

Using Storybooks to Support Young Children's Mathematics Learning at School and Home
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Abstract

Early math skills are crucial to children's math and school success in the following years. The use of storybooks as a mathematics learning method has been discussed frequently in recent years. Shared book reading allows different mathematical conversations to pass between parent or teacher and child. NCTM (1989) promotes the using of mathematics storybooks as a way of introducing mathematical ideas to children, as it offers a meaningful context for teaching mathematics concepts to children. Shared book reading improves children's problem-solving skills, allows for an exchange of ideas, establishes logical, and may prompt discussion of abstract concepts. This chapter reviews how children learn mathematics and research on the use of storybooks for mathematics skill development. It concludes with examples of how explicit and implicit storybooks, in either paper or digital versions, may be used.

Keywords: Storybooks, mathematics, children's learning of mathematics, children's development

1. Introduction

Children's early math skills are strong predictors of their academic skills as they go through school (Huntsinger, Jose,& Luo,2016; Purpura, Logan, Hassinger-Das, & Napoli, 2017). School- and home-based mathematical opportunities for preschool children are often more limited than literacy ones (Ginsburg, Lee, Boyd,2008; Sonnenschein, Metzger, Thompson, 2016). Even when there are available mathematical opportunities, they tend to focus on counting to 20 and identifying simple shapes with little attention to other mathematical skills (Ginsburg et al., 2008). Knowing what we know about the importance of early mathematics skills, along with the need to increase the amount of mathematical opportunities available for young children, shows the need to capitalize on less frequently used methods for teaching mathematics. One such method is using children's storybooks, which according to Development and Research in Early Mathematics Education (DREME), can be used to notice and talk about (1) the number of objects, (2) patterns that repeat and grow, and (3) examples of shapes, and their properties. All of these are examples of mathematics content.

This chapter presents research on young children's mathematical development and suggestions for how teachers and parents can use storybooks to enhance children's exposure to mathematical content. Although school and home clearly are different ecological contexts, teachers and parents can do similar things in their respective settings. The four critical features that are needed to make the mathematics storybook reading interactions effective are: including mathematics language when discussing text, providing the appropriate mathematics content, engaging children's interest, and making the interactions affectively pleasant. In what follows, we address how young children learn mathematics, the use of storybooks for mathematics skill development, and, finally, ways teachers and parents can integrate mathematics into reading storybooks.

How Young Children Learn Mathematics

Young children are most likely to learn new skills when they are presented in the context of engaging, real-life experiences (Sonnenschein, Baker,&Serpell, 2010; Stites & Brown, 2019). Strategies such as questioning, feedback, and practical applications are critical for young children developing strong mathematics skills (Jacobi-Vessels, Brown, Molfese, & Do, 2014). Mathematics instruction needs to engage children in conversations about their understanding of a concept (Linder, Powers-Costello, & Stegelin, 2011) because the use of mathematical language is essential to skills development (Clements, Baroody, & Sarama, 2014; Purpura & Logan, 2015).

Despite what we know about how young children learn mathematics, the ways in which young children are taught mathematics, particularly in school, often focus on more traditional, didactic means of instruction (Ginsburg et al., 2008). Preschool mathematics instruction often lacks play-based interactions using games and toys (Ginsburg et al., 2008) and has lower levels of mathematical language use (Rudd, Lambert, Satterwhite, & Zaier, 2008). A study by Stites, Sonnenschein, Dowling, & Gay (2021) demonstrated that preschool teachers typically use whole group instruction or small, teacher directed centers to teach mathematics, with little to no mathematics instruction occurring during unstructured time, like free play. Parents are more likely to engage in less structured, play based interactions, but not in mathematics (Sonnenschein, Metzger, & Thompson, 2016).This is why parents and teachers need to make mathematics tasks congruent with children's interests because they will be more likely not only to learn mathematics but develop an intrinsic interest in mathematics (Ginsburg, Uscianowski, & Almeda, 2018; NAEYC/NCTM, 2010; Pomerantz & Grolnick, 2017). This, in turn, allows for continued growth of mathematics conceptual understanding (Sonnenschein & Dowling, 2019).

