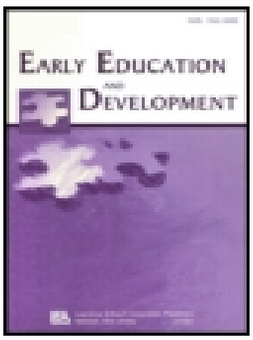

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Mathematics Learning Opportunities in Preschool: Where Does the Classroom Library Fit In?

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ABSTRACT

Research Findings: These two studies examined the different mathematical opportunities provided in preschool classrooms, with a particular focus on the availability of mathematical-themed books in classroom libraries. In study one, we interviewed teachers (N= 150) using an online survey to assess the content of preschool classroom libraries. In study two, we interviewed eight preschool teachers to examine their perceptions of how they teach mathematics and if they view the classroom library as a place for mathematical skill acquisition. Results of the online survey indicated that while teachers encourage the use of classroom libraries, these contained statistically fewer mathematics themed books. Teachers also spontaneously reported that mathematics was something done in the "math center" and not the library. Preschool teachers reported providing many mathematical opportunities throughout the day, but did not necessarily utilize the classroom library for mathematics. *Policy or Practice:* Given the prevalence of classroom libraries in preschools, we may be missing an important means of providing mathematical exploration, exposure, and opportunities for young children. This potential missed opportunity is an area for additional research.

The importance of children's early mathematics skills for their future academic and vocational development cannot be overstated (Blevins-Knabe, 2016; Duncan et al., 2007; Geary, 2011; National Mathematics Advisory Panel, 2008). For example, Watts, Duncan, Siegler, and Davis-Kean (2014), using a large sample from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, found that children's mathematic skills at 54 months predicted their mathematical achievement at 15 years (see also Bailey, Siegler, & Geary, 2014; Lehrl, Ebert, Blaurock, Rossbach, & Weinert, 2019). Unfortunately, far too many children in the United States earn low scores on standardized math assessments (National Mathematics Advisory Panel, 2008). Only 40% of U.S. fourth graders, 34% of eighth graders, and 25% of twelfth graders scored in the proficient or advanced range on the 2017 National Assessment of Educational Progress (NAEP) mathematics assessment (National Center for Education Statistics, 2018). Providing all young children with a solid mathematical foundation at the start of formal schooling or even before is critical for their later success (Claessens & Engel, 2013; Duncan & Magnuson, 2011; Jordan, Kaplan, Ramineni, & Locuniak, 2009; Nguyen et al., 2016; Stites & Brown, 2019).

The preschool classroom can be an important venue for providing such a mathematical foundation (Barnett & Hustedt, 2003; NAEYC/NCTM, 2010; National Council of Teachers of Mathematics, 2013; Pianta, Barnett, Burchinal, & Thornburg, 2009) because many children in the U.S. attend some

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form of preschool (McFarland et al., 2019). However, as Ginsburg, Lee, and Boyd (2008) note, opportunities for young children to engage in mathematics activities in school as well as the types of mathematical activities they engage in is often limited and tend to focus primarily on numeracy, either leaving out or placing far less emphasis on other mathematical skills. Piasta, Pelatti, and Miller (2014) found, based on observations of 65 preschools, that children on average spend about 24 minutes a day with access to mathematics activities, typically spatial awareness and some form of numeracy, out of 101 minutes of instructional time. Such studies, along with the difficulties many children in the U.S. subsequently display with mathematics, highlight the need to investigate further what mathematics learning opportunities are available in preschool classrooms, particularly for different groups of children. A focus on preschool is particularly important because demographic group differences in mathematics skills are evident by then (Siegler, 2009), and the resources in preschools catering to different groups of children may vary (McGill-Franzen, Lanford, & Adams, 2002).

This paper extends prior investigations of opportunities for children's mathematics acquisition by asking preschool teachers to report whether they utilize story books in classroom libraries for mathematics learning (Study 1 and Study 2), and, more generally, how they view mathematics instruction occurring in their classrooms (Study 2). We were particularly interested in the role that classroom libraries play because such libraries are available in many preschool classrooms, at least middle-income ones (McGill-Franzen et al., 2002). Research has investigated the effects of classroom libraries on literacy development (Neuman, 1999), but not mathematics development. In what follows we first review research on how children learn mathematics and then turn to opportunities potentially available in preschool classrooms in general and, more specifically, in classroom libraries. As the review of the literature will show, opportunities for mathematics learning in young children's classrooms are less prevalent than other forms of learning. In addition, our knowledge of what these opportunities are, particularly with classroom libraries, is still quite limited.

