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Mathematics and Science Learning Opportunities in Preschool Classrooms

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Abstract

Research findings—The present study observed and coded instruction in 65 preschool classrooms to examine (a) overall amounts and (b) types of mathematics and science learning opportunities experienced by preschool children as well as (c) the extent to which these opportunities were associated with classroom and program characteristics. Results indicated that children were afforded an average of 24 and 26 minutes of mathematics and science learning opportunities, respectively, corresponding to spending approximately 25% of total instructional time in each domain. Considerable variability existed, however, in the amounts and types of mathematics and science opportunities provided to children in their classrooms; to some extent, this variability was associated with teachers' years of experience, teachers' levels of education, and the socioeconomic status of children served in the program.

Practice/policy—Although results suggest greater integration of mathematics and science in preschool classrooms than previously established, there was considerable diversity in the amounts and types of learning opportunities provided in preschool classrooms. Affording mathematics and science experiences to all preschool children, as outlined in professional and state standards, may require additional professional development aimed at increasing preschool teachers' understanding and implementation of learning opportunities in these two domains in their classrooms.

Keywords

mathematics instruction; science instruction; preschool; early childhood education

As technology and innovations play a heightened role in the global economy, it is essential that Americans demonstrate the necessary mathematics and science skills to remain competitive with other countries. However, the statistics are particularly troubling: when compared with other developed countries, American students consistently score lower on international assessments. In 2009, the Programme for International Student Assessment (PISA) ranked students in the United States 25th out of 33 countries in mathematics literacy and 17th out of 33 in science literacy (Fleischman, Hopstock, Pelczar, & Shelley, 2010). Similarly, data from the National Assessment of Educational Progress (NAEP) show that

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61% of fourth grade students are not proficient in mathematics and 71% are not proficient in science (Lee & Ginsburg, 2007). To combat these faltering statistics, President Obama announced the "Educate to Innovate" initiative, which aims to increase the number and quality of students in science, technology, engineering, and mathematics (STEM; The White House, 2010). In order for the United States to compete with international markets in research and innovation, mathematics and science must become a priority in all grades.

This mandate includes attending to opportunities to learn mathematics and science in preschool. Yet, despite general consensus on the benefits of high quality preschool experiences (e.g., Barnett, 1995, 2011), much of the available literature has focused on promoting children's opportunities to learn language and literacy. This focus is evidenced, for example, in the synthesis conducted by the National Early Literacy Panel (2008) as well as the predominance of language and literacy curricula and measures examined in the Preschool Curriculum Evaluation Research Consortium (2008). Although evidence concerning preschool mathematics is growing (e.g., Clements & Samara, 2009), research concerning preschool science is particularly sparse (e.g., Greenfield et al., 2009). The goal of the current study was to address one important aspect of preschool mathematics and science, namely to attend to and document the mathematics and science learning opportunities typically offered in preschool classrooms. This goal was predicated not only on the calls for attending to early mathematics and science noted above, but also (a) the importance of mathematics and science for young children and (b) the small body of research suggesting that such learning opportunities may be limited and highly variable in preschool classrooms. Each of these points is discussed in more detail below.

The Importance of Mathematics and Science in Early Childhood

Mathematics and science learning is critical during the early childhood years (e.g., Clements, 2001; Connor, Morrison, & Petrella, 2004; Hamre & Pianta, 2005) and has long-term associations with school readiness and continue academic achievement (e.g., Arnold, Fisher, Doctoroff, & Dobbs, 2002; Duncan et al., 2007). Contrary to past thoughts, recent investigations show that preschoolers are capable and eager to learn mathematics and science concepts, serving as an important precursor for later academic achievements. For example, young children are curious about the world and ask questions and talk about both mathematics (Seo & Ginsburg, 2004) and science (National Institute for Early Education Research, 2009) before they enter school. With respect to mathematics in particular, infants understand fundamental concepts, such as *more* and *less*, and during the preschool years, they begin counting, adding and subtracting, and using spatial concepts (Baroody & Dowker, 2003; Gelman & Gallistel, 1986; Greenes, 1999) which are indicative of continued mathematics learning as well as later literacy abilities (Duncan et al., 2007). Several studies suggest that providing preschoolers with a solid foundation of basic mathematics skills facilitates mastery of new, developing skills and the fine-tuning of already existing ones (e.g. Baroody, 2003; Jordan, Kaplan, Ramineni, & Locuniak, 2009; Pungello, Kuperschmidt, Burchinal, & Patterson, 1996). With respect to science, young children demonstrate the capacity for learning basic science knowledge, such as observing and investigating. Greenfield and colleagues (2009) highlighted that young children should learn eight 'process skills,' including *observing*, *describing*, *comparing*, *questioning*, *predicting*, *experimenting*, *reflecting*, and *cooperating*, before entering school, which are critical for continued academic success.

This converging evidence that preschool children can and should learn about mathematics and science is reflected in updated early learning standards. For instance, the National Association for the Education of Young Children (NAEYC) and the National Council for Teachers of Mathematics (NCTM) published a joint position statement emphasizing the need for effective, high-quality mathematics education for children between the ages of three and six (NAEYC and NCTM, 2010). In addition to such national standards, some individual states have created their own mathematics and science learning standards. One example is the state of Ohio, the state in which the current investigation was conducted (Ohio Department of Education, 2006). Ohio's early learning mathematics standards highlight number, number sense, and operations; measurement; geometry and spatial sense; algebra and patterning; and data analysis. Science-related standards include three main content areas (life science, physical science, and earth/space science) as well as expectations that preschoolers learn critical thinking skills commensurate with the process skills set forth in the extant literature (e.g., *observing, describing,* and *comparing;* Greenfield et al., 2009). These standards encourage preschool teachers to provide more mathematics learning opportunities than counting and shapes and to expand science learning beyond weather and plants (Clements, Samara, & DiBiase, 2004; Early et al., 2010; Sackes, Trundle, & Flevares, 2009). Taken together, these state and national standards emphasize the importance of teaching preschoolers about mathematics and science with the expectation that they enter kindergarten with the skills and knowledge necessary for academic success.

Opportunities to Learn Mathematics and Science in Preschool Classrooms

Despite existing data on the importance of mathematics and science in preschool classrooms, a small body of research suggests that preschoolers' opportunities about these domains may be limited. These findings are notable, given empirical evidence that young children's opportunities to learn mathematics and science are associated with subsequent learning gains (e.g. Bodovski & Farkas, 2007; Wang, 1998, 2010; Patrick, Mantzicopoulos, & Samarapungavan, 2009), motivation to learn, and feelings of competency (Mantzicopoulos, Patrick, & Samarapungavan, 2008; Patrick et al., 2009).

