Impacts of Targeted and Global Preschool Curricula on Children's School Readiness:

A Meta-Analytic Review

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Abstract

Researchers, educators, and policymakers have identified preschool programs' use of global and targeted, domain-specific (e.g., math or literacy) curricula as a means to increase school readiness and narrow the achievement gap. Yet the relative impact of different types of curricula on children's school readiness is unknown because few studies have attempted to compare the average effect sizes of curricula *across* the different types (e.g., whole-child versus targeted). By conducting a meta-analysis of 71 experimental and quasi-experimental studies that have been published since 1990, this study extends beyond individual evaluations of preschool curricula to quantify program effectiveness in terms of effect sizes. We find small to moderate effect sizes of targeted curricula relative to global curricula. The positive effects of the academically oriented curricula and the null effects of the global curricula suggest that preschool programs may do well to incorporate evidence-based targeted curricula to improve children's skills in targeted content domains.

Impacts of Targeted and Global Preschool Curricula on Children's School Readiness: A Meta-Analytic Review

High-quality early childhood education (ECE) programs can improve children's school readiness and future academic success (Karoly, Kilburn, & Cannon, 2005; Magnuson, Ruhm, & Waldfogel, 2007), particularly for children from low-income backgrounds who are more likely to be at risk of early school failure (Barnett, 2011; Ramey & Ramey, 2006; Schweinhart, 2006). One of the reasons why ECE programs such as Head Start and state-funded prekindergarten may be effective and high quality is because they use a curriculum. Prior research suggests that having a curriculum is one of the most important aspects of quality in ECE (Duncan & Magnuson, 2013) because it provides a framework to guide interactions and activities in the classroom (Klein & Knitzer, 2006; NAEYC & NAECS/SDE, 2003). Together, these findings have helped motivate the expansion of federal and state-funded ECE. As of 2015, approximately 1.6 million of the nation's 4-year-olds were enrolled in Head Start and state-funded prekindergarten programs (NIEER, 2015), with most using an established curriculum to promote positive development and prepare children for school.

Many different curricula programs are available for districts, programs, and teachers to choose from; however, no clear guidance exists on which type – either targeted, domain-specific curricula or global, whole-child – is the most effective at promoting children's school readiness skills (Clements & Sarama, 2007; Goffin & Wilson, 1994; Preschool Curriculum Evaluation Research Consortium (PCER), 2008; Yoshikawa et al., 2013). *Some* evidence from recent studies indicate that children who receive targeted or content-specific curricula (e.g., literacy or math) during preschool show moderate to large improvements in the targeted content domain (e.g., Clements & Sarama, 2008; Weiland & Yoshikawa, 2013).

It is still unclear how different types of curricula compare with each other as few studies have attempted to compare the effect sizes of curricula *across* the different types (e.g., global versus targeted) and examine their impacts on children's school readiness skills. The primary purpose of the present meta-analytic review is to extend beyond prior evaluations of preschool curricula (e.g., PCER) by quantifying program effectiveness in terms of effect sizes.

Background

Global Curricula

The most commonly used curricula in center-based care are whole-child or 'global' curricula. These curricula typically take a constructivist approach to learning, emphasizing child-centered active learning that is cultivated through strategic arrangement of the classroom environment (DeVries & Kohlberg, 1987; Piaget, 1976; Weikart & Schweinhart, 1987). Whole-child curricula most widely used by preschool classrooms in Head Start and state pre-k programs are Creative Curriculum and High Scope, and packages such as Scholastic and High Reach curricula are other alternatives (Clifford et al., 2005; Hulsey et al., 2011; Phillips, Gormley, & Lowenstein, 2009).

Little empirical support exists for High Scope (Belfield, Nores, Barnett, & Schweinhart, 2006; PCER, 2008; Schweinhart, 2005). The only evidence of its effectiveness comes from the Perry Preschool Study (Belfield, Nores, Barnett, Schweinhart, 2006; Schweinhart, 2005). Results indicate that children who attended Perry and used its High Scope curriculum benefitted more in the short- and long-term compared with children who did not attend the program. However, this study included a small sample of children from the 1960s with counterfactual conditions that no longer apply to ECE today (i.e., no preschool at all). Further, no empirical support exists for Creative Curriculum and it has not demonstrated effectiveness based on rigorous What Works

Clearinghouse standards (U.S. Department of Education, 2013) despite its popularity in preschool classrooms (Hulsey et al., 2011). Only recently have studies begun to examine these global curricula with a renewed interest (see Jenkins, Auger, Nguyen, & Wu, 2017).

The most recent comprehensive study used five samples of preschool children (Head Start Impact Study, National Center for Early Development and Learning Multi-State Study of Pre-Kindergarten, PCER, Head Start Family and Child Experiences Survey 2003 and 2009) to examine whether differences existed across popular global curriculum packages used in preschools in classroom academic activities, overall quality, and children's school readiness outcomes (Jenkins et al., 2017). It is important to note here that two of the five samples in this study (PCER and Head Start Impact Study) were random assignment, but the authors did not exploit the experimental variation. Children in classrooms from the Head Start Impact Study using the Scholastic Preschool Curriculum performed significantly better than children in classrooms using the Creative Curriculum across literacy, math, and socio-emotional outcomes. Although promising, this result did not replicate across the five samples and thus it remains an open question whether Scholastic is effective. No other curricular package demonstrated statistically significant associations with children's school readiness outcomes at the end of preschool. Given the popularity of whole-child curricula in ECE, and that Head Start and public preschool programs often mandate global, whole-child curricula, more evidence is needed on the effect of these curricula compared with targeted, content-specific curricula.

Targeted Curricula

An alternative to whole-child curricula, although less commonly used, is academically targeted or content-specific curricula. Targeted curricula have become increasingly popular in this past decade, stemming from an increasing focus on improving children's academic achievement as well as evidence that exposure to explicit learning opportunities may enhance the effectiveness of early childhood programs (Clements & Sarama, 2007; Hamre, Downer, Kilday, & McGuire, 2008; PCER, 2008).