How Preschool Children Learn Mathematics

Children acquire mathematics competencies and interest in mathematics through direct instruction, seeing others model mathematics interactions, and incidental exposure to mathematics such as playing games and engaging in other mathematics-related activities (Ginsburg et al., 2008; LeFevre et al., 2009; Sonnenschein, Metzger & Thompson, 2016). Children learn best when they are provided with activities that draw upon their everyday experiences and can choose ones that engage their interest (Sonnenschein, Baker, & Serpell, 2010; Sonnenschein, et al.2016; Stites & Brown, 2019). An approach that takes interest and skill development into account allows children to develop appropriate mathematics skills *and* builds upon what many describe as an inherent interest in mathematics (Ginsgurg, Lee & Boyd, 2008; NAEYC/NCTM, 2010; Pomerantz & Grolnick, 2017). This, in turn, can lead to further engagement in mathematics activities and subsequent skill development (Stites & Brown, 2019). Please note that our emphasis on the importance of children's engagement in their learning does not minimize the importance of the role of teachers. It is equally important that teachers have a strong understanding of mathematics content as well as pedagogical knowledge of how to teach mathematics (Ginsburg & Amit, 2008; Ginsburg et al., 2008).

Using Mathematics Storybooks. Research on literacy development shows the significant and positive association between storybook reading and children's frequency of reading and subsequent development (e.g., Serpell, Baker & Sonnenschein, 2005). Such patterns occur because of the language used, helping children become familiar with conventions of narratives and print, and the social-emotional context in which reading occurs (Sonnenschein & Munsterman, 2002). Although research with mathematics storybooks is more limited, similar patterns occur. Reading mathematics storybooks, either through dyadic reading at home or teacher reading in class, increases children's mathematical interest and engagement (Sonnenschein & Dowling, 2019), promotes mathematical discourse (Anderson, Anderson, & Shapiro, 2004; Anderson, Anderson,

& Shapiro, 2005; Hojnoski, Columba, & Polignano, 2014; Rathe, Torbeyns, De Smedt, Hannula-Sormunen, & Verschaffel, 2018), and is associated with the development of children's mathematics skills (Berkowitz et al., 2015). For example, McAndrew, Morris, and Fennell (2017) used storybooks with embedded geometry content to increase second graders' interest in geometry and improve their skills. The teacher read books with embedded geometry content and provided children with a related task to complete. The children demonstrated increased interest in and performance on geometry tasks.

Children need access to mathematics activities, including storybooks, that engage their interest and they need instruction to promote their skills (Chien et al., 2010; Ginsburg et al., 2008). Uscianowski, Almeda, and Ginsburg (2020) categorized books into: (1) 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. counting); and (2) implicit mathematics content (referred to as storybooks) where the topics are secondary to the story. An example of a book with explicit mathematical content is *Chicka, Chicka, 1-2-3* (Martin & Sampson, 2005), where the point of the book is counting. A book with implicit mathematics text is *The Doorbell Rang* (Hutchins, 1986) where the division of the cookies is secondary to the theme of baking and sharing cookies.

van den Heuvel-panhuizen, van den Boogard, and Doig (2009) used storybooks with implicit mathematical themes with five and six-year-old children to determine if exposure to this type of literature improved children's mathematical understanding. The researchers did not provide direct mathematical instruction, but instead allowed children to explore picture books with implicit mathematics concepts with support from their teacher in one-on-one sessions. Children were able to engage in meaningful mathematics experiences that built upon their informal knowledge about geometry, data-analysis, and measurement, and demonstrated an increase in these skills.

In a similar study, van den Heuvel-panhuizen, Elia, and Robitzsch (2016) used a quasi-experimental design to examine the effects of using implicit mathematics storybooks when teachers read to the whole group. Teachers were given books with implicit mathematics storybooks to read with children in their classes and prompts for addressing numeracy, measurement, and geometry skills. The researchers focused on exposure to, rather than direct instruction in, mathematical concepts. Children exposed to the storybooks showed an increase in overall number, geometry, and measurement skills.

An important element of reading mathematics storybooks is the mathematics language (vocabulary) used during the interactions. The mathematical language children hear from teachers or other adults is positively associated with the development of their mathematics skills (e.g., Gunderson & Levine, 2011; Purpura & Reid, 2016). Jacobi-Vessels, Brown, Molfese, and Do (2014) reviewed research showing the importance of teachers utilizing mathematics language during their interactions with children and linking mathematics concepts to real-life situations in order for children to build a strong mathematics foundation (see also Stites & Brown, 2019). Klibanoff, Levine, Huttenlocher, Vasilyeva, and Hedges (2006) observed the amount of mathematics language preschool teachers in 26 preschools engaged in during circle time and the hour immediately afterward. The amount of such talk was significantly related to children's growth in mathematics skills from fall to spring.

