = 5.52$). Mistakes were further classified based on whether the error was made when attempting a simple number concept (counting small sets or recognizing numerals) or complex number concept (counting large sets, comparing magnitudes, or subtracting). The children collectively made 84 mistakes out of 203 simple trials. For complex number concepts, they made 177 mistakes out of a total of 307 complex trials. In other words, when children attempted a simple number task in the context of reading *Monster Birthday Surprise*, they made a mistake 41.37% of the time. When they attempted a complex number task, they made a mistake 57.66% of the time.

The percentages of children’s simple and complex mistakes were compared using a paired samples t test. Results indicated that children made significantly more complex mistakes ($M = .58, SD = .29$) than simple mistakes ($M = .41, SD = .36$), $t(38) = 2.80, p = .008, d = .52$. Furthermore, a bivariate correlation revealed that children’s standardized TEMA-3 scores had a significant, negative relation to both their frequency of simple mistakes ($r = -.47, p = .003$) and complex mistakes ($r = -.49, p = .001$), demonstrating that children's math abilities impacted how they solved math problems in the context of storybook reading.

Two hierarchical linear regression analyses were conducted to explore which child, parent, and household factors were associated with the percentages of simple and complex number mistakes. Kurtosis values of -1.09 for the percentage of simple mistakes and -1.19 for
percentage of complex mistakes indicated a possible deviation from normality. However, attempts at transforming the data did not improve the kurtosis values. In addition, visual inspection of scatterplots, results of the Kolmogorov-Smirnov test and the Durbin-Watson statistic indicated no other violations of the assumptions of regression. The variance inflation factor (VIF), tolerance statistics, and review of the correlation matrix were used to identify possible instances of collinearity. All VIFs were less than 2 and tolerance values were above .2, indicating that collinearity was not an issue in the analyses.

In the first regression analysis, the percentage of children’s simple number mistakes was included as the dependent variable. The child’s age was added in Step 1, the parents’ years of educational attainment and belief scores were added in Step 2, and the frequency of home counting activities was added in Step 3. As shown in Model 2 in Table 4, results indicated that the child’s age, parent’s educational attainment, and parent belief scores combined to explain 40.9% of the variation in children’s simple number mistakes, F(3, 25) = 8.08, p < .001. A nonsignificant F-change statistic from Model 2 to Model 3 indicated that the frequency of home counting activities did not explain additional variance and was not significantly associated with children’s simple number mistake after controlling for parent and child characteristics. The child’s age and parent belief scores were significantly associated with the percentage of simple mistakes. Older children made fewer mistakes when solving simple math tasks in the storybook. In addition, children of parents who held stronger beliefs about the importance of early math learning made fewer mistakes on the simple math tasks.
Table 4

Hierarchical Regression Models for Variables Associated with the Percentage of Children’s Simple Mistakes (n = 39)

<table>
<thead>
<tr>
<th></th>
<th>ΔR²</th>
<th>Total R²</th>
<th>B</th>
<th>SE (B)</th>
<th>β</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>.145*</td>
<td>-.02</td>
<td>.01</td>
<td>-.38</td>
<td>-2.50</td>
<td>.02*</td>
</tr>
<tr>
<td>Step 2</td>
<td>.262**</td>
<td>.409***</td>
<td>-.02</td>
<td>.01</td>
<td>-.38</td>
<td>-2.80</td>
<td>.008**</td>
</tr>
<tr>
<td>Child’s age</td>
<td></td>
<td></td>
<td>-.02</td>
<td>.01</td>
<td>-.38</td>
<td>-2.80</td>
<td>.008**</td>
</tr>
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<td>Parents’ educational attainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Parents’ math beliefs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>.012</td>
<td>.421**</td>
<td>-.02</td>
<td>.01</td>
<td>-.33</td>
<td>-2.26</td>
<td>.03*</td>
</tr>
<tr>
<td>Child’s age</td>
<td></td>
<td></td>
<td>-.02</td>
<td>.01</td>
<td>-.33</td>
<td>-2.26</td>
<td>.03*</td>
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<td>Parent’s educational attainment</td>
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<td>Parents’ math beliefs</td>
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</tr>
<tr>
<td>Frequency of counting activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = p < .05, ** = p < .01, *** = p < .001

The second regression on the percentage of children’s complex mistakes indicated that the children’s ages, parents’ educational attainment, and parents’ beliefs about early math learning combined to explain 23.7% of the variance, as seen in Model 2 in Table 5. The addition of counting activities in Model 3 did not yield a significant R² change; therefore, the frequency of counting activities at home did not explain additional variance. Unlike the regression on simple mistakes, none of the included child, parent, or household factors were significantly related to the percentage of complex mistakes. Additional factors may account for the errors children made when solving complex math tasks in the context of storybook reading. Table 5 shows regression coefficients and standard errors for the second hierarchical regression analysis.
Table 5

*Hierarchical Regression Models for Variables Associated With the Percentage of Children’s Complex Mistakes (n = 39)*

<table>
<thead>
<tr>
<th>Step</th>
<th>ΔR²</th>
<th>Total R²</th>
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<th>SE (B)</th>
<th>β</th>
<th>t</th>
<th>Sig.</th>
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</thead>
<tbody>
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<td>.01</td>
<td>-.18</td>
<td>-1.12</td>
<td>.27</td>
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<tr>
<td>Step 2</td>
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<td>.237*</td>
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<tr>
<td>Child’s age</td>
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<td>.01</td>
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<td>-.05</td>
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<td>-.24</td>
<td>-1.44</td>
<td>.16</td>
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<td>Parents’ math beliefs</td>
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<td>-.21</td>
<td>.11</td>
<td>-.31</td>
<td>-1.89</td>
<td>.07</td>
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<td>Step 3</td>
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<tr>
<td>Child’s age</td>
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<td>.01</td>
<td>-.20</td>
<td>-1.17</td>
<td>.25</td>
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<td>.03</td>
<td>-.22</td>
<td>-1.20</td>
<td>.24</td>
</tr>
<tr>
<td>Parents’ math beliefs</td>
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<td>-.22</td>
<td>.12</td>
<td>-.32</td>
<td>-1.90</td>
<td>.06</td>
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<td>Frequency of counting activities</td>
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<td></td>
<td>.03</td>
<td>.07</td>
<td>.06</td>
<td>.36</td>
<td>.72</td>
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</table>

* = p < .05

In summary, a paired-sample t test and two hierarchical regression analyses were conducted to evaluate which factors were associated with children’s number mistakes. As predicted, children made more mistakes on complex math tasks than simple ones, and the frequency of simple and complex math mistakes decreased as their math proficiency increased. While children made fewer simple math mistakes as their age increased, age was not associated with the frequency of complex mistakes. Although it was not predicted that parental characteristics would impact children’s mistakes, stronger parental belief about the importance of math learning was found to be associated with fewer simple math mistakes but had no relation to children’s complex mistakes.
Research Question 2

Having explored variation in the types of number mistakes and factors associated with those mistakes, this section examines how parents responded to those mistakes. A hierarchical regression analysis assessed the relationship between parent and child factors and the level of support that parents provide in response to children’s number mistakes during shared storybook reading. It is important to remember that increasing levels of support indicated a greater degree of intervention but not a higher quality response. Therefore, this research question was intended to reveal variation in the ways that parents intervened in response to a child’s math mistake and evaluate factors that influenced the degree to which they intervened without suggesting that certain types of support were superior to others.

The highest level of support that a parent provided was recorded in response to each mistake and averaged across the entire storybook reading session to create a single score for each parent on a scale of 0 to 5 ($M = 2.48, SD = 1.04$). Nine of the 47 children did not make any number mistakes while reading the storybook; therefore, their nine parents did not provide any supportive behaviors in response to a number mistake and were excluded from the analysis. The nine parents and their children were compared to the remaining 38 and did not vary across any of the measured characteristics. These particular parents made few extra-textual comments or questions beyond what was printed in the book, thereby limiting the number of opportunities their children had to engage in math thinking and potentially make a mistake. Table 6 lists the frequencies and percentages of parental responses at each level of support for the remaining 38 participants.
Table 6

*Parents’ Supportive Behaviors in Response to Children’s Number Mistake (n = 38)*

<table>
<thead>
<tr>
<th>Parent Support Level</th>
<th>Total Frequency</th>
<th>Total Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0: No response</td>
<td>39</td>
<td>15</td>
</tr>
<tr>
<td>Level 1: Disaffirmation</td>
<td>7</td>
<td>3</td>
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<tr>
<td>Level 2: Provide answer</td>
<td>83</td>
<td>31</td>
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<td>Level 3: Verbal prompt</td>
<td>65</td>
<td>24</td>
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<td>Level 4: Instruction</td>
<td>30</td>
<td>11</td>
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<td>Level 5: Modeling</td>
<td>43</td>
<td>16</td>
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<tr>
<td>Total parent responses</td>
<td>267</td>
<td>100</td>
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</table>

*Note.* The total frequency represents the total number of responses given at each level, summed across all participants.

The child, parent, and household variables were entered in the hierarchical linear regression separately. Step 1 included both the children’s ages and raw TEMA-3 scores to examine how parents’ responses to children’s mistakes varied based on factors related to the child. Step 2 included parents’ educational attainment in years and their beliefs about early math learning to assess the added value of parental factors. Finally, in Step 3, the frequency of counting activities was added because a significant change in $R^2$ in this final model would indicate the unique benefit of controlling for home math activities when analyzing factors associated with parental support of the child’s math learning.

Results of the hierarchical regression model indicated that Model 2 was significant ($F(4, 33) = 3.03, p = .02$) and explained 30.1% of the variance in the degree of support parents provided in response to their children’s number mistake. Model 2 included the child’s age, TEMA-3 raw score, parents’ math beliefs, and years of education. Table 7 presents the results.
The $R^2$, or the amount of variance in parents’ responsive behaviors, increased by .218 with the addition of parent factors from Model 1 to Model 2. Although Model 3 was also significant ($F(5, 32) = 2.79, p = .03$), the $F$-change statistic was not significant from Model 2 to Model 3. Thus, the addition of home counting activities provided no unique variance over the effects of the child and parent characteristics. The only variables significantly associated with the degree of support provided in response to a number mistake were the parent math belief scores and the child’s math ability, as measured on the TEMA-3.