Evidence indicates that children who are in classrooms that implement this type of curriculum during preschool show moderate to large improvements in the targeted content domain (Clements & Sarama, 2008; Diamond, Barnett, Thomas, & Munro, 2008; Duncan et al., 2015; PCER, 2008; Weiland & Yoshikawa, 2013). For example, children who received a literacy-targeted curriculum showed improvements in their literacy and language skills (Justice et al., 2010; Lonigan, Farver, Philips, & Clancy-Menchetti, 2011). Similar gains were also observed in the case of a preschool mathematics curriculum, with children in classrooms implementing this curriculum showing larger gains in their math skills compared with children who received the business-as-usual regular curriculum (Clements, Sarama, Spitler, Lange, & Wolfe, 2011; Clements, Sarama, Wolfe, & Spitler, 2013). Clements and colleagues (2011; 2013) reported an effect size of $g = .72$ at the end of treatment for children who received the Building Blocks mathematics curriculum.

Further, larger, publicly funded programs that have implemented a targeted curriculum also show improvements in content-specific domains. For example, the evaluation of Boston's universal preschool—often referred to as one of the most successful public preschool programs (Duncan & Murnane, 2014)—showed a similar pattern in their findings, with children making the most gains on outcome domains that measure the specific skills targeted by the curricula (Weiland & Yoshikawa, 2013). Yet despite the emerging research lending support for a number of targeted curricula (e.g., Building Blocks), these packages are not yet in widespread use.

Locally-Developed Curricula

Many states allow ECE providers to develop their own lesson plans or curricula rather than purchasing a packaged curriculum. These are designed by local districts or teachers themselves, but may include components of various commercial curricula. Although they are not as common as whole-child curricula in public preschool programs, locally- or teacher-developed preschool curricula make up the business as usual conditions in some of the control classrooms in the studies included in this review. Given the widespread adoption of global curricula such as High Scope or Creative Curriculum and the associated costs per classroom averaging $2000, it is of considerable policy interest to determine which types of curricula are effective across various domains of children's school readiness.

Cross-Curricula Evaluations

Although evidence exists regarding the effectiveness of content-specific curricula on preschool children's development, very few evaluations compare across different types of content-specific curricula or between global or locally-developed curricula. To date, only one large-scale, systematic evaluation of curricula has been conducted. In the early 2000s, 12 grantees across the U.S. were funded by the Institute of Educational Sciences (IES) to study the effect of 14 preschool curricula on children's academic and socio-emotional outcomes up to the end of kindergarten in the Preschool Curriculum Evaluation Research Initiative Study (PCER, 2008). The goal of the PCER study was to understand whether different widely available curricula, or specific features of these curricula, were beneficial in promoting children's learning and development during their preschool year at age 4. Of the 14 intervention curricula, 10 focused on early language and literacy development, one focused on mathematics, and the other three focused on more general domains (Creative Curriculum, Project Approach, Project Construct).

The findings from the PCER study were largely null, although several analytic issues, such as low statistical power (because each curriculum was evaluated individually), have been cited to explain the lack of significant effects (PCER, 2008). However, two content-specific curricula (literacy and math) significantly affected children's reading and math outcomes at the end of preschool, with improvements in the targeted domain (i.e. math curricula affecting math outcomes). In a recent reanalysis of the PCER data, Duncan et al. (2016) pooled the targeted curricula together and found that this type of curricula had an effect on the targeted content domain compared with the business as usual whole-child curricula.

Researchers, educators, and policymakers have targeted preschool programs' use of global curricula and supplementary curriculum-based interventions as a means to increase school readiness and narrow the achievement gap. But without a more comprehensive understanding of curricula effectiveness, practitioners and policymakers cannot determine the most effective curricula type to support children's school readiness during preschool. The current meta-analysis aims to address this gap in the literature by comparing effect sizes across more general, global curricula, and targeted, domain-specific curricula to determine their impacts on children's school readiness skills. Meta-analyses provide an opportunity to examine patterns of findings across a larger set of curricular programs, and such a study goes beyond examinations of individual curricula like those of the PCER report to look at the overall impact of various types of curricula. We answered the following research questions in this meta-analytic review:

1. What is the average effect size of literacy and language curricula compared with (a) whole-child curricula and (b) locally-developed curricula on children's literacy and language outcomes?

2. What is the average effect size of math curricula compared with (a) whole-child curricula and (b) locally-developed curricula on children's math outcomes?
3. What is the average effect size of whole-child curricula compared with locally-developed curricula on children's academic outcomes (i.e., literacy and language outcomes and math outcomes)?

Method

Data

This study draws from a comprehensive database of U.S. ECE program evaluations published between 1960 and 2007. From this sample, we drew only evaluations of preschool curricula from 1990 to 2007. We then conducted a new search of preschool curriculum evaluations from 2007 to 2017 using the same search strategies as before.

Criteria for inclusion. Only studies that occurred after 1990 and before August 2017 (when the search process for this review was completed) were included in this review. In addition to being an ECE curriculum intervention reported on from 1990 to 2017, studies were identified for initial inclusion if they met the following criteria: (1) studies had a treatment and control or comparison group; (2) did not simply assess the growth of one group of children over time; (3) based on groups that included at least 10 participants; (4) incurred less than 50% attrition; (5) did not assess children with medical disorders or learning disabilities; (6) took place in the United States; (7) reported on original research (e.g., no commentaries or reviews); and (8) published in an academic journal, book, conference proceeding, or by an organization.

The majority of the studies used random assignment with the remainder following quasi-experimental designs such as change models, fixed effects models, regression discontinuity, difference in difference, propensity score matching, interrupted time series, instrumental variables, or some other type of matching. Studies that used quasi-experimental designs were also included if they had pre- and post-test information on the outcome or established baseline equivalence of groups on demographic characteristics determined by a joint test. A general goal of the meta-analysis was to use more rigorous inclusion criteria than previous meta-analyses and to ensure that the quality of included quasi-experimental studies be as close as possible to approximating random assignment. A benefit of such a systematic approach for a formal meta-analysis is that it enables researchers to test for whether effect sizes and relationships differ systematically by inclusion criteria such as having a random assignment design.

Search procedure. Several methods were employed to compile the studies included in this synthesis. Electronic databases were searched using keywords and descriptors. In particular, the following databases were targeted: Academic Search Premier (via EBSCO), EconLit, ERIC (Education Resources Information Center), JSTOR, PsycINFO, and ProQuest Digital Dissertations. This resulted in 1,965 documents.