The Use of Storybooks for Mathematics Skill Development

Children's storybooks are an essential educational tool that enable them to develop cognitive, social, language and social emotional skills (Bulut & Kusdemir, 2013; Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012; Uzmen & Magden, 2002). The U.S. National Council of Teachers of Mathematics (NCTM) has long posited the use of storybooks as a way of introducing mathematical concepts to children (Casey, Kersh, & Mercer-Young, 2004). Children's storybooks provide a context through which patterns, problem solving, estimation and probability, and real-world contexts may be explored (Moyer, 2000; Kribs & Ruebel, 2008; Yilmaz-Genç, Akıncı- Cosgun, & Pala, 2017). Storybooks also provide a link between children's language skills and math skills (Hong, 1996), and may decrease mathematics anxiety (Pomykal-Franz & Pope, 2005). In addition, using storybooks also provides real-world opportunities for children to explore mathematics by providing problem-solving texts (Moyer, 2000) as well as allowing for cultural applications and connections (Casey, 2004; Furner, 2018).

Although not explored with mathematics development, the affective quality of reading interactions is important in fostering a positive attitude towards reading and increased frequency of engagement in such activities. For example, kindergarten children who engaged in affectively positive reading interactions increased the likelihood that they would choose to read in first grade (Sonnenschein & Munsterman, 2002), and, in turn, their reading skills were higher in third grade (Baker, Mackler, Sonnenschein, & Serpell, 2001). This has not been studied with interactions involving mathematics content; however, we would expect a similar pattern for such interactions when discussing mathematical content in storybooks.

Literature for young children typically includes illustrations which allow children to contemplate different ideas and concepts as they hear or read the text (Uyanik-Balat, Kılıç, Degirmenci, & Unsal, 2017). A study by Robin (2009) demonstrated that representations in picture books often assist children in learning more easily otherwise complex topics. More specifically, written text and illustrations in children's storybooks provide opportunities for mathematical ideas to be explored (Moyer, 2000).

Previous research has shown a positive association between reading children's storybooks and an improvement in children's mathematics skills (Hendrix, Hojnoski, & Missall, 2019; Horst, & Houston-Price, 2015; Skoumpourdi, & Mpakopoulou, 2011; Van den Heuvel-Panhuizen, Van den Boogaard, & Doig, 2009; Vandermaas-Peeler, Nelson, Bumpass, & Sassine, 2009). In fact, when storybooks with mathematics concepts are used in the classroom, children are more likely to become engaged with mathematics concepts (Sonnenschein & Dowling, 2019) and increase their conceptual understanding (Berkowitz et al., 2015). For example, a study by McAndrew, Morris, & Fennell (2017) used children's storybooks containing geometric concepts in a second-grade classroom. Teachers read the storybooks to the class as a read aloud and then provided the children with a mathematical task to complete. The children who participated in this intervention demonstrated higher levels of engagement and geometric conceptual understanding than when the curriculum was not supplemented by storybooks.

Uscianowski, Almeda, & Ginsburg, (2020) grouped storybooks for mathematics into two categories: (1) storybooks with explicit mathematics content (referred to by the authors as math storybooks) where the goal of the text is to teach a mathematical topic (e.g., measurement); and (2) storybooks with implicit mathematics content (referred to as storybooks) where any mathematical topics are secondary to the story. Storybooks with explicit mathematical content are written to teach a specific mathematical concept. For example, *Feast for Ten* (Falwell, 2008) is a math storybook where children may count along to 10 with a family as they shop and prepare food for a family dinner. In contrast, *The Very Hungry Caterpillar* (Carle, 1994), is an implicit storybook. In *The Very Hungry Caterpillar*, a young caterpillar eats through various types and quantities of food prior to becoming a butterfly. Beyond the explicit story, children can count types of food and days of the week and identify a variety of shapes and patterns.

Storybooks do not have to have an explicit mathematical topic to be a venue for mathematics instruction as both implicit and explicit storybooks have been shown to be effective means for teaching mathematics. Van den Heuvel-Panhuizen, et.al.(2009) provided children storybooks with implicit mathematical themes. The children explored the storybooks independently and then individually interacted with their teacher on tasks including the concepts addressed in the stories they had read. The children demonstrated an increase in geometry, data-analysis, and measurement skills.