Table 7

*Hierarchical Regression Models for Variables Associated With Parents’ Response to Errors (n = 38)*

<table>
<thead>
<tr>
<th>Step</th>
<th>$\Delta R^2$</th>
<th>Total $R^2$</th>
<th>B</th>
<th>SE (B)</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig.</th>
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<td>.083</td>
<td>Child’s age</td>
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<td>.04</td>
<td>-.20</td>
<td>-0.91</td>
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<td></td>
<td></td>
<td></td>
<td>TEMA-3 raw score</td>
<td>-.02</td>
<td>.04</td>
<td>-.12</td>
<td>-0.54</td>
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<tr>
<td>Step 2</td>
<td>.218*</td>
<td>.301*</td>
<td>Child’s age</td>
<td>.02</td>
<td>.04</td>
<td>.11</td>
<td>0.50</td>
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<td></td>
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<td>-.54</td>
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<td>TEMA-3 raw score</td>
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<td>.21</td>
<td>.06</td>
<td>0.36</td>
</tr>
</tbody>
</table>

* = $p < .05$
In summary, substantial variation in parents’ responses to their children’s math mistakes was found. As predicted, parents varied their support based on characteristics of both the parent and child. Parents who held stronger beliefs about the importance of early math learning provided a high level of support when their children made a number mistake. In addition, their degree of support was related to and perhaps influenced by the child’s math ability. Parents provided a higher level of support to low ability children than high ability children. However, parents did not vary their support based on the child’s age, as predicted.

**Research Question 3**

Storybooks such as *Monster Birthday Surprise* can be considered a tool that parents use in the home to promote the exploration of math concepts. With this in mind, Research Question 3 sought to understand the extent to which parents took advantage of the storybook as a math learning opportunity. The next analyses therefore investigated differences in the amount of simple and complex math parents addressed and factors associated with those differences. Table 8 presents the range, mean, and standard deviations.

**Table 8**

*Percent of Total, Simple, and Complex Number Concepts Parents Addressed While Reading Monster Birthday Surprise (n = 47)*

<table>
<thead>
<tr>
<th>Number Concepts</th>
<th>Range</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number concepts</td>
<td>0–71%</td>
<td>43%</td>
<td>17%</td>
</tr>
<tr>
<td>Simple number concepts</td>
<td>0–72%</td>
<td>35%</td>
<td>17%</td>
</tr>
<tr>
<td>Complex number concepts</td>
<td>0–94%</td>
<td>51%</td>
<td>21%</td>
</tr>
</tbody>
</table>
A paired-sample t test revealed that parents addressed significantly more of the complex number concepts than the simple number concepts in the story, $t(46) = -6.87, p < .001, d = 1.02$. Two separate regression analyses were conducted on the amount of simple and complex math parents addressed in the storybook. The children’s ages and TEMA-3 raw scores were entered in Step 1, the parents’ educational attainment in years and math belief scores were entered in Step 2, and the frequency of counting activities was entered in Step 3. Table 9 presents the results. The results of the first regression analysis revealed that the child and parent characteristics in Model 2 combined to explain 30.3% of the variance in the amount of simple math concepts the parent addressed while reading the storybook, $F(4, 42) = 4.57, p = .004$. Although Model 3 was also significant ($F(5, 41) = 3.77, p = .007$), an nonsignificant F-change statistic from Model 2 to Model 3 indicated that the inclusion of counting activities did not explain added variance beyond the child and parent factors. The child’s math ability level had a significant, negative correlation with the percent of simple math concepts parents discussed in the storybook while parents’ math belief scores had a positive relation. In other words, parents of children with lower math abilities took fewer opportunities to discuss the simple math concepts while reading. On the other hand, parents with stronger beliefs about the importance of early math learning took more opportunities to discuss the simple math concepts while reading.

Results of the second regression analysis indicated that the child, parent, and household factors accounted for 15.7% of the variance in the amount of complex math concepts parents addressed in the storybook. However, none of the models and none of the variables were significant. Therefore, it is likely that other unmeasured factors accounted for differences in the number of complex number concepts parents discussed while reading the storybook. Results are presented in Table 10.
In summary, substantial variation was found in the number of the simple and complex 
math concepts parents discussed with their children while reading. Both child and parent factors 
influenced the amount of simple math discussed. Parents discussed more of the simple math 
concepts in the story to children with lower math abilities and the more strongly parents believed 
in the importance of early math learning, the more frequently they discussed simple math 
concepts. Although the child’s age and the frequency of home activities were predicted to impact 
the amount of math discussed in the story, neither factor was statistically significant. In addition,
none of the included child, parent, or household factors were related to the amount of complex math parents discussed with their children.

Table 10

*Hierarchical Regression Models for Variables Associated with the Percentage of Complex Math Concepts (n = 47)*

<table>
<thead>
<tr>
<th>Step</th>
<th>ΔR²</th>
<th>Total R²</th>
<th>B</th>
<th>SE (B)</th>
<th>β</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>.028</td>
<td>.028</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s age</td>
<td>-.01</td>
<td>.01</td>
<td>-.17</td>
<td>-.80</td>
<td>.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td>.00</td>
<td>.01</td>
<td>.00</td>
<td>-.01</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>.122</td>
<td>.150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s age</td>
<td>-.001</td>
<td>.01</td>
<td>-.02</td>
<td>-.10</td>
<td>.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td>-.01</td>
<td>.01</td>
<td>-.25</td>
<td>-1.09</td>
<td>.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents’ educational attainment</td>
<td>-.01</td>
<td>.02</td>
<td>-.08</td>
<td>-.53</td>
<td>.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents’ math beliefs</td>
<td>.16</td>
<td>.06</td>
<td>.41</td>
<td>2.46</td>
<td>.02*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>.007</td>
<td>.157</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s age</td>
<td>.00</td>
<td>.01</td>
<td>.004</td>
<td>0.02</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td>-.01</td>
<td>.01</td>
<td>-.28</td>
<td>-1.17</td>
<td>.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents’ educational attainment</td>
<td>-.01</td>
<td>.02</td>
<td>-.06</td>
<td>-.40</td>
<td>.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents’ math beliefs</td>
<td>.15</td>
<td>.06</td>
<td>.40</td>
<td>2.41</td>
<td>.02*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of counting activities</td>
<td>.02</td>
<td>.03</td>
<td>.08</td>
<td>0.56</td>
<td>.58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = p < .05

**Research Question 4**

This question deals with the individual—child or parent—who completed more of the math tasks while reading the storybook. Table 11 presents the frequencies and percentages of
number tasks completed by the parent, child, and both individuals. One parent-child dyad did not make any extra-textual utterances, and thus the study excluded these data from the analysis.

Table 11

*Differences in the Individual Completing the Number Tasks* (n = 46)

<table>
<thead>
<tr>
<th>Individual</th>
<th>Total Frequency of Number Tasks</th>
<th>Percent of Number Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
<td>473</td>
<td>42</td>
</tr>
<tr>
<td>Child</td>
<td>592</td>
<td>52</td>
</tr>
<tr>
<td>Both parent and child</td>
<td>72</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>1137</td>
<td>100</td>
</tr>
</tbody>
</table>

Overall, children completed a greater percentage of number tasks than parents while reading *Monster Birthday Surprise*. However, there was much variation in this factor. Across all participants, children’s completion of number tasks ranged from 0% to 100%, with a standard deviation of 31%. A hierarchical regression analysis was conducted to investigate which child, parent, and household characteristics were associated with the number of number problems in the storybook that children were solving. The children’s ages and TEMA-3 raw scores were entered in Step 1, the parents’ educational attainment in years and math belief scores were entered in Step 2, and the frequency of counting activities was entered in Step 3.

A kurtosis value of -1.17 indicated a possible deviation from normality. However, inspection of scatterplots, results of the Kolmogorov-Smirnov test and the Durbin-Watson statistic indicated no other violations of the assumptions of regression. In addition, the VIF statistic, tolerance statistics, and correlation matrix indicated that collinearity was not an issue in the analyses.
Results of the hierarchical regression model indicated that the third model was significant and explained 45.2% of the variance in the amount of children’s completion of number tasks in the storybook, \( F(5, 40) = 6.61, p < .001 \). Table 12 presents the results. The frequency of counting activities was the only factor significantly associated with the percentage of number tasks children solved. Children involved in a greater number of counting activities at home completed more of the math tasks in the storybook, overall.

Table 12

*Hierarchical Regression Models for Variables Associated With the Child’s Completion of Math Tasks* (n = 46)

<table>
<thead>
<tr>
<th>Step 1</th>
<th>( \Delta R^2 )</th>
<th>Total ( R^2 )</th>
<th>B</th>
<th>SE (B)</th>
<th>( \beta )</th>
<th>( t )</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s age</td>
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<td>.324</td>
<td>.01</td>
<td>.01</td>
<td>.13</td>
<td>0.72</td>
<td>.47</td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td></td>
<td></td>
<td>.03</td>
<td>.01</td>
<td>.48</td>
<td>2.76</td>
<td>.01*</td>
</tr>
<tr>
<td>Step 2</td>
<td>.044</td>
<td>.368*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s age</td>
<td></td>
<td></td>
<td>.01</td>
<td>.01</td>
<td>.24</td>
<td>1.29</td>
<td>.20</td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td></td>
<td></td>
<td>.02</td>
<td>.01</td>
<td>.32</td>
<td>1.58</td>
<td>.12</td>
</tr>
<tr>
<td>Parents’ educational attainment</td>
<td></td>
<td></td>
<td>.02</td>
<td>.02</td>
<td>.12</td>
<td>0.90</td>
<td>.37</td>
</tr>
<tr>
<td>Parents’ math beliefs</td>
<td></td>
<td></td>
<td>.10</td>
<td>.09</td>
<td>.17</td>
<td>1.16</td>
<td>.25</td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s age</td>
<td>.085*</td>
<td>.452**</td>
<td>.02</td>
<td>.01</td>
<td>.33</td>
<td>1.85</td>
<td>.07</td>
</tr>
<tr>
<td>TEMA-3 raw score</td>
<td></td>
<td></td>
<td>.01</td>
<td>.01</td>
<td>.25</td>
<td>1.30</td>
<td>.20</td>
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<tr>
<td>Parents’ educational attainment</td>
<td></td>
<td></td>
<td>.03</td>
<td>.02</td>
<td>.19</td>
<td>0.19</td>
<td>1.49</td>
</tr>
<tr>
<td>Parents’ math beliefs</td>
<td></td>
<td></td>
<td>.08</td>
<td>.08</td>
<td>.14</td>
<td>0.14</td>
<td>.99</td>
</tr>
<tr>
<td>Frequency of counting activities</td>
<td></td>
<td></td>
<td>.011</td>
<td>.04</td>
<td>.30*</td>
<td>2.49</td>
<td>.02*</td>
</tr>
</tbody>
</table>

* = \( p < .05 \), ** = \( p < .01 \)
In summary, it was expected that the children’s ages would play a significant role in determining who did more of the math problem solving in the story, but age was not found to be a significant factor. Instead, children who engaged in a greater frequency of home counting activities completed more of the math tasks in the storybook. This was the only analysis in which a household characteristic—frequency of counting activities—made a significant contribution to explaining parent or child behaviors during storybook reading. In the previous analyses, the addition of counting activities did not explain additional variation in the model.

