Article:
Bergman Deitcher, D. orcid.org/0000-0002-4303-2649 and Neumann, M.M. orcid.org/0000-0002-9546-7433 (2025) A guide for fostering parent–child math talk and play during shared book-reading across diverse genres. Education Sciences, 15 (7). 805. ISSN 2227-7102

https://doi.org/10.3390/educsci15070805

education sciences

MDPI

Article

A Guide for Fostering Parent–Child Math Talk and Play During Shared Book-Reading Across Diverse Genres

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Abstract

This theoretical paper expands upon previous research and proposes a guide for promoting mathematical talk and play through shared book reading (SBR), with a focus on the home environment. Building on a previously developed classroom-based model, this article describes a design-based research approach to extend the guide to including diverse literary genres—such as narrative, informational, multicultural, and math-specific books in a home setting. Parent–child shared book-reading in authentic contexts can provide a rich platform for "math talk", where references are made to mathematical words, concepts, and content, and may support children's mathematical skills. SBR with quality children's literature can play a promising role in motivating and engaging children's interest and pleasure in both reading and mathematics. However, few studies have explored this with diverse literary genres in the home setting, as the main focus has been in the classroom and using books specifically written to teach math content such as counting or sorting books. The proposed guide provides direction and practical examples for fostering parent–child math talk and play activities that can be used to extend concepts covered during the SBR. The potential application of the SBR guide, and how it can encourage parent–child talk to support a full range of mathematical concepts, encourage home-preschool collaboration, promote effective SBR techniques, and facilitate parent–child conversations about math in new and confident ways is discussed.

Keywords: parent–child interaction; shared book reading; mathematics; multicultural literature; book genres

Academic Editors: Jerome D'Agostino and Susan B. Neuman

Received: 2 May 2025
Revised: 3 June 2025
Accepted: 20 June 2025
Published: 23 June 2025

Citation: Bergman Deitcher, D., & Neumann, M. M. (2025). A Guide for Fostering Parent–Child Math Talk and Play During Shared Book-Reading Across Diverse Genres. *Education Sciences*, *15*(7), 805. https://doi.org/10.3390/educsci15070805

1. Introduction

During preschool years, children's intellectual, cognitive, and emotional development grows significantly and future academic success has been attributed to this stage in life (Ansari et al., 2020; Lipkin et al., 2020; Pace et al., 2019). One area that reflects this is how early mathematical knowledge relates to children's later mathematical outcomes (Jordan et al., 2009). There is extensive longitudinal evidence documenting that early mathematical skills relates to children's academic outcomes in their school years (e.g., Bailey et al., 2020; D. H. Clements et al., 2016; Duncan et al., 2007), even through high school (Watts et al., 2014). Moreover, early intervention promoting math skills was associated with better achievement in fourth and fifth grade (Watts et al., 2018). To support the development of early mathematical skills, researchers recommend that preschoolers be provided with early

learning opportunities that extend beyond traditional math activities such as counting out blocks or using flashcards (Piasta et al., 2014). Activities in authentic contexts that provide opportunities for "math talk", where references are made to mathematical words, concepts, and content, may support a wide range of children's emergent mathematical skills like number sense, which is the knowledge and ability to be flexible and fluent about numbers (L. J. Clements et al., 2021; R. Hojnoski et al., 2016; Son & Hur, 2020; Susperreguy & Davis-Kean, 2016). One activity that can provide a ready-made platform for math talk, is adult–child shared book-reading (SBR), where an adult reads a book with a child/children and engages with them in conversation surrounding the book content (e.g., Uscianowski et al., 2020). This frequent adult–preschooler interaction has been shown to promote young children's language, literacy, and socio-emotional development (Anderson et al., 2019; Hindman et al., 2019; Schapira & Aram, 2020), and initial research suggests that SBR can facilitate children's math capabilities (Purpura et al., 2021; Van den Heuvel-Panhuizen et al., 2016). SBR with quality children's literature can play a promising role in motivating and engaging children's interest and pleasure in both reading and mathematics. Few studies have explored this with diverse literary genres (e.g., narratives, informational, biographies) and the key focus has been in the classroom and using books specifically written to teach math content such as counting or sorting books (Hendrix et al., 2019; Stites et al., 2021).