Supplemental searches produced a list of additional related studies. We also searched for publications relating to early childhood curricula on the websites of three well-known organizations that conduct work on early childhood education and/or provide analyses of relevant work: Child Care and Early Education Research Connections, the National Institute for Early Education Research, and What Works Clearinghouse. Additional studies were found when examining reference lists of studies initially included in this synthesis. These subsequent studies were included when selection criteria were met. Reports such as the PCER study (2008) were examined. Related literature reviews (e.g., Duncan & Magnuson, 2013) and meta-analyses (e.g., Camilli, Vargas, Ryan, & Barnett, 2010) were also searched for eligible studies. This search produced another 134 documents.

Despite the breadth of coverage capable of online databases, hand searches are an essential process in finding studies that have potential for inclusion. Journals that focus on early childhood education and instruction, and on curriculum in particular, were searched. These journals included, but were not limited to: *American Education Research Journal*, *Early Education and Development*, *Early Childhood Education Journal*, *Early Childhood Research Quarterly*, *Journal of Early Intervention*, *Journal of Educational Psychology*, *Journal for Research on Educational Effectiveness*, *Journal for Research in Mathematics Education*, and *Reading Research Quarterly*. This search resulted in 108 documents. In sum, 2,207 documents were identified.

Coding the studies. After a thorough search based on the inclusion criteria described above, 71 studies were included in this meta-analysis, with 96 contrasts and 481 effect sizes. The final list of studies coded and their average end of treatment effect sizes for the outcomes of interest are presented in Appendix Table 1. Studies are defined as independent investigations of curricular interventions. Contrasts are group comparisons that experienced different conditions within a study. Most studies only reported on one contrast of interest, but in some cases one study provided information on more than one contrast. In some cases, two different groups were provided with two different targeted curricula and each was compared with a control group, or different cohorts of children were analyzed separately. The outcomes were recorded in the database as effect sizes, or standardized comparisons of treatment and control groups on a set of academic outcome measures (math and/or literacy and language). Table 1 lists the definitions of the key terms for this meta-analysis.

[INSERT TABLE 1]

Effect Size Calculation. Each study's outcome measures were coded into standardized mean difference effect sizes using the Comprehensive Meta-Analysis computer software program (CMA; Borenstein, Hedges, Higgins, & Rothstein, 2005). We used Hedges' *g*-based definition of effect sizes, which adjusts standardized mean differences (Cohen's *d*) to account for bias arising from small sample sizes.

Analytic Approach

Hierarchical linear modeling. Our database consists of three levels of data where effect sizes were nested within contrasts, and contrasts were nested within studies. We accounted for this multilevel structure of the data by employing multi-level models with random intercepts (Raudenbush & Bryk, 2002). This analytic approach permitted accounting for variation that occurs at each level in which the data were organized and for non-independence within nesting groups (Singer, 1998; Raudenbush & Bryk, 2002). Though there were three levels at which the data were organized, we accounted only for two levels of these levels—the nesting of effect sizes within contrasts because while there are several effect sizes per each contrast, the vast majority of studies had only one contrast.

Weights. Effect sizes were weighted by the product of the precision of the effect size estimates and the inverse of the number of effect sizes within each contrast. The precision of effect sizes is the inverse of the squared standard error of the effect size estimates that were generated by the CMA program. This weights up the studies with greater precision. The second component adjusts for the number of effect sizes within each contrast to avoid placing importance on studies that generate numerous effect size estimates within a given contrast. This component of the weight essentially assigns equal importance to each contrast.

Measures

Types of curricula. A curriculum was coded as either targeting general domains or targeting a specific academic domain. The curriculum was coded as targeting general domains if the goals of the curriculum were to improve children's outcomes at a broad level, including social, cognitive, emotional, and physical outcomes. Examples include High Scope, Creative Curriculum, Project Approach, and Bright Beginnings. A curriculum was coded as targeting a specific academic domain if the curriculum was skill-oriented and focused on a specific domain of academic school readiness, such as math or literacy and language. Examples include Building Blocks, Pre-K Mathematics, Let's Begin with the Letter People, and Ladders to Literacy. A number of studies had different kinds of counterfactuals, and these control curricula were coded as business as usual or locally-developed. We make five different curricula comparisons in this study: (I) literacy and language curricula versus whole-child curricula, (II) literacy and language curricula versus locally-developed curricula, (III) math curricula versus whole-child curricula, (IV) math curricula versus locally-developed curricula, and (V) whole-child curricula versus locally-developed curricula. Figure 1 displays the curricula comparisons made in the current study.

[INSERT FIGURE 1]

Outcomes. Effect size estimates of two domains were included in the current study. The first is children's literacy and language skills, which we defined to be letter knowledge, phonemic awareness, print concepts, early reading, reading comprehension, writing, spelling, receptive vocabulary, and/or language comprehension and production. The second is children's math skills, which we defined to be number knowledge, geometry and spatial thinking, and/or problem solving.

The focus of this paper is on the impacts of different preschool curricula types and children's academic achievement; therefore, effect sizes were only coded in which the outcome of interest was achievement on a direct child assessment. Examples of such assessments include the Woodcock-Johnson Tests of Achievement, the Peabody Picture Vocabulary Test, or a researcher-developed assessment directly administered to the child. Studies in which teachers' reports of academic performance were the outcome of interest were not coded.

Covariates. Our models included a set of covariates to control for effect size variation resulting from differences in other program, participant, and study design characteristics. We included whether a given program treatment started after 2007, the length of the program (in years), whether the study had a sample size greater than 100, and whether the program was targeted at low-income families. Following Shager et al. (2013), we included two indicators of study quality that have shown significant relationships with effect sizes in prior meta-analyses: whether the study was random assignment (versus quasi-experimental) and whether the study reported no significant differences between treatment and comparison groups at baseline.

Results

Descriptive Statistics

In Table 2 we display the descriptive information for the methodological characteristics of curricula targeting global and content-specific domains at the effect size level for each of the curricula comparisons as well as the overall sample. About half of the effect sizes included were reported in a peer-reviewed journal and established baseline equivalence. The majority of programs targeted low-income children, were random assignment, and had samples greater than 100 participants. Across the curricula comparisons, the average length of programs ranged from 6 to 8 months (.57 to .72 years). The majority of the outcomes in the literacy and language and whole-child curricula interventions were standardized, but the majority of outcomes in the math curricula interventions were developed by the authors. Descriptive statistics at the contrast and study level are provided in Appendix Table 2 and 3.

[INSERT TABLE 2]

Effect Sizes

Effect sizes for the relationship between the different curricula comparisons and children's academic school readiness skills are presented in Table 3. We follow the general conventions of effect size estimates where effect sizes of .30 or less are considered small, effect sizes between .30 and .49 are considered moderate, and effect sizes above .50 are considered large (Hill, Bloom, Black, & Lipsey, 2008). We display a summary of the average effect sizes adjusted for covariates for our curricula comparisons in Figure 2.

