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# Time Well Spent: Home Learning Activities and Gains in Children's Academic Skills in the Prekindergarten Year

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Parental engagement in home-based learning activities is linked to children's academic skills. Yet, interventions that try to enhance parental engagement—sometimes targeted to families with low levels of education—have small effects. This study aimed to inform supports for families by examining how different types of home-based learning activities influence academic skills during prekindergarten. We created four measures that assessed the frequency with which parents ($N$ = 307) engaged in unconstrained and constrained language/literacy and math activities at home. Unconstrained language activities predicted gains in children's language skills, and unconstrained math activities were associated with gains in math skills. Both associations were larger for families with lower versus higher levels of parental education. Engagement in constrained activities did not predict gains in skills. Implications for practice and research are discussed.

*Keywords:* parental engagement, home-based learning, academic skills, prekindergarten

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Differences in school readiness skills favoring children from higher- versus lower-socioeconomic status (SES) families emerge early and are substantial at kindergarten entry (Reardon & Portilla, 2016). Researchers have theorized that these gaps can be attributed in large part to the substantial differences in the amount of time and money that parents with higher levels of income and education are able to invest in their young children's cognitive development (Kalil, 2015; Reardon, 2011). Indeed, a wide and rich body of literature has identified the family as the key context influencing the early development of children's academic skills (Kreppner & Lerner, 2013). In turn, school districts, educational practitioners, and policymakers have focused attention on enhancing low-SES parents' engagement in their children's early learning. For example, increasing parental engagement was a key focal point included in both President Bush's No Child Left Behind Act and President Obama's Race to the Top policies (Robinson & Harris, 2014). The Every Student Succeeds Act of 2015 required school districts to allocate at least 1% of federal funds directed at low-income schools to parental engagement activities, including home-based programs (Henderson, 2015). Targeting 0- to 5-year-old children,

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the federal Department of Education in 2014 launched a national campaign to encourage parents to "Talk, Read, and Sing" with their young children every day.

Efforts to increase parental engagement among all types of families in early childhood appear to be working. Parents across educational backgrounds are participating in some home learning activities with their kindergarten-aged children at higher levels than ever before (Bassok, Finch, Lee, Reardon, & Waldfogel, 2016; Kalil, Ziol-Guest, Ryan, & Markowitz, 2016). Even so, most large-scale interventions directed at parental engagement in children's learning have modest effect sizes at best, and typically have little impact on children's skills in the long-term (Kalil, 2015). As parents demonstrate increased engagement in children's home learning, there are growing opportunities to inform and improve interventions directed at parents of young children. To this end, we examined how the *type* of home learning activity might matter in promoting children's language and math gains during the prekindergarten year. Specifically, we contribute to the literature by conceptualizing and measuring home learning activities as supporting children's *constrained* or *unconstrained* skills, following the theoretical framework put forth by Paris (2005) and expanded on by Snow and Matthews (2016).

Constrained skills are directly teachable and have a ceiling, wherein most children can and will achieve perfect performance (Snow & Matthews, 2016). In contrast, unconstrained skills are limitless and are acquired gradually through varied experience rather than direct and specific teaching. Examples of unconstrained skills are vocabulary and problem solving, while constrained skills would include competencies like letter knowledge and counting (Snow & Matthews, 2016). Using these conceptualizations, we first describe the extent to which prekindergarten parents with lower versus higher levels of education engage in unconstrained and constrained language/literacy and math activities. We then examine whether these four distinct domains differentially predict gains in children's receptive language and math skills across the prekindergarten academic year. Finally, we test whether associations between parental engagement activities and gains in children's skills vary by parental education.

Our findings contribute to the literature in several ways. First, few studies to date have considered qualitative differences in the range of home-based learning activities that parents with higher versus lower levels of education engage in with their children, nor have they examined the unique associations that those practices have with children's academic skills before kindergarten for children from varied levels of parental education. Second, the sample of children included in our study attended Boston Public Schools (BPS) prekindergarten—a large-scale program open to any age-eligible child in the city—at age 4. Attending preschool is now the normative experience for 4-year-olds in the United States (Chaudry, Morrissey, Weiland, & Yoshikawa, 2017).[1] It is particularly timely to consider linkages between home-based learning and children's academic skills over and above enrollment in a prekindergarten program that targets math and language skills during the 4-year-old year. Finally, given that the majority of children raised in the United States have parents who work (Bureau of Labor Statistics, 2019), time for home learning activities can be thought of as a limited resource in many households.[2] Our findings can help better pinpoint the specific activity types that optimize this time and complement classroom learning.

## Parental Engagement in Home Learning Activities

There are multiple theoretical frames for conceptualizing home learning activities in the preschool years. For example, Fantuzzo and colleagues (2004) describe three different types of parental engagement in early childhood, one of which captures parents' involvement in their children's learning at home through reading/writing, working on number skills, spending time working on creative activities, and sharing stories. This domain also includes taking the child to educational activities outside the home and creating structures and routines to support academic learning. Home-based learning is distinct from parents' involvement in their children's care center or preschool and communication between parents and teachers/caregivers. Empirically, studies that use this framework have found that parents' active promotion of a high-quality home learning environment is the dimension most predictive of students' academic skills before the start of kindergarten (Boonk, Gijselaers, Ritzen, & Brand-Gruwel, 2018; Fantuzzo et al., 2004; Padilla & Ryan, 2019). In economics, parent investments in young children's learning are conceptualized largely in terms of time and money (Becker, 1991), with studies generally finding links between larger investments in children and increased child cognitive development, educational achievement, and future earnings (Lugo-Gil & Tamis-LeMonda, 2008).

Other frameworks have considered parent engagement in *skill-specific* home learning activities. For example, Sénéchal and LeFevre (2002) have developed and tested a home literacy-specific model positing that children acquire early literacy and language through both informal (e.g., reading) and formal (e.g., parents directly teaching early skills such as letter recognition) learning activities. Across studies involving middle- and upper-SES (e.g., Reynolds, Wheldall, & Madelaine, 2010; Slavin, Lake, Davis, & Madden, 2011) and lower-SES (Rodriguez & Tamis-LeMonda, 2011) children and families, these authors have found moderate to large correlations between engagement in at-home language/literacy activities such as reading and children's vocabulary knowledge (Sénéchal, 2006; Sénéchal & LeFevre, 2002) and reading ability (Sénéchal, 2006). Studies have also identified associations between parental teaching at home and kindergarteners' alphabet knowledge (Sénéchal, 2006) and word reading in all early grades, with correlations ranging from small to moderate across studies (Sénéchal, 2006; Sénéchal & LeFevre, 2002).

Skwarchuk, Sowinksi, and LeFevre (2014) have also considered how at-home learning activities may relate to children's math skills. In a sample of kindergarten-aged children from highly educated families, parental teaching of numbers and sums weakly predicted children's symbolic number system knowledge. In addition, playing more frequent math games at home weakly predicted children's nonsymbolic arithmetic. A study of Australian families with higher levels of income and education linked the general quality of the home numeracy environment with young children's numeracy skills (Niklas, Cohreseen, & Tayler, 2016).

[1] We use the term "preschool" to refer to center-based early childhood education programs for 3- and 4-year-olds. When referring to the Boston program specifically, we use the term "prekindergarten" as this is how the program describes itself.

[2] In 2017, the labor force participation rate of mothers with children under 6 years was 65.1%.

Findings may extend to lower-income samples. Ramani and colleagues (2015) conducted a study in a Head Start sample of 4-year-olds and found that general number-related activities at home predicted children's foundational number skills, while caregivers' advanced math talk predicted children's advanced number skills.

Our study builds on existing research on at-home learning activities to differentiate parent engagement in skill-specific home learning activities *within* the developmental domains of language, literacy, and math. This framework is based in a complementary body of research arguing that young children's skills in these domains can be conceptualized as either constrained or unconstrained (Paris, 2005). Constrained skills are directly teachable and have a ceiling, wherein most children can and will achieve perfect performance (Snow & Matthews, 2016). Teaching the alphabet, writing letters, practicing letter sounds, and spelling one's name would be considered constrained literacy activities. Teaching counting, the names of shapes, and how to calculate simple sums are constrained math activities. In contrast, unconstrained skills do not have a ceiling and are acquired gradually through varied experience rather than direct and specific teaching. Parental storytelling, reading books and asking questions about them, having children explain stories, and defining and discussing new words are examples of unconstrained language activities. Playing with shape blocks, practicing and discussing directional words, talking about money, and reading books about numbers and shapes would be considered unconstrained math activities.

Snow and Matthews (2016) argue that although constrained skills are fundamental for early learning, unconstrained skills are particularly important for predicting longer-term outcomes because they support the higher-order and more complex thinking required past the early grades. This distinction may be important to consider in home learning activities because unconstrained skills have proven more difficult to influence through classroom-based instruction. For example, Wong and colleagues (2008) used an age-based regression discontinuity design to examine effects of public preschool programs across five states and found that program impacts on print awareness—a constrained skill—were four times larger than impacts on receptive vocabulary, an unconstrained skill. Evaluations of the Voluntary Tennessee PreK program (Lipsey, Farran, & Durkin, 2018) and the Boston Prekindergarten Program (Weiland & Yoshikawa, 2013) have also found that short-term effects on letter word identification—another example of a constrained skill—are about 1.5 times larger than effects on receptive vocabulary.