2. Supporting Mathematical Learning at Home

According to Bronfenbrenner's (1979) ecological systems model, children develop within multiple systems, ranging from the microsystem—which relates to their more immediate environment, and the mesosystem—interactions between microsystems such as home and preschool, to the macrosystem—including broader contexts such as cultural elements. Various terminology has been applied to the microsystem of the home setting that relates more specifically to math learning, such as the home learning environment (Eason et al., 2022; Melhuish et al., 2008), home numeracy environment (LeFevre et al., 2009), and home math environment (Zippert & Rittle-Johnson, 2020). Home environments that include math activities and foster children's interest in math can promote positive mathematical outcomes for young children (Eason et al., 2022; Sonnenschein & Dowling, 2019). For example, Susperreguy et al. (2020) found that both formal and informal math activities were related to preschooler's longitudinal growth in math achievement. Parental practices such as SBR were also shown to relate to children's math achievement and promote young children's mathematical development (Op 't Eynde et al., 2023).

Barnes and Puccioni (2017) found that higher-quality parent talk during SBR was associated with children's mathematics achievement, while Purpura et al. (2021) demonstrated that caregiver–child shared reading of math-focused picturebooks promoted children's mathematical language and numeracy skills. Elia et al. (2010) highlighted the utility of the pictures and illustrations in books for promoting children's mathematical thinking and Uscianowski et al. (2020) showed that parents asked more abstract and decontextualized questions when relating to characters' actions on storybook pages without math content compared to when they related to math concepts such as shape and number. However, these studies primarily focused on researcher-designed books that included specific mathematical content aimed at increasing parents' math talk during the SBR interaction (Purpura et al., 2021) or on books that contained significant quantities of embedded math content (Elia et al., 2010; Uscianowski et al., 2020). Our guide proposes that books of diverse genres (e.g., narrative, informational, multicultural), and not just those specifically connected to math, can be used to promote parent–child math talk during SBR. This approach may capitalize on the common practice of parent–child SBR (e.g., bedtime stories) that occurs across various cultures.

3. SBR, Play, and Diverse Genres

Parents and teachers play an important role in scaffolding children's SBR experiences and learning within their Zone of Proximal Development (Vygotsky, 1978), helping children internalize knowledge about the world through repeated scaffolding so they can apply what they have learned (e.g., words, concepts, skills) in different contexts (Neumann, 2020; Pentimonti & Justice, 2010). Research indicates that SBR discourse varies based on book genre. For example, narrative storybooks tend to promote adult-child talk surrounding socio-emotional aspects of the book, while informational books tend to promote more vocabulary and content knowledge-related discussions (Bergman Deitcher & Johnson, 2022; Schapira et al., 2021). SBR of math books or books with specific math content can promote adults' math talk (e.g., Purpura et al., 2021). For example, R. L. Hojnoski et al. (2014) trained parents to engage in discussion relating to math during SBR and found that three of the six parent–child dyads increased in their math talk compared to the baseline. Extending this study, Hendrix et al. (2019) reported that when given both math book and non-math books, three dyads engaged in more math talk when reading the math books compared to the non-math books. In a recent systematic review, Zhang et al. (2023) showed that using picturebooks across age groups and in the classroom for teaching math was associated with a positive learning environment, better math performance, and may promote more interactive learning.

Increasing research has focused on the concept of "playful learning" (Fletcher et al., 2024; Hirsh-Pasek et al., 2010; Levenson et al., 2018), which can promote children's learning in various domains, including academic (Masters et al., 2023) and social-emotional skills (Taylor & Boyer, 2020). In terms of mathematics, guided play improved preschoolers' shape knowledge compared to free play or didactic instruction (Fisher et al., 2013). Moreover, playful interactions with preschool teachers can engage children's mathematical thinking and promote their math achievement (e.g., Trawick-Smith et al., 2016). Although some intervention studies have brought math games into the home setting (Ramani & Scalise, 2020), much of the play-based learning research has focused on the preschool setting as a pedagogical or curricular approach (e.g., Cohrssen et al., 2013).

