Cost and Cost-Effectiveness of a Pre-Primary School Program in Kenya

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The usual disclaimer applies.
Abstract: We analyze the cost and cost-effectiveness of an early childhood development and education (ECDE) program in Kenya which aimed at preparing pre-primary children for primary school. A cluster randomized controlled trial design was used. Enrolled schools were provided with three different treatment packages that aimed at improving the instructional quality of ECDE centres complemented with a health component. We find that for every additional US$ 1 spent on the second treatment package, the intervention yields 0.16 extra percentage points in public ECDE centres over two years of participation. This translates to a cost of US$ 14.83 per child. Similarly, in private ECDE centres, results suggest that the yield of extra learning score per US$ 1 spent on the second treatment package is 0.36 percentage points, which translates to a cost of US$ 17.01 per child. Our findings indicate that combining the training of teachers, supervision staff, teacher support, books and teachers’ guides may be cost-effective. Hence, this pre-primary program could be scaled-up in different counties of Kenya.

Keywords: Cost-effectiveness, cluster randomized controlled trial, early childhood development and education, Kenya.

JEL code: I21, I28, O1.
1. Introduction

Researchers have established that during the early years, stimuli transmitted in the brain through the sensory pathways differentiate the function of neurons, neural pathways and could influence the pattern of brain architecture and behavioral development (Bruer, 1999; Leisman, Mualem, & Mughrabi, 2015; Mustard, 2010; van der Meer & Van Der Weel, 2017). Investment in quality early childhood development and education (ECDE) programs from birth to five years is therefore more effective and economically efficient than during the later years, particularly for disadvantaged children. Provision of quality ECDE services is considered a cost-effective strategy to stimulate children’s language, cognitive and socio-emotional skills, fostering valuable academic skills, enhancing economic growth (Campbell, et al., 2014; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010) and reducing crime (Reynolds, Temple, Robertson, & Mann, 2001; Zigler, Taussig, & Black, 1992). In sub-Saharan Africa (SSA), the past two decades have been marked by considerable efforts from governments, non-governmental organizations (NGOs), religious organizations and policymakers to develop and implement ECDE programs. However, across several countries in SSA, the ECDE programs provided may not be of sufficient quality to improve learners’ achievement and prepare children for primary school. The prevailing situation highlights the need to explore different ECDE packages that are of high quality and cost-effective in improving the literacy, numeracy and socio-emotional skills of pre-primary school children.

In Kenya, ECDE services that consist mainly of pre-primary-based form of care are the most common. These services are delivered through public and private schools which are either stand-alone or attached to a primary school. The public pre-primary school is usually a community-owned and managed venture which follows a curriculum designed by the government. Private pre-primary schools vary from informal low-cost neighborhood ECDE centres owned and run by parents or private individuals (referred to as Alternative Provision of Basic Education and Training [APBET] centres) to formal high-cost private centres operated by education entrepreneurs, NGOs or other institutions such as religious organizations.

An effective way to convince policymakers to invest in ECDE is to present evidence of cost-effectiveness through impact evaluations (Dhaliwal, Duflo, Glennerster, & Tulloch, 2013). Cost-effectiveness is often used to establish the value for money of an intervention. In ECDE, costing and cost-effectiveness could be used to provide enough information to policymakers about the type
of resources that are being spent to deliver *quality* ECDE services and the corresponding costs related to these activities. Such information is of paramount importance in SSA countries where within the budget allocated to education, the amount that goes to ECDE is usually very small.