**Research Question 5**

This section is comprised of a discussion of themes that emerged from coding the parent interviews. An overview of the coding process was presented earlier in this study. The interviewees were first asked specific questions about *Monster Birthday Surprise* to find out what aspects of the story they found beneficial for helping their children to practice their number skills. Subsequent questions related to broader ideas about how parents selected and used math storybooks in general. Appendix B lists the specific interview questions. The following main themes emerged from the 47 parent interviews: (a) storybook selection, (b) features of math storybooks, (c) the reading process, and (d) early number concepts. Appendix D presents the codes that were grouped to form each theme, along with quotes and the number of parents who mentioned ideas related to each code. Each of these themes is described in the following section, with accompanying quotes from parents that illustrate main ideas that arose from the interviews.

**Theme 1: Storybook Selection**

When asked whether they read math storybooks with their children, all 47 parents responded in the affirmative. However, some reported that they did not read explicit counting or number books, but rather found opportunities to count and practice math skills in books that did
not appear overtly mathematical. They were then asked to describe how they chose math storybooks to read to their children, whether from their home libraries, the public library, or a bookstore. A common response was that their children’s interests guided their selection of storybooks, and this notion of interest was closely connected with maintaining the child’s attention. The issue of sustaining attention came up repeatedly throughout many interviews. The parents described their children as being easily distracted due to their young age and expressed more concern over choosing books that “catch the child’s attention” than choosing books based on the presentation of math concepts. One way to keep children focused during storybook reading was to “look for books with topics that I think will draw their attention” and choose books about their child’s favorite characters.

Keeping the children interested and engaged during shared storybook reading appeared to be a primary concern and deriving educational benefits from the story seemed secondary. The parents claimed that reading storybooks that interested the children elicited their attention and therefore provided more time for the children to learn something as they were reading. On the other hand, “If the child has no interest in the character, then the child might be less inclined to listen or participate.” Moreover, “If he isn’t interested enough in the book to sit and listen and engage with the book, then it isn’t going to help him learn anything.” With regard to Monster Birthday Surprise, they found that their children were motivated to engage with the story because its birthday theme was relatable.

The story you did with the monsters was great because he’s excited. He knows what a birthday party is. It’s something exciting, balloons, all those things, something he understands and he’s excited about. If it were something boring, then he would probably not be interested in it.

Similarly, the interviewees expressed a preference for relatable stories because they wanted to connect themes and concepts in the story to something in the child’s life. This enabled
the child to practice the concepts presented in the book in other situations, reinforcing what was read and connecting it to the real world. Relating back to the plot of *Monster Birthday Surprise*, a parent remarked that, “Birthday parties are part of life, which gives kids life skills. I can see her [the daughter] counting at the next birthday we go to.” *Monster Birthday Surprise* also gave parents the opportunity to discuss shopping for things, so when they took their children to the market afterwards, “you can kind of practice the same thing. This is the list I will need to get.”

In addition to considering their children’s interests, a number of parents reported allowing their children to choose storybooks themselves and “get whatever catches her eye.” The parents suggested that giving the children a choice regarding reading material was “the best way to engage her.” “We would go into a library, she’ll choose whatever she wants, then we’ll read at home.” They said that their children selected books that had colorful covers and recognizable, interesting characters that they liked. However, in some families, choosing books was a collaborative process between a parent and child. The parent might first suggest some books before the child made the ultimate decision about which books to purchase or check out of the library and read. However, if the child selected an inappropriate book, the parent would “veto it and make her pick another one.” In other families, the child chose a selection of books first and the parent picked a book to read from the child’s selection. Finally, a few of them mentioned that they asked the library for recommendations or browsed through what librarians or bookstores had put in the “featured” area, demonstrating once again that storybook selection was sometimes a collaborative process among various individuals.

**Theme 2: Features of Math Storybooks**

Two prominent features that parents discussed as important to consider when choosing a storybook that might help their children practice math skills were the illustrations and text. In
general, about half of the interviewees commented that the illustrations were more important than the text in driving their decisions about which storybook to read and the other half considered the words and illustrations equally important.

Yeah, because she can’t read the words yet…. I think there’s oftentimes more going on in the pictures than is represented in the text.

Color was named as a particularly salient aspect of the illustrations. The parents preferred books with “colorful pictures that we both find interesting” and “beautiful artwork.” While colorful illustrations are appealing to parents, they also mentioned that too many colors or overly complex illustrations might distract their child and “draw the child’s attention more to the different colors than to the number of items.” There was also overwhelming agreement that they attended to what was happening in the illustrations more than what was worded in the text when they discussed the storybook with their children.

Maybe, there are some books that have three-word sentences, you know, like then we can focus on that, just to go through letters and stuff. But for the purposes of everything else, like colors and shapes and numbers, pictures are more what we focus on, I think.

Most of the parents reported that they skimmed through a book before reading it to their child. In the process of skimming, they evaluated the “pictures first, then look to see if there is a decent story and good grammar.” When asked to expand on what they were looking for in the pictures, they gave general responses, indicating that they were looking to see if the “pictures are clear” and “how they’re all laid out.” They expressed a preference for large objects in the illustrations that are easy to count and found that the pictures in Monster Birthday Surprise were “mostly good sized, with the exception of the birthday candles, which were a little small for his fingers to follow along with.”

In addition to the size of the objects, they wanted the illustrations to represent realistic objects that resembled their counterparts in the real world. For example, they disliked the fact
that the *Monster Birthday Surprise* included Snozzleberries, which are imaginary objects that do not resemble actual berries. Their children “may not understand [it] is a pretend item. He is three and still learning the names of objects and may be confused with the mixture of real items like cupcakes and pretend ones.” The objects should be “immediately recognizable” and look as realistic as possible to avoid confusion.

The parents also described avoiding books that were overly wordy, preferring those with “relatively short sentences per page” to maintain their children’s focus and engagement. Attention was a driving factor in their decisions about the amount of text and nature of the illustrations in the storybooks they read with their children. If the “narrative is too long on each page, he gets antsy, wanting to turn the page,” so parents searched for and read books “that are short, to the point, not a lot of words. But things that are eye catching for him. Something that I know will keep his attention.” Likewise, it was evident that parents “look for simple illustrations that hold the eye.”

Another aspect of the text that the parents reflected on was the nature of the narrative in the story. Two divergent ideas emerged as they discussed the importance of reading math storybooks with a strong narrative versus more basic counting books that present little more than numbers and countable objects on the page. The age of the child emerged as an important factor that distinguished these two groups. In general, parents of 3-year-old children preferred to read more basic counting books because they believed their children did not have an adequate attention span to follow a plot from the beginning to the end of a story. However, there was evidence of a transition away from basic counting books as the children aged. The presence of a well-developed narrative appeared to become more important as the children were able to focus
for longer, understand more of the story, and therefore participate in lengthier discussions about the plot.

He just turned four, so if we can do it with a story, he tends to pay a lot more attention because he wants to know what’s going to happen next. If it’s just numbers, he’s like no, he gets bored. I’m looking more for a story.

Other interviewees mentioned that the repetitive nature of basic counting books made them uninteresting to their 4-year-old, while a narrative elicited their interest.

I think she probably has a limited capacity for repetitive counting; there’s only so much. She lost attention after a while; maybe a more intriguing plot [would help].

Overall, parents advanced to reading books with lengthier and more developed narratives as the children grew older. One parent of a 3-year-old who reported reading stories with narratives noted that it was difficult to finish an entire text in one sitting, “so what I do is I try to get the gist of the story and kind of say it in a way that he’s still engaged and then do what I have to do and then move on. Sometimes stories may be abbreviated or modified.”

The final storybook feature that arose repeatedly in the interviews was the presence of explicit questions in the text of the story. In certain parts of Monster Birthday Surprise, the reader was explicitly prompted to engage in a math task, such as when Ziggy said, “I wonder if there’s more chocolate cupcakes or strawberry cupcakes?” Some parents wanted the storybook to pose more explicit questions of this sort to prompt the parent and child to do more math tasks throughout the story.

If the parent doesn’t take the initiative to stop and count the items with the child, they [the child] probably aren’t going to do it either. That’s why I think asking questions in the story would make it so the child sort of has to stop to answer and count.

One parent who asked a few questions while reading explained the benefit of embedding questions throughout the text:
I think my child responds best to questions, like at the end when the story asks for his help finding groups of six. This forces him to think about the pictures and actually count them. The earlier pages we didn’t count because I honestly didn’t think about it. The later pages we counted together. If the earlier pictures had asked questions related to how many items were at the store, I think he would have wanted to stop and count them all.

Another parent who did not ask her child any questions while reading remarked, “I do feel that [the book] needs to prompt the children to count. I just read the story and it didn’t have me count anything. Maybe have the monster count in the story or have her ask a question.” Therefore, it may be beneficial for storybooks to include explicit questions in the text of the story to encourage parents to ask questions as they read. These embedded questions may also provide them with guidance about effective types of questions to ask.

**Theme 3: The Reading Process**

The third theme that emerged from the interviews was a description of specific ways that parents used math storybooks as a tool to develop their children’s math thinking. They described the process of reading with their children and how they shaped conversations around the storybook content. A recurring notion was avoiding rote learning “so he actually learns things rather than just memorizing the particular book.” In particular, the interviewees found that storybooks with too much repetitive counting made learning dull and uninspiring, which contrasted with their goal of making counting a fun activity. As one parent described, “A good counting book presents counting in a way that doesn’t feel like counting,” and asking too many repetitive counting questions can “make [the child] feel like she’s taking a test.”