[INSERT TABLE 3]

Literacy and language curricula. The unadjusted effect size for literacy and language curricula compared with whole-child curricula was .18 (SE = .03, $p<.01$) on literacy and language outcomes. Inclusion of covariates produced a similar, small effect size of .17 (SE = .02, $p<.01$). Compared with locally-developed, the effect size for literacy and language curricula was .20 (SE = .05, $p<.01$).

Math curricula. With respect to the math curricula comparisons, the average unadjusted effect size when compared with whole-child curricula was .46 (SE = .04, $p<.01$) on children's math outcomes. When covariates were included in the model, there was some attenuation of associations, with a moderate effect size of .41 (SE = .06, $p<.01$). There were also moderate effect sizes for math curricula compared with locally-developed curricula. The unadjusted effect size was .39 (SE = .03, $p<.01$) and the covariate-adjusted effect size was .36 (SE = .05, $p<.01$).

Whole-child curricula. The effect size for whole-child curricula compared with locally-developed curricula was .07 (SE = .04) unadjusted, and .08 (SE = .05) when adjusted for covariates on the academic outcomes combined. These two effect sizes were not statistically significant.

[INSERT FIGURE 2]

Publication Bias

We assessed the possibility of publication bias arising from studies published with the largest effects and that there may be studies that found no difference that were not published. Bias is a problem if smaller studies tend to produce more consistently positive impacts (Bornstein et al., 2009). Smaller studies generally have less precision, due to their large standard error. We assessed the existence of publication bias using multiple methods. We created a series of funnel plots for effect sizes for each of the curricula comparisons on their key outcomes. Funnel plots display the effect sizes plotted against a measure of study size. In the absence of a publication bias larger studies are more densely concentrated near the average while smaller studies are more scattered around the average resembling a "funnel shape". The funnel plots for the majority of the comparisons generally resembled funnel shapes. According to Egger's test for asymmetry of the funnel plot (Egger et al., 1997), the intercept from the linear regression of the normalized effect estimate (i.e., the estimate divided by its standard error) against precision (i.e., inverse of the standard error of the estimate) is not statistically significantly different from zero, suggesting that publication bias is not a concern in this case.

Discussion

The goal of this meta-analytic review was to understand the overall, average effect sizes of different preschool curricula types on children's academic school readiness skills. The research to date on curricula has examined the effects of individual global or targeted curricula, but no study collectively compares effect sizes across different types of curricula to determine their impacts on children's school readiness skills. Given the call for scientifically validated curricula in large-scale public preschool programs such as pre-k and Head Start, this meta-analysis addresses this critical gap in the literature on how curricula type may influence children's school readiness skills prior to kindergarten entry.

We synthesized 71 studies from 1990 to 2017, and compared children's academic outcomes of global, whole-child curricula and targeted, domain-specific curricula. The analysis supported curricula targeting specific domains of children's school readiness. The direction of the results was consistent with previous studies that directly compared these two types of curricula and found that targeted curricula produced about .10 to .20 standard deviations higher than global curricula (e.g., DeBaryshe & Gorecki, 2007; Sophian, 2004). Targeted curricula were related to children's academic achievement in the domain that was targeted, with effect sizes ranging from .17 to .29. Literacy curricula effect sizes ranged from .17 to .20 and math curricula effect sizes ranged from .14 to .41 on academic achievement. Although the present investigation reflects the status of the current literature, findings must be viewed as preliminary and useful in encouraging and directing future studies of targeted preschool curricula.

One limitation of this study is that outcomes were aggregated into a single global academic outcome, literacy outcome, and math outcome. Researcher-made assessments typically include items that closely match the content and skills fostered in particular interventions. In contrast, standardized assessments may emphasize content and skills that are not always included in an intervention. A possible direction of future research would be to investigate whether effect sizes are comparable regardless of the assessment. More nuanced descriptions of the curricula delivered would provide some additional data needed to interpret the aggregated results reported in this review.

Additionally, non-academic school readiness outcomes were not coded as it was outside the scope of this review, but researchers should work to compare across different types of curricula that are directed at children's socio-emotional development or executive functions such as Tools of the Mind (Diamond et al., 2007). It is imperative that we identify specific features of curricula that lead to detected effects on children's outcomes. Identifying the causal features of preschool curricula should be a priority in future research.

Conclusion

Researchers, policy makers, and practitioners continue to view children's attendance in preschool programs as a way to increase school readiness. Moreover, many preschool programs are adopting published curricula to bring about high-quality instruction. Therefore, it is key that the ECE community understand which curricula programs are most effective in increasing child outcomes, how well teachers implement different curricula types deemed to be valuable, and the degree to which newly implemented targeted curricula produce larger effects on children's learning than the business as usual global curricula used by most preschool teachers. Further, given the millions of federal and state dollars spent each year on curricula for public preschool programs, it is key that we critically evaluate the average effect sizes of various curricula types as a whole on children's school readiness, particularly for children who are disadvantaged and to whom many programs are targeted. More empirical work is needed to understand the relative effects of different curricula types on children's learning outcomes; however, the findings of the present investigation have implications for ECE policy and subsequent research. The generally positive effects of the academically oriented curricula and the null effects of the global curricula suggest that preschool programs may do well to incorporate evidence-based targeted curricula to improve children's skills in targeted content domains. The high-stakes nature of many of these large-scale curricular evaluations makes it necessary for us to ensure that we are getting the developmental and academic content right in ECE to promote school readiness for at-risk preschoolers who stand to benefit from it the most.

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Note: studies included in the meta-analytic calculations are marked with an asterisk.

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Table 1. Key terms for the present meta-analysis.

	Definition
Study	Independent investigations of a curriculum or curricula.
Contrast	Comparisons of groups that experienced different curriculum conditions within a study.
Individual Effect Size	Standardized comparisons of treatment and control groups on a set of outcome measures.
Curricula	
Whole-child	Published curricula that emphasize child-centered active learning and a positive social environment through small- and large-group activities (e.g., music, reading, free play).
Literacy and language	Alternative curricula or supplements to whole-child curricula that target specific literacy and language skills.
Math	Alternative curricula or supplements to whole-child curricula that target specific math skills.
Locally-developed	Curricula described as being nonspecific and developed by the teacher. This category also includes studies that provided an ambiguous description of the comparison curriculum by labeling them as the typical curriculum used in the classroom.
Outcomes	
Literacy and language	Outcomes that measure letter knowledge, phonemic awareness, print concepts, early reading, reading comprehension, writing, spelling, receptive vocabulary, and/or language comprehension and production.
Math	Outcomes that measure number knowledge, geometry and spatial thinking, and/or problem solving.