The current study adds more knowledge to the scant literature on costing and cost-effectiveness of *quality* ECDE in SSA countries in several ways. First, we deviate from other studies on early childhood education which mainly focus on mass school-based deworming program, teacher training, improvements in classroom quality (Araujo, Carneiro, Cruz-Aguayo, & Schady, 2016; Mendive, Weiland, Yoshikawa, & Snow, 2016; Miguel & Kremer, 2004; Pianta, Downer, & Hamre, 2016; Yoshikawa, et al., 2015) by investigating whether a holistic approach that combines the training of the supervision staff, teacher support, books and teachers’ guides could be cost-effective. In Kenya, providing *quality* training to teachers, supervision staff, support to teachers in ECDE centres are inexistent, and most of these staff are often poorly paid and demotivated. Furthermore, as in other SSA countries, books and teachers’ guides are not well designed to meet the specific needs of the learners. Hence, we argue that providing *quality* training to teachers, supervision staff and regular mentorship coupled with books and teachers’ guides could be a cost-effective and scalable ECDE package. Second, our study also incorporates a health component in the context of the ECDE. It has been argued that integrating health component into early childhood education activities could improve learners’ achievement and nutritional outcomes (Bowes & Grace, 2014; Ginsburg, 2007; Hahn, et al., 2016). Giving the fact that the Kenya health system is well decentralized with community health volunteers (CHVs) and community health assistants (CHAs) playing a key role in service delivery at the community level, the policymakers could leverage on this opportunity and provide a strong ECDE policy which could improve the learner’s score. This could also create synergy among the different stakeholders at the ministry of health and education, and an effective coordination in the delivery of ECDE. However, the cost per child enrolled for such intervention is unknown, and more importantly there is still yawning gap on the cost-effectiveness of this approach. Third, we are cognizant that in several SSA countries, ECDE programs are both delivered by public and private entities. These two entities may not have the same cost per child due to the scale of their activities. In the same vein, an ECDE program that is cost-effective in public ECDE may not be the case in private ECDE. Thus, in the current study we examine the cost and cost-effectiveness of different sources of provision of ECDE program in SSA countries namely in Kenya.
In a cluster-randomised controlled study which aimed at preparing children for primary school, three ECDE treatment packages were implemented in public and APBET ECDE centres in Kenya. The schools in the first treatment arm (T1) received a package involving training of teacher coaches, training of teachers, and teacher classroom instructional support. Schools in the second treatment arm (T2) received a package involving all the components in the first package plus provision of instructional materials (e.g. learners’ workbooks, teachers’ guides, big books and charts). The schools in the third treatment arm (T3) received a package involving all the components in the second package plus a health component encouraging healthy or hygienic behavior among learners (e.g. hand washing after visiting the toilet and treatment of drinking water at the point of use) and keeping of learners’ health records for decision making. Schools in the control arm (T0) received no intervention during the study but will receive the package proven to be the most impactful and cost-effective upon completion of the study. We find that for every extra US$ 1 spent on the second treatment package, the additional learning score is 0.16 percentage points in public ECDE centres over two years of participation. This translates to a cost of US$ 14.83 per child enrolled. Similarly, in APBET ECDE centres, results suggest that for every additional US$ 1 spent on the second treatment package the extra learning score is 0.36 percentage points, which translates to a cost of US$ 17.01 per child. Our findings suggest that combining the training of teachers, supervision staff, teacher support, books and teachers’ guides may be cost-effective.

The rest of this paper is structured as follows. The next section describes the study design, intervention and also provides detailed information on the costing data. Section 3 presents our findings while Section 4 discusses the findings and concludes with some policy recommendations.

2. Methods

2.1. Study design

Data used in this paper is derived from a larger study based on the Tayari\textsuperscript{1} ECDE program implemented by the Ministry of Education (MoE) of Kenya among children aged four to five years

\textsuperscript{1} Tayari is a Kiswahili word meaning ready.
through technical support from RTI International. This pre-primary school program aimed at improving school readiness among children in Kenya by supporting national and county governments to develop a cost-effective, affordable and scalable ECDE model. The study design was a cluster-randomized controlled trial with four arms: a control group (T0), and three intervention arms (T1, T2 and T3) for public and APBET centres. Four counties (Nairobi, Uasin Gishu, Laikipia and Siaya) were chosen for the pilot study. These counties were selected by the MoE to reflect the diversity in Kenya: highly urban, agricultural and multi-ethnic.