La Paro and colleagues (2009) studied 240 prekindergarten and 730 kindergarten classrooms in six states. Their findings indicated that, on average, preschoolers spent 6% of time in mathematics, 7% in science and 14% in literacy activities, with time devoted to science decreasing and time devoted to mathematics and literacy increasing as these children moved to kindergarten (to 3%, 11%, and 28%, respectively). Importantly, there was considerable variability among classrooms. Early and colleagues (2010) reported that 8% of preschoolers' time was spent in global mathematics activities and 11% in global science activities. Similarly, Connor, Morrison, and Slominski (2006) investigated 156 preschoolers' classroom experiences and found large amounts of variability across and within classrooms. On average, preschoolers spent about four minutes per day on mathematics and three minutes per day on science whereas approximately 15 minutes were devoted to language and literacy. It is important to note, however, that mathematics and science instruction were not the primary focus of any of these studies, and these topics were thus were not examined in-depth.

To our knowledge, only one study measured and described preschool mathematics or science learning opportunities in detail (Tu, 2006). In this study, Tu exclusively focused on the availability of “formal” and “informal” science learning opportunities in 13 preschool classrooms, albeit not the specific science concepts taught. The author found that of 120 minutes, only 4.5% of activities were dedicated to formal science (e.g., an experiment set up and led by the teacher) and 8.8% to informal science (e.g., a free-choice activity during which some children opt to use magnifying glasses to examine natural artifacts). In other words, 86.6% of the activities were devoted to activities that were unrelated to science (Tu, 2006).

Taken together, this extant literature suggests that the content areas of mathematics and science are emphasized less than other areas in preschool classrooms and that considerable variability may exist among classrooms, in the amounts of learning opportunities provided. To date, however, no study has provided an in-depth description of the amounts and specific types of mathematics and science learning opportunities available in preschool classrooms.

The Current Study

In sum, general agreement exists regarding the importance of early mathematics and science learning opportunities for promoting achievement in the elementary years and beyond. Yet, we currently have a limited understanding concerning the extent to which mathematics and science learning opportunities are afforded in preschool classrooms, with the extant research providing only broad, general accounts of young children’s experiences in these domains. Thus, the purpose of the present study was to provide an in-depth snapshot of preschool mathematics and science learning opportunities in a diverse sample of 65 preschool classrooms. Specifically, we asked: To what extent do preschool children have opportunities to learn about mathematics and about science during a typical day? and What types of mathematics and science learning opportunities do these children experience?

Given the extant literature, we anticipated considerable variability in the extent to which such learning opportunities would be afforded. We therefore considered a third research question aimed at explaining such variability, namely: To what extent are opportunities to learn about mathematics and opportunities to learn about science associated with classroom and program characteristics? The attempt to explain differences in the learning opportunities provided is apt, given large disparities in preschool workforce composition, choice of curricula, and populations served (e.g., Barnett, Carolan, Fitzgerald, & Squires, 2011; Clifford et al., 2005; Rhodes & Huston, 2012) and desire to better understand the extent to which such differences have implications for the learning opportunities offered to children who attend such diverse preschool programming. Previous research findings (e.g., Chien et al., 2010; Early et al., 2010; LaParo et al., 2009; Lee & Ginsburg, 2007; Wang, 2010) suggest six particular classroom and program characteristics that may be associated with provision of learning opportunities: program type, curricula, education and experience levels of the classroom lead teacher, and socioeconomic and minority status of children served.

Work by Wang (2010) and Early and colleagues (2010) are particularly notable, as the only studies to previously consider such characteristics with respect to young children and mathematics and science opportunities. Both of these studies reported differential learning opportunities based on socioeconomic and/or minority status, but did not consider other classroom or program characteristics. The present study thus sought to replicate and extend this work, by also considering other classroom and program characteristics suggested by the literature.

Method

Participants

Data from 65 preschool classrooms in a mid-sized city in Ohio were analyzed for the current study. The lead or co-lead teachers in these classrooms were recruited to participate in a summer professional development series that offered credit necessary for preschool centers to maintain state-level licensure/certification. The professional development series began after the present data were collected. At the time at which all data for this study were obtained, the professional development topics had not been announced, and educators were unaware of a specific focus on mathematics and science. Thus, the present data were unaffected by the professional development in which these educators would later participate. Eligibility for the study required that participants served as a lead or co-lead teacher in a classroom serving 3-and/or 4-year old children. Only one teacher per classroom was allowed to participate. All teachers provided written informed consent. Note that an additional two teachers initially agreed to participate but withdrew prior to data collection due to factors unrelated to the study.

Participating teachers ranged from 20 to 61 years of age ($M = 39.55$, $SD = 11.79$). All but three teachers were female. Forty-eight identified themselves as White, 12 as Black, and 5 of other or multiple racial backgrounds. The majority were the sole lead teacher in the classroom (55%). The highest degree earned for most teachers was a bachelor degree (51%), with 17% earning high school diplomas, 20% earning associate degrees, and 12% earning master degrees. Eight percent of teachers held Child Development Associate credentials, and 40% held state certification to teach preschool-aged children. Preschool teaching experience ranged from 0 to 34 years ($M = 10.45$, $SD = 8.20$). The demographic characteristics of these participating teachers are consistent with descriptors of preschool teachers at the national level (Maroto & Brandon, 2012).

Teachers were employed at 35 different preschool centers reflecting a wide variety of early childhood settings. These included Head Start classrooms (20%), state-funded preschool classrooms within the public schools (8%), religiously-affiliated preschool classrooms (23%), and private preschool classrooms (49%); such percentages appear to be consistent with national data, although differences in national reporting categories prevent direct comparison (Maroto & Brandon, 2012). The majority of teachers taught in programs that were accredited by the National Association for the Education of Young Children (59%) and/or participated in a statewide accreditation program (68%). Teachers' programs were mostly full day (62%) or a mix of half- and full-day (20%). Forty-three percent of teachers' programs were full-time, with classes meeting 4- or 5-days per week; 5% were part-time, with classes meeting 2- or 3-days per week; and 52% had flexible classrooms in which some children attended full-time while others attended part-time. The average class size was 18 children (*SD* = 5.34). All but two classrooms (one 3-year old room and one 4-year old room) served children of mixed ages ranging from 24 months to 79 months. Teachers' classrooms included children considered typically developing (46% of classrooms) or both children considered typically developing as well as those with special needs (54%). Most teachers (55%) reported Creative Curriculum (Dodge, Colker, & Heroman, 2002) as their main classroom curriculum; 14% reported using Innovations (Miller & Albrecht, 2004), 6% reported using Kid Sparkz (Portman, n.d.), 3% reported using Creating Child Centered Classrooms (Coughlin et al., 1997), and 22% reported using curricula that were locally developed.

Procedures

Data for the present study were collected at two time points. Teachers participated in a videotaped classroom observation in March-April of 2010 to assess the extent to which mathematics and science learning opportunities were afforded during a typical preschool day. Classroom and program characteristics were assessed via teacher and parent questionnaires completed in April 2010 and September 2010, respectively.

