An Early Evaluation of a HighScope-Based Curriculum Intervention in Rural Thailand*

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Abstract

This paper evaluates the early impact of an early childhood curriculum intervention on child development. Impact is measured at the end of the academic year, one year after implementation. Teachers in rural childcare centers in northeastern Thailand were encouraged to employ the new curriculum, which is based primarily on the HighScope approach. We overcome the endogenous decision of teachers to adopt the new curriculum by using the randomization of additional teachers as an instrument. We find that the new curriculum significantly improved child development in multiple dimensions, including gross motor, fine motor, expressive language, and personal and social skills. We also find evidence that exposure to the new curriculum significantly helps children with absent parents more than children with at least one parent present. The results are robust with regards to various estimation methods, child development measures, and sample selections.

Keywords: early childhood education; early childhood curriculum intervention; HighScope; child development; developing country; rural development; impact evaluation

JEL classification: I21, J13, J24

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1. Introduction

The Perry Preschool Project has had a wide-ranging and long-lasting impact on early childhood education (Heckman & Masterov, 2007; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010; Schweinhart & Weikart, 1997). Evidence from the project has changed the landscape of education policy around the world. Many countries including Thailand have recently put early childhood education at the forefront of their public policies. However, there are still questions as to whether the HighScope curriculum used in the Perry Preschool Project can be effectively implemented in rural areas of developing countries, as the curriculum was conceived in the U.S.

Researchers have documented evidence of the effectiveness of curriculum interventions in developed countries (Frede & Barnett, 1992; Heckman et al., 2010; Schweinhart, 2005, 2007; Weikart, Bond, & McNeil, 1978, Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; García, Heckman, Leaf, & Prados, 2016; McKey, 1985). Recently, more work has been done on early childhood curriculum intervention in developing countries. The study that most closely resemble ours is an evaluation of a combination of a structured early stimulation curriculum based on the Reach Up and Learn curriculum and a nutrition intervention in Columbia (Attanasio, Baker-Henningham, Bernal, Meghir, Pineda & Rubio-Codina, 2018; Attanasio, Fernandez, Fitzsimons, Grantham-McGregor, Meghir, & Rubio-Codina, 2014). The HighScope Preschool Curriculum was implemented in the Eastern Caribbean Area (ECA) on a large scale in YEAR, but to date, there has been no impact evaluation on child development outcomes.

This study provides evidence of a large-scale HighScope-based curriculum intervention in rural Thailand. The new curriculum, locally called the RIECE curriculum, is based primarily on the HighScope approach, and focused on the Plan-Do-Review learning process (PDR). Our sample of 512 children is significantly larger than the original sample of 123 children in the Perry Preschool. Our larger sample size addresses concerns raised by Charles Murray in Heckman (2013) regarding the small sample size of the original study. To the best of our knowledge, this study is the first multisite evaluation of a HighScope-based curriculum in a developing country. This study is considered an early evaluation because the development outcomes were measured at the end of the first academic year (from January to March 2016), a year after implementation.

We overcome the endogenous decision of teachers to adopt the new teaching approach by using the randomization of additional teachers as an instrument. Even though this intervention was not designed as a randomized controlled trial, 19 additional teachers were randomly assigned to 19 childcare centers (out of a total of 50 centers). This randomization significantly influenced the existing teachers to adopt the new curriculum. We show that the randomization of additional teachers is a valid instrument for the endogenous adoption decision (Angrist & Pischke, 2013; Heckman, 1976, 1978).

This paper also estimates the heterogeneous effects of the RIECE curriculum. We investigate whether the benefits of the curriculum are distributed evenly across subgroups. We consider subgroups based on child gender, whether parents are present or absent, mother's education, and household wealth (Attanasio et al., 2018; Dooley & Stewart, 2007; Fiorini & Keane, 2014; Gregg, Washbrook, Propper, & Burgess, 2005).

The remainder of this paper is organized as follows. Section 2 presents an overview of the intervention and summary statistics. Estimation and identification strategies are discussed in Section 3. Section 4 presents the empirical results, and Section 5, the robustness checks. Section 6 discusses the heterogeneous effects of the new curriculum. Section 7 concludes.

2 Background and Data Sources

2.1 Overview of RIECE Thailand

The Reducing Inequality through Early Childhood Education program (RIECE Thailand) aims to improve the quality of early childhood education in rural Thailand. To do so, the project has developed an innovative early childhood curriculum, called the RIECE curriculum, which is based primarily on the HighScope program.[1] During the first year of implementation, the RIECE curriculum mainly focused on the Plan-Do-Review process (PDR), which is a core activity of HighScope. See Epstein (2012) for details on the HighScope curriculum.

RIECE Thailand was officially launched in May 2015. It covered 50 childcare centers in 26 Tambons or subdistricts of Mahasarakham and Kalasin provinces. Figure 1 shows the locations of all participating childcare centers. Most of the centers have two levels of classes, one for 2- to 3-year-olds, and the other for 3- to 4-year-olds, with only a few exceptions (three centers have four levels up to 6-year-olds, and 11 centers have at least one class with mixed-age children). Each center is administered by a subdistrict administration organization (SAO), a local governmental unit in Thailand. Some SAOs administered more than one center.

[1] See Heckman et al. (2010) and Schweinhart and Weikart (1997) for some key findings regarding the impacts of the HighScope curriculum.

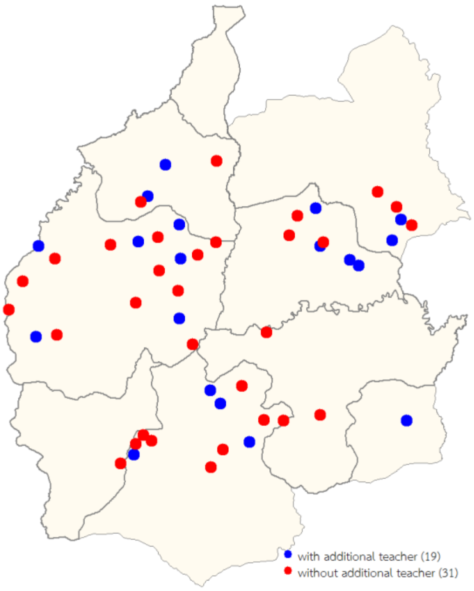

Figure 1: Locations of all participating childcare centers in May 2015.

This project did not randomly assign the new curriculum directly. All existing teachers in all participating centers were encouraged to apply the new curriculum in all classes. Teachers were invited to attend a two-day in-class training (98 percent participation rate) and a two-day intensive workshop (54 percent participation rate) in April 2015. However, teachers may choose not to adopt the new curriculum; that is, the adoption decision is endogenous. By the end of the academic year, only about 35 percent of classrooms (45 out of 127) chose to adopt the RIECE curriculum.

To overcome this endogeneity problem, we utilize the randomization of additional teachers. At the beginning of the project, 19 additional teachers[2] were randomly assigned to co-teach in 19 classrooms in 19 childcare centers for one year.[3] Their main task is to apply the RIECE curriculum in a classroom of 3- to 4-year-olds. They also played an important role in transferring knowledge, and supporting and encouraging existing teachers to adopt the new curriculum. The data show that the presence of an additional teacher significantly increases the

[2] All the additional teachers hold a bachelor's degree in early childhood education from local universities. Most of them graduated in May 2015. They were trained intensively how to apply the RIECE curriculum for two weeks before the semester started.