The sample size calculation was done for independent samples of the public and APBET centres for the treatment and control groups. The intervention was powered at the level of the ECDE centres (unit of analysis) to yield a detectable difference of a standardized school readiness of 0.2 standard deviations between any one treatment arm and the control arm, with an intra-cluster correlation of 0.25, proportion of variance explained by centre-level covariance of 0.5, 95% confidence intervals, a power of 80%, and 5% centre attrition rate. The cluster size was 16. Based on these parameters, the minimum number of public ECDE centres needed was 150. These centres were distributed equally among control arm (75) and each treatment arm –75 for T1, 75 for T2 and 75 for T3 – and spread proportionately across the 72 public zones within the four counties. In other words, 300 public centres were needed to detect the desired effect size. Within the four counties, the treatment packages were randomized within the zones in order to avoid contamination and ensure homogeneity. We also used the probability proportional to size (PPS) allocation method to distribute the 18 zones (for each treatment arm) among the four counties. Similarly, the PPS allocation method was used to allocate the 75 centres in each arm across the four counties. With regards to selection of APBET centres\(^2\), the same methodology was used in assigning the 22 zones in Nairobi which are under the private centre framework, yielding another 300 centres. Furthermore, the intervention was rolled out in a staggered manner over two years: half of these centres (150 centres) were rolled out in 2016, and the remaining half (150 centres) were included to the sample in 2017. There are existing interventions where the unit of randomization is the school (Grydeland, et al., 2014; Li, et al., 2017; Miguel & Kremer, 2004; Sutherland, et al., 2013).

\(^2\) The APBET centres were only found in Nairobi County.
2.2. Description of the intervention

In all of the four counties, the intervention has three treatment packages. As mentioned earlier, the control ECDE centres did not receive any intervention but continued with their routine activities such as usual teaching for children. The intervention treatment packages are described below.

The first treatment package

This treatment package (treatment one-T1) was built on ECDE programs implemented previously in Kenya and supported by the Madrassa Early Childhood Program–Kenya (MECP-Kenya)\(^3\). Schools randomly allocated to this treatment package received a combination of training of sub-County ECD Coordinators (SCECDCs)\(^4\), teacher training and teacher classroom instructional support. The SCECDCs were rigorously trained to effectively train and support teachers in ECDE centres to improve their teaching and pedagogical skills. They visited the schools two times per month, used electronic tablets to facilitate the classroom observation and provided feedback to each observed teacher. The teachers were also trained on specific skills (e.g. letter sounds) and to develop their own teaching materials, and how best to use the existing ones.

The second treatment package

Schools randomly allocated to this treatment package (treatment two-T2) received a combination of training of SCECDCs, teacher training, teacher classroom instructional support, books and teachers’ guides provided by RTI International. Thus, treatment two is similar to treatment one except that in the former there is a provision of learners’ books and teachers’ guides (T2=T1+learners’ books and teachers’ guides). These books and teachers’ guides were of high-quality, designed in collaboration with the MoE, Kenya Institute of Curriculum Development (KICD), and RTI experts. Learners’ books included workbooks for language, number work (numeracy) and charts for life-skills development activities while teachers’ guides included books for language, numeracy, social activities and life skills.

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\(^3\) The MECP-Kenya started in the mid-1980 in the Kenyan costal county by the Aga Khan Foundation.

\(^4\) The equivalent word used for APBET ECDE centres is instructional coaches. These are staff supporting APBET ECDE centres and mainly involved in supervision activities.
The third treatment package

Schools randomly allocated to this intervention package (treatment three-T3) received a combination of T2 and a health support component (T3=T2+health support). This treatment package was designed to integrate the ECDE into the health system with basic training on hygiene such as correct use of toilet, washing of hands after visiting the toilet or before meals, treatment of drinking water at the point of use, and keeping of child health data for decision making. More precisely, CHVs visited schools once per month to provide advice on health practices in ECDE centres. The CHAs were trained for this task and they supported the CHVs in the promotion of child health in ECDE centres.