Preschool classrooms may be less effective in improving unconstrained versus constrained skills because the former are largely shaped by children's exposure to general knowledge of the world and comfort engaging in information exchanges and dialogues with adults. These types of individualized learning experiences are harder to implement in classrooms than constrained activities like counting and letter-sound practice. If home and school settings are thought of as complements, it may be optimal to have families use their limited time to focus on what children are getting relatively less of in preschool (unconstrained skill-building activities) versus what they are getting relatively more of (constrained skill-building activities).

## Differences in Home Learning Activities by Parental Education

Beyond conceptualizing what home learning is in the early years and testing whether it matters, researchers have also extensively studied how home learning varies by parental education (Harding, Morris, & Hughes, 2015). Studies have identified significant gaps in both the general frequency and quality of home learning activities between families with higher versus lower levels of income and education in the lead up to formal schooling (Bradley, Corwyn, McAdoo, & Coll, 2001; Hart & Risley, 1995). Using data from the American Time Use Surveys on children ages 0 to 13, Kalil, Ryan, and Corey (2012) found that gaps in parental engagement in reading and problem solving (activities that we would conceptualize as unconstrained) between mothers with a 4-year college degree and those with only a high school education were largest when children were between 3 and 5 years old.

Yet, some literature has documented a recent narrowing gap in the home learning activities reported on by higher- versus lower-SES parents. Using data from the ECLS-K, Bassok and colleagues (2016) found that, compared with the 1998 cohort, children in the 2010 cohort were exposed to more books in the home, were more likely to play games and puzzles at home, and were more likely to have their parents read to and tell stories to them. However, gaps by SES were still substantial in the 2010 cohort. Ninety-four percent of parents in the top 10% of the income distribution read to their child at least three times per week in 2010 compared with 75% of parents in the bottom 10% of the income distribution. Using data from four nationally representative surveys (NLSY-79, PSID-CSD, NHES, and ECLS-B), Kalil and colleagues (2016) also found that gaps in preschool-aged children's book ownership and the frequency with which they visited the library grew smaller between 1988 and 2012. Yet, across the same time period, SES-based gaps increased in reading and telling stories to children and teaching children letters, words, and numbers, with the highest-SES families pulling away from their middle- and lower-SES counterparts.

Accordingly, contemporary data suggest that there continue to be gaps in the extent to which parents from different levels of income and education engage with their children, and gaps may be largest in activities to support unconstrained skills. Children's acquisition of background knowledge—a critical unconstrained skill—is primarily driven by their exposure to this information outside of the school context, and children whose parents have higher levels of education are more likely to be exposed to such knowledge (Snow & Matthews, 2016). While parents with higher levels of income and education are more likely to read to their children on a daily basis (Kalil et al., 2016), they are also more likely to use more diverse vocabulary, rare words, narrative, and explanation (Rowe, 2012) and engage in longer and higher-quality conversations with children (Bradley et al., 2001). All of these activities would be considered unconstrained.

With respect to math, children from more advantaged families are more likely to be exposed to words, books, and stories involving math (Verdine, Golinkoff, Hirsh-Pasek, & Newcombe, 2014). DeFlorio and Beliakoff (2015) found that parents with higher levels of income and education expected children to achieve higher levels of math skills by age 5 and had a more accurate understanding of which skills were within the developmental range of what

5-year-olds are capable of achieving. Such differences appeared to account for unique variance in children's scores on a subsequent math assessment. Differences by parental education may be larger for unconstrained versus constrained math activities. For example, Vandermaas-Peeler and colleagues (2009) conducted observations of parent–child dyads and found no SES differences in the extent to which parents discussed numbers. However, parents with higher levels of education and income were more likely to bring up topics related to quantity and size comparisons, activities conceptualized as unconstrained. In addition, while most children develop basic counting skills by the start of kindergarten, SES differences are more likely to emerge in more advanced number sense skills (e.g., numerical magnitude estimation) and in subsequent math skills measured with standardized assessments (Engel, Claessens, & Finch, 2013).

An academic risk hypothesis (Hamre & Pianta, 2001) would theorize that children whose parents have lower levels of education—who are at heightened risk for poor school readiness skills (Magnuson, 2007; Reardon & Portilla, 2016)—would stand to benefit more from increased engagement in home learning activities with parents than children who have parents with higher levels of education. Bioecological theory would further suggest that parental engagement in home learning activities and parental education have independent and interactive influences on children's development that may differentiate the negative influence of low-parental education on academic outcomes (Bronfenbrenner & Morris, 1998). Specific types of low-cost home learning activities conceptualized as supporting unconstrained versus constrained skills could provide a compensatory mechanism for families with lower levels of education also typically having less overall time and money to invest in children's early academic development (Harding et al., 2015).

## The Current Study

In this study, we add to the home learning and early childhood literatures by answering four research questions:

1. To what extent do parents of children enrolled in a public prekindergarten program engage in home learning activities that support children's constrained and unconstrained literacy/language and math skills?

2. Does engagement in these four domains of home learning activities vary by parental education?

3. To what extent does parental engagement in these four domains of home learning activities predict gains in receptive vocabulary and math skills across the prekindergarten year?

4. Do associations between parental engagement in these four domains of home learning activities and gains in children's receptive vocabulary and math skills vary by parental education?

Findings will provide information on the specific home learning activities that may best support gains in children's language and math skills over and above enrollment in a public prekindergarten program. The study will also help identify whether any of these activities can help attenuate achievement gaps differentiating children from families with higher versus lower levels of education.

# Method

## Participants and Setting

The sample for the current study consists of 307 students attending the BPS prekindergarten program during the 2016–2017 year and their parents. The research team recruited student participants from 41 classrooms and 20 public schools offering the BPS prekindergarten program, which is free, full-day, and open to any age-eligible child in the city.[3] Ninety-two percent of teachers included in the current study sample reported using BPS's *Focus on K1* curriculum (see McCormick, et al., in press) that uses an adapted version of the Opening the World of Learning (Schickedanz & Dickinson, 2005) language and literacy curriculum and Building Blocks (Clements & Sarama, 2007), an early mathematics curriculum for preschool children. All prekindergarten teachers in BPS meet the same requirements and receive the same compensation as K-12 teachers and are required to have an early childhood (preschool to Grade 2) license from the Massachusetts Department of Elementary and Secondary Education. A prior evaluation study demonstrated moderate to large impacts of the BPS prekindergarten program on children's vocabulary, literacy, math, and executive functioning skills (Weiland & Yoshikawa, 2013).

On average across the current study schools, 48% of students were eligible for free or reduced price lunch, 49% of students were Dual Language Learners (DLL), 26% were Black, 16% were White, 46% were Hispanic, 9% were Asian, and 3% were mixed race or another race. About 40% of third-grade students in study schools met or exceeded expectations on the 2015–2016 state English/Language Arts exam, while 45% met or exceeded expectations on the state math exam. Study schools are generally representative of the broader population of BPS schools offering a prekindergarten program, but had lower proportions of Black students (32% at the district level) and higher proportions of students meeting or exceeding expectations on the 2015–2016 ELA exam (36% at the district level). On average, teachers in participating classrooms had taught for 14.79 ($SD$ = 9.25) years total and 8.60 ($SD$ = 7.37) years in a prekindergarten classroom. Ninety percent had a master's degree and 100% were female. Twenty-two percent of teachers were Black, 49% were White, 13% were Hispanic, and 16% were Asian or another race.

We recruited 307 nonspecial education students (i.e., students without Individualized Education Plans) from participating classrooms. Demographic data on the study sample—including parent and family characteristics—is displayed in Table 1 (demographic information broken down by level of parental education is further illustrated in online supplemental materials Table S14).[4] As illustrated, students were diverse with respect to race/ethnicity, DLL status, and eligibility for free or reduced price lunch. Thirty-percent of children had a parent who had graduated high school or

[3] Children are eligible for BPS prekindergarten if they turn 4 by September 1 of the academic year.

[4] Online supplementary materials are referred to with a leading "S" in the manuscript and available with the online version of this study.