[3] After observing a relatively low adoption rate, the project invited some existing teachers (no more than four teachers per center) from the centers with no assigned additional teacher to attend an informal five-day on-site training in October that year. We found that more teachers adopted the curriculum after the training.

likelihood of adopting the RIECE curriculum in other classrooms in the same childcare center. Excluding the classrooms with the additional teachers, 42 percent (16 out of 38) of classrooms in the 19 childcare centers with additional teachers adopted the curriculum. In the other 31 centers without additional teachers, the adoption rate was only 14 percent (10 out of 70 classrooms). This randomization of additional teachers is a potential instrument to overcome the endogeneity problem.

2.2 Child Development Measures

Child development measures are from the Developmental Surveillance and Promotion Manual (DSPM), developed by the National Institute of Child Health, Department of Health, Ministry of Public Health of Thailand. The DSPM is primarily adapted from the Denver Developmental Screening Test version II or Denver II (Choosri, Pookao, Swangtrakul, & Atkin, 2017; Morrison, Chunsuwan, Bunnag, Gronholm, & Estrin, 2018). The main purpose of the test is to monitor delayed development in young children.

The DSPM is divided into five main skill domains: gross motor (GM), fine motor (FM), receptive language (RL), expressive language (EL), and personal and social (PS). These domains are found to be key to later academic achievement (Davies, Janus, Duku, & Gaskin, 2016). Most of the test items are observed by the evaluators, except some test items in expressive language (EL) and personal and social (PS) domains, which are based on teacher interviews (73 percent of all items for EL and 54 percent of all items for PS). See Appendix B for examples of test items for each domain.

The DSPM is designed for children from birth to 5 years old and categorized into 19 age ranges, each of which may contain several test items for each domain. The details are listed in Table 9. For each domain, a child is first tested using the test items for his own age range. He is recorded as passing the test if he passes all the test items. Failing at least one item implies that the child has delayed development, and the child is recorded as failing the test.

In order to increase the statistical power, we extended the original DSPM testing procedure by applying not only age-appropriate test items but also test items in two age ranges above or below his age range, depending on the test outcomes. If the child passes the test for his age range, he will be tested using items one level above his age range. On the other hand, if he fails the test for his age range, he will be tested using items one level below his age range. To economize on testing time, we allow only up to two levels above or below an age range. For example, suppose a child is 38 months old. For the gross motor domain, the age-appropriate testing item for 37-41 months is to assess whether he can stand on one leg for three seconds (he can try at most three times). If he passes the test, he will then be tested using the item from the 42 months group. The test will end if he fails the 42 months test. If he passes the 42 months test, he will then be tested using the next age range, which is 43-48 months. On the other hand, if he fails the test for his age range (37-41 months), he will then be tested using the item from the 31-36 months group. The test will end if he passes the 31-36 months test. If he fails the 31-36 months test, he will then be tested using the next age range, which is 30 months.

The main measure of child development in this paper— the developmental score—is determined by the median of the highest age range that the child passes. For example, suppose a child is 44 months old. He will begin the test at the 43-48 months range. If he passes the level above (49-54 months) but fails two levels above (55-60 months), then his child developmental score is 51.5 months (the median of the 49-54 months range).[4]

Following Attanasio et al.,(2018) and Fryer Jr & Levitt (2004), we have transformed the median developmental score into an age-standardized score, called the "internally age-standardized score," to deal with differences in the score across ages. Most of the empirical results reported in this paper are based on this standardized score. More formally, let S_{ia} denote the developmental score of child i whose age is in age range a, and $\overline{S}_a$ denote the average score for that age range. The standardized score for that child is

$$SS_{ia} = \frac{S_{ia} - \overline{S}_a}{\sigma_a} \tag{1}$$

where σ_a denotes the standard deviation of the score for that age range. Note that the standard deviation is the unit of the standardized score.

Another important and challenging issue is that the DSPM test is applicable for children up to 60 months old only. Consequently, not all children can be tested up to a maximum of two levels. For example, children older than 55 months can only perform the test for their own age range, and this group consists of roughly 23 percent of the whole sample. These children would generally have lower standardized scores by construction. This, of course, suggests that we should restrict the analysis to the sample of children who can be tested up to a maximum of two levels. However, such a restriction would cost us a significant number of observations. In

[4] We also perform all the analyses using other measures of child development, including the minimum month, the maximum month and the number of steps above/below (above as positive and below as negative) his own age of the highest age-range that the child can pass. The results are robust, and are available upon request.

particular, the whole sample contains 667 children[5] while the two-maximum level sample contains only 291 children. As a compromise, our main results are based on the sample of children who can potentially perform at least one-level above or below their own age range, henceforth called the "one-level maximum sample," which consists of 512 children. Although the one-level maximum sample contains children who can potentially perform more than one level above/below their age range, we calculate the developmental score using up to one-level above/below only. As robustness checks, we perform the same analyses on the other two samples—the "whole sample" and the "two-level maximum sample."

As a first look at the impact of the RIECE curriculum, Figure 2 illustrates the standardized scores of children who have learned using the RIECE curriculum and those who have not, using the one-level maximum sample. Note that the "General" variable here represents the average score across all five domains. Figure 2 shows that children who were exposed to the RIECE curriculum generally performed better than their peers who were not exposed to the curriculum. Similar patterns emerge for the other two samples—the two-level maximum sample and the whole sample—as presented in Figures 3 and 4. For each of the five domains, the average standardized score is positive for children who were exposed to the RIECE curriculum, and negative for those who were not exposed to the RIECE curriculum. In addition, Table 1 shows that pre-intervention characteristics for both groups of children are not statistically different except the age of the children. In other words, the two groups are not significantly different before the introduction of the RIECE curriculum.

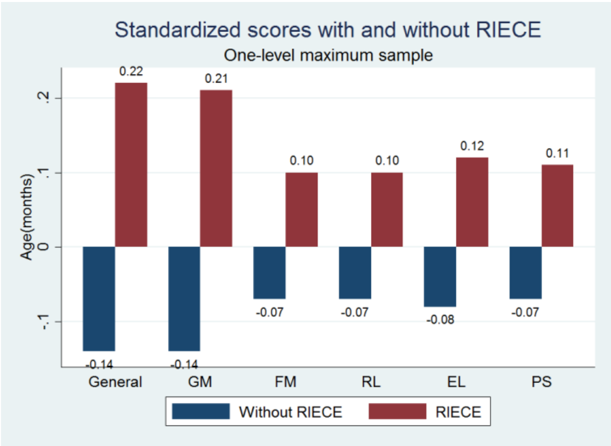

Figure 2: DSPM test results using the one-level maximum sample: the average standardized score for children with (red) and without (blue) the RIECE curriculum.

[5] The whole sample in this paper is from 47 centers only. The three centers, one of which had an additional teacher, are excluded because the survey team had limited time, and could not conduct the test in those centers.

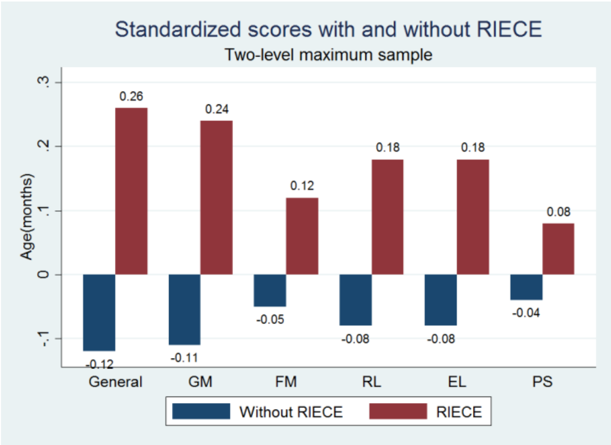

Figure 3: DSPM test results using the two-level maximum sample: the average standardized score for children with (red) and without (blue) the RIECE curriculum.