Classroom observation—All teachers participated in a videotaped classroom observation following procedures similar to those used by Connor et al. (2009); teachers were not informed of a specific focus of the observations (e.g., math and science activities). Observations were scheduled at the teachers' convenience during their self-reported instructional time; teachers were told that we wished to observe the entire period during which they engaged children in instruction or provided learning opportunities but that we did not wish to observe outside play time or naptime. Videotaped activities included a combination of whole group activities, small group activities, free choice and center time, and circle time, Mealtime was included for those teachers who indicated that they utilized mealtimes to enhance children's learning (e.g., encouraging language growth via conversation and vocabulary modeling, asking children to count how many carrot sticks they ate). The average length of observations was 101.32 minutes (*SD*=37.49), with a range from 45.12 to 203.09 minutes. Research staff used two video cameras, one on a tripod with a wide-angle lens to capture as much of the classroom as possible, and one handheld camera to capture details of activities that might have been missed by the other camera. Descriptive notes were also written to provide further information of activities taking place (e.g., "students and teacher are playing a bingo-type game in which the picture cards indicate different seasons and types of weather"). At the end of each observation, teachers confirmed that this represented a typical day in their classrooms, with an average rating of 4.11 (*SD* =. 90) on a scale of 1 (not typical) to 5 (very typical).

Videotaped classroom observations were subsequently coded in the research laboratory using the Early Learning Mathematics and Science (ELMS; Piasta & Miller, 2010) coding scheme. ELMS was developed specifically for this project; it assessed the amounts and types of mathematics and science learning opportunities afforded in early childhood classrooms. The ELMS content was drawn from the synthesis of three sources of information regarding early childhood mathematics and science: (1) the Ohio Early Learning Content Standards (Ohio Department of Education, 2006); (2) additional guidance documents, including developmentally appropriate practice (National Association for the Education of Young Children, 2009), early childhood curriculum, assessment, and program evaluation (National Association for the Education of Young Children & National Association of Early Childhood Specialists in State Departments of Education, 2003), early childhood mathematics (National Association for the Education of Young Children & National Council for Teachers of Mathematics, 2010), national science education standards (National Committee on Science Education Standards and Assessment, National Research Council & Academy of Sciences, 1996), and principles and standards for school mathematics (National Council for Teachers of Mathematics, 2010), and (3) a review of the educational literature on these topics (e.g., Sackes, 2009).

This synthesis yielded a set of categories that exhaustively captured early childhood mathematics and science learning opportunities; these categories were non-overlapping in the sense that any given activity could not be coded in more than one category. Seven categories were used to capture children's involvement in mathematics opportunities: *Numbers and Number Sense, Computation, Geometry and Patterns, Spatial Awareness, Measurement, Sequencing and Time, and Money.* Eleven categories were used to capture children's involvement in three major topic areas of science: *Critical Thinking* and *Tools* captured opportunities to learn about Scientific Investigation and Observation; *Humans, Animals, Plants* captured opportunities to learn about the Living World, and *Water, Air, Light, Recycling and the Environment, Magnets,* and *Seasons and Weather* captured opportunities to learn about the Physical World. See the Appendix for detailed descriptions of each code, including its alignment with mathematics and science learning standards. Note that all areas of the Ohio early learning standards for mathematics and science are reflected in these categories, including the scientific investigation skills that are emphasized.

The ELMS coding scheme was implemented using Noldus Observer Pro software 10.1 software package (Noldus Information Technology, 2010), which provided the amount of time, in minutes:seconds that children were afforded in specific types of mathematics and science opportunities to learn. Any formal or informal learning opportunity in which at least one child was involved for at least 10 seconds was coded as long as the child/children were clearly involved in furthering their understanding of mathematics or science concepts. For many mathematics and science activities, the latter was clear from the activity itself (e.g., activities in which counting occurred, a pattern card was used, children observed a scientific phenomenon and made predictions) or a teacher's or child's verbalization of a mathematics or science concept during activity completion (e.g., "I'm going to put my blocks from biggest to smallest," "Show me the part of your picture that the person uses to *smell*"), Activities that were unclear in the extent to which mathematical or science concepts were being applied (e.g., simply coloring or decorating pictures of faces without specific references to human facial features, senses, or other science concepts) were not coded. Questionable activities were discussed by the coding team to achieve consensus: During regular coding meetings, all coders reviewed the questionable activity, shared their perspective as to which, if any, code applied as supported by the coding manual, and discussed the code(s) put forth until all coders agreed, consensus. A teacher or other adult (e.g. assistant teacher) did not need to be present during the activity in order to be coded since quality preschool activities can involve active attempts and practice, collaboration amongst peers, and be initiated by children (*Developmentally appropriate practice*, 2009) and little research has investigated the relative roles of teacher-guided versus child-initiated learning opportunities in these domains. For instance, some children might work directly with the teacher to make hypotheses regarding how to make ice melt (e.g., placing it in the sun versus shade) while other children might rotate through a variety of centers, including a water table at which they experiment with objects that do and do not float. Within the ELMS coding scheme, both activities would be coded, thus capturing both explicit, teacher-managed activities and child-managed activities (Connor et al., 2006) as well as all mathematics or science learning opportunities that occurred in the classroom, even if they occurred simultaneously.

Coder training included study of a detailed coding manual, individual instruction on the content of the codes and coding process using video exemplars, successful completion of a written test, and successful completion of a practice coding; all training was conducted by one of the coding scheme developers. The written test included eight brief classroom scenarios and asked the coder to supply the correct ELMS code for each (e.g., "After taking a poll of the type of pets they have at home, students make a graph with pictures of the pets at the top and numbers along the side. What code would be used for this activity?"). The practice coding test involved independently coding a gold-standard, master-coded video (i.e., selected project video whose codes were agreed upon by the coding scheme developers) and comparing the trainee's codes to the master codes. Scores of at least 85% exact agreement, calculated by the lead coder, were required to pass the written and practice coding tests. Double-coding of 10% of randomly selected videos indicated high continued reliability, with an intraclass correlation of .99 across all categories.

Questionnaires—Data concerning a number of program characteristics were gathered via teacher and parent questionnaires. For purposes of the present study, teachers were asked to report: (a) program type (i.e., public preschool including Head Start and state-funded programs, private center-based preschool, or parochial or religiously affiliated preschool); (b) whether or not they held a college degree (associates or higher); (c) years of preschool teaching experience; and (d) curriculum, which was coded for analysis purposes as whether teachers used Creative Curriculum, another commercial curriculum, or a locally-developed curriculum.

To characterize the populations of children typically served in teachers' classrooms, socioeconomic and race/ethnicity data were collected via parent questionnaires for a subsample of children enrolled in 60 of these classrooms (n = 358; 46% female; parents in the classrooms of five teachers were not asked to complete questionnaires). Parents reported the highest level of education completed by children's mothers or female guardians on a scale of 1 (eighth grade or less) to 9 (doctoral degree). Highest education levels completed included less than a high school diploma (25%), high school diploma (22%), associates degree (6%), bachelors degree (34%), and graduate degree (34%). Parents were also asked to report children's race (69% White, 18% Black, 6% multiracial, 7% other/unknown) and ethnicity (6% Hispanic). These data were then aggregated by classroom to indicate the average level of maternal education as a measure of SES ($M_{\text{classroom}}$ = 6.41, SD = 1.42 on the 9-point scale) and the proportion of children from minority backgrounds based on race/ethnicity ($M_{\text{classroom}}$ = .33, SD = .35).