Table 1 provides an overview of the three different treatment packages.

[Insert Table 1 about here]

2.3. Measure of the impact of the intervention

For the purpose of computing the incremental cost-effectiveness ratio (ICER), an impact evaluation of the intervention was conducted. The learners enrolled in the ECDE centres were assessed using a brief direct assessment tool adapted from the UNICEF/UNESCO school readiness tool, early grade literacy and numeracy assessment tools developed by experts from RTI International and the African Population and Health Research Centre. The final tool used was a result of rigorous work by several ECDE stakeholders which included ECDE experts and practitioners, scholars from universities, MoE, and KICD staff. The tool was used to assess learners’ progress in literacy, numeracy, health and nutrition knowledge and psychosocial skills. The tool covered five domains: execution function, psycho-social skills, literacy, numeracy, health and hygiene. The tool was administered on a one-to-one basis and each assessment took about 15 minutes. After several workshops and intensive expert meetings, a school readiness index called the Tayari school readiness index (TSRI) was developed to cover 10 subtasks including backward digit span, rhyme, letter-name knowledge, letter-sound knowledge, initial sound identification, listening comprehension, shape naming, quantity discrimination, measurement vocabulary and oral addition. The TSRI was weighted 10% in each of the 10 subtasks, implying that the maximum
possible learner score on the TSRI was 100%. The assessment was administered at baseline, midline and endline.

With regards to the evaluation of the intervention, a multilevel regression which controls for several baseline factors that could influence learner’s achievement such as teacher, school, learner characteristics, and period of exposure was estimated. Specifically, the multilevel regression used was a two-level regression model with the learners at level 1, schools at level 2. The model included teacher’s age, teacher’s education, gender of the teacher, gender of the learner, language of instruction (Kiswahili or English), class size as well as the phase and baseline TSRI scores which were aggregated at the school level. The aggregation at the school level was necessitated by the fact that the evaluation tracked schools rather than learners. *The in-depth analysis of the impact evaluation of Tayari pre-primary school is beyond the scope of the current study.* We will only use the effectiveness results for the purpose of the analysis of the cost-effectiveness of this pre-primary school program.

### 2.4. Costing data

We estimate the ICER which represents the incremental cost per unit of incremental effect or the cost of improving the learner’s score (McEwan, 2012). In other words, to estimate the cost per additional learner’s score, we divide the average cost per child over the impact of the intervention (Miguel & Kremer, 2004). This ratio gives information on the cost that policymakers need to spend per child to improve the learner’ score in pre-primary school in Kenya. It is the cost of buying an extra learner’s score. Furthermore, we also report the gain per dollar spent. This is also helpful to explore the value for money of this intervention and often useful when there is a financial constraint (Levin, et al., 2012). The ICER can only be estimated if the cost and effectiveness of the intervention are first computed. This is not always straightforward and requires a lot of information of the activities that were involved in rolling out the intervention. The costing exercise is done by looking at the incremental cost of adding ECDE packages into the existing pre-primary school program in Kenya. Put differently, the costing is done by exploring what it costs on

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5 The gain per dollar spent provides useful information to policymakers on the extra gain that they could derive from the intervention in terms of learner’s score for every US$ 1 spent.
providing resources to *quality* ECDE program over and beyond what pre-primary school children in Kenya are already receiving.

The costing covers the period of the intervention (two years) and was done from the provider’s perspective. We use the ingredient approach which: (i) describes the different activities/process of production of the intervention; (ii) identifies and quantifies the different types of resources used by distinguishing research activities and activities dedicated to the intervention’s implementation; and, (iii) computes total costs excluding research costs. We exclude any research activities involved during the intervention such as training and salaries of the fieldworkers, development of the tools for data collection, etc. Furthermore, an Excel costing tool (available upon request) was developed to track all the expenditures related to the intervention. We prospectively collected the cost data as the intervention was evolving via the financial report and direct interaction with the financial accountant and program managers.