Table 1
*Demographic Information for Study Sample and Child Achievement Descriptive Statistics*

| Characteristic | *M* | *SD* | Percent missing |
|---|---|---|---|
| Child characteristics | | | |
| Race/ethnicity | | | |
| Hispanic | 0.30 | — | 0.00 |
| White | 0.27 | — | 0.00 |
| Black | 0.20 | — | 0.00 |
| Asian | 0.16 | — | 0.00 |
| Other race | 0.07 | — | 0.00 |
| Female | 0.50 | — | 0.00 |
| Eligible for free or reduced lunch | 0.58 | — | 0.00 |
| Dual language learner | 0.54 | — | 0.00 |
| Child age at baseline | 4.66 | 0.29 | 0.00 |
| Fall of prekindergarten achievement measures | | | |
| PPVT raw | 73.50 | 28.43 | 3.26 |
| PPVT standardized | 97.77 | 23.61 | 3.26 |
| WJAP raw | 12.52 | 5.18 | 2.93 |
| WJAP standardized | 104.62 | 15.06 | 2.93 |
| WJAP W score | 406.44 | 26.92 | 2.93 |
| Spring of prekindergarten achievement measures | | | |
| PPVT raw | 87.02 | 27.22 | 4.89 |
| PPVT standardized | 102.24 | 19.62 | 4.89 |
| WJAP raw | 15.69 | 4.73 | 5.21 |
| WJAP standardized | 106.40 | 13.81 | 5.21 |
| WJAP W score | 421.27 | 22.52 | 5.21 |
| Parent characteristics | | | |
| Parent education | | | |
| High school diploma/GED or less | 0.30 | — | 5.21 |
| Two-year degree or equivalent | 0.25 | — | 5.21 |
| Four-year degree | 0.17 | — | 5.21 |
| Advanced degree | 0.28 | — | 5.21 |
| At least one parent works 35 hr per week | 0.89 | — | 6.19 |
| At least one parent attended Head Start or prekindergarten | 0.57 | — | 6.84 |
| Age of mother at first child's birth | 27.42 | 6.89 | 7.49 |
| Number of people living in household | 4.34 | 1.74 | 7.17 |
| Parents are married/have a partner | 0.69 | — | 5.21 |
| Parent respondent age at baseline | 36.37 | 7.09 | 8.47 |
| Mother was respondent | 0.86 | — | 5.54 |
| Father was respondent | 0.12 | — | 5.54 |
| Parent survey response date | 113.50 | 48.35 | 0.00 |

*Note*. $N$ = 307. PPVT = Peabody Picture Vocabulary Test; WJAP = Woodcock Johnson Applied Problems. Parent survey response date operationalized as number of days after September 1, 2016.

had a GED, 25% had a parent who had a 2-year degree or equivalent, 17% had a parent with a 4-year college degree, and 28% had a parent with a graduate degree. Relative to the study sample, students in the general population of BPS prekindergarten were more likely to be Black (28% of BPS population) or Hispanic (38% of BPS population) and less likely to be White (19% BPS population) and Asian (9% of BPS population).

## Procedure

The Institutional Review Boards (IRB) at the lead and partner organizations for this study approved the human subjects plan before the commencement of study activities. The project name is ExCEL P-3, MDRC is the institution granting approval, and the IRB approval number is 860661–15.

**School and classroom recruitment.** We randomly selected 25 schools to recruit for the study from the 76 schools in the broader district offering the public prekindergarten program. Twenty-one of the targeted schools agreed to participate and signed a memorandum of understanding with the study team. Of the 21 schools, there was one school that professed an interest in helping the research team to pilot test new measures that could be used in the study schools. As such, we excluded this school from the study sample and instead worked with the teachers there to test the reliability of our data collection procedures. The remaining 20 schools made up the study sample. We asked all prekindergarten teachers assigned to general education or inclusion classrooms in each of the 20 schools to participate in the study in the fall of 2016. Ninety-six percent ($N$ = 41) agreed, including allowing their students to participate in direct assessments with the research team.

**Student and parent recruitment.** We attempted to collect active consent for all prekindergarten students enrolled in participating classrooms. Research staff sent home backpack mail providing an overview of the study and a consent form for the parent to complete and return. We did regular sweeps to pick up consents. Recruitment activities began in late September 2016 and ended by late November 2016. Eighty-one percent of children in participating classrooms consented. Of the total number of children who consented, we randomly selected 50% (~6–10 per classroom) to participate in student-level data collection activities for a total sample size of 307. The consenting parent for each of these children was enrolled in the study as well.

**Direct assessments.** We trained research staff to reliability and then collected direct assessments of children's school readiness skills in the fall of 2016 (October 1st through December 12th) and spring of 2017 (April 5th through June 16th). We used the Prelanguage Assessment Scale (preLAS; Duncan & DeAvila, 1998) Simon Says and Art Show tests (Duncan & DeAvila, 1998) as a warm up to the assessment battery and to determine the administration language for a subset of assessments (Barrueco, Lopez, Ong, & Lozano, 2012). The preLAS assesses preliteracy skills and an individual's proficiency in English.[5] Of the 307 children in the current study sample, 20 (6.5%) did not pass the preLAS and completed a subset of assessments in Spanish in the fall and six students did not pass the preLAS and completed assessments in Spanish (2%) in the spring. There were eight children in the study who did not pass the preLAS and had a home language other than Spanish. These students were assessed in English. There were 299 children who participated in the fall assessment (98% of total sample) and 292 completed the spring assessment (95% of total sample).

**Parent survey.** In the fall of 2016, we contacted the consenting parents of all students who were selected for the study sample to complete a 20-min survey via text message and e-mail. Parents received biweekly reminders to complete the survey. We used backpack mail to collect outstanding surveys from parents. We translated the surveys into Spanish, Vietnamese, and Mandarin. Parents provided demographic information about themselves and

[5] If the child answered fewer than five items on the preLAS incorrectly, the assessor administered the battery in English. In contrast, if the child answered five or more items incorrectly *and* the parent indicated that Spanish was his or her home language, the assessor administered a subset of the assessments in Spanish. If the child answered five or more items incorrectly and spoke English or another language at home, the assessor administered the battery in English.

their child and reported on educational activities they engaged in with their child in the past month. The large majority of participating parents (91%) completed the survey in English. Remaining parents completed the survey in Spanish (6%), Mandarin (2%), and Vietnamese (1%). Eighty-six percent of respondents were mothers and 12% were fathers. All parents received a $25 gift card. In total, 289 of the parents included in the current study (94%) completed a parent survey.

## Measures

**Receptive language skills.** We used the Peabody Picture Vocabulary Test IV (PPVT IV) to directly assess children's receptive language skills in the fall and spring of the prekindergarten year. The PPVT IV is a nationally normed measure that has been used widely in diverse samples of young children. The test has excellent split-half and test–retest reliability estimates, as well as strong qualitative and quantitative validity properties (Dunn & Dunn, 1997). It requires children to choose (verbally or nonverbally) which of four pictures best represents a stimulus word. In our primary analysis, we used the raw score total as our outcome measure. However, models using the age-standardized versions of the PPVT IV scores are included in online supplemental materials Tables S4 and S5. We assessed all children on the PPVT—regardless of whether they passed the PreLAS language screener—to describe an equivalent measure of receptive language skills in English across the full sample.

**Math skills.** We used the Woodcock Johnson Applied Problems III (Woodcock, McGrew, & Mather, 2001) subtest to directly assess children's math skills in the fall and spring of the prekindergarten year. We assessed Spanish-speaking children who did not pass the PreLAS language screener using the equivalent Spanish language version of the assessment from the Batería III Woodcock Muñoz (Schrank et al., 2005). The WJ/WM Applied Problems direct assessment is a numeracy and early mathematics measure that requires children to perform relatively simple calculations to analyze and solve arithmetic problems. Its estimated test–retest reliability for 2- to 7-year-old children is 0.90 (Woodcock et al., 2001) and it has been used with diverse populations. In our primary analyses, we present results using the raw score of the measure. Models using the age-standardized and W score versions of the Applied Problems scores are reported in online supplemental materials Tables S4–S6. We combined scores from the English and Spanish versions of the assessments together so the full sample could be analyzed together. We then examined whether findings were sensitive to this decision.

**Home learning activities.** Using a 4-point Likert scale (1 = *never*, 2 = *once or twice a week*, 3 = *three to six times a week*, 4 = *everyday*), parents reported on the frequency with which they engaged with their child in 27 different home learning activities to support language/literacy and math skills during the past week. We drew these items from the parent surveys from the Head Start Impact Study (Puma, Bell, Cook, Heid, & Lopez, 2005; $N = 21$ items), as well as work done by LeFevre and colleagues (2009; $N = 5$ items) and Starkey and Klein (2000; $N = 1$ item). We used the items to create four separate constructs representing parent engagement activities to support constrained literacy skills (six items), constrained math skills (six items), unconstrained language skills (seven items), and unconstrained math (five items) skills. Of the 27 total items, we did not analyze three of the items. Two items involved computer use and were associated with inequalities related to technology access. One additional item was ambiguous and it was unclear whether it represented an activity to support constrained or unconstrained skills. For each of the four constructs, we created a composite measure by averaging across the values of all items in the construct. Items included in each of the constructs are listed in Table 2. We present detailed information on the reliability and validity of the constructs in the analytic approach section below. As described more fully there, we created four constructs to represent home-based learning activities and each demonstrated high levels of internal consistency—literacy constrained ($\alpha = .87$), math constrained ($\alpha = .82$), language unconstrained ($\alpha = .81$), and math unconstrained ($\alpha = .81$).