Table 2. Descriptive statistics for methodological characteristics of curricula targeting global and content-specific domains at the effect size level.

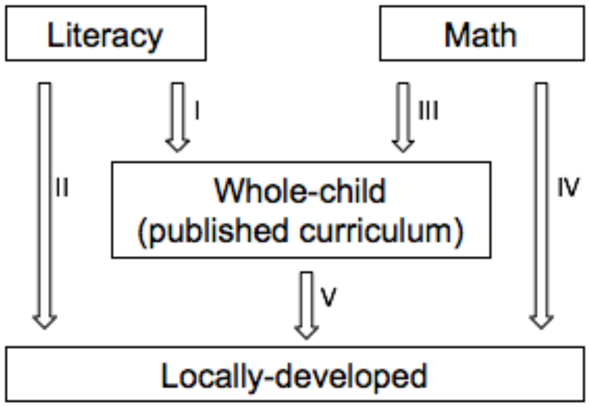
	Curricula Comparison					
	I: Literacy vs. whole-child	II: Literacy vs. locally-developed	III: Math vs. whole-child	IV: Math vs. locally-developed	V: Whole-child vs. locally-developed	All comparisons
	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)
Study Characteristics						
Published in a peer-reviewed journal	.51	.53	.61	.60	.20	.55
Program targeted low-income children	.75	.82	.79	.88	.97	.79
Random assignment	.95	.66	.71	.84	.97	.79
Established baseline equivalence	.42	.59	.32	.76	.74	.53
Sample greater than 100	.97	.82	.71	.80	.68	.82
Program length in years	.72 (.26)	.57 (.26)	.68 (.12)	.59 (.19)	.61 (.32)	.59 (.27)
Study published after 2007	.95	.52	.71	.84	.65	.69
Outcomes						
Language	.14	.06	.64	.72	.35	.17
Literacy	.57	.66	.25	.20	.55	.59
Math	.29	.27	.11	.08	.25	.25
Type of Assessment						
Author-created	.10	.03	.54	.48	.29	.13
Standardized	.90	.97	.46	.52	.71	.87
Number of effect sizes	138	221	28	25	69	481
Number of contrasts	21	42	10	13	10	96
Number of studies	16	28	7	12	8	71

Table 3. Adjusted multilevel linear models of end-of-treatment effects for comparisons of curricula targeted general and skill-specific domains.

Curricula Comparison	Unadjusted ES	Adjusted ES
Literacy and language outcomes		
I: Literacy vs. whole-child	.18 (.03)**	.17 (.02)**
II: Literacy vs. locally-developed	.20 (.05)**	.20 (.05)**
Math outcomes		
III: Math vs. whole-child	.46 (.04)**	.41 (.06)**
IV: Math vs. locally-developed	.39 (.03)**	.36 (.05)**
Academic outcomes		
V: Whole-child vs. locally-developed	.07 (.04)	.08 (.05)

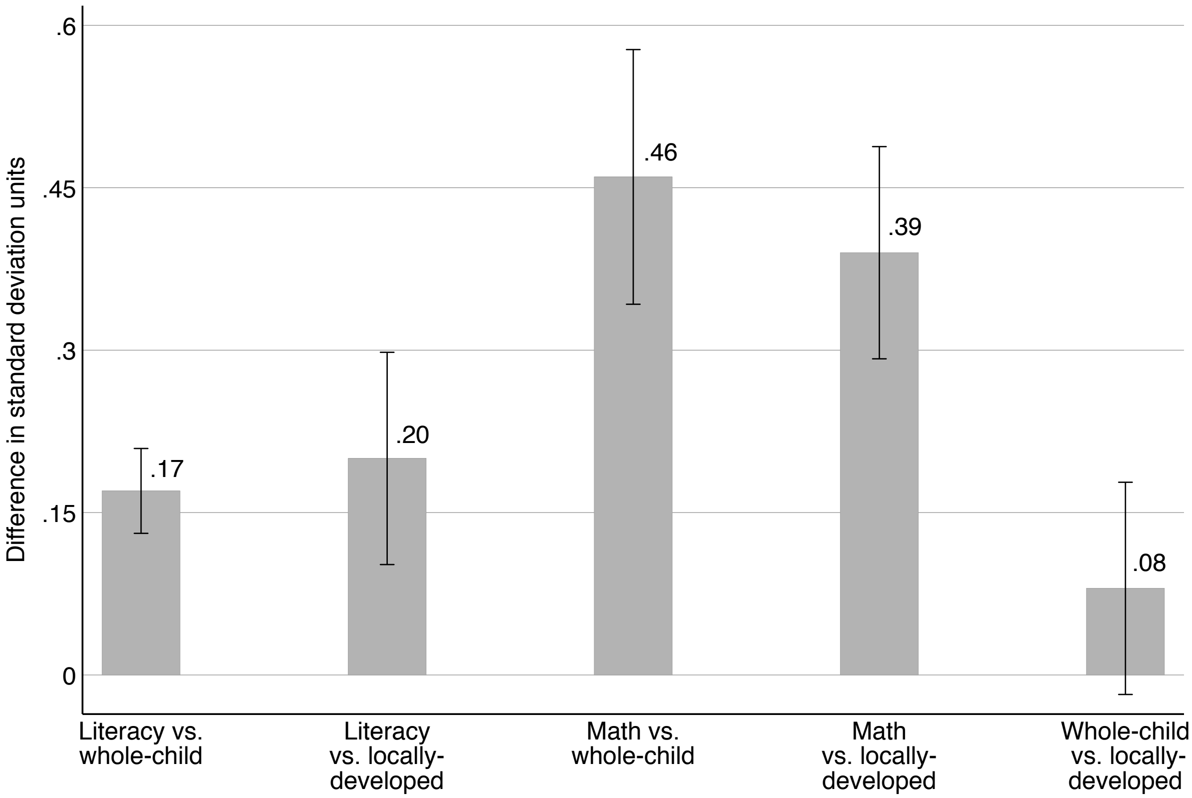
Note. ES = effect size. Effect sizes are only displayed for the key outcome for each curricula comparison. Each comparison for a given outcome is a separate model. Academic outcomes is a composite of the literacy and language outcomes and the math outcomes. Covariates include: random assignment, baseline equivalence, program length, and whether the program targeted low-income families. All models were weighted by the inverse of the standard error square of the individual effect size estimates. **$p<.01$.