In addition, diverse multicultural literature has been an important tool to help young children see their own real-life and authentic experiences reflected in picture books, or learn about other cultures, and can stimulate children's imagination (Bishop, 1990). Multicultural literature and illustrations can be used to foster children's appreciation of diversity, connect children with rich language and different cultures and encourage critical consciousness (Osorio, 2018). At the same time, as with other children's literary genres, multicultural literature also may have the potential to support children's math talk, and it is possible that adults may require more guidance in how to use non-focused math books, multicultural stories, and play-related activities to support children's learning of math and other concepts during SBR. While there is extensive research on parent–child SBR, including some exploring various book genres, there is minimal exploration of how the different genres can be harnessed for math talk. The proposed "SBR math talk" guide discussed below may help fill this gap, extending previous research on shared reading by highlighting how various book genres can be used to promote math talk, along with play-based authentic parent–child interactions.

4. The SBR Math Talk Guide

We previously developed a framework for using classroom-based SBR of quality award-winning narrative books to promote children's mathematical thinking in early education settings (Bergman Deitcher & Neumann, 2023). However, as the home environment is an important context for young children's learning, the aim of the present work was

to extend this work to include diverse children's book genres, with a specific focus on parent–child SBR as little work has explored using SBR of non-math focused books to support math talk and associated concepts. SBR with different and diverse genres of quality children's literature has the potential to expand children's imagination and help them learn about the world.

Relying upon the process model proposed by Hoadley and Campos (2022), this design-based research approach enabled the extension of an earlier framework (Bergman Deitcher & Neumann, 2023) to other book genres and the home setting, incorporating play-based activities as part of the conceptualization. The design-based research process involved the authors' covering four iterative cycles to extend the guide: *Grounding*, *Conjecturing*, *Iterating*, and *Reflecting*. Grounding began with analyzing existing research on SBR and its potential for fostering math talk with young children in the home context. This included a particular look at R. L. Hojnoski et al. (2014) and Hendrix et al. (2019), which utilized a SBR intervention as a means of promoting parents' math talk. Drawing on this analysis, the researchers conjectured about key elements and strategies for integrating math talk into the SBR of picture books. These strategies were based on a dialogic approach of asking literal and inferential questions, discussing the meaning of new words in the context of the book, providing content knowledge, and connecting to the child's life, which have been linked to children's developmental outcomes, such as language and literacy skills, reading enjoyment and motivation, and mathematical knowledge (Hindman et al., 2019; Pillinger & Vardy, 2022; Purpura et al., 2017; Whitehurst et al., 1988).

The guide, which included a discussion of six relevant elements (in no specific order—genre, book title, emergent math concepts, text, math talk, and play-based activities), was then presented as part of a workshop titled "Playful mathematics learning during the early years: out-of-school environments." The workshop included approximately 15 mathematics researchers, early education specialists, and other experts in the field, a number of whom were also parents. Workshop participants received a selection of books of various genres and provided feedback on the book, emergent math concepts, elements from the text and potential math talk. The workshop participants were asked to consider both the books and the reader guide as if they were engaging in shared reading. Iterative cycles followed, where the conjectured guide was reviewed, discussed, and evaluated as part of the workshop. Participants noted certain math concepts that had not been considered, such as large numbers and comparisons. They also noted potential "math talk" relating to the books. For example, for the information book *Owls* (Gibbons, 2006), participants suggested "Is the round face of the owl a circle" as a utilization of math talk. Based upon the feedback, the guide was refined by adding in further concepts including large numbers, symmetry, comparisons, and the idea of including multicultural books to make the guide more accessible to families from different backgrounds. Following each iteration, the researchers identified areas for improvement and revised the guide accordingly. This process continued and a robust guide for math-focused SBR emerged, encompassed by the general elements depicted in Figure 1 and examples for each book genre detailed in Table 1.