Results

Opportunities to Learn Mathematics, Science, and Related Concepts

The first research aim was to ascertain the extent to which children are afforded opportunities to learn mathematics and science on a typical preschool day. Results are presented in Table 1. A vast majority of children had opportunities to learn about mathematics and science, with 95.38% of classrooms affording time to learn about mathematics and 96.92% affording time to learn about science. Overall, an average of 24.49 minutes or 24.17% of total instructional time was devoted to mathematics learning opportunities and an average of 26.32 minutes or 25.98% of instructional time was dedicated to science learning opportunities. Notably, there was considerable variability in the learning opportunities presented in these classrooms, and distributions for both types of learning opportunities were positively skewed. For example, time spent in mathematics opportunities ranged from 0 to 120 minutes, and time devoted to science opportunities ranged from 0 to 102 minutes. Correlations indicated that classrooms in which a greater percentage of time was devoted to one type of learning opportunity (mathematics versus science) tended to afford less time in the other, $r = -0.29$, $p = .021$; however, there was not a significant association between the amounts of time spent in mathematics and science learning opportunities, $r = -0.07$, $p = .572$. Additional analyses indicated small-to-moderate correlations such that classrooms with greater amounts of instructional time (i.e., longer observations) also tended to afford more mathematics and science opportunities and a greater percentage of science opportunities, rs = 0.27 to 0.51, ps < .028. There was no association between amount of instructional time and percentage of that time spent on mathematics opportunities, $r = 0.01$, $p = .955$.

Specific Types of Mathematics, Science, and Related Learning Opportunities

We next examined the amounts of time dedicated to specific types of mathematics and science learning opportunities afforded in early childhood classrooms. Similar to overall amounts of time in each content area, descriptive statistics for each type of learning opportunity are presented in Table 1, including duration in minutes and percentage of time relative to the entire observation. For ease of interpretation, these results are discussed in terms of their proportion relative to total time spent in the relevant content area and also depicted graphically in Figure 1. For mathematics, children were primarily provided with opportunities to learn about spatial awareness (57.82% of all mathematics instructional time), numbers (21.64%), basic geometry and patterns (16.70%), and sequencing and time concepts (3.63%). Note, however, that these distributions (and the science distributions discussed subsequently) were also positively skewed; learning opportunities of these types were provided in 64.62%, 69.23%, 41.54%, and 47.69% of classrooms, respectively. Children were provided opportunities to learn about computation, measurement, or money in few (one or two) classrooms. Accordingly, learning opportunities of these types constituted

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only 0.08%, 0.04%, and 0.04% of time spent on mathematics. Correlations among time spent in various types of mathematics learning opportunities were generally small and non-significant (*r*s = −0.14 to 0.17, *p*s > .183) with one exception: classrooms that afforded opportunities to learn about computation also tended to provide opportunities to learn basic geometry and patterns ($r = 0.44$, $p < .001$).

The majority of opportunities to learn about science (58.05%) were devoted to investigation and observation skills, including time spent learning critical thinking skills (12.73% of all science time) as well as the purpose and use of tools (45.33%). Such opportunities were afforded in 63.08% and 50.77% of classrooms, respectively. Approximately one quarter of science instructional time (25.72%) was devoted to learning about the living world. On average, 18.77% of science instructional time was devoted to learning about animals (provided in 47.69% of classrooms), 5.02% to learning about plants (16.92% of classrooms), and 1.94% to learning about humans (26.15% of classrooms). The remaining 16.26% of science instructional time was spent providing opportunities to learn about the physical world. These opportunities included learning about seasons and weather (6.57% of time; provided in 41.54% of classrooms), magnetism (4.45% of time; 4.62% of classrooms), and recycling and the environment (3.88% of science instructional time; 9.23% of classrooms). No classrooms afforded opportunities to learn about water or air, and opportunities to learn about light were afforded in one classroom, constituting 1.37% of overall time spent on science. Correlations among time spent in various science activities were generally small and non-significant (*r*s = −0.18 to 0.17, *p*s > .153) with a few exceptions. Classrooms that afforded more opportunities to learn about the physical world tended to afford more opportunities to learn investigation and observation skills ($r = 0.27$, $p = .028$). This association appeared to be due to positive relations among specific types of physical world and investigation and observation opportunities: magnetism and critical thinking skills, $r = 0.50$, $p < .001$, and seasons and weather and tools, $r = 0.41$, $p = .001$. Additionally, there was a negative trend such that classrooms that afforded more opportunities to learn about the physical world tended to afford fewer opportunities to learn about the living world ($r = -0.22$, $p = .081$).

Associations with Classroom and Program Characteristics

The third research aim explored the extent to which opportunities to learn mathematics and science were associated with various classroom and program characteristics. *T*-tests were used to examine the amounts of mathematics and science learning opportunities provided in different program types and in classrooms staffed by a lead teacher who did versus did not hold a college degree, as these variables were represented by categorical data. Similarly, a one-way analysis of variance was used to examine whether amounts of learning opportunities differed by curricula. Associations with continuous variables (i.e., lead teachers' preschool teaching experience, average classroom socioeconomic status, and proportion of children from minority backgrounds) were examined via correlations. Results concerning amounts of mathematics and science are presented; note that parallel results were obtained when examining percentage of total instruction time spent in mathematics and science.

For program type, results indicated a trend in which parochial or religiously affiliated preschool programs afforded the fewest mathematics learning opportunities (M = 12.57 minutes, 13.70% of instructional time) as compared to public or private center-based preschool programs [M = 29.82 minutes, 28.70% of time, $t(64) = 1.98$, $p = .052$ and M = 27.07 minutes, 26.41% of time, $t(64) = 1.86$, $p = .068$, respectively], but no difference for public versus private programs, $t(64) = 0.38$, $p = .709$. Amounts of time spent in science learning opportunities were not significantly different with respect to program type (M = 20.44 minutes for parochial programs, M = 31.51 minutes for public programs, and M = 27.20 minutes for private center-based programs, ps > .212). For teacher education background, programs staffed with a lead teacher who held a college degree afforded significantly more opportunities to learn about science (M = 28.67 minutes) than those staffed by a lead teacher without a college degree (M = 14.77 minutes), $t(64) = 2.77$, $p = .009$. The difference in amount of mathematics learning opportunities between programs whose lead teacher did and did not hold a college degree (M = 26.24 minutes and M = 15.88 minutes) was not statistically significant, $t(64) = 1.24$, $p = .220$. No differences in amounts of mathematics or science learning opportunities were found based on the curriculum used, $F(2, 64) = 0.12$, $p = .889$ and $F(2, 64) = 2.06$, $p = .137$ for math and science respectively.