**Parental education.** We used parent reports of highest level of education completed to describe parental education in two different ways. First, we created a series of indicator variables, coding 1 if the category described the parent and 0 otherwise. These mutually exclusive groups were (a) high school diploma/GED or less; (b) 2-year college degree or less; (c) 4-year college degree or less; and (d) more than a 4-year college degree/graduate degree (the reference category in analyses). This coding approach was used to describe the sample and capture variation across these four conceptually distinct groups. Second, we dichotomized this variable for our moderation analyses by creating an indicator for whether the parent had a 4-year college degree or higher (coded 1) or not (coded 0). We made this decision given the salience of a 4-year college degree for describing differences in home learning activities identified by Kalil and colleagues (2012) and to maximize statistical power for our moderation analysis. However, we retain the nuanced coding of the measure when including it as a covariate in other models.

**Child characteristics from administrative data.** We accessed administrative data on child demographics from the school district in the fall of the prekindergarten year. We first created a series of indicators to describe children's race/ethnicity (Black, Hispanic, Asian, or Other Race/Ethnicity [including mixed race children]), coding 1 if the child fell into the indicated category and 0 otherwise. The reference group was White. We used similar indicators to describe children's eligibility for free or reduced price lunch (FRPL; 1 if eligible; 0 if not) and gender (1 = female; 0 = not female). A dummy variable for DLL was set equal to 1 if the parent reported that there was a language other than English spoken at home and 0 otherwise. Finally, we used the child's birthdate made available by the school district to calculate age at the time of the fall 2016 assessment in years.

**Family characteristics from parent survey.** Parents reported on demographic characteristics in the fall of the prekindergarten year and we used these characteristics as covariates in analyses. We coded variables as 1 if the characteristic described the parent and 0 if not. These variables indicated whether the parent had attended PreK or Head Start, whether there was at least one parent in the home working full-time, whether the parent was married or lived with a partner, and whether the respondent was the child's mother or father (reference group is other relationship). We used continuous variables to describe the age of the child's mother at her first birth, household size, the parent respondent's age in the fall of the prekindergarten year, and the date that the parent survey was completed.

Table 2
*Summary Statistics of Individual Survey Items Used in Home Learning Constructs*

| Construct | Survey item | Survey item *M* (*SD*) | Construct *M* (*SD*) |
|---|---|---|---|
| Literacy constrained | Show how to read book | 3.03 (1.02) | 2.93 (0.76) |
| | Practice writing alphabet letters | 2.86 (0.91) | |
| | Practice sounds letters make | 3.03 (0.92) | |
| | Practice rhyming words | 2.56 (1.06) | |
| | Learn names of letters/words | 3.07 (0.90) | |
| | Practice writing or spelling name | 3.02 (0.95) | |
| Math constrained | Count number of things you can see/touch | 3.04 (0.92) | 2.78 (0.70) |
| | Count out loud | 3.27 (0.85) | |
| | Name/teach/learn shapes | 2.75 (1.00) | |
| | Identify written numerals | 2.72 (1.04) | |
| | Sort by size/color/shape | 2.52 (1.01) | |
| | Teach simple sums | 2.34 (1.03) | |
| Language unconstrained | Read books | 3.47 (0.78) | 3.08 (0.65) |
| | Retell/make up stories | 2.79 (0.92) | |
| | Teach about world around them | 3.38 (0.84) | |
| | Talk about world around them | 2.94 (1.02) | |
| | Have child explain parts of storybook | 2.85 (0.99) | |
| | Define/discuss new words | 3.07 (0.94) | |
| | Name objects in books/world around you | 3.14 (0.94) | |
| Math unconstrained | Play with shape blocks | 2.51 (0.98) | 2.45 (0.78) |
| | Talk about how big something is/how much something holds | 2.45 (1.04) | |
| | Practice/teach directional words | 2.60 (1.11) | |
| | Read books about numbers/shapes | 2.54 (1.00) | |
| | Talk about money | 2.17 (1.00) | |

*Note*. Each skill was rated by parents on a scale of from 1 to 4 (1 = *never*, 2 = *once or twice a week*, 3 = *three to six times a week*, 4 = *everyday*). $N$ = 290 for literacy constrained, $N$ = 286 for math constrained, $N$ = 290 for language unconstrained, $N$ = 287 for math unconstrained; 6.84% missing for literacy constrained, 8.79% missing for math constrained, 8.47% missing for language unconstrained, 10.10% missing for math unconstrained.

**Selection of study covariates.** Using these variables, we identified two blocks of covariates that were included in predictive models. The first block included the covariates created from the administrative data—race/ethnicity, eligibility for free/reduced price lunch, Dual Language Learner status, child gender, and child age. The second block included the covariates created from the parent survey—parental education, parental work status, parental Head Start or PreK attendance, age of mother at first child's birth, household size, parental marital status, parental age, role of respondent (father, mother, or other relationship), and parent survey response date. The first reason we chose to include these covariates is that they have all been shown to predict parental engagement in home learning (Bassok et al., 2016; Bierman, Morris, & Abenavoli, 2017; Kalil et al., 2016) and/or children's academic skills in early childhood across a range of studies (Choi, Jeon, & Lippard, 2018; Powell, Son, File, & San Juan, 2010; Reardon & Portilla, 2016). Second, given our ability to access data on these demographics from the school district and fairly high completion rates for our parent survey, we had relatively complete and reliable information on these covariates for all children in the study. Third, in our initial exploration of the data, we found that this set of student-level covariates explained a substantial amount of variation in children's academic skills in the spring of PreK. The current covariate list allows us to isolate the effects of at-home learning activities, over and above a range of child and family characteristics found to be strongly linked to these activities and children's skills.

## Analytic Approach

**Missing data.** Overall, there was a relatively low amount of missing data across study variables. As illustrated in Table 2, 6.8% of students were missing the literacy constrained measure, 8.8% were missing the math constrained construct, 8.5% were missing the language unconstrained measure, and 10.1% were missing the math unconstrained measure. Missingness was also low among the assessed outcomes ranging from 2.9 to 5.2% across the PPVT and WJAP assessments conducted in fall and spring as seen in Table 1. All parent covariates had less than 9% missing. We did not find evidence for systematic differences between the children missing and not missing data.

Given the low levels of missingness, we present results using complete case analysis in the main set of results. However, as a robustness check, we used multiple imputation with Stata 15 (Graham, 2009) to impute child and parent covariates, fall PPVT and WJAP scores, and the four home learning constructs. We imputed 100 data sets using multivariate normal regression. We did not impute outcome variables. We followed procedures recommended by von Hippel (2009) and did not impute interaction terms of interest to maintain a clear definition between groups based on dichotomized parental education (see online supplemental materials for further discussion of multiple imputation).

**Confirmatory factor analysis.** After creating theoretically defined constructs representing constrained literacy, constrained math, unconstrained language, and unconstrained math activities, we conducted a confirmatory factor analysis in Mplus 7.0 (Muthén & Muthén, 2007) to evaluate the psychometric properties of each construct. As shown in online supplemental materials Table S15, there was moderate fit across the constructs, with math unconstrained having the best fit (root means square error of approximation, RMSEA 90% confidence interval, CI [0.00, 0.11]; comparative fit index, CFI = 0.99; Tucker Lewis Index, TLI = 0.99; weighted root mean square residual, WRMR = 0.41), followed by literacy constrained (RMSEA 90% CI [0.10, 0.17], CFI = 0.98, TLI = 0.97, WRMR = 0.88), math constrained (RMSEA 90% CI [0.06, 0.13], CFI = 0.98, TLI = 0.96, WRMR = 0.74), and language unconstrained (RMSEA 90% CI [0.12, 0.17], CFI = 0.93, TLI = 0.89, WRMR = 1.14). Cronbach's $\alpha$ across the constructs ranged from 0.81 to .87, demonstrating evidence of strong internal consistency (online supplemental materials Table S16). Interitem correlations across the constructs ranging from 0.40 to 0.54 illustrated unidimensionality within constructs (online supplemental materials Table S16; Clark & Watson, 1995). Constructs were moderately correlated with each other, with the highest correlation between math constrained and math unconstrained activities ($r$ = .68; online supplemental materials Table S17) and the lowest between math unconstrained and language unconstrained ($r$ = .56; online supplemental materials Table S17).

**Descriptive analysis.** To address our first research question—examining the extent to which parents engage in constrained versus unconstrained home learning activities—we calculated the means, standard deviations, and ranges for each of the four constructs across the full sample. For our second research—considering the extent to which parental engagement in the four constructs of home learning differed by parental education—we used an analysis of variance (ANOVA) to test whether reports of engagement in the four constructs varied by four levels of parent education.

**Multilevel modeling.** We then used multilevel modeling to answer research Question 3 and test whether engagement in the four home learning constructs was associated with gains in receptive vocabulary and math skills across the prekindergarten year. Because students ($N$ = 307) in our sample were nested within classrooms ($N$ = 41) nested within schools ($N$ = 20), we fit null models for the spring PPVT and WJAP assessment scores to calculate intraclass correlations (ICCs) and examine the extent to which observations were nonindependent at these levels. Fifteen percent of the variation in the PPVT spring scores and 9% of the variation in WJAP spring scores was between schools. Two percent of the variation in PPVT spring scores and 0% of the variation in WJAP spring scores was between classrooms. As such, we used a two-level model with random intercepts for school to test research Question 3 (Snijders & Bosker, 2012).