The parents expressed a desire to involve their children as active participants during storybook reading. One way in which they accomplished this was through asking questions, which they connected back to the notion of maintaining the child’s attention. They noted that questioning was a useful tool when “just trying to keep his attention,” although they varied the
number of questions they posed to older and younger children. In particular, those who reported having several children conveyed that they engaged each one differently during storybook reading based on the child’s age. Some parents posed more questions to their younger children in order to keep them focused on the page, and they asked older siblings fewer questions because the older child “is listening more, and as long as the book has the message we’re trying to get through, he’s absorbing most of what there is already and we don’t need to add as much.” Yet others reported the opposite, suggesting that a younger child would not have the focus to answer many questions.

The parents expanded on their reasoning in terms of asking particular types of questions or addressing certain content while reading. They overwhelmingly indicated that their questions were not planned in advance, but posed in the moment in reaction to what was happening on the page. However, they commonly stated that they asked questions to reinforce or build upon skills that their children were currently learning in preschool or at home, demonstrating that parents were attentive to their children’s present level of knowledge when engaging them in storybook reading. Some parents whose children attended preschool explained how they kept track of what their child was learning at school and “if the school is doing something, we try to continue what they’re doing in school. This way it’s building on what they’re teaching her as a sense of reinforcement.”

While the parents asserted a desire to strengthen their children’s math knowledge through questioning, they expressed differing opinions about the appropriate level of questions to ask. Some of them asked questions at the child’s current level of knowledge so that the child could practice preexisting skills. One parent conveyed that she asked questions that her child was likely to answer correctly “just because I want to know that she’s going to know it, or maybe find some
encouragement in herself.” In this way, some parents were using the storybook as a tool to solidify the child’s knowledge and boost their confidence in math. Yet others asked questions above the children’s current level of knowledge because “she’s a fast learner so she could definitely handle some things that are little bit more challenging.”

Well, we always, at least for me, I feel that we know the level that she’s at and we always just try to put her up to the next level just to continue building.

One parent believed his child was “not going to learn anything if you only ask her questions that she’s good at.” Yet other parents asked challenging questions to keep the children’s attention focused on the book, “because [if] it’s so easy, she gets bored quickly.” These patterns of responses suggested that parents held disparate ideas about the importance of asking challenging questions that might grow their children’s knowledge and maintain their attention versus less challenging questions that might reinforce the children’s current knowledge and increase their confidence.

**Theme 4: Early Number Concepts**

As they evaluated *Monster Birthday Surprise* and discussed math storybook reading more generally, the parents commented on specific number concepts that they noticed and discussed with their children while reading together. Ideas expressed in this theme were closely tied to previous themes because the parents’ notions about the appropriateness of certain number concepts appeared to influence how they selected and read storybooks at home. Nearly every parent mentioned the importance of learning to count at an early age; therefore, they liked the fact that *Monster Birthday Surprise* provided many opportunities to count different objects in the illustrations. Throughout the interview, they named counting skills that they deemed important and practiced with their children as they read, such as “grouping items,” “hearing repeated spoken numbers,” “seeing the numbers written out,” and connecting quantities with written
numerals by “not just reading a number via the text but also being able to see that number of pictured items.” One aspect of the text that the interviewees repeatedly focused on was the presence of number symbols (e.g., “7”), which they considered important in their child’s development of number concepts. They disliked the fact that Monster Birthday Surprise often did not include the written symbols alongside the countable objects in the illustrations. The parents wanted the symbol to accompany objects that were intended to be counted in the illustration because “The trick is being able to connect all of those. Like the written one and the symbol and the amount. Putting all of that together is really important.” Other parents found the written numbers useful because they expected their children to learn how to recognize the number symbol before learning how to read the written number word; therefore, including the number symbol would give the children independence to “read” and count on their own.

Although all 47 parents agreed that storybooks could help their children practice counting, some expressed concern with engaging their child in math that might be too difficult “for her stage at the moment.” For example, some of them chose books that presented smaller sets of objects to enable their children to practice counting small groups of objects before moving onto larger numbers. When choosing a storybook, the parents “try to make sure it includes things my child can do and that isn’t too advanced.” The child’s age, attention span, and current math knowledge were connected to parents’ beliefs about which math concepts were appropriate to include or address in a math storybook. A child who “doesn’t have enough of an attention span yet” may not be able to engage with the more complex math concepts in a number book. One parent gave an example from Monster Birthday Surprise:

For example, the Monster needs six balloons, but takes seven and then returns one. For a child who is just learning the concept of counting and the significance of the object-number relationship, adding another layer to the basic 1, 2, 3 structures can be confusing and overwhelming.
Another parent described how her child’s age influenced her ideas about the math presented in the story:

The only thing that I noticed that was a little bit advanced for him is when you ask him to point out the groups of six. That’s something that you would want in a little bit older child or more advanced child. I would definitely want that in another year or two. I do want him to have those skills but he can’t do that right now.

However, some parents suggested that books with more complex number concepts were not necessarily detrimental because “maybe children can grow with the book” and tackle those concepts as they age.

**Summary of Findings**

In the interviews, the parents discussed how they decided which math storybooks to read to their child and described the reading process, namely what questions they asked and the content they discussed while reading. They also expressed their opinions about the presentation of math concepts in the text and illustrations. Three factors emerged repeatedly as pertinent to these decisions and opinions: the child’s age, attention span, and math knowledge. A child’s young age or perceived poor attention span might influence parents to choose more basic counting books with few words and simple illustrations that will not detract from the counting. As the child’s age and perceived attention span increase, parents shift towards reading longer stories with stronger narratives. Regardless of whether parents were reading a more basic or narrative counting book, they agreed that the book needed to relate to the child’s interests in order to maintain their focus. They also preferred books that related to the child’s everyday life, with math topics that can be reinforced during other activities after reading.

Overall, parents indicated that it was important to involve their children as active participants as they read together. Questioning was frequently mentioned as a means of engaging
the child. The parents’ responses indicated that they asked questions as they read, for a variety of reasons. At times, they posed questions to keep their children focused on the storybook. Some parents asked questions that the children were likely to answer correctly to reinforce skills the children had already demonstrated, while other parents asked more challenging questions that might advance the child’s knowledge. In addition, many parents named specific number skills that their children either demonstrated or were struggling to acquire. The parents tended to justify the types of math storybooks they chose and what they discussed with their children while they read, based on their beliefs about their children’s math knowledge. This suggested that parents were attentive to their child’s math abilities, which influenced their storybook reading practices and perhaps other home activities as well.

The parents named various counting skills they noticed in *Monster Birthday Surprise* and looked for in other math storybooks. Frequent responses related to the importance of learning how to identify the written number symbol, count small and large sets of objects, and connect the number symbol to the set of objects. However, few parents noticed other math concepts presented throughout the story, such as the opportunity to decide whether there were more strawberries or chocolate cupcakes (magnitude comparison) or figure out how many balloons were left after Ziggy let one fly away (subtraction). The parents seemed to be aware that developing a mastery of counting was a vital early math skill, but they might not have considered that they could encourage their children to apply their counting skills to solve more complex problems. Since they did not mention opportunities to address these additional number skills, they may be missing opportunities in everyday activities as well.

Finally, parents mentioned giving their children agency in choosing a storybook to read. This suggested that workshops or instructional material geared towards parents about how to
select appropriate math storybooks may not be beneficial because parents may not be the ones who are selecting the books. Parents indicated that children choose books based on their covers and depictions of familiar characters, but these books may not present interesting, relevant, or developmentally appropriate math concepts.
The present study expanded on the extant shared math storybook literature to examine how parental beliefs and home practices are related to number-related interactions between parents and their children. This observational study was conducted using 47 pairs of parents and their 3- to 5-year-old children. Parents varied across income levels and educational levels, although this factor was not found to be related to their math reading behaviors. The parent-child dyads read a storybook that contained explicit references to number concepts, such as counting and comparing the magnitude of sets. Subsequently, parents filled out the Early Math Questionnaire (EMQ), which measured the frequency of home math activities and parents’ math beliefs. Children were given the Test of Early Mathematics Ability, 3rd Edition (TEMA-3) (Ginsburg & Baroody, 2003) to measure their early math ability. Finally, parents were interviewed about how they selected and read math storybooks with their children at home. The data were analyzed to determine which child, parent, or household factors were related to differences in the math mistakes children made, how parents responded to those mistakes, the degree to which parents discussed math concepts in the story, and the extent to which parents and children completed number tasks appearing in the story. In the study, basic math concepts were analyzed separately from complex math concepts because research has demonstrated that children’s involvement in more complex math predicts higher math achievement (Elliott et al., 2017; Gunderson & Levine, 2011; Skwarchuk, 2009). Moreover, studies found that engaging children in more basic math activities either had no impact on their math skills (Ramani et al.,
2015) or was associated with lower numeracy knowledge (Skwarchuk, 2009). All number activities may not be equally beneficial for children, and it is important to examine differences in parent support and exposure to math activities of varying complexities.

The present findings contributed to the growing number of studies that examined how home activities such as storybook reading can guide and develop children’s mathematical thinking. Three primary findings emerged from this study. First, parental beliefs about the importance of early math learning played an important role in parent-child math interactions. Second, engaging children in more counting activities at home was associated with completing more math tasks in the storybook. Finally, none of the child, parent, or household characteristics was related to children’s complex mistakes or the amount of complex math that parents discussed with children.

In the following sections, these findings are discussed in greater depth and interpreted to elucidate parent/child math reading behaviors and their relations with child, parent, or household factors. Next, the implications of these findings are discussed and compared with prior research. Finally, this chapter concludes with an overview of the study’s limitations and directions for future research in the study of parent-child interactions during shared math storybook reading.

**Parents’ Responses to Children’s Math Mistakes**

As expected, children made fewer mistakes when solving number tasks as their math abilities and ages increased. It was also unsurprising to discover that complex math problems elicited more mistakes than did simple math problems. Parents’ supportive responses to those simple and complex mistakes were a primary interest in this study, one goal of which was to explore variation in the ways that parents intervened when a child made a number mistake and
examine associated factors like child ability or parent characteristics like beliefs about the importance of math learning.