Our base year for the costing is 2016. With regards to expenditures of activities implemented before 2016, we adjust for the expenditures accounting for inflation. Furthermore, we present the estimates in US$ (1 KES=US$ 0.0098). The sources of the costing data are the financial reports of RTI International and interviews with the program manager, while information on the impact of the *Tayari* pre-primary program is from the datasets provided by the impact evaluation team. The intervention is summarized into pre-implementation, recurrent and capital activities.

*Pre-implementation activities*

Before launching the implementation of *Tayari*, some meetings were organized with the MoE to discuss the intervention and inform other stakeholders about the programmatic activities of the intervention. We tracked the cost incurred during these activities and allocated the total cost equally to each arm of the treatment package. This is due to the fact that these activities were not a function of the quantity of the resources used per treatment package.
Recurrent costs

These are the costs incurred repeatedly and consumed within a year of procurement. In the current study, they were divided into three: human resources (training of the trainers, SCECDCs, instructional coaches, teachers, CHVs, CHAs), consumables such as language and mathematic workbooks which have a useful life of less than one year, and supervision activities.

In the financial report, the cost of human resources and supervision activities were not disaggregated into public and APBET ECDE centres but per treatment package. Hence, we set up an allocation rule. To estimate the cost per type of ECDE centre and treatment package, we allocate the total expenditure of the training prorated according to the number of staff involved in the activities for each treatment package. The same approach is used for consumables. For instance with regards to SCECDCs and instructional coaches, we allocate the cost pro rata of the number of SCECDCs (instructional coaches) in public (APBET) ECDE centres. Concerning the supervision activities, in each treatment package, we allocate the monthly supervision expenditures pro rata of the number of staff involved in these activities.

Capita costs

These are costs for inputs that were used for longer than one year. These included learners’ books, teachers’ guides and tablets. Books were provided to all learners in T2 and T3 except during the baseline and control arms. Teachers’ guides were provided to all teachers in treatment package T2 and T3, whereas tablets were provided to SCECDCs and instructional coaches in treatment package T1, T2, T3 in public and APBET ECDE centres as well.

The capital costs are estimated per treatment package (T1, T2, and T3) and type of ECDE centres. In the financial report, the costs were not disaggregated by public and APBET schools but per treatment package. Thus, in each treatment package we first annualized the cost using an interest

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\[ \frac{1 - (1 + r)^{-n}}{r} \]

with \( n \) the useful life and \( r \) the interest rate. A standard table could also be used for the annualization factor.
rate of 3% and appropriate useful life for the materials⁷. We then allocate pro rata of the activities related to the cost. For instance for learners’ books (teachers’ guides), we first annualize the cost in each treatment package and then allocate pro rata of the number of children reached (number of teachers) in each type of ECDE centres. The same estimation procedure is used for the tablets except that the allocation rule was pro rata of the number of SCECDCs (instructional coaches) in public (APBET) ECDE centres.

3. Results

Cost profile

Based on Table 2 (Panel A) with regards to public ECDE centres, irrespective of the treatment group, the main driver of the cost is the human resource activities namely the training activities. These activities account for 89.76%, 63.21%, and 68.68% of the total cost of treatment package T1, T2, and T3, respectively. The intervention is therefore labor intensive mostly driven by the training of staff. Results of the study also indicate that treatment package T2 consumes most of the resources for implementation with a total cost of US$ 468,281.45 over two years of participation in the Tayari pre-primary program. The total cost of the intervention in public ECDE centres is approximately US$ 817,551.32.