Correlations with the remaining classroom and program characteristics are presented in Table 2. Results indicated that classrooms serving children from higher socioeconomic backgrounds, as measured by average maternal education, afforded more science learning opportunities. There was also a slight tendency for classrooms with more experienced teachers to afford more mathematics learning opportunities, although this trend did not meet traditional levels of significance, $p = .096$. Correlations with the proportion of children from minority backgrounds were not significant.

Discussion

The current study examined the amounts and specific types of mathematics and science learning opportunities afforded in preschool classrooms as well as the classroom and program characteristics associated with such opportunities. To answer the study's three research questions, the ELMS coding scheme was designed and implemented based on detailed investigation of state and national mathematics and science standards. Results revealed two major findings. First, opportunities to learn about mathematics and science are available in preschool classrooms, perhaps to a greater extent than previously observed. Second, there is considerable variability in mathematics and science experiences in preschools. This finding is significant in that it may impact the extent to which children arrive at kindergarten prepared to continue their development of mathematics and science skills. We further discuss each of these findings and implications below.

Mathematics and Science Opportunities to Learn in Preschool Classrooms

The early childhood classrooms represented in our study afforded a variety of mathematics and science learning opportunities, with approximately 24 minutes devoted to mathematics and 26 minutes devoted to science. These estimates are considerably higher than the four and three minutes per day, respectively, documented by Connor and colleagues (2006).

Estimates of the percentages of instructional time devoted to mathematics and science learning opportunities, approximately 25% each in the present study, are also higher than indicated in the past (i.e., 5% to 11%; Connor et al., 2006; Early et al., 2010; La Paro et al., 2009), although we must note that the operational definitions of "instructional time" varied among studies.

We find it encouraging that children may have more mathematics and science experiences in preschool than formerly thought, particularly given the links between such learning opportunities and achievement in these areas (e.g., Bodovski & Farkas, 2007; Wang, 1998, 2010), and we offer two explanations as to why these may differ from previous studies. First, our estimates of mathematics and science preschool experiences may reflect the greater attention recently placed on children's early mathematics and science learning, as reflected in national initiatives and new state early learning standards. Beyond directly impacting curricula used in classrooms, these enterprises may also have increased teachers' knowledge and feelings of efficacy in these areas. For example, The Office of Early Learning and School Readiness in the Ohio Department of Education has initiated professional development aligned with the state's early learning content standards with offerings specific to language and literacy, mathematics, science, or social studies. Professional opportunities such as these may be critical in promoting mathematics and science opportunities to learn in preschool classrooms.

Second, the current study represents the first, to our knowledge, to specifically and exclusively examine preschool mathematics and science learning opportunities. The exclusive focus on mathematics and science is important because, perhaps to a greater extent than in elementary classrooms, early childhood teachers are encouraged to integrate instruction both within and across content areas (National Association for the Education of Young Children, 2009). Thus, in early childhood classrooms, instructional content often overlaps, which proves difficult to capture in broad observational coding schemes requiring mutually-exclusive content codes. For example, a teacher might choose to read a book such as The Very Hungry Caterpillar (Carle, 1994) to accomplish a variety of learning goals. In previous studies (but cf. with those that used the Snapshot coding scheme), this entire activity would likely have been coded as literacy. However, our intention with the ELMS coding scheme was to code all possible opportunities to learn about mathematics and science, recognizing that such opportunities might be embedded within activities typically associated with other academic or content areas. Our specific attention to mathematics and science therefore allowed us to capture mathematics and science opportunities, such as when a teacher pauses in reading the book to highlight number and counting concepts (e.g., "Let's count how many pieces of food the caterpillar ate on Saturday.") or engages the children in a discussion about animals and the living world (e.g., how the caterpillar formed a chrysalis and turned into a butterfly).

We acknowledge that our means of capturing all mathematics and science learning opportunities that occur in preschool classrooms has the potential to slightly overestimate the total time in which a preschool child could be involved in such activities. If two small groups of preschoolers were engaged in separate mathematics activities concurrently, for instance, both activities were captured and coded using the respective ELMS codes despite the fact that these occurred simultaneously. However, such situations were observed and coded very infrequently for the teachers and children participating in the current study lending confidence to the present results.

We also acknowledge that while our results indicate that more mathematics and science may be occurring in preschool classrooms than previously believed, we cannot speak to the relative emphasis that preschool teachers place on different content areas. In other words, the 25% of time devoted to mathematics learning opportunities and the 25% of time devoted to science learning opportunities may not have been mutually exclusive. Furthermore, as illustrated by The Very Hungry Caterpillar scenario described above, we cannot conclude that only 50% of preschoolers' time is spent developing capabilities in other areas, such as language and literacy, social and emotional competence, and so forth. Although we rarely observed multiple mathematics or science activities occurring simultaneously, activities targeting other content areas frequently took place at the same time (e.g., reading a book about science concepts). Finally, we note that our coding scheme included opportunities to develop scientific investigation skills, based on their inclusion in the state early learning standards and other early science work (e.g., Greenfield et al., 2009; Tu, 2006), although it is unclear whether these were included as science in the available extant literature. Nonetheless, estimates of science learning opportunities when not including these codes (i.e., M = 11.04 minutes) continue to suggest greater provision of science in preschool classrooms as compared to the work by Connor et al. (2006) and La Paro et al. (2009) but a similar percentage of time as reported by Early et al. (2010).

Variability of Mathematics and Science Opportunities

Our second major finding revealed that there is considerable variability in the mathematics and science experiences afforded to preschool children. This result is not only highlighted by the large standard deviations associated with the amounts of time ascribed to the various mathematics and science learning opportunities, but also in the numbers of classrooms in which children were and were not provided opportunities to learn in these content areas. For example, although 62 classrooms afforded at least some opportunity to learn about mathematics over the course of the day, three classrooms did not afford any such opportunities. Similarly, two classrooms did not afford any opportunities for children to engage with science. Notably, our findings showed that the distributions for mathematics and science learning opportunities were positively skewed and also indicated that only brief amounts of mathematics and science were provided in many classrooms. While we recognize that preschool teachers face the challenge of providing instruction across many important content areas and that our observation represented only one day, we echo the calls of others for ensuring that mathematics and science are fully integrated into comprehensive preschool curricula that provide daily opportunities to engage with these and other critical content areas (e.g. National Association for the Education of Young Children, 2003; National Association for the Education of Young Children, 2010; National Institute for Early Education Research, 2009).