Prior studies of storybook reading have not addressed how parents respond to children’s math mistakes while reading a book. However, the pattern of responses to children’s mistakes in the present study can be compared with the findings of Bjorklund and colleagues (2004), Ramani and colleagues (2012), and Vandermaas-Peeler and Pittard (2014), who used a similar system to code parent behaviors while playing board games and answering math worksheets with their children. Two categories of parental reading responses were notably different from those prior studies—providing the answer and modeling. In the present study, the most frequent response to a child’s number mistake was providing the answer, which comprised approximately 31% of all parents’ responses. This contrasted vastly with Bjorklund et al. (2004), who found that parents provided the answer in response to a child’s error only 6% of the time when playing a board game and 1% of the time when solving math problems. Neither of the other two studies explicitly coded when a parent provided the answer. There was also a noticeable difference in the frequency of responses in which the parent modeled the correct answer. In the present study, only 16% of parental responses were categorized as instances of modeling. However, Ramani et al. (2012) classified 65% of responses as modeling and Vandermaas-Peeler and Pittard (2014) classified 41% of responses as modeling. In both studies, parents were playing a number board game with their children. Bjorklund et al. (2004) combined instances of instruction and modeling and labeled them cognitive directives, which comprised 13% of parental responses when playing a board game and 53% of parental responses when solving math problems. Frequencies of providing disaffirmations (“No, that’s wrong”), verbal prompts (“Why don’t you try counting
that again?”), and instruction (“Make sure you touch each balloon only once as you count them”) were similar across studies.

Overall, these patterns of responses revealed that parents provide some types of supportive responses regardless of the context in which the child made a number mistake. However, the number of times parents provided the answer or modeled how to solve a problem correctly may vary across contexts. In this study, math storybook reading elicited high frequencies of providing the answer and low frequencies of modeling. Parents may be more likely to model when they are engaging their children in activities that involve materials they can physically manipulate, such as the counters when playing a board game. Since storybooks are not accompanied by physical materials that can be manipulated, parents may not be prompted to demonstrate how to count or compare quantities correctly.

The results were not only expected to reveal variation in how parents guided children’s math development, but it was also predicted that parents would vary the amount of support they provided based on the child’s ability level. The results supported this hypothesis and indicated that parents provided more support for low-ability children and less support for high-ability children, demonstrating that parents were sensitive to their children’s math knowledge when reacting to their mistakes. This finding can be situated within Vygostky’s (1978) sociocultural view of learning. Parents were attempting to provide support within children’s zone of proximal development by taking into account what the child cannot do independently, based on perceived math skills, and by adjusting their guidance accordingly. Furthermore, it was predicted that parents would vary the amount of support they provided based on the child’s age, but this finding was not supported. One possible explanation is the unequal distribution of ages in the sample,
with nearly twice as many 3-year-olds than 4-year-olds. This may have made it difficult to detect differences in parental responses to children’s mistakes across ages.

However, another possible explanation for the nonsignificant influence of children’s ages and the high frequency of providing the answer was the nature of the activity. Parents may not have viewed storybook reading as a suitable context for explicitly correcting children’s errors. The parent interviews revealed that parents wanted their children to develop an appreciation of reading. They also expressed the desire to make early math learning fun and engaging. Therefore, providing higher levels of intervention that model how to solve a problem correctly may seem too didactic and take away from the enjoyment of reading. In the context of storybook reading, it may be more appropriate for parents to provide the correct answer when the child errs in order to continue the story. In the interviews, parents frequently mentioned their children’s attention levels and suggested that their children, especially the 3-year-olds, struggled to follow a plot from the beginning to the end of the story. Therefore, parents may not want to interrupt the plot for an extended period of time. Quickly correcting the child by providing the correct answer allowed the parent to continue the story and move the plot along. In their studies on parents’ support of children’s mistakes, Bjorklund and colleagues (2004), Ramani and colleagues (2012), and Vandermaas-Peeler and Pittard (2014) studied parent-child interactions while playing board games and solving math problems. These activities may be more effective contexts for parents to pause and provide more time-intensive forms of intervention than during storybook reading.

In addition to varying the amount of support they provided based on the child’s ability level, parents were also influenced by their own beliefs about the importance of early math learning. Parents who agreed more strongly with statements such as *Even very young children can learn about mathematics, It is as important to develop early math skills as it is to develop...*
early reading skills, and I can influence my child’s math skills were more likely to provide higher levels of support, like modeling, than parents who agreed less strongly with such statements. These results were particularly pertinent because they were consistent with prior research demonstrating the unique contribution of parents’ attitudes to the HNE. For example, children whose parents reported more positive math attitudes were exposed to a greater frequency of home numeracy activities (LeFevre et al., 2010) and scored higher on measures of numeracy knowledge (Skwarchuk et al., 2014). This study extended those findings by demonstrating that parent beliefs and attitudes may not only influence numeracy practices and children’s math outcomes, but they may also relate to parents’ behaviors as they interact with their children in the home environment.

Math Concepts Addressed During Shared Storybook Reading

Providing children with opportunities to engage in math conversations and practice numeracy skills contributes to their math achievement (Gunderson & Levine, 2011; Levine et al., 2010; Ramani et al., 2015). Therefore, the present study measured how much of the math content parents addressed with their children during reading and whether the parent or child completed more of the number tasks in Monster Birthday Surprise. The storybook was considered to be a math tool parents can use in the home, analogous to a board game or deck of playing cards. Each of these types of activities is likely to promote different interactions between parents and their children. The current analyses were meant to uncover the extent to which parents and children utilized the affordances of the storybook by discussing and solving the number tasks presented throughout the text and illustrations. Results indicated that parents discussed an average of 35% of the simple number concepts and 51% of the complex number concepts in the story, although this varied greatly among dyads. While some parents mentioned very little of the math in the
storybook and made few extra-textual comments beyond what was printed in the text, other parents discussed nearly all of the math in the story. Clearly, children may be exposed to different amounts of math overall in reading, as well as in the home environment generally, which could lead to differences in math learning and school readiness.

Although math talk in general may be beneficial for young children (Levine et al., 2010), math conversations and activities involving more advanced math, such as counting large sets of objects and simple arithmetic, may be especially conducive to developing strong foundational math skills (Elliott et al., 2017; Gunderson & Levine, 2011). Therefore, it was encouraging to find that the parents in the present study discussed more of the complex math concepts in Monster Birthday Surprise than the simple math concepts, although this finding differs from previous studies. Naturalistic observations of parents and young children doing daily activities at home have found that parents rarely involved their children in complex math tasks, such as subtracting or comparing quantities (Ramani et al., 2015; Susperreguy & Davis-Dean, 2016). It is possible that storybooks can encourage parents to discuss more complex math than can other types of home activities, particularly if the storybooks present rich math content, as in the case of Monster Birthday Surprise.

Factors associated with the amount of simple and complex math that parents discussed were examined. Parents addressed fewer simple math concepts as children’s TEMA-3 scores increased, indicating that parents were sensitive to their children’s math abilities and varied the simple math content they discussed with them accordingly. In addition, parents who held stronger beliefs about the importance of early math and their role in helping their child to learn it addressed more of the simple math concepts in the story. However, the same pattern was not found with complex math. Parents did not vary the number of complex math concepts addressed
in the story in relation to either the child’s age or math ability, or any of the remaining parent or household characteristics. This suggested that parents may be more comfortable discussing simple math ideas, such as reading written numerals and counting small sets of five or fewer items. Therefore, they might be better able to adjust their behaviors when interacting around simple math concepts based on the child’s ability level. In addition, the lack of findings regarding both children’s complex math mistakes and the amount of complex math parents discussed with their children suggests that less is understood about how parents engage their children in complex math at home.

Within this sample, children solved an average of 52% of the number tasks in *Monster Birthday Surprise*, compared to the 42% that parents solved. Previous studies have found a different pattern in the number of math tasks that parents and children completed. For example, Susperreguy (2013) found that mothers made more math-related utterances than their preschool-aged children in 57% of their exchanges recorded during daily interactions. Furthermore, using a sample of Head Start families, Ramani et al. (2015) recorded caregivers and children during play activities. Caregivers made nearly twice as many math utterances as their children. Given that previous studies have found that parents dominated parent-child math interactions, it is notable that the present study yielded the opposite finding. This finding reinforced previous studies that identified shared storybook reading as an activity conducive to engaging children in math thinking and math conversations (Anderson et al., 2005; Hojnoski et al., 2014; van den Heuvel-Panhuizen et al., 2009).

One household practice that influenced the number of math tasks that children solved was the frequency of involvement in counting activities. Children of parents who reported higher frequencies of counting objects and reading numbers solved a greater number of math tasks in
the storybook than their parents. Several researchers have examined correlations between the occurrence of home numeracy activities and children’s math performance to understand how numeracy exposure is related to academic achievement. However, their studies yielded inconsistent and sometimes contradictory results, with some findings suggesting no association between home numeracy practices and children’s math abilities (DeFlorio & Beliakoff, 2015; Missall et al., 2015), whereas others have found a significant relationship (Kleemans et al., 2012; Niklas & Schneider, 2014, Vandermaas-Peeler & Pittard, 2014). In the present study, the frequency of number and operations activities was positively related to children’s math performance on the TEMA-3, but the frequency of counting activities did not have this same relation. Furthermore, parental reports of exposure to counting activities at home had a positive impact on the number of number tasks in the storybook that children solved. However, the frequency of counting activities was not associated with any other parent or child behaviors. This suggested that there may be a weak direct relation between the frequency of home activities and the HNE. Investigating the time spent engaging in math activities may not yield sufficient information without also considering other characteristics of the home environment, such as parental beliefs and attitudes and factors related to the child, such as age, academic ability, attention span, and interest in the activity. We would expect that children who are accustomed to counting during various other home activities will continue counting in a storybook context. Although this finding was not necessarily surprising, it was important because it demonstrated that at least some children’s behaviors are consistent across different home number activities.