Figure 1. Curricula comparisons in the study sample.



Note. Information about specific curricula comparisons presented in Table 1.

Figure 2. Impacts of various curricula on academic outcomes.



Note. The height of each column represents the covariate adjusted mean of effect size estimates within each group, controlling for study characteristics and weighted by the inverse of the standard error squared of the individual effect size estimate. The first and second bars are effect size estimates for literacy and language outcomes. The third and fourth bars are effect size estimates for math outcomes. The last bar represented effect size for composite scores of literacy and language outcomes and math outcomes. Bars show 95% confidence interval.

Appendix Table 1. Average end of treatment effect sizes for literacy and language and math outcomes.

Curriculum	Literacy & language outcomes	Math outcomes	Source
Whole-child curricula			
Bracken Concept Development	-.05	.46	Wilson (2004)
Creative Curriculum	-.08	-.03	Lipsey et al. (2009)
	.03	.11	PCER (2008)
Curiosity Corner	.03	.09	PCER (2008)
Montessori	.21	-	Cusumano (2005)
	.23	-	Jackson et al. (2006)
Project Approach	.23	.12	PCER (2008)
Project Construct	-.04	-.16	PCER (2008)
REACH	.08	-	Moore (2003)
Ready to Learn	.19	-	Brigman (1999)
BELL	.16	-	Layzer et al. (2007)
Breakthrough to Literacy	-.32	-	Flanagan (2006)
	.47	-	Layzer et al. (2007)
Bright Beginnings	.03	.06	Lipsey et al. (2009)
	.16	.11	PCER (2008)
DLM Early Childhood Express with Open Court Reading Pre-K	.49	.26	PCER (2008)
Doors to Discovery	.14	-	Assel et al. (2007)
	.13	.07	PCER (2008)
Literacy curricula			
Early Literacy and Learning Model	.25	-	Cosgrove et al. (2006)
	.13	-.01	PCER (2008)
Emergent literacy skills intervention	.18	-	Lonigan et al. (2013)
Evidence-Based Program for Integrated Curricula - Literacy	.17	-	Fantuzzo et al. (2011)
Exceptional Coaching for Language and Literacy	.20	-	Hindman & Wasik (2012)
Exemplary Model of Early Reading Growth and Excellence	.23	-	Gettinger & Stoiber (2008)
Head Start REDI	.25	-	Bierman et al. (2008)
Ladders to Literacy	-.15	.02	PCER (2008)
	-.05	-	Good (2003)
Language-Focused Curriculum	.31	-	Justice et al. (2008)
	.11	.12	PCER (2008)
Let's Begin with the Letter People	.06	-	Assel et al. (2007)
	.13	-	Fischel et al. (2007)
	.04	.09	PCER (2008)
Literacy Express Preschool Curriculum	.27	-	Lonigan et al. (2011)
	.12	.00	PCER (2008)
Media-Rich Early Literacy Curriculum	.33	-	Peneul et al. (2009)

Opening the World of Learning	.20	-	Abdullah-Welsh et al. (2009)
Paley Storytelling Curriculum	.51	-	Cooper et al. (2007)
PAVEd for Success	.33	-	Schwanenflugel et al. (2010)
Phonological Awareness Training plus Letter Knowledge Training	.08	-	Guidry (2003)
	.36	-	Phelps (2003)
	.22	-	Pietrangelo (1999)
	.58	-	Raisor (2006)
Preschool Emergent Literacy Curriculum	.25	.19	Sophian (2004)
Read it Again!	.28	-	Justice et al. (2010)
	.06	-	Mashburn et al. (2016)
Ready, Set, Leap!	.09	-	Davidson et al. (2009)
	.01	-	Layzer et al. (2007)
	.06	-.04	PCER (2008)
Unspecified literacy curriculum	.23	-	Bennett (2000)
	.08	-	Ciancio (2004)
Waterford Early Reading Program	.08	-	Fischel et al. (2007)
Whitehurst & Wasik	.25	-	Bierman et al. (2007)
	.19	-	Epstein (1994)
	.13	-.12	Shaller (2006)
	.29	-	Wasik et al. (2006)
	.14	-	Whitehurst et al. (1999)
	.49	-	Zevenbergen et al. (2003)
	Math curricula		
Big Math for Little Kids	-	.32	Presser et al. (2015)
Building Blocks	-	1.28	Clements & Sarama (2007)
	-	1.07	Clements & Sarama (2008)
	-	.72	Clements et al. (2011)
	-	.51	Farran et al. (2013)
	-	.05	Morris et al. (2016)
	.15	-	Sarama et al. (2012)
Building Blocks & Pre-K Mathematics Curriculum	-	.62	Sarama et al. (2008)
Evidence-Based Program for Integrated Curricula - Math	-	.22	Fantuzzo et al. (2011)
HighScope Numbers Plus	-	.18	HighScope Foundation (2017)
MyTeachingPartner-Math/Science	-	.40	Kinzie et al. (2014)
PBS KIDS Transmedia Math Supplement	-	.12	Pasnik & Llorente (2012)
	-	.08	Pasnik & Llorente (2013)
Pre-K Mathematics	-	.55	Klein et al. (1999)
Pre-K Mathematics with DLM Early Childhood Express	.13	.54	PCER (2008)
Preschool Math Curriculum	-.20	.24	Sophian (2004)

Note. - indicates the given outcome was not measured in the study.

Appendix Table 2. Descriptive statistics for methodological characteristics of curricula targeting global and content-specific domains at the contrast level.