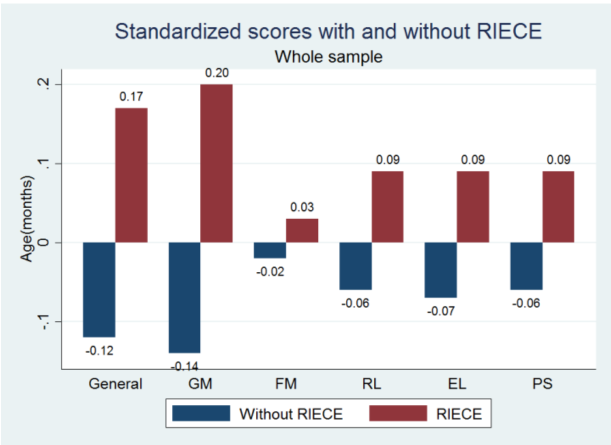

Figure 4: DSPM test results using the whole sample: the average standardized score for children with (red) and without (blue) the RIECE curriculum.

2.3 Data on Teachers and the Adoption of the RIECE curriculum

Data on teachers and the adoption of the RIECE curriculum come from teacher interviews by the survey team of RIECE Thailand. The team began their visits in November 2015, and continued for four rounds until March 2016. The data used in this paper come from the last round of the survey. Ninety-four percent of classrooms in 50 centers (120 out of 127 classrooms) have complete information.

One main question in the interview is: “Has your classroom started applying the RIECE curriculum yet?”. If the teacher answers in the affirmative, the teacher was then asked: “How many days of the week do you apply the curriculum, and in which month did you start using the curriculum?". The data show that among classrooms that adopted the RIECE curriculum, the average number of days per week in which the curriculum is applied is 4.90 days (slightly larger than 4.75 when classrooms with the additional teachers are excluded) and the standard deviation is 0.44. This figure implies that once a teacher decides to use the RIECE curriculum, she tends to apply it almost everyday. As a result, this variable is not informative and will be dropped. On the other hand, among classrooms that adopted the RIECE curriculum, children were exposed to the curriculum for an average of 6.4 months and standard deviation of 2.61.[6] There is sufficient variation in the exposure period across classrooms. Therefore, we utilize the number of months as the exposure period. Importantly, the data allow us to match students to teachers and classrooms. By doing so, we can identify whether a sampled child has been exposed to the new curriculum or not. The curriculum adoption dummy variable for each child is our key variable.

Another important piece of information is the quality of curriculum adoption. The assessment of the adoption quality was collected by early childhood education experts[7] from RIECE Thailand. The project randomly assigned these experts to visit all 50 centers regularly (on average three times a year). In addition to monitoring and supporting all teachers, these experts were assessed the adoption quality as well. Unfortunately, data on the adoption quality is available only for 41 percent of the classrooms. Nevertheless, at the end of year, the expert team did qualitatively evaluate all 50 centers by assigning a score on a discrete scale from zero (worst adoption quality) to one (best adoption quality). The average score of all 50 centers is 0.68 while the minimum and maximum scores are 0 and 1.00, respectively. We calculated the adoption quality score of a particular classroom by multiplying the curriculum adoption dummy variable of that classroom with the score of the center to which it belongs.[8]

2.4 Data on Children and Households

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[6] The number of months is calculated from the first month in which the teacher started using the new curriculum up to the month of the DSPM test for each child.

[7] There were four early childhood education experts in the team: two of them held a master's degree in early childhood education, and the other two held a bachelor's degree in early childhood education and have a year of experience with the RIECE curriculum.

[8] The weakness of this score is that it represents the quality of the whole center, and not the quality of a specific classroom. Therefore we only use this (incomplete) piece of information as a robustness check.

The key advantage of the RIECE data is that it has information on both schooling and households. The baseline dataset used in this paper is a stratified random sample based on children’s age and childcare centers. The data includes no more than 25 randomly selected children from each childcare center. If a center has fewer than 25 children, all children will be selected. Approximately 60 percent of the sample in each center are older than three years old. The baseline data consist of 1,275 children from 1,054 households.

The survey comprises three main components: teachers, households, and children. The household questionnaire was developed based on the annual Townsend Thai Data survey. The household questionnaire focuses on socioeconomic status, including household demographics, occupations, labor supply and leisure for each household member, household assets, income, expenditure, borrowing, and lending.

The children questionnaire was developed from several surveys, including the Denver Developmental Screening Test, National Educational Panel Study, World Health Organization Quality of Life, Early Childhood Longitudinal Program, and Cohort Study of Thai Children. For this questionnaire, the respondent must be the main caretaker of the sampled child, who is between 2 and 5 years old. If there is more than one child in a household, the main caretaker will be asked about each child separately. The children questionnaire contains basic information on the children in the household (e.g., age, gender, birth weight, child's health, chronic diseases, disability status, and education attainment), and early childhood investments including time and material inputs, parenting style, and nutritional inputs.

We report children’s age in months, as of the date of the DSPM test. The dummy for chronic diseases equals one if the child has had asthma, allergies, thalassaemia, glucose-6-phosphate dehydrogenase deficiency (G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy during the last 12 months of the interview, and zero otherwise. The sibling dummy equals one if there was at least one sibling living in the same household, and zero otherwise. The low birth weight dummy equals one if the child's birth weight was below 2,500 grams, and zero otherwise (World Health, 2006). Similarly, each dummy for Lego, jigsaw, plastic/wooden shape sorter toy, and clay is defined as one if the household owned at least one piece of the corresponding item.

2.5 Summary Statistics of Key Variables

Table 1 presents the summary statistics of key variables related to children categorized by classroom curriculum adoption (with or without the RIECE curriculum). All statistics are calculated from the “one-level maximum” sample of 512 children, which is the sample used in our main analyses.[9] The first column is the treatment group: the children who were exposed to the RIECE curriculum, which is 40 percent of the sample. The second column is the control group: the children who were not exposed to the curriculum. The summary statistics of the two groups are very similar. The only notable difference between the groups with and without the RIECE curriculum is the children's age.

3 Estimation Methods

This paper estimates the impact of the RIECE curriculum on child development using the following linear model:

$$SS_{ia}^{j} = \beta_0 + \beta_1 T_i^j + \beta_2 X_i^j + \varepsilon_i^j, \qquad (2)$$

where SS_{ia}^{j} denotes the child development standardized score of child i attending classroom j, X_i^j denotes a vector of control variables[10], and ε_i^j denotes the error term. The treatment variable of interest is T_i^j, which equals one if child i attending classroom j has been exposed to the new curriculum, and zero otherwise. Our main goal is to identify and estimates β_1, which captures the average treatment effect of the RIECE curriculum on child development.

A statistical challenge in this paper is the endogeneity problem, caused by teachers' decisions to adopt the RIECE curriculum. Unobserved characteristics of teachers, such as their abilities and preferences, can potentially influence their adoption decisions. At the same time, these unobserved characteristics likely affect child development independent of their adoption of the curriculum. As a result, the error term ε_i^j, which contains the unobserved characteristics, and the curriculum adoption dummy T_i^j are clearly correlated, i.e., $Cov(\varepsilon_i^j, T_i^j) \neq 0$. This correlation leads to an inconsistent estimate of the main parameter of interest, β_1.

We overcome the endogeneity problem by using the randomization of additional teachers as an exclusion restriction. Let RT^j equal one if classroom j belongs to a center that received an additional teacher from the RIECE project, and zero otherwise.