The Preschool Classroom as an Opportunity for Mathematics Acquisition

As Early et al. (2010) discuss, activities in preschool classrooms frequently fall into one of three categories: meals/routines, teacher directed, and free choice (see also Chien et al., 2010; Ginsburg et al., 2008). Meals and routines are considered to be transitions, snack, and bathroom breaks. Teacher-directed activities are either didactic in nature (e.g. teacher uses modeling or direct instruction with small or large groups of children) or scaffolded (teacher prompts and extends child thinking). Free choice is defined as any activity that a child self- directs and is not dictated by the teacher. For example, a specific art project with defined instructions (e.g. everyone makes

a butterfly) at the art center is teacher directed; having different types of art materials for children to explore and create something of their own choosing is free choice. Based on observations of 2061 children in 652 prekindergarten classrooms in 11 states, Early et al. found that only six percent of free choice time was spent engaging in some form of mathematics. Note that the classroom library is typically viewed as a free choice option because children are able to choose a book and independently explore it. However, Early et al. (2010) did not separately consider classroom library time as a part of free choice time, leaving the question of how the classroom library is used to foster mathematics development.

Although the number and frequency of math activities appear to be limited in preschool classrooms, classroom libraries are common in these classrooms. Therefore, the library may be an important resource for increasing children's exposure to math, however, research has not yet addressed this question. Research on children's classroom library use is positively associated with aspects of children's literacy development, particularly when teachers encourage children to use the library (Hunter, 1999; Neuman, 1999). However, research on the impact of the classroom library on children's mathematics development is sparse. Much of the research has focused on increasing children's access to storybooks and seeing growth in children's reading skills.

Although research shows that dyadic or group-based reading interactions using books with mathematics content leads to growth in children's mathematics skills (e.g., Hassinger-Das, Jordan, & Dyson, 2015; Uscianowski et al., 2020; van den Heuvel-panhuizen et al., 2009), teachers do not frequently engage in such types of reading interactions with young children. Studies that have observed teacher read-alouds found that teachers read mathematics-related books far less frequently than other types of books. For example, Pentimonti, Zucker, and Justice (2011) found that of 426 books read to their students by 13 preschool teachers, only 31 were mathematics-related. Yopp and Yopp (2012) had similar results. It is clear that many opportunities exist for incorporating more mathematics into the preschool classroom. In particular, classroom libraries appear to be underutilized resources for mathematics, however, research has not yet directly examined using these resources.

The Present Study

Exposure to mathematics storybooks facilitates preschool children's mathematics skills (Hassinger-Das et al., 2015; Uscianowski et al., 2020; van den Heuvel-panhuizen et al., 2009) and attitudes toward mathematics (Hong, 1996; Uscianowski et al. 2020). Classroom library use is positively associated with children's literacy development, particularly when storybooks are available and teachers encourage children to use the library (Hunter, 1999; Neuman, 1999). However, there does not appear to have been research on whether the library in preschool classrooms is used by teachers to foster children's mathematics engagement.

To address this gap in the literature, Study 1 used an online survey to assess teachers' reports about the content of their preschool classroom libraries and whether/how they encouraged children to make use of these libraries. Study 2, using a small group of preschool teachers, builds upon the findings from Study 1 in two ways. One, we further explored how teachers used mathematics storybooks in the classroom library. Two, serendipitous findings from Study 1 indicated that the classroom library may not be seen as a venue for mathematics exposure and learning, at least for some teachers. Accordingly, we interviewed a small group of teachers about what they do to foster preschool children's mathematics development.

The two studies in this paper address the following main research questions:

(1) Do preschool teachers use the classroom library to foster children's mathematics development, and if so, how?
(2) How do preschool teachers report teaching mathematics?

Findings from these studies are important because they provide evidence for what teachers report doing to foster young children's mathematics skills. Such information then can serve as a foundation for ways to engage children in mathematics activities and facilitate the development of mathematics skills.

Study 1

Study 1 examined if and how the classroom library is used to teach mathematics in preschool classrooms. This study used a mixed-methods approach to investigate the content of preschool teachers' classroom libraries. Of particular interest was the relative number of mathematics texts in the libraries and what teachers said they did to encourage children to use them.

Method

Participants

After obtaining approval from our institution's IRB, participants were recruited through social media sites for preschool teachers. These sites were moderated by practicing preschool teachers; members were screened prior to group acceptance to ensure appropriateness for the group. Surveys also were distributed by local state and educational agencies, and via e-mail through convenience sampling. A total of 250 people participated in this survey. The majority of participants were female (98%), White (73%), and college-educated (92%). The mean age of participants was 45 years (SD = 11.63). Most of the participants were lead or head teachers in their classrooms (87%). About 18% worked at Early Head Start/Head Start or Title 1 schools. Table 1 provides an overview of demographic information There were no statistically significant differences in key responses based on the gender of the teachers, the income of families using the facility, the educational level of the teacher or the number of years of experience teaching. Accordingly, these are not considered factors in subsequent analyses.

Table 1. Study 1 participant characteristics (N = 250).