	Curricula Comparison					
	I: Literacy vs. whole-child	II: Literacy vs. locally-developed	III: Math vs. whole-child	IV: Math vs. locally-developed	V: Whole-child vs. locally-developed	All comparisons
	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)
Study Characteristics						
Published in a peer-reviewed journal	.62	.60	.80	.46	.30	.62
Program targeted low-income children	.71	.74	.60	.85	.90	.74
Random assignment	.90	.76	.70	.85	.90	.81
Established baseline equivalence	.38	.52	.40	.69	.80	.52
Sample greater than 100	.95	.81	.70	.77	.60	.81
Program length in years	.72	.57	.65	.60	.52	.57 (.26)
Study published after 2007	.90 (.30)	.62 (.49)	.70 (.48)	.85 (.38)	.50 (.53)	.72
Outcomes						
Language	.11	.06	.83	.93	.32	.26
Literacy	.58	.63	.12	.05	.62	.52
Math	.31	.31	.05	.02	.22	.24
Type of Assessment						
Author-created	.08	.03	.66	.66	.29	.20
Standardized	.92	.97	.34	.34	.71	.80

Appendix Table 3. Descriptive statistics for methodological characteristics of curricula targeting global and content-specific domains at the study level.

	Curricula Comparison					
	I: Literacy vs. whole-child	II: Literacy vs. locally-developed	III: Math vs. whole-child	IV: Math vs. locally-developed	V: Whole-child vs. locally-developed	All comparisons
	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)	Prop./Mean (SD)
Study Characteristics						
Published in a peer-reviewed journal	.36	.41	.50	.50	.17	.49
Program targeted low-income children	1.00	.65	.50	.80	.83	.76
Random assignment	.91	.71	.75	.90	.83	.82
Established baseline equivalence	.45	.59	.38	.60	.67	.52
Sample greater than 100	1.00	.76	.75	.80	1.00	.82
Program length in years	.89	.60	.67	.65	.75	.63 (.28)
Study published after 2007	.91 (.30)	.53 (.51)	.75 (.50)	.90 (.32)	.83 (.41)	.74
Outcomes						.32
Language	.18	.06	.83	.91	.27	.47
Literacy	.53	.56	.11	.06	.54	.23
Math	.29	.37	.06	.03	.20	
Type of Assessment						
Author-created	.12	.03	.68	.61	.15	.23
Standardized	.88	.97	.32	.39	.85	.77

Appendix Table 4. Unadjusted multilevel linear models of end-of-treatment effects for comparisons of curricula targeted general and skill-specific domains.

	Literacy and language outcomes		Math outcomes	
Curricula Comparison	ES	ES with bias adjustment	ES	ES with bias adjustment
I: Literacy vs. whole-child	.18 (.03)**	-	.14 (.03)**	-
II: Literacy vs. locally-developed	.20 (.05)**	-	.15 (.04)**	.12 (.04)**
III: Math vs. whole-child	.16 (.02)**	.13 (.04)*	.46 (.04)**	.38 (.05)**
IV: Math vs. locally-developed	.16 (.01)**	-	.39 (.03)**	.27 (.05)**
V: Whole-child vs. locally-developed	.08 (.05)+	-	.08 (.05)	.02 (.04)

Note. ES = effect size. In the ES with bias adjustment column, - denotes that trim and fill analyses yielded no trimmed/filled effect sizes using Duval and Tweedie's trim and fill method. Each comparison for a given outcome is a separate model. All models were weighted by the inverse of the standard error square of the individual effect size estimates. +p<.10; *p<.05; **p<.01.

Appendix Table 5. Regression model coefficients for end of treatment effect sizes for literacy and language outcomes.

	Curricula Comparison				
	I: Literacy vs. whole-child	II: Literacy vs. locally-developed	III: Math vs. whole-child	IV: Math vs. locally-developed	V: Whole-child vs. locally-developed
Intercept	.16**	.18**	.14*	.13**	.06
	(.04)	(.04)	(.06)	(.03)	(.04)
Published in a peer-reviewed journal	.12	.01	.04	-.04	.02
	(.07)	(.07)	(.11)	(.11)	(.14)
Program targeted low-income children	.11*	.13*	.17+	.20*	.30*
	(.05)	(.06)	(.09)	(.09)	(.12)
Random assignment	.11+	.17+	.12	-.12	.08
	(.06)	(.09)	(.08)	(.08)	(.07)
Established baseline equivalence	-.13	.08	.08	.15*	.03
	(.07)	(.10)	(.12)	(.06)	(.14)
Sample greater than 100	.17*	-.12	.14	-.08	.25*
	(.08)	(.13)	(.13)	(.12)	(.12)
Program length in years	.13*	.11	.15*	.14	-.13
	(.06)	(.17)	(.07)	(.13)	(.16)
Study published after 2007	.04	.17	.12	-.15	-.14
	(.17)	(.12)	(.13)	(.11)	(.10)

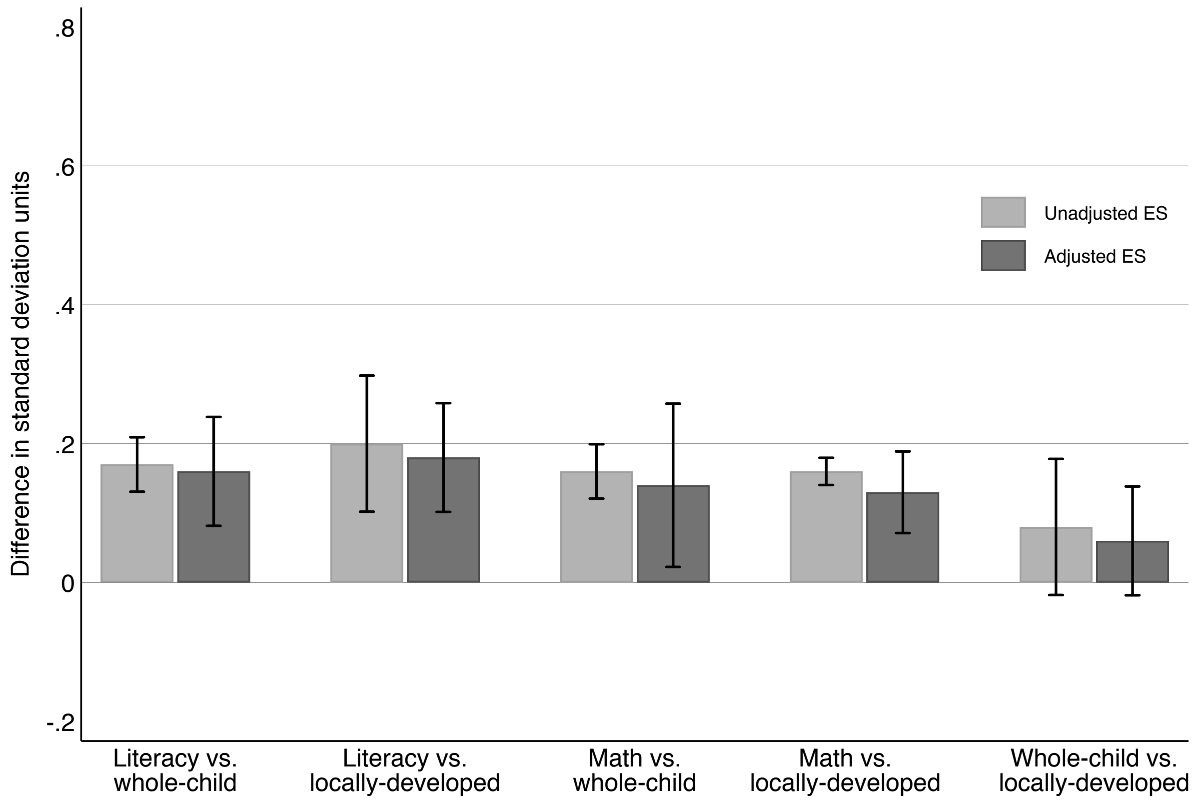
Note. +p<.10; *p<.05; **p<.01.