Our call for further attention to mathematics and science in preschool is further underscored by four specific and somewhat unexpected findings. First, in addition to three classrooms in which no mathematics learning opportunities were provided, an additional 39 classrooms did not afford any opportunities to learn about numbers and number sense. The fact that children in these classrooms did not engage in any counting or number activities over the course of their day is surprising given the importance of early number concepts for later mathematics learning (Clements, Sarama & DiBase, 2004; Duncan et al., 2007; Jordan et al., 2009). Second, fewer than half of the classrooms afforded opportunities to learn about seasons or weather, with an average of less than 2 minutes devoted to such topics. Given that calendar time is fairly ubiquitous in preschool classrooms, we anticipated that most teachers would take advantage of this natural opportunity to discuss science concepts. Third, we found that 41 classrooms (63%) afforded children with various critical thinking experiences, such as predicting, observing, and asking questions. As described earlier, such experiences provide opportunities to learn science 'process skills' considered foundational for future learning in all educational domains (Greenfield et al., 2009). On one hand, this finding is promising in suggesting that many preschool teachers recognize the importance of these skills for children's continued development and have worked to integrate higher-order science concepts into their instruction. On the other hand, children were engaged with critical thinking for an average of only 3.35 minutes and a full third of classrooms did not afford any opportunities to engage in higher-order thinking. Together, these three findings are disconcerting given the general consensus evidenced in research and early learning standards that number sense, seasons and weather, and higher-order thinking learning opportunities should be emphasized in preschool classrooms (Bracken & Crawford, 2010; Brenneman, Stevenson-Boyd, & Frede, 2009; French, 2004; Greenfield et al., 2009; Neuman & Roskos, 2005; Sackes et al., 2009; Scott-Little, Kagan, & Frelow, 2006). Such results argue that greater preservice or professional development efforts may be necessary to support preschool teachers in implementing mathematics and science learning opportunities supported by research and reflected in standards documents.

Fourth and finally, our results suggest that variability in mathematics and science learning opportunities is linked to lead teachers' years of experience, teachers' levels of education, and the socioeconomic status of children served. These associations were found despite the limitation that data from only one lead teacher were collected in classrooms served by multiple co-lead teachers. These findings are not entirely unexpected based on the literature (e.g., Early et al., 2010; LoCasale-Crouch, Konold, Pianta, Howes, Burchinal, & Bryant, 2007) but are somewhat disconcerting in indentifying systematic differences in the extent to which children are afforded mathematics and science learning opportunities prior to formal school entry. Fewer mathematics and science experiences for children from disadvantaged backgrounds, specifically, corresponds with previous evidence that such children often do not arrive to kindergarten well-prepared in these areas (e.g., Jordan et al., 2009; Starkey, Klein, & Wakeley, 2004; Wang, 2010) and are disproportionately served by teachers less prepared to teach about these topics (e.g., Hill, 2007). As Chien and colleagues (2010) argued, providing early learning opportunities in preschool may be particularly important for promoting the academic trajectories of children from disadvantaged backgrounds as they may not have sufficient opportunities to learn at home. In the context of the present findings, changes in preservice preparation and inservice professional development may be necessary

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to ensure that early mathematics and science learning opportunities are provided to *all* children enrolled in preschools.

Limitations, Future Directions, and Conclusion

The present results significantly extend previous research in documenting the extent to which children do and do not have various types of mathematics and science learning experiences prior to formal school entry. We acknowledge that replication of these results is desirable, given that the current findings represent one day of the school year. One or two day classroom observations are not atypical in educational research, given the intensive resources required for observation and coding (e.g., Connor et al., 2006; La Paro et al., 2009), and, in theory, the aggregate results ought to be representative of a typical preschool day based on sampling theory and the fact that teachers were blind as to the specific mathematics and science focus. Greater confidence in findings, however, necessitates replication in independent samples. The latter would also assist with external validity. Although the current sample was diverse with respect to teacher qualification and types of early childhood settings (e.g., half and full day, public and private), the sample was limited to those working in one specific state and presumably adhering to the same state early learning standards.

Additionally, we recognize that our coding scheme was necessarily narrow in scope, as guided by our specific research questions concerning the types of mathematics and science learning opportunities offered in preschool classrooms; our findings thus cannot speak to the quality of these experiences or the context in which they occurred (e.g., during whole group, small group, or free play; with or without teacher guidance). The percentages of time ascribed to these learning opportunities must also be viewed as relative to the instructional time observed; the percentages do not account for the additional time that children spent playing or learning outside of the classroom, napping, or in other activities not considered as affording learning opportunities by their particular teachers. Moreover, while our results provide an impetus for further examining the mathematics and science experiences afforded to preschoolers, we leave many unanswered questions requiring additional investigation. In particular, future research should more thoroughly investigate the links between early mathematics and science learning opportunities and child learning outcomes, including the amounts and types of mathematics and science early learning experiences optimal for placing children on the path to success in elementary school and beyond. Future research might also afford a closer examination of teacher, classroom, and program characteristics predictive of preschool mathematics and science learning opportunities. Such research could consider additional factors such as teachers' preservice preparation and professional development experiences, substantive and pedagogical knowledge, and efficacy beliefs in these domains.

In sum, our study finds that although many young children do have access to mathematics and science learning opportunities, there is not a general consensus among educators about how much and what types are essential in early childhood classrooms. Affording mathematics and science experiences to all preschool children, as outlined in professional and state standards, may require additional professional development aimed at increasing preschool teachers' understanding and implementation of mathematics and science learning opportunities in their classrooms. Ultimately, future research will provide new insight regarding best practices about mathematics and science in preschool.

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Appendix

This appendix provides additional details regarding the ELMS coding scheme, including definitions of codes, sample activities, and relevant mathematics and science early learning standards. Note that sample activities are not exhaustive. Relevant standards are abbreviated as OELCS (Ohio Early Learning Content Standards; Ohio Department of Education, 2006), NCTM (National Council of Teachers of Mathematicsematics, 2010), and NSES (National Science Education Standards; National Committee on Science Education Standards and Assessment, 1996).

Mathematics

Promoting development of number concepts and the ways that numbers, shapes, sizes, sequences, and colors are part of everyday life as well as with concepts regarding the measurement and passage of time and movement in space.

Numbers and Number Sense

- Definition: understanding number concepts, their forms, and how they are used in the everyday world.
- Example activities: singing a counting song such as, "The Ants Go Marching" or "Five Little Monkeys," rolling a die or spinning a spinner and moving a token on a game board, or matching a numeral to an amount of items.
- Relevant standards: OELCS Number and Number Sense 1–11; NCTM Number and Operations Standards Section 1, NCTM Algebra Standard Section 2, NCTM Process Standards

Computation

- Definition: exploring the concepts of addition and subtraction.