We regressed each outcome on the four home learning constructs entered into the model together while controlling for the baseline level of the outcome. We made this decision because the correlations between the home learning constructs were moderate and we wanted to understand the unique effect of each construct on gains in skills, net of the other constructs. We then added covariates to the models in two conceptual blocks (first block = child-level covariates; second block = parent-level covariates). We examined the stability of the point estimates for the home learning constructs across the models to examine how sensitive coefficients were to covariates. For the fourth research question—testing whether associations between engagement in the four home learning constructs and gains in receptive vocabulary and math skills differed based on parental education—we built on the prior model and added the interaction between each home learning construct and a dummy variable indicating whether the child's parent had a 4-year college degree (coded 1) or not (coded 0). To simplify interpretation of the intercept and the interacted terms, we grand mean centered the assessment scores in models testing research Question 4.

## Results

### Research Question 1: Engagement in Home Learning Activities

We found that parents reported engaging in unconstrained language activities most often ($M$ = 3.08, or about 3–6 times per week; $SD$ = 0.65) and unconstrained math activities least often ($M$ = 2.45, or about 2–3 times per week; $SD$ = 0.78). See Table 2 for further details. General engagement levels were high, and parents reported engaging in all home learning constructs at least once or twice a week, on average.

### Research Question 2: Variation in Home Learning Activities by Parental Education

Figure 1 summarizes variation by parental education in reports of engagement in home learning. Constrained activities—for both literacy and math—did not vary by parental education. However, there was a statistically significant difference in parent reports of the unconstrained domains. Specifically, parents with higher levels of education reported more frequent unconstrained language activities, $F(280) = 3.30$; $p < .05$ while parents with lower levels of education reported more frequent engagement in unconstrained math activities, $F(275) = 6.69$; $p < .001$. Full descriptive statistics for home-based learning by parental education are presented in online supplemental materials Table S18 (four parental education groups) and online supplemental materials Table S19 (dichotomous indicator for parental education used in interacted models).

### Research Question 3: Associations Between Engagement in Home Learning Activities and Gains in Vocabulary and Math Skills During the Prekindergarten Year

We found statistically significant associations between parents' engagement in unconstrained activities and gains in language and math skills. Table 3 displays the results for receptive vocabulary in the left panel and for math in the panel on the right. Model 1 shows results of the unconditional model, Model 2 illustrates findings using only the home learning constructs and the baseline level of the outcome. Model 3 includes the home learning constructs, the baseline level of the outcomes, and child covariates. Model 4 includes the variables from Model 3 plus parent covariates. We focus on summarizing results from this final model in this section as point estimates were relatively stable across specifications. There was a statistically significant association between parents' engagement in unconstrained language activities and gains in receptive vocabulary ($\gamma$ = 5.59, $SE$ = 2.55, $p$ = .019). We calculated a standardized association of 0.22 by dividing this coefficient by the standard deviation ($SD$) of the outcome. Moving from engaging in unconstrained language activities

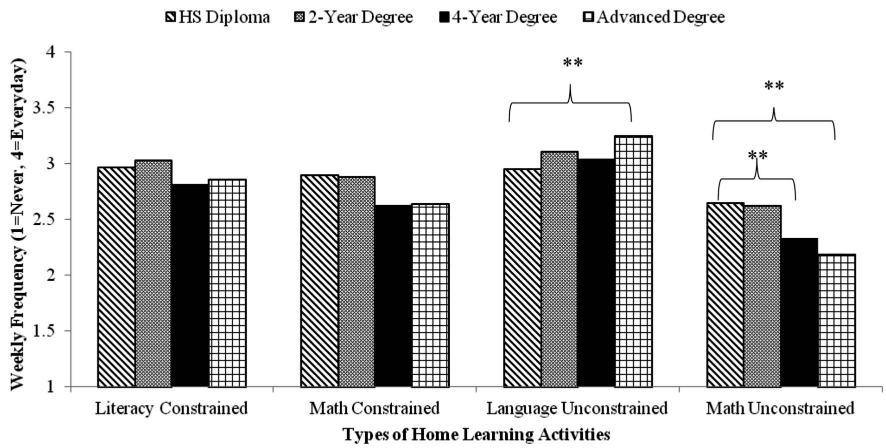


*Figure 1.* Average weekly use of home learning activities by parental education. This plot summarizes the mean differences in home-based learning activities between students whose parents have varied levels of education (high school diploma or less, 2-year college degree, 4-year college degree, or advanced degree). Statistically significant differences occur between high school diploma and advanced degree for language unconstrained (Mean difference = 0.31, *SE* = 0.10, 95% confidence interval CI [0.05, 0.56]) and math unconstrained (Mean difference = −0.46, *SE* = 0.12, 95% CI [−0.77, −0.15]) and between 2-year degree and advanced degree for math unconstrained (Mean difference = −0.44, *SE* = 0.12, 95% CI [−0.76, −0.12]; as illustrated by the significance levels denoted in those comparisons on the graph). Statistical significance levels are indicated as: $^{**}$ $p < .05$.

once or twice a week to three to six times a week would be associated with a 0.22 *SD* increase in children's vocabulary gains across the prekindergarten year, on average.

We also found a statistically significant association between parents' engagement in unconstrained math activities and gains in math skills ($\gamma = 0.98$, $SE = 0.43$, $p = .049$). We found that moving from engaging in unconstrained math skills once or twice a week to three to six times a week would be associated with a 0.18 *SD* increase in children's math skill gains across the prekindergarten year, on average. We did not find that parents' constrained literacy and math activities were associated with gains in receptive language or math skills. There was no evidence that engagement in unconstrained language activities were associated with gains in math skills, or that engagement in unconstrained math activities was associated with gains in receptive language.

## Research Question 4: Variation in Associations by Parental Education

There was a statistically significant interaction between the dummy for parental education and unconstrained language activities ($\gamma = -6.06$, $SE = 3.01$, $p = .048$). Further probing of the interaction (illustrated in Figure 2) revealed that there was a stronger relationship between unconstrained language activities

Table 3
*Associations Between Home Learning Constructs and Gains in Children's Academic Skills*

| Fixed effects | Receptive vocabulary (PPVT raw score) | | | | Math (WJAP raw score) | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Predictors | | | | | | | | |
| Literacy constrained | | −2.20 (2.28) | −2.17 (2.25) | −2.02 (2.26) | | −0.04 (0.42) | −0.07 (0.42) | 0.01 (0.41) |
| Math constrained | | 1.48 (3.09) | 2.81 (3.09) | 1.65 (3.13) | | −0.67 (0.56) | −0.73 (0.56) | −0.81 (0.55) |
| Language unconstrained | | 6.63$^{***}$ (2.34) | 5.10$^{**}$ (2.43) | 5.59$^{**}$ (2.55) | | −0.10 (0.41) | −0.12 (0.44) | −0.19 (0.45) |
| Math unconstrained | | −4.01$^{*}$ (2.31) | −3.16 (2.36) | −2.34 (2.38) | | 0.67 (0.44) | 0.86$^{*}$ (0.44) | 0.98$^{**}$ (0.43) |
| Constant | 89.30$^{***}$ (2.94) | 24.68$^{***}$ (5.38) | 22.13 (16.25) | 19.95 (20.72) | 15.96$^{***}$ (0.42) | 7.51$^{***}$ (1.03) | 10.75$^{***}$ (3.02) | 10.33$^{***}$ (3.70) |
| Covariates | | | | | | | | |
| Child level | | | X | X | | | X | X |
| Family level | | | | X | | | | X |
| Random effects | | | | | | | | |
| School-level variance | 107.23 (54.43) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 1.74 (1.17) | 0.51 (0.48) | 0.60 (0.51) | 0.84 (0.58) |
| Residual variance | 599.47 (58.04) | 229.98 (21.29) | 216.26 (20.04) | 207.27 (19.18) | 17.60 (1.71) | 7.34 (0.73) | 6.86 (0.68) | 6.14 (0.62) |

*Note*. $N = 233$. PPVT = Peabody Picture Vocabulary Test; WJAP = Woodcock Johnson Applied Problems; FRPL = free or reduced price lunch; DDL = Dual Language Learners. Standard errors in parentheses. Covariates include FRPL status, gender, race/ethnicity indicators, DLL status, child age at baseline, parental education indicators, whether at least one parent worked at least 35 hr per week, whether at least one parent attended head start or PreK, mother's age at first child's birth, number of people in household, parental marital status, parental age at baseline, whether mother or father was respondent, and parent survey completion date. Statistical significance levels are indicated as: $^{*}$ $p < .10$. $^{**}$ $p < .05$. $^{***}$ $p < .01$.