Appendix Table 6. Regression model coefficients for end of treatment effect sizes for math outcomes.

	Curricula Comparison				
	I: Literacy vs. whole-child	II: Literacy vs. locally-developed	III: Math vs. whole-child	IV: Math vs. locally-developed	V: Whole-child vs. locally-developed
Intercept	.12**	.12*	.41**	.36**	.07
	(.05)	(.06)	(.06)	(.05)	(.05)
Published in a peer-reviewed journal	-.02	.07	.08	.09	-.09
	(.06)	(.09)	(.07)	(.06)	(.07)
Program targeted low-income children	.17*	.15**	.26**	.29**	.17+
	(.06)	(.06)	(.06)	(.07)	(.10)
Random assignment	-.03	-.02	.09	.17+	.03
	(.08)	(.13)	(.12)	(.09)	(.07)
Established baseline equivalence	.06	.07	.13**	.15*	.07
	(.05)	(.05)	(.04)	(.07)	(.06)
Sample greater than 100	.04	.07	-.03	.17**	.09
	(.08)	(.05)	(.03)	(.02)	(.05)
Program length in years	.11	.15	.17*	.10*	.01
	(.09)	(.10)	(.08)	(.05)	(.08)
Study published after 2007	-.15*	-.10	-.11	-.07	-.07
	(.07)	(.07)	(.08)	(.08)	(.07)

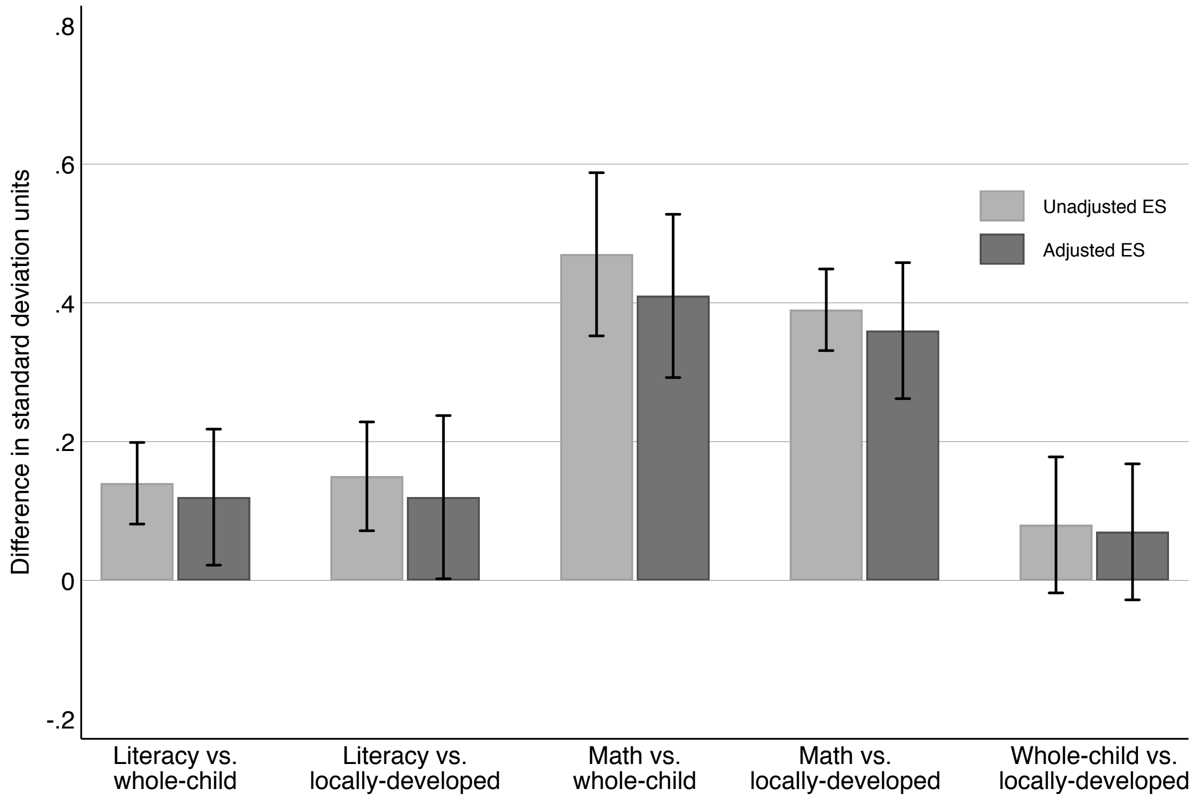
Note. +p<.10; *p<.05; **p<.01.

Appendix Figure 1. Comparisons of effect size estimates between various curricula for literacy and language outcomes.



Note. ES = effect size. The height of each light gray column represents the unadjusted mean of effect size estimates within each group. The height of each dark gray column represents the covariate adjusted mean of effect size estimates within each group, controlling for study characteristics and weighted by the inverse of the standard error squared of the individual effect size estimate. Bars show 95% confidence intervals.

Appendix Figure 2. Comparisons of effect size estimates between various curricula for math outcomes.



Note. ES = effect size. The height of each light gray column represents the unadjusted mean of effect size estimates within each group. The height of each dark gray column represents the covariate adjusted mean of effect size estimates within each group, controlling for study characteristics and weighted by the inverse of the standard error squared of the individual effect size estimate. Bars show 95% confidence interval.