Variable	*M* (*SD*) or %
Age (years)	44.75 (11.63)
Gender (% female)	98.4
Race/Ethnicity (%)	
American Indian or Alaskan Native	<1
Asian	4.4
African American/Black	13.7
Latino/a/x	2.4
White	73.4
Bi-, multi-racial/ethnicity	3.6
Other	2.0
Highest Educational Degree (%)	
Less than HS	<1
HS/GED	7.1
AA	14.3
BA/BS	47.3
Post-Graduate	30.8
Position in Classroom (%)	
Head/lead teacher	87
Assistant teacher	6
Teacher's aide	<1
Other	6.5
Teacher works in Early Head Start/Head Start Center (%)	
Yes	4.8
No	95.2
Teacher works in Title 1 School (%)	
Yes	13.1
No	86.9

Procedure

The survey was distributed online on social media, after securing permission from the site master and via e-mail. The link to the survey was reposted bi-weekly over the course of three months.

Measure

The Qualtrics online survey contained 37 multiple-choice and open-ended questions, including a section on the participant's demographic background and questions about the contents of the classroom library. Prior to full scale distribution, the survey was piloted with 10 preschool teachers. Feedback from the pilot study was used to modify the survey before dissemination of the final instrument.

Participants reported whether they had a library in their classroom, how frequently, on average, children used this library, and the number of different types of books (e.g., informational texts, ABC books, picture/storybooks, mathematics storybooks) available in the classroom library. Teachers also reported what, if anything, they did to encourage their students to use the classroom library. Sample questions are provided in Table 2.

Coding and Scoring of Data

Quantitative questions were downloaded directly from Qualtrics and analyzed. Responses to the question asking what teachers did to encourage the use of the library were reviewed independently for themes by two of the authors. The authors then compared themes and reconciled any questions. Overall, coders demonstrated 96% interrater reliability. The few discrepancies in coding were resolved by discussion (see Table 3).

Table 2. Study 1 survey items.

	Items	Response type
Q3	Do you have a library/reading center in your classroom that is accessible to children?	Yes/no
Q4	On a typical day, approximately how many books are available in your classroom library?	Open-ended
Q5	Are any books in your classroom library digital?	Yes/no
Q6	On a typical day, approximately how much time do children spend in the classroom library?	Open-ended
Q7	What type of books are available in your classroom library? (a) Informational texts (e.g. factual books, nature or science books) (b) Fantasy books (c) Story/picture books about people (d) Story/picture books about animals (e) Math storybooks (e.g., books focused on math topics like counting, patterns, etc.) (f) Other	Check all that apply
Q9–11	Of the books available in your classroom library, approximately how many of these books are [informational text, story/picture books, math storybooks]?	Open-ended
Q12	What additional materials, if any, (e.g., flannel boards, puppets, games, etc.) are available in your classroom library?	Open-ended
Q13	How many games/activities in your classroom library focus on math?	Open-ended
Q14	If you do have autonomy to choose books, materials in your classroom library, how do you do so? Please explain.	Open-ended
Q16	Are there materials you wish you had, but are unable to access/acquire for some reason? Please explain.	Open-ended
Q17	Do you do anything to encourage children to use the classroom library? Please explain.	Open-ended
Q18	Do you allow children to take books/games from the classroom library home?	Yes/no
Q19	Are there any other thoughts (positive or negative) about your classroom library that you would like to share?	Open-ended

Only content-relevant items are included in table. Demographic questions from survey are excluded.

Table 3. What do you do to encourage children to use the classroom library? (n = 161).

Codes	Frequency (*n*)	Frequency (%)
Provide time for library use		
Open during center rotation and/or free choice	23	14
Library used for transition between activities	22	14
Scheduled library/book time	12	7
Used for quiet time or as rest area	7	4
Planned independent reading/DEAR time	6	3
Library is always a choice	3	1
Materials/space		
Rotate materials available in library/include new materials	29	18
Choose materials of interest to children	22	14
Place toys, games, and other materials in library (e.g., stuffed animals, flannel boards)	16	10
Create space that is comfortable and inviting to children	16	10
Place books throughout the classroom (e.g., in other centers)	5	3
Easily accessible to children	5	3
Teacher behaviors		
Provide opportunities for children to read with adults (e.g., story time, adult present in library center)	41	25
Introduce books to children/read book aloud before placing in library	35	22
Model reading behaviors to children	23	14
Engage in activities related to books (e.g., play, have children create their own book)	18	11
Encourage children to choose or look at books	15	9
Encourage buddy/peer-to-peer reading	12	7
Talk about reading/how to treat books or behave in library	11	7
Allow children to take books home	6	4
Involve children during group reads (e.g., let them turn pages or select story)	4	2
Positive reinforcement for reading (e.g., prizes)	3	2

Results and Discussion

How the Classroom Library is used

Fifty-eight percent of teachers said they encouraged children to use the classroom library at some point during a typical school day. To encourage use of the library, teachers noted different ways of getting the children excited about the library. For example, one teacher noted, "I spend as much time as possible with the children in the library, reading, talking, asking questions, and listening. I try to keep materials fresh and new and relevant to what they are currently interested in". Another stated, "We guide kids to the library materials if we think they will enjoy them". Of the teachers who reported encouraging use of the library, 23% spontaneously noted that they allowed library use during free choice activities; 22% noted it was available for use during transitions between activities, such as after snack, and when children finished other work. Seventy-five percent of the teachers who had a classroom library indicated that it was available to children between 10 and 30 minutes per day (range 0–140 minutes).