Storybooks have also been shown to increase children's mathematical language use, which in turn, increases mathematics skills (Gunderson & Levine, 2011; Purpura & Reid, 2016) as well as their ability to think and communicate mathematically (Moyer, 2000). When teachers model mathematical language while engaging with children and connect mathematics concepts to children's interests, the children's mathematics skills increase (Jacobi-Vessels et.al., 2014; Stites & Brown, 2019). In fact, preschool children's growth in early numeracy skills from fall to spring is associated with the amount of mathematics language their teachers use (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006) and provides teachers a means for evaluating children's understanding through questioning (Furner, 2018).

Researchers and teachers agree that the learning activities young children engage in at home are critical for their early educational development (McCormick et al., 2020; Sonnenschein & Sawyer, 2018). However, although parents believe both reading and mathematics skills are important, they emphasize and value reading more than (Sonnenschein et al., 2016). This failure to prioritize mathematics learning at home may stem from a lack of confidence in both how to foster mathematics skills and knowledge of the mathematical concepts themselves (Cannon & Ginsburg, 2008; Sonnenschein et al., in press). Parental anxiety related to mathematics may negatively impact their ability to foster meaningful mathematical experiences for their children (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Storybooks is a way parents may overcome their own mathematics anxiety and support their children's skill development.

Research has shown that parents support their children's mathematics skills through formal and informal mathematics activities (Blevins-Knabe & Musun-Miller, 1996; Huntsinger et al. 2016; LeFevre, Polyzoi, Skwarchuk, Fast, & Sowinski, 2010; Metzger, Sonnenschein, & Galindo, 2019; Skwarchuk, 2009; Sonnenschein & Sun, 2016). When parents read a storybook with their children, they provide an opportunity to facilitate the development of their children's problem-solving skills, exchange their ideas, and establish logical relationships between the elements in the story and discuss abstract concepts (Hindman, Skibbe, & Foster, 2014; Hojnoski et al., 2014; Van den Heuvel-Panhuizen, Elia, & Robitzsch, 2016).

Storybooks is a vehicle for mathematical discussion between a parent and child (Boonen, Kolkman, & Kroesbergen, 2011; Gunderson & Levine, 2011; Hojnoski, Columba, & Polignano, 2014). During these mathematical conversations, children can explain their thinking about a skill or problem using their own words (Fuson, Kalchman, & Bransford, 2005). Research has demonstrated that these mathematics conversations are especially effective in supporting the mathematical knowledge of young children, especially if there is use of mathematical language (Ferrara, Hirsh-Pasek, Newcombe, Golinkoff, & Lam, 2011; Ginsburg, 2009; Perry & Dockett, 2008).

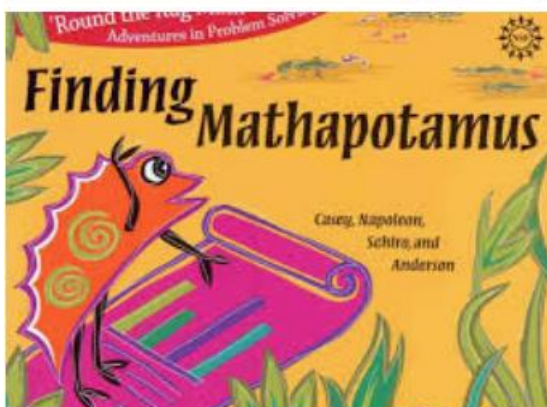
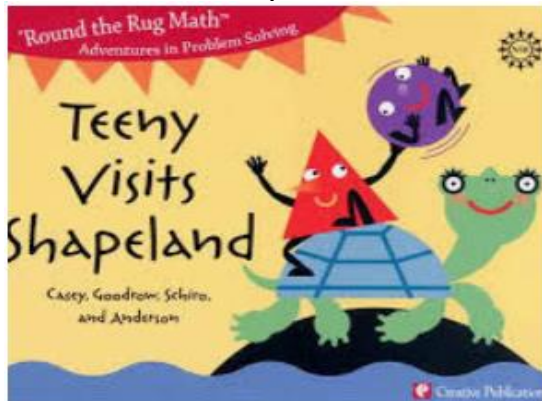
Ways Teachers and Parents Can Integrate Mathematics into Reading Storybooks

As discussed earlier in the chapter, storybooks can be effective tools for teaching mathematics to preschool children. Storybooks can be hardcopy or digital depending on availability and preferences. Digital storybooks embed multimedia technologies and make the storybooks highly interactive and thus, engaging (Ginsburg et al., 2018).