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[9] Although the baseline data comprise 1,275 children, only 735 children have been tested with the DSPM. Further, some key variables are missing for 68 children. As a result, the final sample contains 667 children.

[10] The control variables for most of the estimations include the student-teacher ratio including additional teacher, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home.

More formally, following Heckman (1976, 1978), we can rewrite the main empirical model together with the adoption decision equation as follows:

$$SS_{ia}^{j} = \beta_0 + \beta_1 T_i^j + \beta_2 X_i^j + \varepsilon_i^j, \qquad (3)$$

where

$$T_i^j = \begin{cases} 1, & \text{if } T_i^{j*} > 0, \\ 0, & \text{if } T_i^{j*} \le 0, \end{cases} \qquad (4)$$

$$T_i^{j*} = \gamma_0 + \gamma_1 RT^j + \gamma_2 X_i^j + \gamma_3 Z^j + \eta_i^j, \qquad (5)$$

Z^j is the vector of control variables for classroom j,[11] and η_i^j is the error term. We focus on the estimates of this model using the maximum likelihood estimation (MLE).

For robustness checks, we also estimate model (2) using the instrumental variable approach with the randomization of additional teachers as an instrument. As pointed out by Kelejian (1971), we can consistently identify the main parameter of interest, β_1, using a two-stage least squares (2SLS) approach, in which the first-stage estimation is a simple linear probability model instead of a probit model (see also Heckman, 1978). The first-stage regression is the following linear specification:

$$T_i^j = \gamma_0 + \gamma_1 RT^j + \gamma_2 X_i^j + \gamma_3 Z^j + \eta_i^j, \qquad (6)$$

The data show that the additional teacher significantly influences the adoption decision of existing teachers in the center (the correlation between RT^j and T_i^j is approximately 0.69). The first-stage estimation results in Table 3 indicate that the instrumental variable is relevant. In particular, the dummy variable of the randomization of additional teachers is statistically significant, and the F-statistic on the excluded instrument is larger than 228, which precludes the possibility of a weak instrument problem.

Moreover, the random assignment of additional teachers lends support to the assumption that the assignment of additional teachers is uncorrelated to the error term. Although we cannot verify that groups with and without additional teachers are not significantly different in terms of unobservables, we confirm that observable characteristics of groups with and without additional teachers are not significantly different, as shown in Table 2.

As additional robustness checks, each estimation is performed on three samples: (i) the one-level maximum sample, (ii) the two-level maximum sample, and (iii) the whole sample.

The instrumental variable approach is also employed to estimate the effects of the length of exposure to the RIECE curriculum. In contrast to the preceding analysis focusing on

[11] These variables include the student-teacher ratio including additional teacher and age level dummies.

the extensive margin of adoption, this estimation captures the intensive margin using the number of months as a measure of exposure period. In addition, we estimate the impact of adoption quality on child development using a two-stage least square (2SLS) approach.

We also estimate the effect of the new curriculum on the likelihood of passing the standard age-appropriate DSPM tests. Here, the child development outcome is now a dummy indicating if a child passes his own-age test items for each category. We employ the instrumental variable probit approach (Amemiya, 1978; Newey, 1987).

4 Empirical Results

4.1 The Impacts of the RIECE Curriculum on Child Development: Extensive Margin

This section presents empirical results based on the main empirical model in equations (3)-(5). The results using the one-level maximum sample, shown in Table 4, suggest that the RIECE curriculum has a significant impact on the developmental outcomes of children. The first column indicates that the general score of children using the RIECE curriculum is significantly higher than the non-RIECE group by approximately 0.6 standard deviation.[12] In addition, we find that the RIECE curriculum has positive impacts on child development in all five domains: gross motor (GM), fine motor (FM), receptive language (RL), expressive language (EL), and personal and social (PS). Furthermore, these impacts are statistically significant in all domains except receptive language (RL).

The 2SLS estimations are very similar to the MLE estimations both in terms of magnitude and significance level except for the receptive language domain (RL), which has a positive sign but is not statistically significant. Overall, the results confirm that the RIECE curriculum has a significant impact on child developmental outcomes.

To better understand the endogeneity problem, we present the results from an ordinary least squares (OLS) estimation in Table 4. Qualitatively, the results are quite similar but noticeably different in both magnitude and significance level. In particular, the coefficient of the general score is now about 0.3 standard deviations compared to 0.6 standard deviations using the MLE method. On the other hand, the OLS estimate for the fine motor (FM) domain is not statistically significant anymore.

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[12] A back-of-envelope calculation implies that the RIECE curriculum boosts child development on average by 1.16 months (0.6 multiplied by 1.9308, which is the average standard deviation across all age ranges).

4.2 The Impacts of Curriculum Exposure Period on Child Development: Intensive Margin

This section discusses the impacts of curriculum exposure period, as measured by the number of months that students have been exposed to the new curriculum. Table 5 shows the results for the one-level maximum sample. We find that an additional month's exposure to the RIECE curriculum is correlated with an increase in child development of 0.08 standard deviation. The results are qualitatively similar to the results in Table 4. The RIECE curriculum has positive impacts on child development in all five domains. These impacts are statistically significant in all domains except receptive language (RL). We also present the results from an ordinary least squares (OLS) estimation, which are quite similar sign but noticeably different in both magnitude and significance level.

5 Robustness Checks

5.1 The Impacts of Adoption Quality

Another variable of interest is the quality of curriculum adoption. Due to data limitation, we generate a measure of adoption quality by interacting a center's score with a classroom's curriculum adoption dummy. I.e., a classroom that adopts the RIECE curriculum is assigned the center's adoption quality score. This new variable is not a perfect measure of each classroom's quality of curriculum adoption but should at least contain some information reflecting the true quality. We expect adoption quality to have a significant effect on child development.

Table 6 shows the results for the one-level maximum sample from a two-stage least squares (2SLS) estimation. Adoption quality significantly improves child development. In particular, a one-percentage-point increase in adoption quality boosts overall child developmental score by 0.66 standard deviations at a 99.9% significance level. As before, adoption quality has positive effects on developmental scores in all five domains, and these effects are statistically significant in all domains except Receptive Language (RL).

5.2 Alternative Samples

This section replicates the analyses using the two-level maximum and whole samples. Table 4 shows the impacts of the RIECE curriculum using these two alternative samples. The RIECE curriculum has significant effects on child development in the general, GM, FM and EL domains in these two samples. On the other hand, the effect of the curriculum on child domain in the PS domain is statistically significant only in the whole sample. Nevertheless, the estimates in all five domains have positive signs even though some are not statistically significant.

Similarly, the impacts of curriculum exposure period and adoption quality on child development are qualitatively comparable to the benchmark case with the one-level maximum sample. The results for length of exposure are shown in Table 5, and the results for adoption quality are shown in Table 6.

To summarize, we find that the RIECE curriculum significantly improves several dimensions of child development using different samples.

5.3 An Original Measure of Child Development for DSPM: Pass/Fail Outcomes

We estimate the effects of the RIECE curriculum on the likelihood of passing the standard age-appropriate tests as another robustness check. Note that the overall development variable, "General," in this case equals one if the child passes the standard age-appropriate tests for all five domains, and zero otherwise. We employ an instrumental variable probit model (Amemiya, 1978; Newey, 1987). The child development outcome for each domain is now a dummy variable that equals one if the child passes his own-age items in the domain, and zero otherwise.

Table 7 presents the marginal effects (at the mean) of the new curriculum on the likelihood of passing the test. The results are based on the one-level maximum sample. The impacts on general development, GM, FM, EL, and PS domains are all positive and statistically significant. For example, being exposed to the new curriculum increases the likelihood of passing all five domains by 16 percent at a 99.9% confidence level. As before, the impact on RL is not statistically significant.