Table 3 shows the three general ways that teachers encouraged the children to use the classroom library (making time available, making the library attractive, and specific behaviors teacher engaged in). The most common teacher behavior (25%) was providing opportunities for children to read with an adult either through group read-alouds or by having an adult available in the classroom library during the day. Teachers (22%) also reported introducing and drawing children's attention to new books or reading the books aloud first and then making the book available in the library. Teachers employed several strategies to keep children interested in the library. Frequently reported strategies included rotating available materials in the library (18%) and choosing materials that were of interest to children in the classroom (14%). One teacher noted, "We have built-in transitions where the children are able to choose a book to 'read'. Our Quiet Area bookshelf is full of interesting reading material. We rotate out books regularly to keep children interested. We set up our bookshelf with brightly colored books to garner attention!"

Content of Preschool Classroom Libraries

Almost all teachers (98%) reported having a classroom library; 81% of those who had a classroom library reported that their libraries contained mathematics storybooks. However, there reportedly were significantly fewer mathematics texts (M = 6.86) in the classroom libraries, than storybooks (M = 24.66), informational texts (M = 12.27), or alphabet texts (M = 9.05), $F(3, 531) = 110.774$, $p = .000$, $\eta p^2 = .385$.

Although most teachers reported having mathematics books in their classroom libraries, 11% spontaneously reported keeping mathematics materials in a separate "math center" and not in the library. For example, one teacher stated, "I have a math area that is not in the library. The math books and materials are in the math area." Another teacher spontaneously mentioned, "the math games/activities, and books are mostly in my math center. My math center is in a separate area of the room, and I have books in that center that are focused on the unit and activities in the math center." Teachers who reported using mathematics centers indicated that they populated them with hands-on, engaging materials for mathematics. One teacher said,

> "We have a math center separate from the library with counting manipulatives, dice for math games, dry erase worksheets for writing numbers, dry erase math books, paint dabbers for dabbing the numbers on worksheets, geometry sticks for building shapes, board games, teacher-made materials that go along with themes, measurement materials- cups, scales, etc."

These statements suggest that teachers may be providing engaging materials to foster their children's mathematical skills. However, this should not discount the potential importance of the classroom library, which, if used to foster mathematics, may provide children with a different or additional set of pertinent experiences.

In sum, most preschool teachers (98%) reported having a classroom library that was available to children throughout the course of the day. However, there were significantly fewer mathematics texts in the library than other types of books. In fact, as noted above, about 11% of the teachers spontaneously reported that the library was not a place for mathematics learning to occur. Although those teachers discussed ways they populated mathematics centers, such centers, while important, may not provide children with the same experiences as a classroom library containing mathematics books might.

Study 2

This study builds upon findings from Study 1 that the classroom library may not be viewed as a venue for fostering children's mathematics development, at least for some teachers. To better understand how teachers conceptualize the nature of mathematics exposure and instruction in the preschool classroom, we interviewed a small group of preschool teachers (N = 8). We again asked about the use of the preschool library and explored further how teachers use math storybooks in their libraries. We also explored other opportunities for mathematics instruction and the nature and content of that instruction. We wanted to know what teachers' approaches to mathematics instruction was, whether mathematics instruction was a teacher-directed activity, a free choice option, or a combination of both. As well, we asked teachers how confident they felt to teach mathematics. And, finally, we examined what kinds of mathematics activities teachers reported as being available for children to engage in during free choice activities. As in Study 1, we used a mixed-methods design.

Method

Participants

After receiving IRB approval from our institution, two preschool administrators of local centers located on or near college campuses were approached and agreed to allow their teachers to participate in this study. Both centers were run by the YMCA and served children from ages three to five.

The final sample in this study consisted of seven preschool teachers and one assistant teacher, all of whom were female. Four identified as White, 3 as Black/African, and 1 as Asian American. Data saturation was achieved after eight interviews. That is, the content of the responses across teachers had become redundant and additional interviews would not likely have uncovered new information. This is typical of samples that are relatively homogeneous (Aldiabat & Le Navenec, 2018; Bonde, 2013; Guest, Bunce, & Johnson, 2006). Participating teachers had been teaching for an average of 14 years (M = 14, SD = 8.78, range 2–22 years) and had completed a minimum of 90 hours of child-care education.