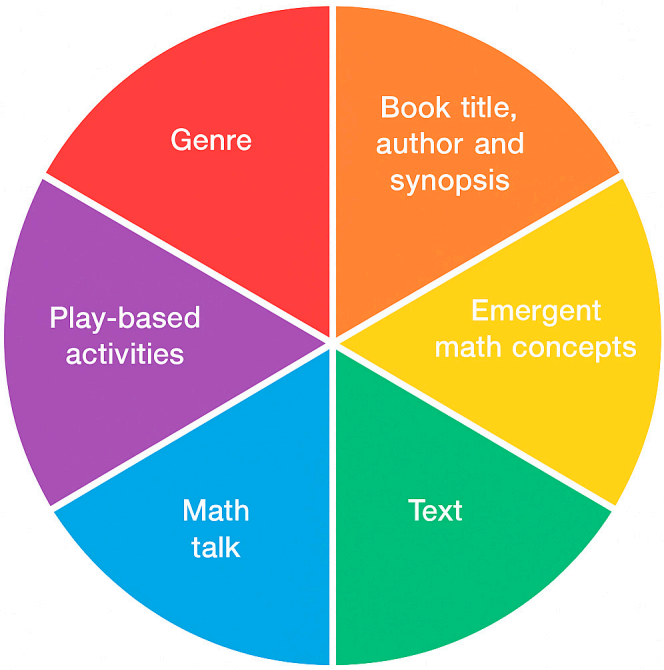

Figure 1. A guide to promoting math talk during SBR.

5. The Six Elements of the SBR Math Talk Guide

Parents and those working with families (e.g., teachers, therapists, intervention specialists) can be directed on how to use the guide and select books that can promote math talk (see Figure 1). More specifically, books do not need to have a particular math focus in the title or on the cover as research has shown that when selecting books, parents should take into consideration children's interests and personal experiences and illustrations (Bergman Deitcher et al., 2019; Daniels et al., 2022). This approach is embedded in the proposed SBR guide to assist in broadening parents' book selection criteria when selecting books for SBR that stimulate math talk. Parents can first examine the *genre* of the book, along with the *title*, *author*, *and synopsis*, taking their children's interests, and their goals in reading into consideration. Parents can learn to look for signposts of *emergent math concepts* in the book—are there elements that can be counted? Are there words that signal quantity or relative size. Once the book is selected, parents can read through the *text* to become familiar with it and imagine the *possible math talk*—types of questions and prompts they can ask their child about different math concepts (see Table 1 for examples). Finally, *play-based activities* are also included, which can be incorporated during and following SBR to further extend opportunities for child–adult math talk and revisiting math concepts discussed during SBR. In general, adults read the same book multiple times with young children (Frey & Fisher, 2018), which is an effective way to revisit ideas and concepts that emerged from the math talk on the different pages of a book.

Importantly, linking SBR and play has been found to be beneficial for promoting children's learning and fostering parent–child interactions (Mendelsohn et al., 2018; Weisleder et al., 2019). Parents can be encouraged to view SBR as a type of guided play, where scaffolded learning takes place within a pleasurable activity in which they may already engage (Landry et al., 2012). The addition of playful activities suggested in Table 1 can foster engaging ways for promoting math talk through SBR and extended play activities.

Table 1. Examples of shared book reading and play activities to support math talk and children's mathematical thinking.