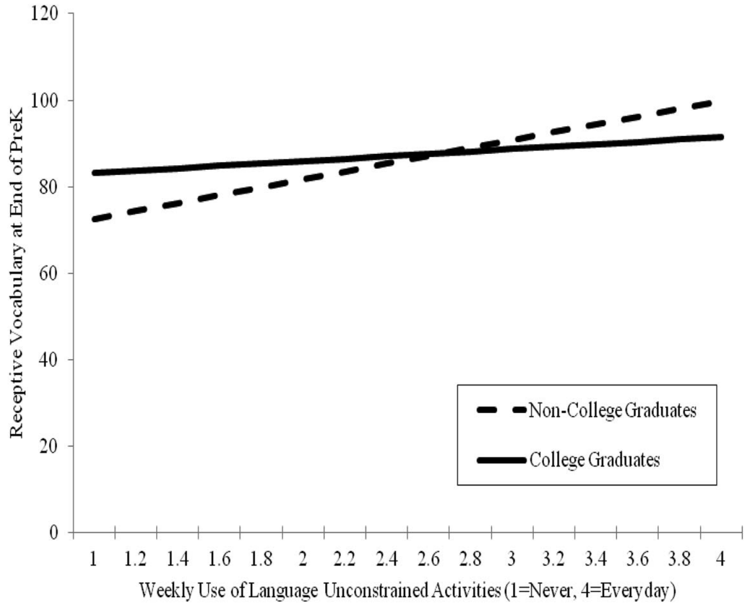


*Figure 2.* Relations between language unconstrained home learning construct and children's receptive vocabulary gains by parental education. This plot illustrates the predicted outcome scores for two prototypical groups (children whose parents have a 4-year degree vs. children whose parents do not have a 4-year degree), based on the findings from our interacted models. The 95% confidence interval (CI) on the interaction between the dummy variable for 4-year degree and language unconstrained activities is 95% CI [−12.44, −.32] suggesting substantial individual variation around these predictions. The solid line demonstrates the predicted outcome scores for children of college graduates at varied levels of language unconstrained activities, while the dotted line does the same for children of parents who did not graduate from college. The predicted outcome scores adjust for free or reduced price lunch (FRPL) status, gender, race/ethnicity indicators, Dual Language Learners (DLL) status, child age at baseline, parental education indicators, whether at least one parent worked at least 35 hr per week, whether at least one parent attended Head Start or PreK, mother's age at first child's birth, number of people in household, parental marital status, parental age at baseline, whether mother or father was respondent, and parent survey completion date.



and gains in receptive language for children whose parents had lower levels of education (less than a 4-year college degree). In predicting gains in math skills, we also identified a statistically significant interaction between engagement in unconstrained math activities and parental education ($\gamma = -1.16$, $SE = 0.46$, $p = .012$) such that there was a stronger relationship between unconstrained math activities and gains in math skills for children whose parents had lower levels of education (less than a 4-year college degree; see Figure 3). A full summary of the findings from interacted models is included in Tables 4 and 5.

## Robustness Checks

We conducted a number of sensitivity analyses to examine the robustness of our findings across a variety of modeling and measurement choices. For parsimony, a full description of these checks and results appears the supplemental online materials (and in online supplemental materials Tables S1–S13). In brief, we found our results to be fully robust to replacing our constrained/unconstrained predictors with variables measuring total activities, total language and literacy activities, and total math activities (fit separately). This check confirmed that *type* and not just total activities was important in predicting children's gains (none of the "total" variables predicted gains in children's language or math skills). Results were also robust in models controlling for classroom quality (as measured with the emotional support, instructional support, and classroom organization domains of the CLASS; see Pianta, LaParo, & Hamre, 2008) and in models excluding "outlier parents" (those who reported never using any of the home learning activities or the six parents who reporting using them every day). Results were robust to inclusion of another covariate indicating whether the parent reported overall high levels of engagement across activities. In addition, although we did find evidence that students who had higher levels of vocabulary skills in the fall of prekindergarten experienced more frequent unconstrained at-home language activities, further investigation into this selection issue revealed that associations between unconstrained language activities and gains in vocabulary did not vary by baseline skills. Finally, we tested whether our interaction results were consistent when we considered all four levels of parental education rather than dichotomizing education to represent 4-year degree or higher versus less than a 4-year degree.

There was, however, some evidence of sensitivity in three of our robustness checks. While results were robust in models predicting standardized math scores differentially by parental education, the association between unconstrained language activities and gains in standardized scores of language skills by parental education was

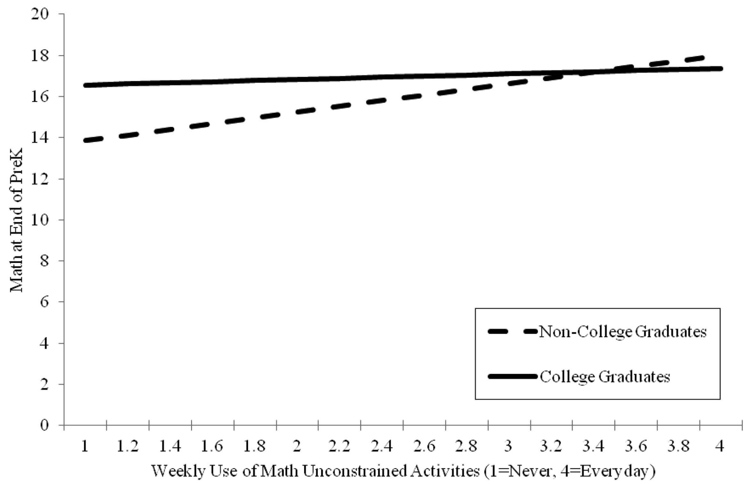


*Figure 3.* Relations between math unconstrained home learning construct and children's math gains by parental education. This plot illustrates the predicted outcome scores for two prototypical groups (children whose parents have a 4-year degree vs. children whose parents do not have a 4-year degree), based on the findings from our interacted models. The 95% confidence interval (CI) on the interaction between the dummy variable for 4-year degree and math unconstrained activities is 95% CI [−2.06, −.26] suggesting some individual variation around these predictions. The solid line demonstrates the predicted outcome scores for children of college graduates at varied levels of language unconstrained activities, while the dotted line does the same for children of parents who did not graduate from college. The predicted outcome scores adjust for free or reduced price lunch (FRPL) status, gender, race/ethnicity indicators, Dual Language Learners (DLL) status, child age at baseline, parental education indicators, whether at least one parent worked at least 35 hr per week, whether at least one parent attended Head Start or PreK, mother's age at first child's birth, number of people in household, parental marital status, parental age at baseline, whether mother or father was respondent, and parent survey completion date.



not statistically significant. However, the standardized associations were similar across these two models (main effect changed from 0.33 to 0.36 while that for the interaction term changed from −0.22 to −0.20). Given that our sample differs from the national norming samples for these measures, we emphasize results using the raw scores but note the detected sensitivity to score choice for one outcome in our limitations section. We also fit models using multiple imputation to address missingness on some covariates. As illustrated in the online supplemental materials, the estimates for the models testing research Question 3 showed some sensitivity to multiple imputation, as did the estimates for the interaction between unconstrained language activities and parental education in the model predicting language skills. For example, the relationship between unconstrained language activities and gains in vocabulary skills decreased from 0.22 to 0.14 *SD* units while the standardized association between unconstrained math activities and gains in math skills decreased from 0.18 to 0.11 (and both were no longer statistically significant). Even so, prior work has shown that multiple imputation can introduce more bias and error than complete case analysis when the level of missingness relative to the sample size is small and there is limited evidence to suggest that data are Missing at Random (Gelman & Hill, 2007). Given the small amount of missingness relative to the sample size, we view the complete case analysis approach that we presented in the body of the text as the more valid approach to address missing data in this study. Finally, although we found that our interaction results using four parental education groups were consistent for the language models, we did not find that the 4-year operationalization was robust in the interacted models predicting math. However, we argue that given limited statistical power to detect interactions for small cell sizes—that the more nuanced coding of the measure creates—the results of the dichotomous education indicator likely represent the more valid approach.