6 Heterogeneity

This section investigates whether the effects of the new curriculum are heterogeneous across sub-groups. We focus on the heterogeneous effects of child gender, parental absence, mother's education, and household wealth.

6.1 Child Gender

To investigate whether the effect of the RIECE curriculum on child development differs by gender, we estimate the model by adding an interaction term between child gender and the curriculum adoption dummy. The coefficient of the new interaction term is interpreted as the measure of the difference (Angrist & Pischke, 2013; Blundell, Dearden, & Sianesi, 2005). The results in Table 8 show that the difference between the impacts on boys and girls is statistically insignificant in all domains except PS. In other words, both genders appear to benefit equally from the RIECE curriculum.

6.2 Parental Absence

As shown in Dinh and Kilenthong (2018), approximately 45 percent of children in the survey area are living with neither parent present at home. Most children live with elderly and mostly low-educated grandparents or relatives. Parental absence might affect child development.

As before, we include an interaction term between the parental absence dummy and the curriculum adoption dummy. The second panel of Table 8 suggests that the RIECE curriculum has a greater impact on children with absent parents than on children who are living with at least one parent. Specifically, all coefficients of the interaction terms are positive and statistically significant for the general score, EL, and PS.

6.3 Mother's Education

The literature shows that mother's education is correlated with children's outcomes (Attanasio et al., 2010; Fiorini & Keane, 2014; Gregg et al., 2005). We create a dummy for mother's education that equals one if the mother went beyond 9th grade or has more than nine years of schooling (highly-educated), and zero (low-educated) otherwise. We repeat the analysis using an interaction term between the mother's education dummy and the curriculum adoption dummy, shown in the third panel of Table 8. The difference between the impacts on the two groups is statistically insignificant for all domains except PS. The results suggest that mother's education has no strong influence on the effect of the RIECE curriculum on children's development.

6.4 Household Wealth

Another interesting variable is household wealth, which is a proxy for the household's socioeconomic status. We construct a household wealth index by running a Principal Component Analysis (PCA) using asset holdings[13] Again, we employ an interaction of the household wealth index and the curriculum adoption dummy, as shown in the fourth panel of Table 8. The difference between the impacts on the two groups is statistically insignificant for all domains.

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[13] Asset holdings used in this exercise include the number of houses/buildings, barns, huts, bicycles, motorcycles, cars, vans/pick-up trucks, motorized carts, farm tractors, four-wheel tractors, trucks, boats, boats with a small motor, telephones, computers/laptops, printers, tablets, air conditioners, cable TVs/satellite dishes, washing machines, televisions, refrigerators, and microwaves.

7 Conclusion

This paper has shown that the RIECE curriculum, a HighScope-based curriculum, significantly improved multiple dimensions of child development, including gross motor, fine motor, expressive language, and personal and social skills. The results are robust to various estimation methods, child development measures, and sample selections. These findings complement the findings of the Perry Preschool Project (Heckman et al., 2010; Schweinhart & Weikart, 1997) but in the context of a developing country. Interestingly, we found that significant exposure to the RIECE curriculum boosts child development for children with absent parents more than for children with at least one parent present. On the other hand, there is no strong evidence for heterogeneous effects of child gender, mother's education, or household wealth.

One key limitation of this paper is the incomplete data on the quality of curriculum adoption. Ideally, we would have data on adoption quality for each classroom, and adoption quality would be measured along several dimensions. Unfortunately, more detailed investigations on the implementation of the curriculum are beyond the scope of this paper.

Another limitation is related to the child development measurement itself. The DSPM test is just one of many available tests, e.g., executive functions, behavioral problem index, cognitive skills and non-cognitive skills. With more resources, the RIECE project should conduct different tests to establish whether our findings are sensitive to development measures. Moreover, some of the tests, e.g., Mathematics, Sciences, and Language, are more appropriate for older children. The RIECE project should apply these tests to ascertain the impact of the curriculum on elementary school or middle school children.

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APPENDIX A

Table 1: Summary Statistics of Key Variables Categorized by Curriculum

VARIABLES	With RIECE	Without RIECE	Total	Number of Observations
Boy dummy	0.49	0.50	0.50	512
	(0.50)	(0.50)	(0.50)	
Child's age (months)	47.39	45.61***	46.32	512
	(5.68)	(5.85)	(5.84)	
Low birth weight dummy	0.09	0.07	0.08	512
	(0.29)	(0.26)	(0.27)	
Sibling dummy	0.44	0.49	0.47	512
	(0.50)	(0.50)	(0.50)	
Chronic disease dummy	0.12	0.10	0.11	512
	(0.33)	(0.30)	(0.31)	
Vitamin intake dummy	0.54	0.60	0.57	512
	(0.50)	(0.49)	(0.49)	
Lego dummy	0.60	0.56	0.58	512
	(0.49)	(0.50)	(0.49)	
Jigsaw dummy	0.24	0.28	0.26	512
	(0.43)	(0.45)	(0.44)	
Shape dummy	0.26	0.29	0.28	512
	(0.44)	(0.46)	(0.45)	
Clay dummy	0.59	0.55	0.57	512
	(0.49)	(0.50)	(0.50)	
Student-teacher ratio	12.77	13.87	13.43	104
	(4.72)	(4.32)	(4.50)	
Student-teacher ratio	15.28	13.94	14.48	104
(excluding additional teachers)	(5.94)	(4.21)	(4.99)	
Fraction of sample	39.65%	61.35%	100%	

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Standard deviations are in parentheses. The first two columns report the statistics for children who are exposed to the RIECE curriculum and children who are not exposed to the RIECE curriculum, respectively. The third column shows the statistics for all children in the one-level maximum sample. The average student-teacher ratio here is calculated based on student-teacher ratio in each classroom.

Table 2: Summary Statistics of Key Variables Categorized by Additional Teacher

VARIABLES	Centers with additional teacher	Centers without additional teacher	Total	Number of Observations
Boy dummy	0.50	0.49	0.50	512
	(0.50)	(0.50)	(0.50)	
Child's age (months)	46.71	46.01	46.32	512
	(5.81)	(5.85)	(5.84)	
Low birth weight dummy	0.10	0.07	0.08	512
	(0.30)	(0.25)	(0.27)	
Sibling dummy	0.43	0.49	0.47	512
	(0.50)	(0.50)	(0.50)	
Chronic disease dummy	0.10	0.11	0.11	512
	(0.30)	(0.32)	(0.31)	
Vitamin intake dummy	0.55	0.59	0.57	512
	(0.50)	(0.49)	(0.49)	
Lego dummy	0.56	0.59	0.58	512
	(0.50)	(0.49)	(0.49)	
Jigsaw dummy	0.21	0.30*	0.26	512
	(0.41)	(0.46)	(0.44)	
Shape dummy	0.27	0.28	0.28	512
	(0.45)	(0.45)	(0.45)	
Clay dummy	0.59	0.55	0.57	512
	(0.49)	(0.50)	(0.50)	
Student-teacher ratio	13.56	14.66	14.23	47
(excluding additional teachers)	(3.82)	(3.64)	(3.71)	
Fraction of sample	43.75%	56.25%	100%	

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Standard deviations are in parentheses. The first two columns report the statistics for children in childcare centers that are received an additional teacher and children in childcare centers that are not received an additional teacher, respectively. The third column shows the statistics for all children in the one-level maximum sample. The average student-teacher ratio here is calculated based on student-teacher ratio in each center.