Genre	Book Title and Author	Synopsis	Emergent Math Concepts	Text	Examples of "Math Talk"	Play Activities
Narrative	*Where the Wild Things Are* by Maurice Sendak	After making mischief and chasing his dog down the stairs, Max is sent to his room, where he sails to an island and becomes king of all the Wild Things. . .until he returns home.	Calendar, time, distance	". . .sailed off through night and day, and in and out of weeks and almost over a year"	"How long is a week?"; "How many weeks in a year?"; "What would Max need to take with him in his boat if he was going on a long trip?"; "How much of each thing would he need?"	When it is bathtime and you are splashing in the water, imagine the bath is Max's boat and you are travelling with Max to the island. Talk with your child about how long it would take to get there and how much food you would need to survive the watery journey.
Narrative	*I Want My Hat Back* by Jon Klassen	A bear has lost his hat and asks each of the other animals if they have seen his hat, until something jogs his memory.	Shapes, ordering	"I saw a hat once. It was blue and round. . .it is red and pointy."	"What kind of shape do you see in the picture here?"; "Does that look blue and round?"; "Which animal do you think he's doing to go to next?"	Find hats belonging to each family member. Then, count and order them in size. Play hide and seek hats where someone hides them around the house and the person who can find the most hats wins!
Narrative	*Seven Blind Mice* by Ed Young	Six colored blind mice individually set out to explore a strange "something." The seventh mouse discovers that the whole is greater than the sum of its parts.	Ordering, counting	"The sixth to go was Blue Mouse."	"Let's see if we can remember the order the mice went"; Let's count the mice in this picture"	Find a board game in your home that has dice. Each time you roll the dice, count up the number of dots on the dice, then count together as you move your counter on the board game. Then, ask whose turn is it next to roll the dice! If you do not have a board game, have a go at creating your own with cardboard and crayons!

Table 1. *Cont.*

Genre	Book Title and Author	Synopsis	Emergent Math Concepts	Text	Examples of "Math Talk"	Play Activities
Information	*Animals in Winter* by Henrietta Bancroft and Richard G. Van Gelder	The book provides information on a variety of animals and what they do in the winter (migrate, change color, etc.).	Time, sequence, cardinality, symmetry	"Does he sleep for a day? Longer than that. Does he sleep for a week? Longer than that. A month? Even longer! A woodchuck can sleep as long as four months!"	"Look at the picture here, it shows the months when the woodchuck is sleeping. December, January, February, March. Do you know what month comes next? When do you think he wakes up?"	Take a wall calendar and look at what the months are—which month is the child's birthday or other family members' events?
Information	*Owls* by Gail Gibbons	Detailed information about types of owls, where they live, their size, and their behaviors.	Time (day/night), shapes, categorization, measurements	"The smallest owl, the elf owl, is 5 inches (12.5 cm) long. . . Most owls hunt at night. Day or night, they can see much better than people."	"5 inches, that's pretty small. Do you know how big you are? Should we measure you?"; "Wow, owls hunt at night—what do you do at night?"	Take animal toys (e.g., teddy bears, farm animals) from the child's bedroom and line them up by size. Which is the largest? Which is the smallest? Maybe find a tape measure and measure the height and width of the toys.
Math content	*Ten Black Dots* by Donald Crews	Various actions that can be performed with a black dot, counting from 1 to 10.	Counting, fractions, addition, division	"Six dots can make marbles that you hold—half are new, the rest are old."	"Let's see how many are in this hand, and how many are in that hand. So if we want to take six and divide it into two equal parts, we get three and another three." "Let's count: 1, 2. . ."	In the kitchen, find some fruits (e.g., grapes, plums, oranges, or apples) and count them and share them between two people. Ask, if we have grapes, how many do you and I need to pick out so we have an equal number of grapes each? Count the two sets of grapes, then eat them!

Table 1. *Cont.*

Genre	Book Title and Author	Synopsis	Emergent Math Concepts	Text	Examples of "Math Talk"	Play Activities
Math content	*Counting to Bananas* by Carrie Tillotson	A humorous counting book with a banana "narrator" who wants his turn in the spotlight.	Counting; large numbers	"13 melons, 14 peaches, 15 kumquats, 16 leeches. Ew. Well you didn't like the other animals. . . If I have to see one more animal in a fruit books, I am going to go completely BANANAS." "40 cherries, 60 grapes, 80 berries"	"Do you think we can count all the melons? Let's try."; "Wow, 80 berries, that's a lot. I don't think we can count that on the page!"	At the grocery store or fruit store, count each banana in the bunch, then keep counting more of your favorite fruits as you place them in your shopping bag or cart. If you lose count, you need to start again!
Multicultural	*Sammy Spider's First Passover* by Sylvia Rouss	Sammy the Spider learns about that holiday of Passover while also learning how to spin a new web.	Counting, shapes	". . . He was hovering on a silky strand above the table watching the Shapiros at their seder. CRUNCH went the matzah, as Mr. Shapiro broke it in half. Sammy watched him wrap one of the broken pieces in a bright red napkin."	"Look, he took one square piece of matzah, and now it's in two triangles".	Let us see what else we can take from a square and make triangles. How about we make sandwiches for lunch. We can cut my square sandwich into two triangles. What shapes can we cut your sandwich into to get four smaller pieces? Let's mix up the shapes, count them and make a jigsaw puzzle, then gobble them up!