Procedure

Teachers were individually interviewed by trained graduate and advanced undergraduate research assistants. Interviews were conducted in a quiet room in the teacher's school. These interviews were audio recorded and the interviewer took field notes. The audio recordings were transcribed and the transcripts were checked for accuracy by the interviewer as well as another research assistant.

Measure

Interviews were semi-structured in nature. Although the questions included how teachers fostered children's literacy, mathematics, and science development, we report here only on questions focusing on mathematics development. Questions were piloted with five preschool teachers and were modified based on feedback.

Interview questions (see Table 4) focused on how mathematics is taught and how mathematics skills are developed using teacher-directed centers, free-play, and the classroom library. For example, "Do you set aside explicit instruction time for math?" and "Do you have a mathematics center?" Teachers were also asked, "What types of mathematics materials are available during free play?" and "Do you do anything to encourage children to use mathematics materials during free play?" Teachers also reported on whether or not they had mathematics storybooks in their classroom library and if they kept other mathematics materials in the library. The final set of questions examined teachers' beliefs about the importance of mathematics in the preschool classroom and their confidence in fostering these skills. For example, "How important do you think it is to teach mathematics to

Table 4. Survey 2 interview questions.

	Sample question	Response type
Q4	Can you provide examples of how math is incorporated throughout the day?	Open-ended
Q5	Do you set aside explicit instructional time for math?	Yes/no
Q5[b]	For each of the activities described above can you tell me if these activities occur: one-on-one whole group in teacher-led small groups or other?	Open-ended
Q7	Do you have a math center(s)?	Yes/no
Q7[a]	Do you do anything to encourage children to use the math center?	Open-ended
Q8	What types of math materials are available during free playtime? (Probe if needed: For example, blocks)	Open-ended
Q8[a]	Do you do anything to encourage children to use math materials during free play?	Open-ended
Q10	Does your classroom library have math storybooks?	Yes/no
Q10[a]	Can you tell more about this? What types of books does your library have? Can you provide specific titles?	Open-ended
Q10[b]	Does the library include any math games?	Yes/no
Q11	When you read traditional storybooks aloud to children, do you ever incorporate math themes?	Yes/no
Q12	Do you use math activities in any other ways during the day that we have not talked about?	Open -ended
Q13	How important do you think it is to teach math to preschool children?	Likert scale 1–5
Q14	How confident are you in your ability to support your students' math learning?	Likert scale 1–5
Q15	What, if any, additional assistance would be helpful to make you better able to support your student's math learning?	Open-ended
Q16	Do you have any other thoughts or opinions about fostering math in preschool that you would like to share with us?	Open-ended

Table 5. Study 2 qualitative coding scheme and frequencies.

Interview Codes	Illustrative Quote	Frequency (*n*)
Where math is taught		
Circle time/whole group	*"Circle time always includes the calendar. The date of the current day of the week will not be up when circle time begins. Instead, they'll start by asking how old the month (e.g., April) was yesterday and then asking how old it is today."*	8
Math center	*"There are games and manipulatives."*	7
Routines	*"When we line up we count the students."*	2
Incidental exposure	*"We find shapes when we go outside."*	5
Free choice[a]	*"We have [free choice] games that require them to do things like counting, or sorting."*	7
Content of instruction		
Counting	*"We count shapes, we count the sides of the shapes.*	8
Geometry	*" … when we're outside there's different shapes outside. And that's also a good way to introduce three dimensional shapes … "*	8
Patterning	*" … we do patterns with our bears … "*	3
Spatial awareness	*"They like to do Legos, so then they make towers."*	2
Graphing	*"We do graphing in the class based on our theme."*	1
Measurement	*"If they're building something, I'll give them the tape measure, and they can see how tall the blocks are … "*	2
Use of mathematics storybooks		
Placed in library without direction	*"They can pick whatever book they want … "*	8
Finding mathematical themes while reading aloud	*"I love Pete the Cat. He has a lot of math in some of his books that we use in story time."*	7

[a]Centers are defined as teacher-planned, small groups with specific instructions. In contrast, free choice, regardless of the locale is defined as children choosing and directing their own play or activities.

preschool children?" and "How confident are you in your ability to support your student's mathematics learning?" A complete list of questions is included in Table 4.

Coding and Scoring Approach

Several questions allowed for direct scoring (e.g. confidence level for teaching mathematics, presence of a library, etc.). After this was completed, the full transcripts for all eight teachers were independently reviewed by the first two authors and then compared. There was 95% overall agreement between the authors. The few discrepancies in codes were resolved with discussion. We first used a top-down approach to coding by reviewing the transcripts for the three categories of preschool instruction developed by Early et al. (2010): meals/routines, teacher directed, and free choice. We also considered whether the various mathematics activities were whole group, small group, or individually oriented. In addition, to our predetermined coding categories, we were open to allowing the richness of the data to reveal other themes. Table 5 provides an overview of the codes that emerged as well as sample teacher statements. We also considered whether these activities were whole-group, small group, or individually oriented. And, finally, we categorized the type of mathematics content mentioned by the teachers.