## Discussion

This study aimed to disaggregate home-based learning into distinct domains of unconstrained and constrained language/literacy and math activities and to identify whether those constructs uniquely predicted academic skills in a diverse sample of children. Results revealed that overall engagement in home learning activities was generally moderate to high. This finding reflects national trends showing that all parents—regardless of income or education—are interacting with and engaging in learning activities at home (e.g., reading books, doing art projects, and playing games) on a fairly frequent basis (Bassok et al., 2016; Kalil, 2015). The current study is the first to our knowledge, however, that has conceptualized a broad range of home learning activities as reliable measures of constrained and unconstrained literacy/language and math practices. Operationalizing the constructs in this way has allowed us to identify distinct patterns in the *types* of activities that parents do with their prekindergarten-age children, and how that engagement varies across levels of parental education. Although the methods used in this paper are nonexperimental and results cannot be interpreted causally, we have taken pains to implement a number of robustness checks to assess the sensitivity of findings to different specifications. Findings were generally consistent across these robustness checks. Accordingly, these results provide

Table 4
*Relations Between Home Learning Constructs and Children's Receptive Vocabulary Gains (PPVT Raw Score) by Parental Education*

| Fixed effects | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Predictors | | | | |
| Constant | 2.28 (2.94) | −17.72** (7.411) | −20.94 (17.53) | −22.21 (21.20) |
| Baseline vocabulary | | 0.73*** (0.04) | 0.71*** (0.05) | 0.71*** (0.05) |
| Language unconstrained | | 8.49*** (2.82) | 8.20*** (2.89) | 8.98*** (3.01) |
| Language Unconstrained × College Plus | | −5.03 (3.22) | −6.23* (3.21) | −6.06** (3.01) |
| College plus | | 19.00* (10.21) | 18.26* (10.07) | 17.00 (10.36) |
| Literacy constrained | | −2.33 (2.26) | −2.10 (2.24) | −2.28 (2.24) |
| Math constrained | | 2.42 (3.10) | 3.04 (3.09) | 2.14 (3.13) |
| Math unconstrained | | −3.89* (2.32) | −3.49 (2.35) | −2.83 (2.37) |
| Free or reduced price lunch | | | −4.62 (2.97) | −3.74 (3.07) |
| Female | | | −0.95 (1.96) | −0.72 (2.01) |
| Asian | | | 2.35 (3.57) | 1.08 (3.62) |
| Black | | | −1.99 (3.48) | −0.97 (3.61) |
| Hispanic | | | −4.20 (3.31) | −3.45 (3.36) |
| Other race/ethnicity | | | 6.73* (3.66) | 7.26** (3.65) |
| Dual language learner | | | 1.39 (2.58) | 0.35 (2.63) |
| Child age at baseline | | | 1.27 (3.44) | 1.38 (3.50) |
| Parent attended Head Start | | | | −2.07 (2.04) |
| Mother's age at first child | | | | 0.03 (0.24) |
| Household size | | | | 0.04 (0.61) |
| At least one adult working | | | | −2.64 (3.67) |
| Married/partner | | | | 5.23* (2.86) |
| Parent age at baseline | | | | −0.09 (0.21) |
| Mother is respondent | | | | −0.96 (9.24) |
| Father is respondent | | | | 3.71 (9.60) |
| Survey completion date | | | | 0.02 (0.03) |
| Random effects | | | | |
| School level variance | 107.23 (54.43) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| Residual variance | 599.47*** (58.04) | 225.20*** (20.86) | 212.79*** (19.72) | 206.03*** (19.05) |

*Note*. $N = 233$. PPVT = Peabody Picture Vocabulary Test; FRPL = free or reduced price lunch; DDL = Dual Language Learners. Standard errors in parentheses. Covariates include FRPL status, gender, race/ethnicity indicators, DLL status, child age at baseline, parental education indicators, whether at least one parent worked at least 35 hr per week, whether at least one parent attended Head Start or PreK, mother's age at first child's birth, number of people in household, parental marital status, parental age at baseline, whether mother or father was respondent, and parent survey completion date. The predictors for home-based learning in these models are grand-mean centered. Statistical significance levels are indicated as: * $p < .10$. ** $p < .05$. *** $p < .01$.

fairly strong evidence that can be used to inform future work using experimental methods to rule out threats to internal validity posed by confounding variables.

We found that overall, parents reported doing unconstrained language activities most frequently, followed first by constrained literacy activities and then by constrained math activities. The high levels of unconstrained language activities likely reflect the growing social norm in the United States related to reading in early childhood (Kalil, 2015) because of large-scale efforts over the last 20 years to increase the frequency of home-based reading and children's exposure to books (Roskos, 2017). Parents also reported high engagement in constrained literacy and math activities. Within both of these domains, these practices—teaching letters and sight words for example—are simple enough for most parents to do. They are also clearly defined activities that are likely to lead to quick changes in children's skills. For example, parents may engage in activities to support constrained math skills, such as counting or adding simple sums, and be able to quickly determine whether their teaching was productive by directly observing their child count or complete simple addition soon afterward.

In contrast, parents reported the least frequent engagement in unconstrained math activities. These types of practices may be more difficult to define, harder to teach, and more difficult to discern whether children are benefiting from them (Snow & Matthews, 2016). Playing with shape blocks with a child, for example, is not likely to lead quickly to a clear and quantifiable improvement in that child's math skills and knowledge. Similarly, the finding that parents reported lower levels of engagement in math activities is consistent with prior work showing that parents are less likely to participate in math and complex problem solving activities with children than they are to read to their children (Berkowitz, Schaeffer, Maloney, et al., 2015).

In this study, we were able to leverage a diverse sample of parents to also examine how engagement in these home learning activities varied by parental education. Parents with higher levels of education reported more frequent engagement in activities supporting unconstrained language activities relative to children whose parents had lower levels of education. In contrast, lower-education parents reported more frequent engagement in activities supporting unconstrained math skills than higher-education parents. Although we recognize that these parent reports are certainly subject to reporter bias and measurement error, these results may also reflect variation in how parents with different levels of education approach home learning. Higher-education parents, for example, are more likely to participate in the regular verbal interactions and discussions (Rowe, 2012) that make up the sets of activities included in unconstrained language practices (e.g., retelling or making up stories and asking children to define and describe the

Table 5
*Relations Between Home Learning Constructs and Children's Math Gains (WJAP Raw Score) by Parental Education*

| Fixed effects | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Predictors | | | | |
| Constant | 0.28 (0.42) | −0.94 (1.16) | 1.97 (3.16) | 3.25 (3.70) |
| Baseline math | | $0.67^{***}$ (0.04) | $0.67^{***}$ (0.04) | $0.67^{***}$ (0.04) |
| Math unconstrained | | $1.17^{**}$ (0.48) | $1.33^{***}$ (0.48) | $1.53^{***}$ (0.47) |
| Math Unconstrained × College Plus | | $-0.85^{*}$ (0.47) | $-1.06^{**}$ (0.47) | $-1.16^{**}$ (0.46) |
| College plus | | $3.24^{***}$ (1.22) | $3.46^{***}$ (1.22) | $3.68^{***}$ (1.23) |
| Literacy constrained | | −0.15 (0.41) | −0.18 (0.41) | −0.12 (0.41) |
| Math constrained | | −0.32 (0.56) | −0.48 (0.56) | −0.60 (0.55) |
| Language unconstrained | | −0.38 (0.41) | −0.19 (0.43) | −0.34 (0.43) |
| Free/reduced price lunch | | | 0.43 (0.53) | 0.56 (0.54) |
| Female | | | 0.22 (0.35) | 0.16 (0.35) |
| Asian | | | 0.44 (0.67) | 0.40 (0.66) |
| Black | | | −0.94 (0.65) | −0.55 (0.66) |
| Hispanic | | | $-1.20^{**}$ (0.60) | $-1.24^{**}$ (0.59) |
| Other race/ethnicity | | | 0.19 (0.65) | 0.33 (0.63) |
| Dual language learner | | | 0.44 (0.46) | 0.35 (0.46) |
| Child age at baseline | | | −0.71 (0.63) | −0.48 (0.64) |
| Parent attended Head Start | | | | −0.09 (0.36) |
| Mother's age at first child | | | | 0.06 (0.04) |
| Household size | | | | $0.28^{**}$ (0.11) |
| At least one adult working | | | | −0.84 (0.64) |
| Married/partner | | | | 0.48 (0.49) |
| Parent age at baseline | | | | −0.05 (0.04) |
| Mother is respondent | | | | $-2.85^{*}$ (1.61) |
| Father is respondent | | | | $-3.15^{*}$ (1.66) |
| Survey completion date | | | | −0.01 (0.04) |
| Random effects | | | | |
| School level variance | 1.74 (1.17) | 0.68 (0.54) | 0.92 (0.61) | 1.27 (0.73) |
| Residual variance | $17.60^{***}$ (1.71) | $6.90^{***}$ (0.68) | $6.48^{***}$ (0.64) | $5.93^{***}$ (0.60) |

*Note*. $N = 233$. WJAP = Woodcock Johnson Applied Problems; FRPL = free or reduced price lunch; DDL = Dual Language Learners. Standard errors in parentheses. Covariates include FRPL status, gender, race/ethnicity indicators, DLL status, child age at baseline, parental education indicators, whether at least one parent worked at least 35 hours per week, whether at least one parent attended Head Start or PreK, mother's age at first child's birth, number of people in household, parental marital status, parental age at baseline, whether mother or father was respondent, and parent survey completion date. The predictors for home-based learning in these models are grand-mean centered. Statistical significance levels are indicated as: $^{*}p < .10$. $^{**}p < .05$. $^{***}p < .01$.

world around them). In contrast, Sonnenschein, Metzger, and Thompson (2016) found that parents in a low-income sample were more likely to endorse the use of daily living activities to foster children's math skills than they were to integrate supports for reading into their daily activities. The authors theorized that low-income parents associate supports for literacy/language with entertainment practices, such as reading to children to amuse them. In contrast, parents with lower levels of income and education are less likely to describe math activities as "entertainment" and more likely to endorse the integration of activities like talking about money and quantities into their daily life.