- Example activities: having a total of 21 crackers and sharing 3 each among 7 friends, having 2 books and adding one more, starting the week with 5 snacks and eating one each day until none are left.
- Relevant standards: OELCS Number, Number Sense and Operations 13–16, OELCS Patterns, Functions and Algebra 3; NCTM Number and Operations Standard Sections 2 and 3, NCTM Algebra Standard Section 3, NCTM Process Standards

Geometry and Patterns

- Definition: recognizing shapes and associated features as well as identifying and producing patterns.
- Example activities: making a pattern with blocks (i.e., red, blue, red, blue, etc.), identifying and talking about common shapes, sorting objects by color or shape
- Relevant standards: OELCS Geometry and Spatial Sense 1–4, OELCS Patterns, Functions and Algebra 1–2; NCTM Algebra Standards Section 1, NCTM Geometry Standard Sections 1 and 4, NCTM Process Standards

Spatial Awareness

- Definition: developing spatial awareness and related vocabulary.
- Example activities: completing interlocking puzzles, following directing to move through an obstacle course (i.e., crawling under a table, then walking slowly across a balance beam), or following a “treasure map” of the classroom to find hidden object(s).
- Relevant standards: OELCS Geometry and Spatial Sense 5, OELCS Physical Sciences 4–5; NCTM Geometry Standards Section 2 and 3, NCTM Process Standards

Measurement

- Definition: understanding principles and uses of measuring, ordering or sorting objects according to size, weight, or length.
- Example activities: putting toys or blocks in order from smallest to largest or heaviest to lightest, measuring heights of the students with a meter stick and/or a shoe box to see who is tallest/shortest, weighing items to compare weights
- Relevant standards: OELCS Measurement 4–6; NCTM Algebra Standard Section 4, NCTM Measurement Standard Sections 1 and 2, NCTM Data Analysis and Probability Standard Section 1, NCTM Process Standards

Sequencing and Time

- Definition: understanding chronological time and learning about the different ways time can be measured (i.e., clock, timer, calendar).

- Example activities: at circle time identifying the current month, day, or year, talking about upcoming events (i.e., special activity, field trip, classmate birthday), or sequencing pictures of themselves chronologically to share life history
- Relevant standards: OELCS Measurement 1–3, OELCS Geometry and Spatial Sense 5

Money

- Definition: exploring the value of money and its various denominations.
- Example activities: playing "store" where children choose items and buying them with pretend or real money, matching monetary amounts to the coins they represent
- Relevant standards: OELCS Number, Number Sense and Operations 12

Science

Investigation and Observation

Promoting understanding that knowledge can be applied to novel situations, and tools can be used to assist with this purpose.

Critical Thinking

- Definition: using scientific inquiry and the scientific reasoning cycle.
- Example activities: listening to a teacher reading a story and predicting what might happen next or connecting the book to their own life, predicting what might happen when a teacher puts an ice cube into a cup of tea, asking questions about observed daily events (e.g., "What happens to the classroom plant if we forget to water it?") or testing if materials will sink or float when put into water or which ramp will make a car go farthest.
- Relevant standards: OELCS Scientific Inquiry 1–8, OELCS Scientific Ways of Knowing 1, 3; NCTM Data Analysis and Probability Standard Section 3, NCTM Process Standards; NSES Science as Inquiry Standard, NSES History and Nature of Science Standards

Tools

- Definition: exploring ways that objects may be safely used to manipulate items in the environment or accomplish a purpose. Note: *Writing materials were not considered tools for the purposes of this study.*
- Example activities: learning to safely play with handheld tools in the sensory table or sandbox to accomplish a particular goal, or looking at items using a hand lens or magnifier.
- Relevant standards: OELCS Science and Technology 1–4, OELCS Physical Sciences 1–3

The Living World

Promoting understanding that humans, animals, and plants are all living things, interact within an ecosystem, share a relationship with one another, and recognizing living versus non-living entities.

Humans

- Definition: learning about human beings, their life cycles, and their needs.
- Example activities: talking about nutrition and sorting foods into food groups or by types of foods that should be eaten "every day", "sometimes", and "rarely", reading a story and talking about real vs. pretend, or going on a sensory walk and talking about the 5 senses.
- Relevant standards: OELCS Life Science 1–5, OELCS Physical Sciences 6; NSES Life Science Standards, NSES Science in Personal and Social Perspectives Standards

Animals

- Definition: learning about animal species, their life cycles, needs, habitats, and characteristics.
- Example activities: matching pictures of animal parents to their offspring, identifying foods that animals eat or typical habitats, or reading a story about an anthropomorphic animal and deciding if its actions were real or pretend (i.e., *Goldilocks and the Three Bears*)
- Relevant standards: OELCS Life Science 1–5, OELCS Earth and Space Sciences 3: NSES Life Sciences Standards, NSES Science in Personal and Social Perspectives Standards

Plants

- Definition: learning about plant species, their life cycles, needs, and characteristics.
- Example activities: planting a seed and caring for the plant, reading a story about how plants provide necessary resources (i.e., oxygen, food, medicine, clothes, etc.)
- Relevant standards: OELCS Life Science 1–5, OELCS Earth and Space Sciences 3: NSES Life Sciences Standards, NSES Science in Personal and Social Perspectives Standards

The Physical World

Promoting understanding of the properties of the physical world and how these forces interact in the real world.

Water

- Definition: understanding the properties and functions of water.

- Example activities: freezing water and observing which makes it melt faster (i.e., using salt, warm water poured on top, sitting in sun vs. shade), manipulating the flow of water through tubes or a hose to see how the flow or direction changes, or putting items into a tub of water to determine if they will sink or float.
- Relevant standards: NSES Physical Sciences Standards, NSES Earth and Space Sciences Standards, NSES Physical Science Standards

Air

- Definition: understanding the properties and functions of air.
- Example activities: putting a cotton ball or feather on hand and blowing it away, reading a story about air (i.e., *Curious George and the Hot Air Balloon* or *Air is All Around You*), listening to music such as Vivaldi's "Four Seasons" and painting a representation of air.
- Relevant standards: NSES Physical Science Standards, NSES Earth and Space Science Standards

Light

- Definition: understanding the physical properties of light.
- Example activities: observing a naturally-occurring rainbow, exploring with a prism, playing with shadows.
- Relevant standards: OELCS Physical Sciences 7; NSES Physical Science Standards, NSES Earth and Space Science Standards

Recycling and the Environment

- Definition: understanding natural resources and how human action may cause changes in the environment.
- Example activities: classifying items that can be recycled by type (plastic, metal, paper), composting food waste from snack time, reading a story about recycling (i.e., *I Can Save the Earth!* or *Don't Throw That Away!*)
- Relevant standards: OELCS Scientific Ways of Knowing 2, OELCS Earth and Space Sciences 4–5, NSES Science and Technology Standards, NSES Earth and Space Science Standards

Magnets

- Definition: understanding the properties of magnets and magnetism.
- Example activities: using a magnetic wand to see which items will be attracted to the magnet or to what the magnet will be attracted.
- Relevant standards: NSES Physical Science Standards

Seasons and Weather

- Definition: understanding characteristics of the different seasons and observing the weather.
- Example activities: discussing appropriate clothing choices based on weather, reading a story about the seasons (i.e., *The Reasons for Seasons*), observing the position of the sun in the sky at various times of the day.
- Relevant standards: OELCS Earth and Space Sciences 1–2, 4, and 7; NSES Earth and Space Science Standards, NSES Physical Science Standards