Table 3: First-Stage Estimation (One-level Maximum Sample)

	Maximum Likelihood Estimation						2SLS
VARIABLES	General	GM	FM	RL	EL	PS	
Additional teachers	2.748***	2.726***	2.715***	2.729***	2.728***	2.729***	0.7391***
	(0.214)	(0.211)	(0.211)	(0.209)	(0.210)	(0.211)	(0.0344)
Child's age	0.0663	0.0526	0.0743	0.0442	0.0460	0.0707	-0.0034
	(0.170)	(0.173)	(0.168)	(0.172)	(0.173)	(0.175)	(0.0361)
Child's age squared	-0.000866	-0.000735	-0.00101	-0.000650	-0.000663	-0.000923	0.00001
	(0.00190)	(0.00193)	(0.00188)	(0.00192)	(0.00193)	(0.00194)	(0.00039)
Boy dummy	-0.133	-0.113	-0.0999	-0.114	-0.117	-0.141	-0.0249
	(0.150)	(0.149)	(0.149)	(0.149)	(0.150)	(0.151)	(0.0304)
Low birth weight dummy	-0.0273	-0.0275	-0.0168	-0.0332	-0.0398	-0.0324	-0.0069
	(0.256)	(0.257)	(0.264)	(0.259)	(0.260)	(0.253)	(0.0612)
Sibling dummy	-0.123	-0.104	-0.0994	-0.109	-0.103	-0.138	-0.0163
	(0.146)	(0.148)	(0.147)	(0.148)	(0.148)	(0.144)	(0.0300)
Chronic disease dummy	0.442†	0.421†	0.405†	0.429†	0.426†	0.447†	0.0781
	(0.231)	(0.232)	(0.231)	(0.232)	(0.232)	(0.234)	(0.0495)
Vitamin intake dummy	-0.153	-0.142	-0.152	-0.139	-0.140	-0.130	-0.0251
	(0.153)	(0.154)	(0.153)	(0.154)	(0.153)	(0.153)	(0.0313)
Lego dummy	0.309†	0.299†	0.306†	0.292†	0.304†	0.299†	0.0576†
	(0.165)	(0.165)	(0.166)	(0.164)	(0.165)	(0.164)	(0.0345)
Jigsaw dummy	0.119	0.0909	0.102	0.0811	0.0782	0.0787	0.0056
	(0.176)	(0.182)	(0.178)	(0.180)	(0.181)	(0.175)	(0.0368)
Shape dummy	-0.280	-0.275	-0.286	-0.262	-0.275	-0.274	-0.0445
	(0.182)	(0.181)	(0.182)	(0.180)	(0.182)	(0.181)	(0.0371)
Clay dummy	-0.0474	-0.0585	-0.0291	-0.0581	-0.0549	-0.0344	-0.0166
	(0.148)	(0.147)	(0.148)	(0.148)	(0.148)	(0.149)	(0.0310)
Class type							
3-4 year-olds	1.166***	1.194***	1.207***	1.217***	1.193***	1.190***	0.2437***
	(0.226)	(0.219)	(0.219)	(0.223)	(0.226)	(0.222)	(0.0438)
Mixed	0.626**	0.655**	0.615**	0.654**	0.650**	0.667**	0.1398***
	(0.213)	(0.209)	(0.207)	(0.212)	(0.210)	(0.209)	(0.0388)
4-5 year-olds	0.778†	0.800†	0.818*	0.822†	0.808†	0.714†	0.1462†
	(0.417)	(0.415)	(0.408)	(0.419)	(0.417)	(0.416)	(0.0760)
Student-teacher ratio	0.0592**	0.0573**	0.0573**	0.0570**	0.0568**	0.0592**	0.0108*
	(0.0205)	(0.0201)	(0.0209)	(0.0201)	(0.0201)	(0.0201)	(0.0043)
ρ	-0.2663**	-0.0576	-0.2677**	-0.0852	-0.0485	-0.2169*	NA
	(0.0953)	(0.1030)	(0.0897)	(0.1071)	(0.0818)	(0.1005)	
σ	0.9592***	0.9754***	0.9774***	0.9683***	0.9785***	0.9667***	NA
	(0.0327)	(0.0228)	(0.0372)	(0.0301)	(0.0562)	(0.0316)	
F-Statistic on the excluded instrument	NA	NA	NA	NA	NA	NA	228.051
Observations	2.748***	2.726***	2.715***	2.729***	2.728***	2.729***	0.7391***

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child age, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease including asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies. $\sigma^2 = Var(\varepsilon_i^j)$ and $\rho\sigma = Cov(\varepsilon_i^j, \eta_i^j)$.

Table 4: The Impacts of the RIECE Curriculum on Child Development

VARIABLES	General	GM	FM	RL	EL	PS	Number of Observations
One-level maximum sample							
RIECE curriculum (MLE)	0.565***	0.408**	0.361**	0.194	0.283*	0.329*	512
	(0.128)	(0.134)	(0.127)	(0.137)	(0.130)	(0.137)	
RIECE curriculum (2SLS)	0.538***	0.399**	0.437**	0.124	0.232†	0.302*	512
	(0.132)	(0.133)	(0.136)	(0.135)	(0.127)	(0.137)	
RIECE curriculum (OLS)	0.332***	0.357***	0.123	0.119	0.240*	0.138	512
	(0.0929)	(0.0951)	(0.0947)	(0.0944)	(0.0954)	(0.0939)	
Two-level maximum sample							
RIECE curriculum (MLE)	0.640***	0.537**	0.468**	0.306†	0.516**	0.0697	291
	(0.179)	(0.198)	(0.175)	(0.182)	(0.186)	(0.243)	
RIECE curriculum (2SLS)	0.580**	0.435*	0.544**	0.214	0.420*	0.0893	291
	(0.191)	(0.194)	(0.195)	(0.184)	(0.191)	(0.205)	
RIECE curriculum (OLS)	0.388**	0.349**	0.145	0.263*	0.344**	0.111	291
	(0.127)	(0.130)	(0.129)	(0.126)	(0.129)	(0.127)	
Whole sample							
RIECE curriculum (MLE)	0.494***	0.484***	0.228*	0.168	0.201†	0.260*	667
	(0.106)	(0.116)	(0.110)	(0.112)	(0.120)	(0.118)	
RIECE curriculum (2SLS)	0.482***	0.489***	0.276*	0.115	0.155	0.239*	667
	(0.112)	(0.119)	(0.116)	(0.114)	(0.117)	(0.121)	
RIECE curriculum (OLS)	0.296***	0.358***	0.0248	0.143†	0.214**	0.143†	667
	(0.0808)	(0.0819)	(0.0827)	(0.0815)	(0.0826)	(0.0821)	

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, † $p<0.1$. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child's age, child's age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease (e.g., asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy), a dummy for taking additional vitamins, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for the classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies.

Table 5: The Impacts of Curriculum Exposure Period on Child Development

VARIABLES	General	GM	FM	RL	EL	PS	Number of Observations
One-level maximum sample							
Curriculum Exposure Period (2SLS)	0.0767***	0.0590**	0.0631**	0.0140	0.0321†	0.0449*	508
	(0.0197)	(0.0201)	(0.0206)	(0.0199)	(0.0189)	(0.0203)	
Curriculum Exposure Period (OLS)	0.0419**	0.0376**	0.0217	0.0192	0.0224	0.0223	508
	(0.0136)	(0.0140)	(0.0138)	(0.0137)	(0.0140)	(0.0137)	
Two-level maximum sample							
Curriculum Exposure Period (2SLS)	0.0920**	0.0738*	0.0904**	0.0291	0.0652*	0.0149	287
	(0.0332)	(0.0344)	(0.0350)	(0.0321)	(0.0326)	(0.0351)	
Curriculum Exposure Period (OLS)	0.0632**	0.0446*	0.0274	0.0407†	0.0585**	0.0291	287
	(0.0211)	(0.0215)	(0.0213)	(0.0208)	(0.0212)	(0.0209)	
Whole sample							
Curriculum Exposure Period (2SLS)	0.0663***	0.0681***	0.0382*	0.0140	0.0212	0.0345*	663
	(0.0159)	(0.0168)	(0.0164)	(0.0160)	(0.0165)	(0.0170)	
Curriculum Exposure Period (OLS)	0.0389***	0.0434***	0.00724	0.0167	0.0231†	0.0243*	663
	(0.0116)	(0.0117)	(0.0118)	(0.0116)	(0.0118)	(0.0117)	

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child age, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease including asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies.