Results from our predictive analyses revealed that the *type* of parental engagement appears to matter for academic gains when children are receiving concurrent supports in a school-based learning context. Specifically, we found that more frequent engagement in unconstrained language and math activities was associated with larger gains in language and math skills, respectively, controlling for levels of constrained literacy and math activities. The standardized associations—.22 *SD*s for language and .18 *SD*s for math—were aligned with or larger than the magnitude of correlations that other researchers have found when examining associations between different parent involvement practices and children's academic skills. For example, Fan and Chen (2001) conducted a meta-analysis of parent involvement practices in studies involving children from kindergarten through high school—including correlational studies that ranged in their degree of rigor and sets of control variables—and found standardized associations of .18 and .17 between parental involvement and math and language skills, respectively. More recent meta-analytic work by Castro and colleagues (2015) found a standardized association of .16 between reading to children—one of the unconstrained language skills included in the current study—and academic skills across child age. However, when the authors considered variation in associations by child grade, they found a nonstatistically significant effect size of .05 between parent engagement practices considered collectively and academic skills during kindergarten, the youngest grade included in the analysis.

Experimental findings from programs intended to enhance parental engagement with the goal of improving children's academic skills have demonstrated similarly small effects (Kalil, 2015). For example, in a randomized trial of families participating in the Home Instruction for Parents of Preschool Youngsters program (Baker, Piotrkowski, & Brooks-Gunn, 1998), researchers found no evidence that the intervention—designed to enhance the home literacy environment and parents' ability to help their children learn—improved children's cognitive skills. Similarly, in a large-scale randomized trial of the Even Start program—an expensive program that aimed to enhance at-home learning activities—Ricciuti, St Pierre, Lee, and Parsad (2004) found no impacts of the program on children's cognitive outcomes. Although standardized associations from the current study could be considered small, contextualizing them against existing evidence suggests further investigation of unconstrained at-home learning activities for boosting children's skills before kindergarten.

In contrast to our findings for unconstrained skills, we did not find any associations between parental engagement in constrained activities and gains in children's skills during the prekindergarten year. All students in this study were enrolled in BPS prekindergarten classrooms implementing the Opening the World of Learning language/literacy (Schickedanz & Dickinson, 2005) and Building Blocks math curricula (Clements & Sarama, 2007). They were exposed to strong, evidence-based programming at school. Parents—and particularly low-education parents—may have limited time to interact with their children in education activities (Coleman, 2018). Our results suggest that it may best serve these parents to focus on increasing their time on the *unconstrained* activities—like one-on-one reading and storytelling—that children are less likely to be exposed to at school (Snow & Matthews, 2016). Unconstrained learning activities can be embedded into daily life, including during transportation to/from school and other destinations (e.g., practicing directional words), general leisure time (e.g., playing with shape blocks), family mealtime (e.g., telling stories), and/or bedtime routines (e.g., reading books). In this way, parental investments of time could be more targeted and efficient. At the same time, we must emphasize that our results do not necessarily indicate that constrained home learning activities do not matter for supporting children's academic skills. Indeed, a wide body of work has shown that constrained skills are foundational competencies that support the development of higher-order and more complex skills (Snow & Matthews, 2016). It might be that because engagement in constrained activities was relatively high, unconstrained at-home learning activities were most likely to benefit children's skills over and above what they already experienced at school. Additional supports to enhance engagement in activities to support unconstrained skills may add more value to supporting children's academic skills than doing more of the constrained activities that children may already be exposed to in a prekindergarten program.

Further, a key result from this analysis is that students whose parents had lower levels of education appeared to drive the associations between parents' engagement in unconstrained activities and gains in academic skills across the prekindergarten year. This is a critical finding given that a major impetus for our study was to identify key factors that may help reduce early achievement gaps in children's skills before kindergarten entry (Reardon & Portilla, 2016). Families with lower levels are education are also likely to have less money to invest in their children's development (Harding et al., 2015; Waldfogel, 2016). Work by Kornrich and Furstenberg (2013) has found that across the period from 1972 to 2007, families' spending on children—particularly on activities thought to relate to academic development—increased substantially among families with high income and education while spending among families with income and education stayed fairly consistent. Our findings indicate that lower-education parents who are able to invest in *time* with their children spent engaging in unconstrained language and math activities may be able to provide supports that help close gaps in academic skills at kindergarten entry favoring children from families with higher levels of education.

## Strengths and Limitations

The current study has a number of strengths including the use of different data sources for operationalizing home learning activities, child outcomes, and study covariates, two time points of data that allowed us to examine gains in children's skills across time, and a series of robustness checks to consider alternative explanations to the study findings (see online supplemental materials). However, there are also a number of limitations that future work should seek to address. First, these data are nonexperimental and the findings from the analyses cannot be interpreted causally. For example, we lack a measure of parent–child interaction quality, a key factor that could affect both the frequency of home-based learning activities and the outcomes of interest. Moreover, with two time points of data we cannot assess the bidirectional and dynamic interplay between children's skills and parental engagement that likely exists within and across levels of parental education. Data from the current study revealed that parental engagement did not vary by children's baseline math skills for low- or higher-education parents. However, children in the highest quartile of baseline language skills had parents who engaged in unconstrained language activities most frequently in both low- and higher-education parents. Yet, parental engagement in unconstrained language activities did not vary between the children who had baseline language skills outside the top quartile. Future research taking advantage of multiple time points as children move from kindergarten to third grade will help build on this work to understand whether and how linkages between children's skills and parental engagement operate in a bidirectional and dynamic way.

A second limitation of the study is that although parent reports are a standard data collection format, the parent report of home learning activities is certainly subject to reporting and recall bias, as well as social desirability bias. Third, our outcome measurement was limited to one assessment of language skills that captures an unconstrained skill and one math assessment that captures a more constrained skill. We were not able to tell whether parents' engagement in constrained activities did link to growth in children's constrained literacy skills. Future work should consider having four outcomes to capture distinct domains of language unconstrained, literacy constrained, math unconstrained, and math constrained skills. Fourth, our main findings demonstrated sensitivity to some robustness checks, namely operationalizing outcomes, standard scores and multiple imputation, and breaking our binary parental education variable into four groups for interacted models. Even so, raw scores are more appropriate for this study than standardized scores because the norming sample differs from the study sample. In addition, because there was a small amount of missing data on covariates in this study and covariate data were not systematically missing, we view complete case analysis as the more appropriate strategy for examining our main research questions. Finally, the sample size for the current study is fairly small raising potential concerns about limited statistical power, particular for detecting statistically significant interactions. When breaking up the parental education interactions into four groups, we were likely underpowered to detect statistically significant effects.

Although we did find a fairly consistent set of statistically significant results for the most part, future work examining these constructs should aim to use a larger study sample to generate greater statistical power. Finally, the study sample is limited to students who selected into the BPS public prekindergarten program and excludes students enrolled in other center-based care, children who did not enroll in formal care during their 4-year-old year, and students from localities without public prekindergarten programs. Future work may replicate results with a broader sample.

## Implications

Results from this study can inform development and implementation of programs and interventions that aim to support diverse parents' engagement in high-quality learning activities with their children. As we noted earlier, most interventions aiming to improve parental engagement to enhance student outcomes have had small effects that tend to fade out quickly (Kalil, 2015). It may be that these interventions are replicating similar sets of constrained activities that schools and early childhood programs are already working on with students. Or it may simply be that interventions do not focus explicitly enough on helping increase the frequency with which parents engage in unconstrained language and math activities with their children. Our study findings suggest that programs should help schools and parents use their time wisely and perhaps increase engagement in *unconstrained* language and math activities at home. One application of our findings might be the growing number of programs that use technology platforms and/or text messages to parents to provide easy to understand suggestions for different language/literacy and math home-learning activities (Hall & Bierman, 2015; Martin, Weiland, & Page, 2018). Such interventions can build off our findings to focus more explicitly on enhancing unconstrained sets of activities at home.

School districts are also engaged in efforts to increase effective parental engagement in children's learning, often focusing explicitly on families with lower levels of education and income. The Boston Public Schools Department of Early Childhood, for example, developed a support for parents called Home Links, which is a set of interactive tools that are sent home and aim to connect families to the curriculum and activities that prekindergarten and kindergarten-aged children are participating in at school.[6] Families receive a Home Links activity sheet weekly and are encouraged to read each night and then choose three activities to complete over the course of the week, at which point the parents can send the sheet back to school to share what the family learned at home. Such district programs may benefit from the findings in the current study. Future work may consider examining the Home Links materials to improve balance across constrained and unconstrained activity types and increasing on supports for unconstrained skills in the domains of language and math. An important advance in the field would be to then use experimental methods to test whether changes in programming yield positive impacts on children's academic skills.

[6] See https://www.bpsearlylearning.org/family-engagement/.

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