Parents’ Selection and Use of Math Storybooks

Based on the parent interviews, three main factors that appeared to drive parents’ selection of math storybooks were children’s interest, attention spans, and math abilities. Parents
explained that they often considered their children’s interest when choosing a storybook to read because interesting topics or characters will sustain children’s attention. Neither children’s interest in the storybook nor their attention levels were measured in the study, although it is possible that either factor may have influenced the results. Perhaps children who were more interested in the theme of monsters and birthday parties were more engaged and attentive when reading *Monster Birthday Surprise*, thereby prompting their parents to provide more support or discuss more of the math concepts in the storybook than parents of disinterested and inattentive children. The role of children’s interests and attention should be explored in future studies of math storybook reading.

Parents also conveyed that they considered math to be an important subject for their children to learn, which refuted other researchers’ beliefs that parents do not regard early math learning as a valuable endeavor (Coates & Thompson, 1999; Weisbaum, 1990). All 47 parents reported reading storybooks to help their children learn about numbers, although some parents said they did not read books that were explicitly mathematical but rather found opportunities in non-math storybooks to explore counting. Parents acknowledged the desire for their children to become proficient at numbers, particularly the ability to count and read written numerals. Parents were able to name specific examples from *Monster Birthday Surprise* that they considered beneficial in helping their children practice their counting skills, such as the depiction of groups of objects alongside corresponding numerals on page 2. However, few parents mentioned the importance of learning more complex math concepts, such as comparing sets of objects to determine which had more or less. This was surprising because parents discussed more of the complex math in the storybook, so it is possible that something in the storybook primed parents to ask their children about the complex math. Indeed, the storybook was designed to introduce
Interesting math problems and concepts. Other studies have found that parents infrequently discussed complex number concepts during home activities (Ramani et al., 2015; Susperreguy & Davis-Dean, 2016), which supported findings from the parent interviews.

Parents mentioned that they often gave their children autonomy over choosing which math storybook to borrow from the library or purchase from the bookstore. When parents did report that they selected a storybook to read, they mentioned a number of factors they considered important in their selection. They preferred books with few words per page and simple illustrations that were not distracting or confusing. In particular, parents expressed a preference for illustrations that depicted realistic objects that had real-world counterparts. Parents of younger children tended to choose more basic counting books without narratives because they worried that their children would struggle to follow the plot from beginning to end. Parents of older children, on the other hand, chose books with narratives because of their children’s growing attention span and increasing ability to understand and follow the plot. Parents’ considerations when selecting storybooks reflected the previous findings that parents were sensitive to their children’s ages and abilities when choosing materials to use in the home learning environment.

In general, parents appeared to consider many factors when choosing and reading storybooks with their children. They reported that their children’s ages, math abilities, and attention spans impacted their reading behaviors, including the kinds of questions they posed and how much of the math content they paused to discuss. However, results from observing the parents and children read Monster Birthday Surprise did not fully support these claims. Child-level factors were generally found to be non-significant indicators of the parental support for children’s mistakes and the amount of math in the story parents addressed. It is possible that
parents were adjusting their behaviors in response to their children’s ages in the study, but it may have been difficult to detect due to the uneven distribution of ages in the sample. Furthermore, parents may have modified their behaviors based on their perceptions of their children’s abilities rather than their children’s true abilities, as measured on the TEMA-3. Research has suggested that parents tend to overestimate their children’s counting abilities and knowledge of the cardinal principle (Fluck, Linnell, & Holgate, 2005). Moreover, Zippert and Ramani (2016) found that parents were more likely to make inaccurate estimations of children’s advanced math skills, such as arithmetic and symbolic magnitude comparison. Their findings also indicated a significant relation between the frequency of complex home math activities and parents’ overestimation of children’s advanced math abilities. Therefore, parents’ beliefs about their children’s math skills may have a greater influence on how parents choose materials and interact with their children using those materials in the HNE than children’s true abilities. Future studies can explore this further by obtaining a measure of parents’ perceptions of their children’s numeracy skills.

**Limitations of the Study and Future Directions**

There were several limitations of the study. One limitation was that parent-child dyads were only observed reading one math storybook, which may limit the generalizability of the findings regarding reading. In addition, some parents expressed the concern that children’s weak attentional skills may negatively impact their ability to follow the plot, which might have influenced how parents read with their children. Future studies can include a range of storybooks from basic counting books without a narrative to those with more intricate narratives to see how parents address the numeracy content based on the type of math book. Furthermore, it is possible that the outcomes will be influenced by characteristics of the storybooks, such as the amount of text or how the math concepts were presented in the illustrations. Future studies can vary features
of the text and illustrations to evaluate the relation between parents’ reading behaviors and storybook features.

A further limitation was the condition under which the parent-child interactions were observed. Parents were aware that the study involved an analysis of math interactions, which may have prompted parents to emphasize more math content in the storybook and elicited different behaviors than would have been observed in a typical reading interaction. Even the presence of the researcher with a video or audio recording device may have influenced parent and child behaviors while reading the storybook. The use of an audio recording device such as the Language ENvironment Analysis System (LENA) tool can allow for more naturalistic data gathering. The LENA captures conversations in a non-invasive manner without the need for a researcher to be physically present in the home environment. Although the LENA or a similar tool was not used, capturing parent-child interactions in the home environment instead of a laboratory setting was one advantage of this study. This took into account the sociocultural context of storybook reading and helped situate any findings about children’s mistakes, parents’ responses, and their joint interactions around the storybook in what was a more or less natural situation for them.

Furthermore, future studies can also include a more diverse distribution of children’s ages and ethnicities. There were nearly twice as many 3-year-olds as 4-year-old in this study, and this uneven distribution may have made it difficult to detect how the child’s age influenced parent-child interactions. In addition, despite attempts to recruit ethnically diverse participants, the sample was overwhelmingly Caucasian. Families of varying ethnicities may have unique cultural practices and beliefs associated with their reading behaviors. More observational studies of families from diverse cultures are necessary to understand how math learning is supported in
different ways across cultures. Additional parent characteristics that can be measured and included in future studies include parents’ math abilities and enjoyment of math, which have been associated with aspects of the HNE in previous studies (e.g., Skwarchuk, 2009).

Future studies can also study the effects of parents’ gender, which was not feasible in the current study due to the small number of fathers. Prior studies have found that mothers and fathers interacted with their preschool-aged children in different ways. For example, Rowe, Coker, and Pan (2004) found that fathers posed more complex questions to their children than mothers, so it is conceivable that fathers may also ask children about more complex math in the storybook than mothers. On the contrary, Davidson and Snow (1996) discovered that mothers’ talk was more cognitively complex than fathers, and mothers were more likely to invite children to participate in the conversation. Including parents’ gender in future studies of shared math storybook reading may help clarify these conflicting findings and illustrate which conditions and factors influence how mothers and fathers behave differently.

This study provided an interesting account of how storybooks can be used to elicit child engagement in math and how parents supported children’s developing number knowledge by responding to their mistakes. Although the current study measured variation in parental support, it did not address which type of parental supports were most effective in advancing children’s number knowledge. Longitudinal studies could help clarify whether certain types of support are advantageous by capturing how parents respond to children’s math mistakes at various time points and measuring children’s later math abilities. Alternatively, experimental studies in which parents are trained to provide certain types of supports during storybook reading can help uncover which supportive responses might predict math outcomes. The impact of parental guidance for children’s numeracy skills has been examined in the context of board game play
(Ramani et al., 2012; Vandermaas-Peeler, Ferretti, & Loving, 2012) and cooking (Vandermaas-Peeler, Boomgarden et al., 2012). Therefore, it may also be beneficial to study parent-child dyads engaging in other math activities in addition to storybook reading to evaluate how parents’ supportive behaviors vary across contexts. For example, not only did Bjorklund et al. (2004) find that parents employed different types of supportive behaviors when playing a board game as opposed to solving math problems with their children, but the math problem task elicited higher levels of support.

Finally, in the current study, only the highest level of support in response to each mistake was recorded and averaged across each parent-child dyad, partially due to the small sample size and therefore the small number of observations. This method of measuring parents’ responses to children’s number mistakes may not have captured the full variation of ways that parents provided support. Collecting observations from a larger sample of dyads engaging in more than one math activity in the future would allow for more precise ways of capturing the types and degrees of parental support of children’s math learning. In addition, the present study is underpowered due to the small sample size. Collecting data from a larger sample would help future studies to detect differences between groups.

Despite these limitations, this study contributes to the literature of the HNE and, more specifically, studies of shared math storybook reading. The current findings are correlational, but one important finding emerging from this study is that parental beliefs are related to parent and child behaviors during storybook reading and therefore may influence other math interactions in the home environment. This important finding may help contribute to an understanding of how parents interact with their children during shared storybook reading and explain differences in parenting behaviors.
General Implications

Results of the present study have implications for researchers and practitioners who provide workshops and create instructional materials for families and caregivers. Responses from the parent interviews supplemented the quantitative findings and further contributed to the storybook reading literature, which has thus far not included a study addressing how parents select and use storybooks at home. By knowing the various ways that parents are already using storybooks, workshops and materials can use a strength-based approach and build on what parents are already doing to support their children’s number knowledge while suggesting additional supportive strategies parents may not have considered. Parents can be provided with case examples to illustrate the kinds of math mistakes children are likely to make while reading number storybooks, along with possible ways of responding to those mistakes. Parents can also be given a list of suggested storybooks along with math games and activities covering the same math content from the storybook to supplement the reading. As noted by Ginsburg, Duch, Ertle, and Noble (2012), preschool-aged children are capable of learning math and parents can use a variety of activities to bolster their children’s math knowledge at home. While storybooks can be used to immerse children in math language and math talk (Anderson et al., 2005; Hassinger-Das, Jordan, & Dyson, 2015; Hojnoski et al., 2014) and increase their motivation and interest in math (Jennings et al., 1992; Hong, 1999), games and activities may be more suitable contexts for providing more intensive intervention in response to a child’s math mistake. Therefore, the combination of reading storybooks and doing follow-up activities can benefit children in unique but complementary ways.

It is noteworthy that parents give their young children more agency in choosing storybooks than expected. Children cannot preview a book to make sure it has beneficial aspects,
such as accurate and developmentally-appropriate depictions of math in the text and illustrations. This has implications for workshops and instructional materials geared towards helping parents select and read storybooks with their children. If parents are not the primary party responsible for choosing storybooks, they may need instruction in how to address potentially inaccurate and non-developmentally appropriate content in the storybooks their young children choose to read.