Results and Discussion

Teachers' Views of Mathematics

All of the interviewed teachers reported that they believe teaching mathematics in preschool was important or very important (M = 4.38, SD = 0.74). Seven of the eight teachers reported feeling confident or very confident in their abilities to teach mathematics. The remaining teacher reported that she was moderately confident.

Use of the Classroom Library to Teach Mathematics

All of the teachers, regardless of the type of center/preschool they taught in, reported having a classroom library that was available for children during free choice time, transitions, and/or nap time and that it contained mathematics-themed books, such as *Pete the Cat* and number/counting books. Although some teachers stated that they encouraged children to find books related to themes or topics being studied in class, they did not encourage them to find mathematics-themed books. For example, one teacher mentioned that she encouraged children to find books about presidents because that was their current theme, but when asked about the current mathematics topic, she responded that she did not encourage the children to find books with mathematics objectives. One teacher noted "no, the library is just free play". Despite not encouraging children to seek out books in the library with mathematical topics, all but one of the teachers reported incorporating mathematics topics into general storybook reading. That is, these teachers talked about ways they brought mathematics content into their storybook reading, using implicit texts where the mathematics was secondary to the main story. For example, one teacher reported that she liked to have the children count the number of objects on a page while another responded that she often has children look for patterns in books.

How Mathematics is Taught

Although the classroom library was not a primary venue for learning mathematics, mathematics reportedly was taught in multiple ways throughout the day. Six teachers reported a specific time for teacher-directed mathematics instruction. The two teachers who did not have a specific time for mathematics instruction reported that it occurred throughout the day. Explicit mathematics instruction occurred in whole groups (n = 3), small groups (n = 2), and a mix of the two (n = 3). Teachers could provide more than one answer to this question as well as others.

The teachers who reported using whole group mathematics instruction noted that it frequently occurred during circle and calendar time. These teachers indicated that circle and calendar time focused on objectives around number sense, defined as understanding numbers and number relationships (Jordan et al., 2009; Malofeeva, Day, Saco, Young, & Ciancio, 2004) and being able to subitize, compare amounts, count, and complete simple addition and subtraction (Berch, 2005; Jordan et al., 2009). Four teachers reported engaging in counting activities during whole group instruction while five noted specifically focusing on number identification. One teacher remarked that she engaged in basic addition during whole group instruction. Geometry in the form of shape identification was mentioned by one teacher as occurring during whole group instruction when reviewing the calendar.

All of the teachers reported having a mathematics center where teacher-directed, small group instruction as well as free choice exploration occurred. Materials in the mathematics center often included counting cubes, measuring items, pattern blocks, and number sticks. Teachers who reported having games with mathematics themes kept them in the mathematics center for teacher- or child-directed play. While mathematics centers and circle/calendar time were the most frequently reported means of teaching mathematics, seven teachers did note that they incorporated mathematics teacher-directed instruction into other parts of the day including outside time (counting flowers) and transitions (counting the number of children in line and counting to 10 while washing hands). For example, one teacher stated, "the kids like counting on the monkey bars" while another noted, "I like to measure their height".

In short, teachers reported teaching mathematics using whole group and small group instruction in various ways throughout the day. Teachers also reported using free choice mathematics centers that they populated with a variety of materials such as games, manipulatives, and blocks. Transitions were noted as opportunities for spontaneous mathematics instruction. While the classroom library was sometimes noted as a transition activity, it was not reported to be a primary place for mathematics learning. Given how relatively infrequently mathematics activities may occur in

preschool classrooms (e.g., Early et al., 2010), the classroom libraries seem to be an under-utilized resource for promoting mathematics in preschool.

General Discussion

Researchers and key advocacy groups have called for an increased emphasis on early childhood mathematics, highlighting that young children are capable of learning complex and advanced mathematics (Clements & Sarama, 2011; NCTM & NAEYC, 2010). Consistent with an emphasis on the importance of mathematics for preschool children, Claussens and colleagues (Claessens & Engel, 2013; Claussens, Duncan, & Engel, 2009) and Bodovski and Farkas (2007) and others have shown that children's mathematics skills in kindergarten predict their later mathematics growth and development. In fact, children whose mathematics skills at kindergarten entry are lower, show slower growth in mathematics than children with more advanced skills. Despite research on its importance and calls from advocacy groups, mathematics reportedly still receives limited attention in early childhood classrooms (Bachman et al., 2018; Farran, Meador, Christopher, Nesbitt, & Bilbrey, 2017). For example, Early et al. (2010) found that on average only 8% of a full preschool day was devoted to mathematics compared to 17% for literacy.