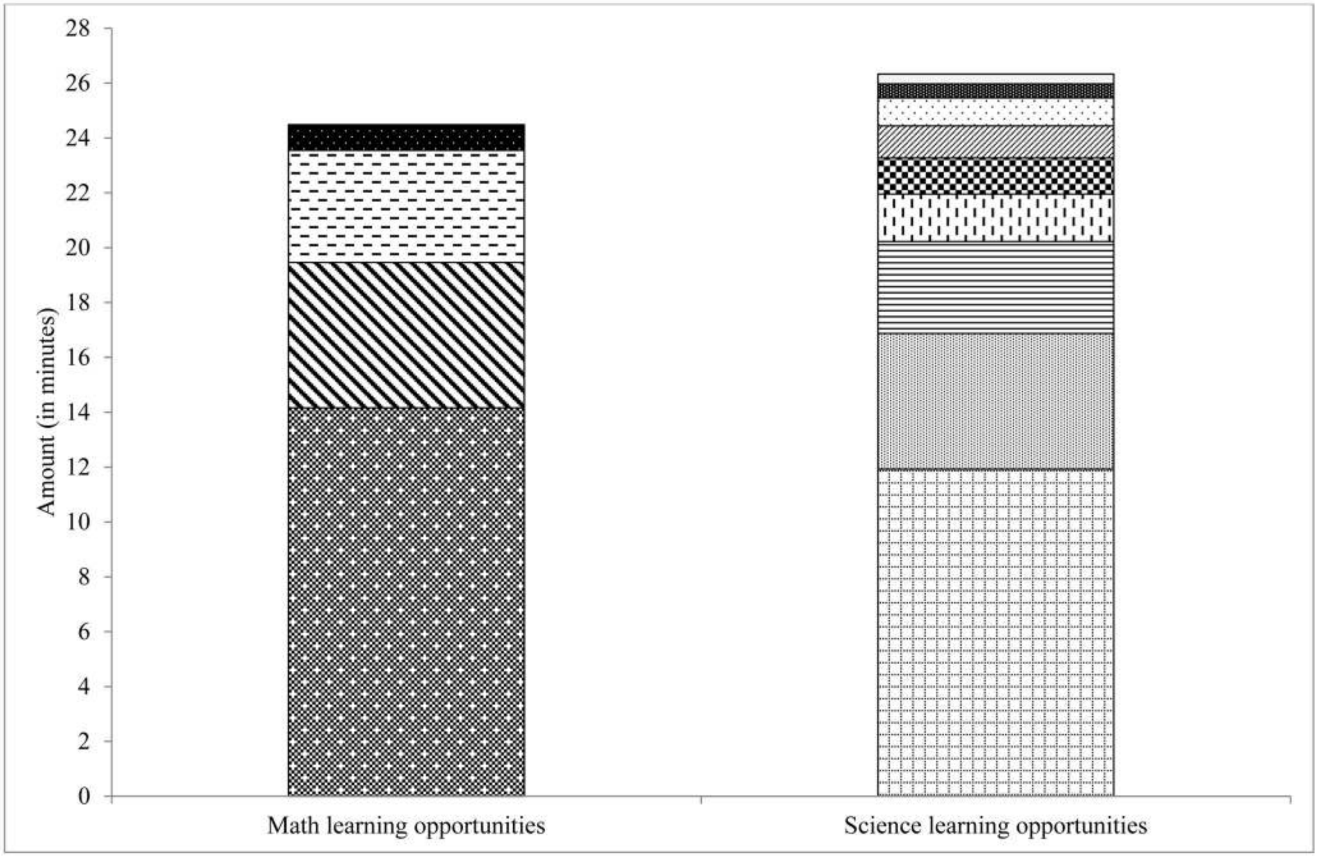

Figure 1.
Amount (in minutes) of specific mathematics and science learning opportunities. No amounts are shown for Air or Water learning opportunities, given that these were not provided to children in any classrooms in the sample.

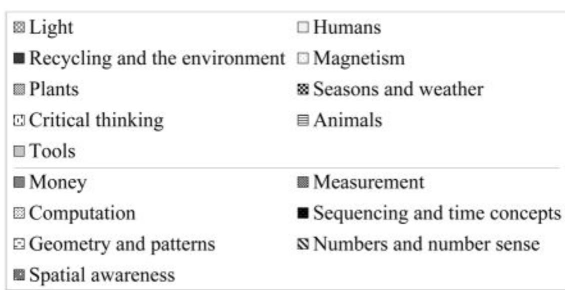

Table 1

Amount and Percentages of Time Spent in Mathematics and Science Learning Opportunities

	Number of classrooms affording opportunity	Duration (in minutes)			Percentage of overall instructional time	Percentage of content area time
		M	*SD*	Range		
Overall instructional time	65	101.32	37.49	45 – 203		
Mathematics learning opportunities	62	24.49	25.40	0 – 120	24.17%	
Numbers and number sense	45	5.30	11.18	0 – 63	5.23%	21.64%
Computation	2	0.02	0.12	0 – 1	0.02%	0.08%
Geometry and patterns	27	4.09	10.39	0 – 56	4.04%	16.70%
Spatial awareness	42	14.16	17.62	0 – 64	13.98%	57.82%
Measurement	2	0.01	0.05	0 – 1	0.01%	0.04%
Sequencing and time concepts	31	0.89	1.26	0 – 4	0.88%	3.63%
Money	1	0.01	0.08	0 – 1	0.01%	0.04%
Science learning opportunities	63	26.32	25.06	0 – 102	25.98%	
Investigation and observation	50	15.28	18.02	0 – 64	15.08%	58.05%
Critical thinking	41	3.35	5.13	0 – 26	3.31%	12.73%
Tools	33	11.93	16.52	0 – 50	11.77%	45.33%
Living world	39	6.77	9.86	0 – 38	6.68%	25.72%
Humans	17	0.51	1.20	0 – 6	0.50%	1.94%
Animals	31	4.94	7.66	0 – 29	4.88%	18.77%
Plants	11	1.32	5.22	0 – 35	1.30%	5.02%
Physical world	33	4.28	9.96	0 – 50	4.22%	16.26%
Water	0	0.00	0.00	0	0.00%	0.00%
Air	0	0.00	0.00	0	0.00%	0.00%
Light	1	0.36	2.94	0 – 24	0.36%	1.37%
Recycling and the environment	6	1.02	3.51	0 – 18	1.01%	3.88%
Magnetism	3	1.17	6.52	0 – 50	1.15%	4.45%
Seasons and weather	27	1.73	6.84	0 – 49	1.71%	6.57%

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Table 2

Correlations between Mathematics and Science Learning Opportunities and Classroom and Program Characteristics

Measure	2	3	4	5
1. Mathematics learning opportunities (minutes)	−.07	.21^{t}	−.08	.06
2. Science learning opportunities (minutes)	–	.11	.33**	−.14
3. Lead teacher's preschool teaching experience		–	.21	−.16
4. Average classroom socioeconomic status			–	−.65**
5. Proportion of children from minority backgrounds				–

$^{t}p < .10$.

** $p < .01$.