Furthermore, this study demonstrated that parents’ beliefs about the importance of early math learning play a significant role in how they engage their children in math during storybook reading. Efforts can be made to help parents realize that developing early math competencies is important for their young children and that math storybooks can be a source of math input. Workshops or materials intended for parents can demonstrate ways that children learn math through stories and show videos of children having enjoyable math conversations with their parents while reading, demonstrating that storybooks can be a fun and engaging way to expose children to mathematical ideas.

Summary and Conclusions

The present study highlighted the variety of ways that parents interact with their children while reading a math storybook in the home environment. It demonstrated that storybook reading is an effective context for parents to engage their children in both simple and complex number tasks. Parents in the study, on average, discussed 43% of the math content presented in the text and illustrations with their children, supporting previous findings that number books can be an effective tool to elicit parent-child math conversations and provide children with the opportunity to practice their number skills. Parents also responded to their children’s number mistakes in various ways, although storybook reading may not be the most beneficial context for parents to provide intensive levels of intervention. Overall, parental beliefs about the importance of early
math learning and their role in helping their children learn math played a significant role in shaping their behaviors while reading. This characteristic of the parent had a greater influence of parent-child reading interactions than any of the remaining child or household factors, demonstrating the importance of examining and targeting parental beliefs in future work on the HNE. By gaining a better understanding of how parent attitudes and beliefs impact the way they engage their children in math practices at home, researchers and educators will be able to create targeted and effective interventions that equip parents to support their children’s early math learning. Thus, the present study adds valuable information about the nature of parent-child interactions during shared math storybook reading and reaffirms previous findings that children can benefit from joint engagement with a math storybook.
REFERENCES


Appendix A

*Monster Birthday Surprise* Storybook Pages

Page 1

Ziggy woke up and looked at the calendar. Today was a special day. It was her sister Nona’s sixth birthday!

Page 2

Ziggy needed to buy some things for Nona’s birthday party. She looked at her list. First on the list was balloons.

Page 3

“There are so many balloons to choose from!” Ziggy thought.

Page 4

Ziggy took some balloons and counted to make sure she had the right amount.

Page 5

“Whoops!” Ziggy said, “I took too many!” She let one balloon fly back.

Page 6

Next on the list was snacks. Ziggy checked her list to see how many boxes of Monster Mix she would need. Then she found the Monster Mix in the store.
Ziggy started filling her cart with Monster Mix. "One, two, three. That's three boxes of Monster Mix," Ziggy counted.

Next up was Snuzzleberries. Ziggy put each Snuzzleberry in her cart slowly, one at a time, as she counted them.

Time to buy cupcakes! Ziggy checked her list so she could tell the baker how many cupcakes she needed.

Ziggy checked to make sure the baker gave her the right number of cupcakes.

“Hmm,” she said. "I wonder if there’s more chocolate cupcakes or strawberry cupcakes?"

Ziggy realized she forgot to put party hats on the list! She went to the party store and was surprised at how many hats she saw.
"If there will be four monsters at the party, how many party hats will I need?" Ziggy wondered.

Ziggy put four of the party hats into her cart. "Now I have everything I need for Nona’s birthday party!" Ziggy said.

SURPRISE! Happy birthday Nona!

Can you help Nona find groups of six things?
Appendix B

Parent Interview Questions

1. Do you think this story can help your child practice their number skills? Why or why not?
2. What aspects of the story might help your child practice their number skills?
3. What aspects of the story might not help your child practice their number skills?
4. Did you notice anything about the way the math is presented in the text or illustrations that your child might find difficult?
5. Do you read math storybooks (e.g., number or shape books) to your child?
6. When you're at the library, bookstore, or choosing a book from your home library, how do you choose what number storybook to read with your child?
7. When choosing a number or shape storybook to read with your child, do you preview the book yourself before reading with your child?
8. (If the parent answers in the affirmative) When skimming through the book beforehand, which parts of the book do you pay more attention to when deciding whether the book could help your child learn about numbers?
9. When reading a number storybook with your child, which parts of the book do you think can help your child learn about numbers?
10. As you’re reading a number book with your child, can you tell me about how you decide what parts of the story to point out to your child and how you decide what questions to ask.
### Appendix C

**Early Math Questionnaire Mean Ratings for All Activity and Belief Items**

<table>
<thead>
<tr>
<th>Activity item (“I encourage or help my child to…”)</th>
<th>Mean (Range)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Count out a number of items from a larger group</td>
<td>2.55 (0 – 4)</td>
<td>1.16</td>
</tr>
<tr>
<td>A2. Count using his or her fingers</td>
<td>2.70 (0 – 4)</td>
<td>1.27</td>
</tr>
<tr>
<td>A3. Count by 2’s, 5’s, or 10’s—something other than by 1’s</td>
<td>0.89 (0 – 4)</td>
<td>1.32</td>
</tr>
<tr>
<td>A4. Write numbers</td>
<td>1.19 (0 – 4)</td>
<td>1.38</td>
</tr>
<tr>
<td>A5. Match printed numbers with group size or a collection</td>
<td>1.64 (0 – 4)</td>
<td>1.41</td>
</tr>
<tr>
<td>A6. Count aloud</td>
<td>3.30 (0 – 4)</td>
<td>1.02</td>
</tr>
<tr>
<td>A7. Count backward</td>
<td>1.23 (0 – 4)</td>
<td>1.35</td>
</tr>
<tr>
<td>A8. Read numbers</td>
<td>2.36 (0 – 4)</td>
<td>1.26</td>
</tr>
<tr>
<td>A9. Estimate a small number for small groups and a large number for large groups</td>
<td>1.15 (0 – 4)</td>
<td>1.32</td>
</tr>
<tr>
<td>A10. Count the number of objects in a group</td>
<td>2.77 (0 – 4)</td>
<td>1.13</td>
</tr>
<tr>
<td>A11. Distinguish between one-digit and two-digit numbers</td>
<td>1.32 (0 – 4)</td>
<td>1.46</td>
</tr>
<tr>
<td>A12. Compare groups of objects to identify more or less or same=equal</td>
<td>1.51 (0 – 4)</td>
<td>1.32</td>
</tr>
<tr>
<td>A13. Identify numbers as more or less</td>
<td>1.49 (0 – 4)</td>
<td>1.44</td>
</tr>
<tr>
<td>A14. Match equal groups of objects</td>
<td>1.38 (0 – 4)</td>
<td>1.31</td>
</tr>
<tr>
<td>15. Use counting words like first, second, and last</td>
<td>1.94 (0 – 4)</td>
<td>1.49</td>
</tr>
<tr>
<td>A16. Understand that adding or taking away from an amount creates more or less</td>
<td>1.40 (0 – 4)</td>
<td>1.41</td>
</tr>
<tr>
<td>A17. Add and subtract using objects</td>
<td>1.02 (0 – 4)</td>
<td>1.22</td>
</tr>
<tr>
<td>A18. Recognize how parts make a whole</td>
<td>1.23 (0 – 4)</td>
<td>1.37</td>
</tr>
<tr>
<td>A19. Create equal-sized groups from a larger group</td>
<td>0.98 (0 – 4)</td>
<td>1.24</td>
</tr>
<tr>
<td>A20. Put shapes together to make a larger shape</td>
<td>1.77 (0 – 4)</td>
<td>1.46</td>
</tr>
<tr>
<td>A21. Match shapes by size</td>
<td>1.49 (0 – 4)</td>
<td>1.49</td>
</tr>
<tr>
<td>A22. Name simple shapes (circle, square, triangle, rectangle)</td>
<td>2.70 (0 – 4)</td>
<td>1.12</td>
</tr>
<tr>
<td>A23. Play with blocks</td>
<td>2.87 (0 – 4)</td>
<td>1.08</td>
</tr>
<tr>
<td>A24. Identify basic shapes when flipped or turned vertically or horizontally</td>
<td>2.04 (0 – 4)</td>
<td>1.25</td>
</tr>
<tr>
<td>A25. Identify shapes in everyday settings and activities</td>
<td>2.51 (0 – 4)</td>
<td>1.27</td>
</tr>
<tr>
<td>A26. Copy shapes onto paper</td>
<td>1.83 (0 – 4)</td>
<td>1.37</td>
</tr>
<tr>
<td>A27. Use words like over, under, above, on, beside, next to, and between to describe locations of objects</td>
<td>2.77 (0 – 4)</td>
<td>1.31</td>
</tr>
<tr>
<td>A28. Use shapes to make a picture</td>
<td>1.62 (0 – 4)</td>
<td>1.39</td>
</tr>
<tr>
<td>A29. Order objects from smallest to largest</td>
<td>1.43 (0 – 4)</td>
<td>1.43</td>
</tr>
<tr>
<td>A30. See that one object is bigger or smaller than another by directly comparing them</td>
<td>2.17 (0 – 4)</td>
<td>1.29</td>
</tr>
<tr>
<td>A31. Use comparative terms like bigger, longer, taller, and heavier</td>
<td>2.40 (0 – 4)</td>
<td>1.47</td>
</tr>
<tr>
<td>A32. Use a ruler or other objects (string, paperclips, laid end to end) to measure and discuss length</td>
<td>0.72 (0 – 4)</td>
<td>1.06</td>
</tr>
<tr>
<td>A33. Use measuring cups and spoons to measure and discuss amount</td>
<td>1.17 (0 – 4)</td>
<td>1.34</td>
</tr>
<tr>
<td>A34. Recognize patterns or repeating sequences of things in everyday settings and activities</td>
<td>1.81 (0 – 4)</td>
<td>1.42</td>
</tr>
<tr>
<td>A35. Duplicate simple patterns</td>
<td>1.53 (0 – 4)</td>
<td>1.43</td>
</tr>
<tr>
<td>A36. Create simple patterns</td>
<td>1.70 (0 – 4)</td>
<td>1.38</td>
</tr>
</tbody>
</table>