Table 1. *Cont.*

Genre	Book Title and Author	Synopsis	Emergent Math Concepts	Text	Examples of "Math Talk"	Play Activities
Multicultural	*The Coloured Echidna* by Eunice Day	A young echidna who has quills that change to match all the rainbow colors goes on a journey across Australia to discover why he is different.	Matching, size, shapes, quantity, distance, patterns, sequencing, counting	"Coloured echidna was not happy. Wherever he went his quills changed to match the landscape. But he could never look like the other echidnas. No matter how hard he tried, his rainbow colors always shone through"	"What different types of colors and shapes can you see in the picture of the echidna's spiky quills? Look at all the dark and light stripes on his back. Let's count those stripes. What a wonderful pattern! Why do you think the echidna has a pattern on his back?"	When going out and about to the park, zoo or a visiting a natural setting (e.g., beach, forest), point out the different patterns and shapes in your surroundings (e.g., on an animal's fur such as a striped cat) or a leaf with lines and relate that back to the echidna story and the colorful patterns in the landscape.

6. Discussion

The proposed SBR math talk guide, developed through a design-based research approach in consultation with math education experts, has the potential to provide enhanced opportunities for parent–child math talk. Although focused on parents (or other caregivers), the use of the proposed guide raises the potential for collaboration between the home and preschool microsystems (Bronfenbrenner & Morris, 2006). SBR across a child's home and school setting greatly supports early learning of foundational skills (Hindman et al., 2008). However, research has shown some variation between home and school in that parents use different SBR strategies than teachers, providing different SBR experiences for children. For example, when reading at home, children may benefit from more personalized opportunities for SBR math talk interactions with their parent or caretaker, whereas at preschool, children tend to engage in more whole class and group-based interactive experiences with their peers and a trained preschool teacher (Grolig, 2020). To harness these positive SBR experiences across home and school, parents and teachers can collaborate and share the SBR knowledge they have with others so that children's home and school SBR math talk experiences could be enhanced and revisited in both settings. Through this collaborative and coordinated home–school process (Susperreguy & Davis-Kean, 2016), parents and preschool teachers could discuss the math concepts that are being covered at preschool and then aim to talk about these concepts during SBR at home. Similarly, the same picture books can be read both at home and at preschool, allowing for the continuity and repetition of math talk conversations for the child. The guide (Table 1) may be a useful tool that both parents and teachers can utilize to harness quality picture books and SBR for supporting early math learning.

In both the home and preschool settings, elements of the SBR math guide may provide additional opportunities to support children's learning and promote math. For instance, SBR allows for the use of more decontextualized or distancing talk, which goes beyond the "here and now," which is associated with children's learning (Grolig, 2020; Sun et al., 2020). Ribner et al. (2020) found that mothers' distancing language during SBR was associated not only with children's literacy skills, but also with their math skills. The authors suggested that this kind of language may promote more abstract thinking that not only applies to language or literacy, but to other areas such as math. Our proposed guide includes various examples of decontextualized talk such as text-to-child statements that encourage children to go beyond the here and now, such as by reminiscing about a past event or making links to everyday activities. Additionally, studies have found that questioning practices are also associated with levels of elaboration and children's language skills (Blewitt & Langan, 2016; Walsh & Hodge, 2018). Open-ended questions are generally considered to be more cognitively demanding and may promote children's inferential thinking and language learning (Deshmukh et al., 2019; Hindman et al., 2012). For instance, Duong et al. (2021) showed that parents' increased use of higher cognitive demand questions was associated with better spatial skills and higher standardized math scores. The authors explain that "high-CD [cognitive demand] questions may promote abstract thinking and complex language use, which are involved in spatial and mathematical reasoning" (p. 26). The variety of question types in the proposed guide, including those that are higher cognitive demand, such as asking "why" or asking for a prediction, lends strength to the guide (Table 1).