Table 6: The Impacts of Adoption Quality on Child Development

VARIABLES	General	GM	FM	RL	EL	PS	Number of Observations
One-level maximum sample							
Adoption quality (2SLS)	0.664***	0.489**	0.528**	0.162	0.297†	0.370*	512
	(0.159)	(0.160)	(0.164)	(0.164)	(0.156)	(0.166)	
Adoption quality (OLS)	0.436***	0.465***	0.231*	0.170	0.250*	0.141	512
	(0.108)	(0.111)	(0.110)	(0.110)	(0.111)	(0.110)	
Two-level maximum sample							
Adoption quality (2SLS)	0.795**	0.603*	0.693**	0.314	0.609*	0.114	291
	(0.253)	(0.255)	(0.255)	(0.244)	(0.252)	(0.267)	
Adoption quality (OLS)	0.471**	0.398*	0.277†	0.351*	0.326*	0.0611	291
	(0.152)	(0.155)	(0.153)	(0.151)	(0.154)	(0.152)	
Whole sample							
Adoption quality (2SLS)	0.581***	0.587***	0.329*	0.143	0.189	0.284†	667
	(0.133)	(0.140)	(0.138)	(0.136)	(0.141)	(0.145)	
Adoption quality (OLS)	0.407***	0.484***	0.0963	0.213*	0.221*	0.136	667
	(0.0943)	(0.0955)	(0.0968)	(0.0954)	(0.0969)	(0.0963)	

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child age, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease including asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies.

Table 7: The Marginal Effect of the RIECE Curriculum on the Likelihood of Passing the Test (One-level Maximum Sample)

VARIABLES	General	GM	FM	RL	EL	PS
RIECE curriculum dummy	0.1613***	0.0539	0.0872	0.0284	0.0679†	0.1418**
	(0.0449)	(0.0551)	(0.0599)	(0.0490)	(0.0411)	(0.0551)
Child's age	0.2393***	-0.0101	0.3365***	0.0378	-0.0324	0.1096***
	(0.0582)	(0.0463)	(0.0527)	(0.0348)	(0.0312)	(0.0423)
Child's age squared	-0.0027***	-0.00004	-0.0040***	-0.0004	0.0004	-0.0013***
	(0. 0006392)	(0.0005143)	(0.0005816)	(0.0003917)	(0.0003474)	(0.0004723)
Boy dummy	-0.0551†	-0.0112	-0.0331	-0.0100	-0.0189	-0.1349***
	(0.0314)	(0.0358)	(0.0392)	(0.0305)	(0.0235)	(0.0348)
Low birth weight dummy	0.0205	-0.0369	-0.1400*	-0.1646*	-0.0498	-0.0421
	(0.0645)	(0.0671)	(0.0699)	(0.0712)	(0.0532)	(0.0664)
Sibling dummy	0.0332	0.0047	0.0669†	0.0070	0.0173	0.0650†
	(0.0320)	(0.0354)	(0.0396)	(0.0301)	(0.0226)	(0.0351)
Chronic disease dummy	0.0286	0.0228	-0.0682	-0.1375*	-0.0334	-0.0021
	(0.0487)	(0.0521)	(0.0597)	(0.0599)	(0.0441)	(0.0542)
Student-teacher ratio	-0.0009	0.0021	-0.0060	-0.0032	0.0065	-0.0008
	(0.0039)	(0.0044)	(0.0050)	(0.0037)	(0.0042)	(0.0043)
Number of Observations	512	512	512	512	512	512

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child age, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease including asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies.

Table 8: Heterogeneous Effects of the RIECE Curriculum on Child Development

VARIABLES	General	GM	FM	RL	EL	PS	Number of Observations
(1) Child's Gender							
RIECE curriculum	0.559***	0.460**	0.418*	0.203	0.350*	0.163	512
	(0.160)	(0.159)	(0.164)	(0.160)	(0.160)	(0.154)	
Boy dummy	-0.274*	-0.0399	-0.0179	-0.160	-0.00370	-0.527***	512
	(0.114)	(0.119)	(0.108)	(0.115)	(0.124)	(0.116)	
RIECE x Boy dummy	0.00669	-0.109	-0.112	-0.0240	-0.143	0.347*	512
	(0.177)	(0.178)	(0.184)	(0.180)	(0.176)	(0.168)	
(2) Parental Absence							
RIECE curriculum	0.391**	0.402**	0.263†	0.0723	0.148	0.186	511
	(0.144)	(0.147)	(0.143)	(0.150)	(0.151)	(0.150)	
Parental absence dummy	-0.170	0.0241	-0.103	-0.145	-0.151	-0.144	511
	(0.115)	(0.117)	(0.107)	(0.115)	(0.130)	(0.119)	
RIECE x Parental absence	0.418*	0.0202	0.192	0.277	0.342*	0.381*	511
dummy	(0.175)	(0.182)	(0.187)	(0.181)	(0.170)	(0.176)	
(3) Mother's Education							
RIECE curriculum	0.747***	0.383†	0.256	0.253	0.413†	0.761***	448
	(0.176)	(0.199)	(0.179)	(0.183)	(0.225)	(0.173)	
Mother's education	-0.00462	-0.00509	-0.211†	0.0194	0.193	-0.0140	448
dummy	(0.121)	(0.126)	(0.116)	(0.124)	(0.136)	(0.129)	
RIECE x mother's	-0.0564	0.185	0.297	-0.0300	-0.235	-0.337†	448
education dummy	(0.180)	(0.194)	(0.192)	(0.185)	(0.196)	(0.176)	
(4) Wealth Index							
RIECE curriculum	0.722***	0.492**	0.423**	0.287†	0.324*	0.502***	468
	(0.136)	(0.152)	(0.138)	(0.152)	(0.148)	(0.142)	
Wealth index	-0.0252	-0.00787	0.0414	-0.0200	-0.0324	-0.0579	468
	(0.0844)	(0.0769)	(0.0681)	(0.0739)	(0.0818)	(0.0822)	
RIECE x Wealth index	-0.0826	-0.0179	-0.141	-0.0605	0.0204	0.00257	468
	(0.107)	(0.102)	(0.122)	(0.0926)	(0.0975)	(0.105)	

*** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Robust standard errors are in parentheses. The control variables, X_i^j, for most of the estimations include student-teacher ratio including additional teacher, child age, child age squared, a dummy for being a boy, a dummy for having low birth weight, a dummy for having at least one sibling in the household, a dummy for having a chronic disease including asthma, allergy, thalassaemia, glucose-6-phosphate dehydrogenase deficiency(G6PD), anemia, heart disease, epilepsy, tonsillitis, lymphadenitis, pneumonopathy, enteropathy, mycosis, or nephropathy, a dummy for taking additional vitamin, a dummy for having Lego at home, a dummy for having at least one jigsaw puzzle at home, a dummy for having at least one plastic/wooden shape sorter toy at home, and a dummy for having at least one set of clay at home. The control variables for classroom, Z^j, include student-teacher ratio including additional teacher and age level dummies.