The two studies in this paper investigated the use of the classroom library to foster mathematics (Study 1) and, more generally, where and how preschool teachers view mathematics instruction occurring in their classroom (Study 2). While the teachers in this study perceived themselves as incorporating mathematics instruction throughout the day, their responses suggested that they generally do not view using the classroom library as a venue for mathematics learning, despite addressing mathematics topics when engaging in oral storybook reading. Therefore, they may be missing an important opportunity to engage children's interest in mathematics. That is, the classroom library could be used as a supplemental location beyond mathematics centers to spark children's interest and reinforce mathematical concepts and provide opportunities for children to "do" mathematics.

Mathematics storybooks have been shown to engage children's interest in mathematics and increase their mathematics skills. (e.g., Hassinger-Das et al., 2015). NCTM provides its members with many resources to incorporate children's literature into mathematics instruction, however, research continues to demonstrate that mathematics storybooks are not being incorporated into mathematics instruction by teachers (e.g., Pentimonti et al., 2011; Yopp & Yopp, 2012). In fact, teachers in the present study reported that while they have some mathematical-themed books in their preschool classroom libraries (or elsewhere in the classroom), mathematics was primarily taught in places other than the library. One way to increase the use of mathematics storybooks to reinforce children's skills and engage their interest is to support teachers in making the classroom library a place for mathematics learning.

To make the classroom library another "mathematics area," teachers can use mathematics storybooks and encourage children to use these books. Toys, both traditional (e.g. blocks, puzzles, etc.) and digital, may also be added as they have been shown to increase spatial language use in young children (Verdine et al., 2019). More explicit mathematics books may be needed in libraries and teachers may need to incorporate the mathematics included in books with implicit mathematics themes. By allowing children to explore the topics in the books, teachers may increase children's mathematics interest, provide another opportunity to "do" mathematics, and increase children's mathematics skills. Mathematics skills are often acquired using both direct mathematics instruction (Ginsburg et al., 2008), and child-directed exploration (Ginsburg & Amit, 2008). Abstract skills such as identifying quantities that are more or less, identifying shapes, and patterns are frequently observed during informal experiences such as play (Ginsburg et al., 2008; Seo & Ginsburg, 2004). The classroom library has the potential to allow children a venue inside the preschool classroom to further develop different facets of their mathematics understanding.

In addition to traditional paper texts, the addition of interactive, digital storybooks to classroom libraries may also increase preschoolers' mathematics abilities because they allow children to consistently interact and therefore remain engaged. Interactive, digital storybooks allow children to engage with the mathematics concepts and receive immediate feedback, which does not occur with traditional texts (Ginsburg, Uscianowski, & Almeda, 2018). The use of the preschool classroom library as a place for mathematics learning may allow young children to begin school with a more solid mathematics foundation.

The conclusion from much of the writing on mathematics education is that there is not enough of an emphasis on mathematics in the preschool classroom, and teachers need more instruction on how and what to teach (Ginsburg et al., 2008; NAEYC/NCTM, 2010). The classroom library may be a missing link because it can provide exposure to and engagement in mathematics concepts (Author, 2019). Prior research has demonstrated that using books with mathematics themes may also increase mathematics conversations (Anderson, Anderson, & Shapiro, 2004; Anderson et al., 2005; Hojnoski et al., 2014; Rathe et al., 2018). While the classroom library is not meant to and should not replace more traditional mathematics instruction, based on what we know about using children's literature, it may be an effective means of peaking interest and curiosity in the subject. The classroom library may also offer less structured, child-driven exposure as compared to whole group and center-based instruction which is often teacher planned and provisioned.

Limitations and Future Directions

This set of studies examined the beliefs of teachers, but did not observe their actual mathematics instruction. Also, the effect of the teachers' instruction on the children's mathematics skills was not addressed. That was not the purpose of these studies. However, future research should consider how the different forms of mathematics instruction and activities effect children's interest in mathematics and the development of their skills. Despite these limitations, we consider these data an important and valid addition to the field.

This paper investigated preschool teachers' reports of their classroom activities. Our data (Study 2) suggest that teachers believe they engage in frequent instruction of mathematics throughout the day. They reported being confident in their ability to teach mathematics to preschool children and used various methods, including teacher-directed instruction and free choice activities. Instruction was mainly whole group or small group and the content included different aspects of numeracy and geometry. In other words, the data on the amount of mathematics instruction and activities available in the classroom, based on these teachers' reports, seems inconsistent with data from research using classroom observations (see Ginsburg et al., 2008). It suggests a need for future investigations with a larger sample of teachers from more diverse backgrounds. If teachers believe they are doing more mathematics than actually occurs, this could be a critical area for intervention.

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