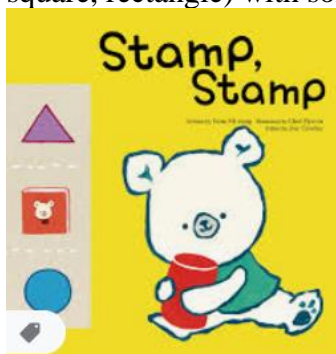
It is important to keep in mind that some parents may not be comfortable supporting their children's mathematical skills (Cannon & Ginsburg, 2008). Accordingly, teachers may need to

support these parents by providing resources for them and guiding them through what to do with their children. A critical component for choosing storybooks to support mathematics learning is ensuring that all books are reviewed for mathematics content, visual appeal, gender, and cultural inclusiveness (Whitin & Whitin, 2004). The following paragraphs present examples of explicit, implicit, and digital storybooks.

An example of a book with explicit mathematics content is the, “*Round the Rug Math: Adventures in Problem Solving*” series by Beth Casey (2004). This series of books teaches early childhood mathematics (Pre-K to Grade 2), through a series of six problem-solving adventure stories. Teachers and parents can select from the supplementary books in this series to enrich their teaching and address gaps in their present mathematics curriculum (Casey, 2004). Below are two examples of “*Round the Rug Math*” series books.

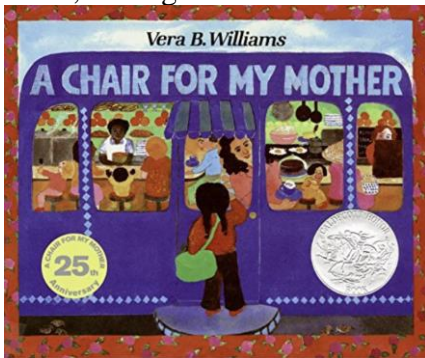


“*Stamp, Stamp*” (Eom, 2015) is designed to teach children shapes. The teddy bear prints are in different geometric shapes. The cute teddy bear associates basic shapes (round, triangle, square, rectangle) with solid objects and everyday items.



Adults can integrate storybooks with implicit mathematical themes into daily reading as well. For example, in “*A Chair for My Mother*” (Williams, 1993), a family saves money for a

new chair after their belongings are lost in a fire. Adults can work with children on counting coins, talking about how much money is needed, and even identifying shapes in the home.



Digital storybooks allow children to engage in mathematics, reading, and games while exploring the storybook. DREME recommends digital storybooks like “*Monster Music Factory*, *Monster Birthday Surprise*, and *Monster Frog Pond*” to support young children’s mathematics learning.



Please see DREME for a listing of storybooks and ways to implement them into mathematics (<https://familymath.stanford.edu/activities/reading-together/>).

Conclusion

In this chapter we have outlined how young children learn mathematics, why storybooks are an effective means for teaching young children mathematics, and how to use storybooks in teaching mathematics skills. Using storybooks to teach mathematics is not a new concept; researchers have long posited their effectiveness in engaging young children in learning mathematics skills (Hassinger-Das, Jordan, & Dyson, 2015). However, preschool teachers continue to teach mathematics using more traditional methods of teaching mathematics such as direct instruction (Stites et al., 2021). Parents, on the other hand, report not reinforcing mathematics skills in the home as frequently as those associated with reading likely due to a lack of confidence in their own skills (Cannon, & Ginsburg 2008; Sonnenschein et al., in press). It is important that we continue to support both preschool teachers and parents in using storybooks to teach mathematics by sharing the resources provided by associations like DREME and NCTM.

Using storybooks provides young children with an engaging way to “do” mathematics, and improve their skills. This is critical because we know preschool classrooms often lack mathematical opportunities, teachers need more support to effectively increase mathematical engagement (Ginsburg et al., 2008; NAEYC and NCTM, 2010; Stites et al., 2021) and parents are less likely to engage in mathematics interactions with their children (Ginsburg et al., 2008; Metzger et al., 2019). Storybooks provide a means for teaching mathematics that is accessible to both teachers and parents.

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