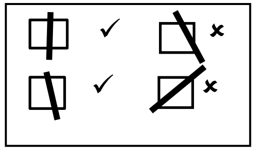
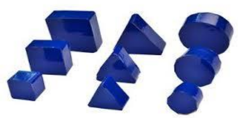
Table 9: The Number of DSPM Items over 19 Age Ranges

Age range	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
Birth- 1 month	1 item	1 item	1 item	1 item	1 item
1-2 months	1 item	1 item	1 item	1 item	1 item
3-4 months	1 item	1 item	1 item	1 item	1 item
5-6 months	1 item	1 item	1 item	1 item	1 item
7-9 months	2 items	1 item	1 item	1 item	1 item
9 months	2 items	2 items	1 item	2 items	1 item
10-12 months	1 item	1 item	1 item	1 item	1 item
13-15 months	1 item	1 item	1 item	1 item	1 item
16-18 months	1 item	1 item	1 item	1 item	1 item
18 months	2 items	2 items	2 items	2 items	2 items
19-24 months	1 item	1 item	1 item	1 item	1 item
25-29 months	1 item	1 item	1 item	1 item	1 item
30 months	2 items	2 items	2 items	1 item	1 item
31-36 months	1 item	1 item	1 item	1 item	1 item
37-42 months	1 item	1 item	1 item	1 item	2 items
42 months	2 items	2 items	2 items	2 items	3 items
43-48 months	1 item	2 items	1 item	1 item	1 item
49-54 months	1 item	1 item	1 item	1 item	1 item
55-60 months	1 item	1 item	1 item	1 item	1 item

APPENDIX B

Examples of the Developmental Surveillance and Promotion Manual (DSPM)

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
43-48 months	101. Jumping on one leg continuously at least 2 times. (Tester may demonstrate)	102. Cut 2 square pieces of paper with a size of 10 cm. (Tester may demonstrate)	104. Identify which object is bigger/smaller **The evaluation**: Point to the medium-sized object. Then ask the child "Which object is bigger than this?" and "Which object is smaller than this?". Repeat for 3 sets of objects, starting and then asks the child that "which one is bigger than this" "which one is smaller than this". Ask all 3 sets of objects: circle, rectangle, and triangle.	105. Speak at least 3 consecutive words in different contexts. (If cannot observe the child, ask either parent or teacher) **The evaluation**: Observe whether the child can communicate in 5 different contexts as follows: 1. Goodbye, e.g., "See you later." 2. Greeting, e.g., "Hello, mother." 3.Thankfulness, e.g., "Thank you teacher."	106. Put on 3 big buttons with a size of 2 cm by himself. (Tester may demonstrate) **The evaluation**: Put on and remove the buttons, and then let the child do it by himself.

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
	Pass: If the child can continuously move forward while jumping on one leg at least 2 times.	**Pass**: If the child uses the scissors to cut the paper into 2 parts separately at least 1 of 3 times (See the picture below)  **Tools**: 1. A pair of scissors. 2. A square piece of paper with a size of 10 cm.	**Pass**: If the child can correctly answer 2 of 3 sets of objects. **Tools**: 3 sets of different objects of the same color. 	4.Opinion, e.g., "I think this one is more beautiful." 5.Apology, e.g., "I am sorry." **Pass**: Children can speak at least 3 consecutive words in all 5 contexts. **Observe/ask from** ☐ **Children** ☐ **Teacher** ☐ **Parent**	**Pass**: If the child can put on 3 buttons by himself. **Tools**: A rag doll that has three buttons of at least 2 cm.

Age \ Domain	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
	☐ Pass ☐ Fail	**Note**: Demonstrate every time, stop if the child cannot do. ☐ Pass ☐ Fail	☐ Pass ☐ Fail	☐ Pass ☐ Fail	**Note**: No restriction of the sequence. ☐ Pass ☐ Fail
43-48 months		103. Copy the positive sign (+) by drawing. (Tester must always demonstrate) **Pass**: If the child can copy the positive sign (the vertical line intersects the horizontal line) at least 1 of 3 times. **Tools**: 1. Pencil 2. Paper **Note**: The size of the child's drawing is not necessarily the same as the size of the sample. ☐ Pass ☐ Fail			

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
49-54 Months	107. Jumping on two legs to the left, the right, and backward continuously. (Tester may demonstrate) **Pass**: If the child can move to the left, the right, and the reverse continuously while jumping on two legs.	108. Assemble the parts of the pictures that were cut into 8 pieces. (The tester must show the child the completed picture before scrambling the 8 pieces.) **Pass**: If the child can assemble all 8 pieces correctly.	109. Select the pictures that represent day and night. (The tester must alternate the picture) **Pass**: If the child can point to the correct picture in 2 of 3 sets.	110. The child gives a reasonable response when he is asked "What will you do when you feel hot/sick/hungry/cold?” **Pass**: If the child can correctly answer 2 of 3 questions. (Fill the child's answers) Hot ………………................. Sick... ……………................. Hungry...……………................. Cold	111. Cleans himself after defecating (**both the anus and hand**). **Pass**: If the child can clean his anus **and** hand by himself after defecating. **Observe/ask from** ☐ **Children** ☐ **Teacher** ☐ **Parent**

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
	☐ Pass ☐ Fail	**Tools**: 1 picture which is cut into 8 pieces.  ☐ Pass ☐ Fail	**Tools**: Pictures 1. 3 pictures of day 2. 3 pictures of night ☐ Pass ☐ Fail	☐ Pass ☐ Fail	☐ Pass ☐ Fail

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
55-60 Months	112. Walking on heels. (Tester may demonstrate) **Pass**: If the child can walk forward on his heels for 4 steps without losing balance	113. Holds a pencil correctly. (Tester does not demonstrate) **The evaluation**: Give a piece of paper and a pencil to the child, and then tell child to "write your name." **Pass**: If the child holds a pencil approximately 1-2 cm above the tip, and the pencil is grasped between the thumb, forefinger, and middle finger.	114. Choosing 8 colors according to the order. **Pass**: If the child can pick up 8 color blocks correctly, according to the order. **The order of color** If correct fill ✓ in ☐ wrong fill ✕ in ☐ 1. Red ☐ 2. Green ☐ 3. Blue ☐ 4. Black ☐ 5. White ☐ 6. Pink ☐	115. Take turns talking in a group. (If cannot observe, ask either parent or teacher) **Pass**: If the child can take turns talking in a group. **Observe/ask from** ☐ **Children** ☐ **Teacher** ☐ **Parent**	116. Play the role of an adult (If cannot observe, ask either parent or teacher) **Pass**: The child can play the role of an adult, e.g., father, mother, teacher, doctor, nurse, group head, by mimicking the tone, action, attire. **Observe/ask from** ☐ **Children** ☐ **Teacher** ☐ **Parent**

Domain / Age	Gross Motor (GM)	Fine Motor (FM)	Receptive Language (RL)	Expressive Language (EL)	Personal and Social (PS)
	Note: The child can extend his arms for balance while walking ☐ Pass ☐ Fail	**Tools**: 1. Pencil 2. Paper ☐ Pass ☐ Fail	7. Orange ☐ 8. Yellow ☐ **Tools**: 10 blocks with different colors **Note**: Do not order **Violet and Brown** ☐ Pass ☐ Fail	☐ Pass ☐ Fail	☐ Pass ☐ Fail