**Belief item (“Rate how you think and feel about math”)**

| B1. When I was growing up my family valued math | 3.09 (1 – 4) | 0.78 |
| B2. When I was young I was likely to seek math help from the adult female caregiver in my home | 2.89 (1 – 4) | 0.89 |
| B3. When I was young I was likely to seek math help from the adult male caregiver in my home | 2.96 (1 – 4) | 0.86 |
| B4. Young children should learn about mathematics in the preschool setting | 3.38 (1 – 4) | 0.61 |
| B5. Mathematics is important for daily living | 3.57 (1 – 4) | 0.58 |
| B6. Even very young children can learn about mathematics | 3.47 (1 – 4) | 0.58 |
| B7. It is my responsibility for me to teach my child at home | 3.55 (1 – 4) | 0.54 |
| B8. I can influence my child’s math skills | 3.57 (1 – 4) | 0.54 |
| B9. I am competent teaching math skills | 3.15 (1 – 4) | 0.83 |
| B10. I feel comfortable teaching math skills | 3.13 (1 – 4) | 0.80 |
B11. I prefer to do early literacy tasks (e.g., reading) with my child more than early numeracy (e.g., talking about numbers)  
3.04 (1 – 4)  0.83
B12. It is as important to develop early math skills as it is to develop early reading skills  
3.47 (1 – 4)  0.72
B13. I have good math skills  
3.06 (1 – 4)  0.94
Appendix D

Examples and Frequencies of Coding Categories

<table>
<thead>
<tr>
<th>Theme</th>
<th>Code</th>
<th>n</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storybook selection</td>
<td>Child’s interest</td>
<td>27</td>
<td>And then also if she has her own interests, if we find she had an interest in something, then we’ll try to get books or things that are revolving around that because we know it’s going to capture her attention.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I honestly just look for books with topics that I think will draw their attention. Right now they seem to be interested in monsters, Fly Guy books, books containing any character from TV, and my son has one rebus book that he is currently in love with because it gives him the opportunity to &quot;read.&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I think there has to be something that grabs her interest, either maybe a character that she likes like Mickey Mouse. If my child has no interest in the character then the child might be less inclined to listen or participate.</td>
</tr>
<tr>
<td>Attention span</td>
<td></td>
<td>19</td>
<td>I review my child’s overall interest and attention to the book. If he isn’t interested enough in the book to sit and listen and engage with the book then it isn’t going to help him learn anything.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>It can (be a useful book), but I think maybe too advanced for him- or he doesn’t have enough of an attention span yet.</td>
</tr>
<tr>
<td>Relatable stories/Connection</td>
<td></td>
<td>21</td>
<td>The story you did with the monsters was great because he’s excited. He knows what a birthday party is. It’s something exciting, balloons, all those things, something he understands and he’s excited about. If it were something boring, then he would probably not be interested in it.</td>
</tr>
<tr>
<td>to everyday life</td>
<td></td>
<td></td>
<td>But we also try to choose books that give life skills like how to share and how to behave in certain places. We have a set of books that have like first time at the doctor’s office, at the dentist’s office. At the beginning before she started school, she wasn’t sharing so much because she didn’t have anybody here to fight for over toys. So everything could be hers. So we bought a book about things like sharing or … Because we knew she was going to school.</td>
</tr>
</tbody>
</table>

99
know we have friends that have issues like hitting or biting. So we brought her a book just in case with like hands are not for hitting.

I also try and find ones that maybe relate... For example, if they're counting cups, I can pull cups out of the cabinet, versus school buses. So that I can try and bring it into our home, so when we're reading, we can make it into a hands-on experience, versus just, here's the school buses on the page, but I don't really have anything to show you. So cars I can pull out, toy cars or something like that.

Child chooses 20
I let her pick. We would go into a library, she’ll choose whatever she wants, then we’ll read at home.

He's into *Paw Patrol, Daniel Tiger*, like the different things, sometimes he's into giraffes, so it kind of... I kind of let him do the picking. And then seeing what he's leaning toward, I kind of pick what he likes. Very simple though, simple stuff that doesn't take too long but we're able to get through a story, but that we're at least able to get some information out of it.

Storybook features Illustrations 47
Maybe, there’s some books that have three word sentences, you know, like then we can focus on that, just to go through letters and stuff. But for the purposes of everything else, like colors and shapes and numbers pictures are more what we focus on, I think.

But I mean the fact that the pictures, I mean for her age, that they're big and she can count, point and count, that's good. I like that. And the fact that there's a reminder of the list on the page when you're looking for that. That was good.

I make sure there are pictures corresponding to with words so I can point things out and ask him about them. I would probably say pictures probably would be the most useful. I think especially at this stage, cause they're not (inaudible) the words as much as the pictures, I think. I think that's something that would be (important). The visuals at this point.

Realistic objects 19
My concern though is the made-up objects like snoozleberries that my child may not understand is a pretend item. He is 3 and still learning the names of objects and may be confused with the mixture of real
<table>
<thead>
<tr>
<th>Simple</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>I choose very simple worded books right now. If the narrative is too long on each page, he gets antsy wanting to turn the page.</td>
<td></td>
</tr>
<tr>
<td>I pay attention to the number of words on a page mostly. If there is long paragraphs and the illustrations are not very involved, it won't hold my kid's attention. I like words with a decent amount of words, but not too many, and they love books with crazy illustrations.</td>
<td></td>
</tr>
<tr>
<td>I like things that are very simple and symmetrical and not confusing to them especially with him being so small. I can understand an older child or one who's more advanced than him I guess with... Anyway that's what I remember about that. The simpler the better for when they're learning to count.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Text</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>I pay attention to the number of words on a page mostly. If there is long paragraphs and the illustrations are not very involved, it won't hold my kid's attention. I like books with a decent amount of words, but not too many, and they love books with crazy illustrations.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Written numerals</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>I liked where you had written out the number, like the number six was written in letters and then the number and then the pictures together. I think that’s really good, especially for the younger ones. It gives you something for the older one to look at with the letters trying to match up what the word looks like with the number, and then the picture of it. He’s really only looking at the picture at this stage, but his brother will be looking for the number.</td>
<td></td>
</tr>
<tr>
<td>I liked when it had the number next to the amount. I felt like that gave us something different to look at</td>
<td></td>
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</tbody>
</table>
because she knows what numbers look like in addition to the counting of the numbers.

I think that asking how many birthday hats and cupcakes as well as showing the actual numbers of those items is extremely beneficial so you're not just reading a number via text but also being able to see that number of pictured items.

<table>
<thead>
<tr>
<th>Narrative</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>He just turned four, so if we can do it with a story, he tends to pay a lot more attention because he wants to know what’s going to happen next. If it’s just numbers, he’s like no, he gets bored. I’m looking more for a story.</td>
<td></td>
</tr>
<tr>
<td>I basically try to make sure the content is wholesome and that the narrative is engaging enough that the number practice seems natural, that’s why I think a good narrative but not an over developed narrative is good, there's a sweet spot so that they get into the numbers for the sake of the story.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Reading process</th>
<th>Ask questions</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want to say that I'm thinking of skills that are going to help her, but most of the time, I think I do like hearing that she knows the correct answer. Sometimes I do ask her things just because I want to know that she's going to know it, or maybe find some encouragement in herself.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>It's more the first time I read it, it's usually not so much with me knowing what questions to ask. But the more we read them, the more I'm able to customize the questions that I'm asking him, so that he gets the integrity of what we're trying to teach.</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Maintain attention</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well, I think with him I find I'm asking him more just to make sure, “Is he paying attention? Is he getting out of it what I'm hoping he's getting out of it?” I ask him more questions than I ask his older brother. Because I feel like his older brother is listening more and as long as the book has the message we're trying to get through, he's absorbing most of what there's already and we don’t need to add as much. It's usually focused on, is he paying attention?</td>
<td></td>
</tr>
<tr>
<td>It's all because of the attention span, because I found that when I was focusing on the words, we never made it through a story or a couple of pages. So what I do, is I try to get the gist of the story, and kind of say</td>
<td></td>
</tr>
</tbody>
</table>
it in a way that he's still engaged, and then do what I have to do and then move on. Sometimes stories may be abbreviated, or modified.

| Involve child | 20 | It's not about "I've got to get through the book". I really want him to be involved in it and really think about what he's looking at. |
| Complexity | 29 | You definitely want to reinforce what she already has, but at the same time, I think she's very smart and she picks up quick. She's a fast learner. So, she could definitely handle some things that are little bit more challenging. I try to think of what I know that she's capable of and then something that has maybe a little more, a little less so that she got some confidence but then also push her a little bit. |
| Reinforce current skills | 32 | Well, one of the things that we do look at because she's in school so if the school is doing something, we try to continue what they're doing in school this way it's building on what they're teaching her as a sense of reinforcement. He goes to preschool twice a week, and so I build on whatever... I know they're using letter sounds, so sometimes I’ll focus on if he can recognize, "Hey, I see a picture that starts with an A, what starts with an A?" |
| Early math concepts | Difficulty level | 25 | I try to make sure it includes things my child can do and that isn’t too advanced. I think we try to ask her very basics of what she understands. I usually try to push her as much as I can until I feel that she's either losing interest or doesn't really know or care, you know? |
| Age level | 20 | The only thing that I noticed it was a little bit advanced for him is when you ask him to point out the groups of six, that’s something that you would want in a little bit older child or more advanced child. I would definitely want that in another year or two. I do want him to have those skills but he can’t do that right now. At this age, my son has trouble counting bigger than 5 objects all at once, he has a tendency to just spew out numbers instead of slowing down and actually counting. |
I kind of view the preschool as to reinforce it but I feel like if they just play that's okay right now, but I know they do a combination of both. I don't expect anything from them right at this point but that may change in two years, you know? Right now, she's in the youngest preschool group and I just want her to play and be interested in it and if counting is involved, math is involved, great.

<table>
<thead>
<tr>
<th>Math concepts mentioned</th>
<th>47</th>
</tr>
</thead>
<tbody>
<tr>
<td>For a child at 3 to 4 who is just learning to count efficiently, it isn't helpful to purposefully confuse them by having too many of one item then the counting introduced in the beginning of the story. For example, the monster needs six balloons, but takes seven and then returns one. For a child who is just learning the concept of counting and the significance of the object-number relationship, adding another layer to the basic 1-2-3 structures can be confusing and overwhelming.</td>
<td></td>
</tr>
</tbody>
</table>

Having the number written numerically on each page for the amount to count would be helpful…Or even if there's like a number, like here. Anything like that like here. Like how many, six. She knows how to read the number six and then I don't have to tell her. She'll read it and count to six. But she doesn't know how to read yet, so I have to read that to her. But if she sees the number six, she'll know.

It has them count and explore the concepts of more and less and equal.

(I liked) counting each thing and hearing repeated spoken numbers.

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1The numbers in this column represent the number of parents who mentioned ideas related to each code during the parent interviews.