By bringing math talk into a frequent playful interaction in families, the proposed SBR guide can serve as a direction for scaffolding important parent–child interactions. Indeed, parents who have a welcoming attitude toward math may be more likely to help their child engage in math activities at home and use more math language (Susperreguy et al., 2020). Such positive parent attitudes to math have been reported to relate to children's higher

math ability and performance (e.g., Becker et al., 2022). As some parents may be anxious about engaging with math (Schaeffer et al., 2018; Soni & Kumari, 2017), it is important to provide them with enjoyable and practical ways to talk with children about math in the home environment. Although speculative, using SBR may have the potential to help alleviate math anxiety because parents and children can relate the story back to their own personal experiences where math is interwoven into daily lives and experiences. If parents already see the value in SBR, they may already be familiar with some quality picture books from diverse genres. Therefore, parents could adopt some of the approaches in Table 1, such as discussing how long it might take Max to travel by boat to the island of Wild Things, then relate that back to their everyday experiences (e.g., talking to their child about distance and the time needed to take the city ferry boat to travel to a destination). Therefore, the SBR experience may also act as a prompt or conversation starter for children to talk with others and learn more about math. By discovering these real-life math connections through SBR, both parents and children may be provided with more ways to experience and talk about math in new and confident ways.

Despite the various opportunities the guide may provide, it has yet to be tested within the natural home environment. Further, there are certain possible barriers to the implementation of the guide, including parents' education and language and literacy levels, especially if English is their second language. Similarly, parents from lower socio-economic backgrounds may find accessing and selecting diverse children's picture books more challenging. Parents may also be restricted by time constraints or a lack of confidence and knowledge, leading to reluctance in adopting the SBR math guide, and some parents might prioritize literacy skills over math skills or have different cultural beliefs about approaching math teaching at home. Similarly, parents may have a particular goal in mind for SBR, such as fostering reading or bonding with their child (e.g., Audet et al., 2008; Leyva et al., 2021), and including too many topics in SBR may be overwhelming for children or their parents. Parents also might require additional coaching on how to engage their children in SBR; therefore, further support from policymakers, community initiatives, and preschools might be required to help address these challenges. Taking these potential limitations into consideration, the next step to the current design-based research study of developing the guide would be to empirically test it with parents and preschoolers, which we plan to complete in a future study. Soliciting parental feedback on the guide and making necessary adjustments can also contribute to greater implementation and effectiveness. A controlled study design with participant groups and standardized measures is needed to provide a clearer understanding of the direct impact and effects of the proposed SRB math guide on early math learning in the home environment. In addition, it is essential to continue testing the guide with parents and preschool children across a range of diverse communities in order to ecologically validate it as a practical tool to guide and support the early learning of math during home-based SBR activities.

7. Conclusions

The proposed SBR math talk guide, which integrates aspects of diverse genres and play into SBR, has the potential to be adopted by parents to use to foster math talk with their child. However, future research is needed to empirically examine parents' implementation of the guide in authentic interaction in the home alongside children's outcomes. Such future research would also need to consider providing parents with math talk coaching to ensure they have the confidence to select quality genres of children's literature and identify if the books they select for SBR would interest their child and have the potential to provide opportunities for math talk within playful and real life settings.

Author Contributions: Both authors were involved in the conceptualization, writing, and editing of the manuscript. D.B.D. was involved in presenting to the workshop and incorporating the feedback prior to writing. All authors have read and agreed to the published version of the manuscript.

Funding: No funding was received for any stage of this research and paper preparation.

Institutional Review Board Statement: Ethical review and approval were not applicable for this paper as the research did not involve humans or animals.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments: The authors extend their thanks to the workshop participants for their participation and feedback on the SBR Math Talk Framework.

Conflicts of Interest: The authors state that there are no financial or non-financial conflicts of interest.

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