With regards to APBET ECDE centres, results in Table 2 (Panel B) indicate that irrespective of the treatment group, the main driver of the cost is the human resource activities (similarly to public ECDE centres). Results also suggest that the intervention is labor intensive with 88.80%, 66.63% and 60.83% of the total cost in treatment package T1, T2, and T3, respectively, mainly driven by

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⁷ For books, we use four years for the big books, flash cards, and two years for charts as useful life. With regards to teachers’ guides such as language teachers’ guides, mathematics teachers’ guides, social activities teachers’ guides and life skills teachers' guides, four years are used as useful life. The same goes for tablets.
the training of the staff. Treatment package T2 consumes most of the resources with a total cost of US$ 78,406.05. The total cost for APBET ECDE centres is approximately US$ 195,104.25.

[Insert Table 2 about here]

Unit costs
Based on Table 3 (Panel A) for public ECDE centres, the cost per learner over a two-year period of participation in pre-primary school is US$ 8.39, US$ 14.83 and US$ 21.69 for treatment package T1, T2, and T3, respectively. Furthermore, results for APBET ECDE centres indicate that over a two-year period of participation in pre-primary school, the cost per learner is US$ 8.79, US$ 17.01 and US$ 15.07 for treatment package T1, T2, and T3, respectively. Put differently, if policymakers in Kenya were to scale-up T1 and T2 ECDE packages in public ECDE centres, it would cost on average US$ 8.39 and US$ 14.83, respectively to enroll one child. For APBET ECDE centres, on average it would cost US$ 17.01, US$ 15.07 for T2 and T3, respectively, to enroll one child in APBET ECDE centres.

[Insert Table 3 about here]

Incremental cost-effectiveness ratio
We estimate the cost of improving the learner’s score in public and APBET ECDE centres. As can be seen in Table 3 (two last columns of Panel A), for public ECDE centres the ICER is US$ 5.08, US$ 6.31 and US$ 20.66, for treatment package T1, T2, and T3, respectively. This clearly indicate that T2 seems to be the most affordable treatment package though the impact of the intervention is only significant at the 10% level. Thus, for an additional expenditure of US$ 6.31 using T2 package, policymakers could enhance the learner’s score by one percentage point. Using the standardized effect size, results also indicate for a 0.1 increase in standard deviation of the TSRI score, this would on average cost US$ 11.41. For decision making we can still make the results more straightforward by estimating the incremental effect per unit of incremental cost or the gain
per dollar spent. Therefore, for every extra US$ 1 spent on T2 package, policymakers could enhance the learning score by 0.16 percentage points\(^8\).

The findings of the study indicate that for APBET centres (Panel B in Table 3), the ICER is US$ 2.82 and US$ 2.92 for treatment package T2 and T3, respectively. Our results indicate that T2 package has the lowest ICER though not so different from T3, implying that for an additional expenditure of US$ 2.82 using T2 package, policymakers could enhance the learning score by one percentage point. This also means that for a 0.1 increase in standard deviation of the TSRI score, this would cost on average US$ 4.72.

Though not a perfect comparison, we attempt to compare the ICER of the current study with other educational interventions implemented in Kenya for teacher incentives and textbooks programs\(^9\) (Glewwe, Ilias, & Kremer, 2003; Glewwe, Kremer, & Moulin, 1997; Kremer, Miguel, & Thornton, 2009; McEwan, 2012). All estimates are inflated to our base year cost using the gross domestic product deflator. Since our ICER has the lowest value as compared to the teacher incentives and textbooks programs (Table 4), we conclude that an ECDE program which provides a combined package of training teachers, SCECDCs, teacher support, books and teachers’ guides could be cost-effective to improve the learner’s score in public and APBET ECDE centres. In a more recent study conducted in Malawi on early childhood education, Ozler et al. (2018) found that an early childhood education program that advocates for a holistic approach consisting of provision of play and learning materials, training and mentoring of teachers, teacher incentives and parenting education is the most cost-effective. The average cost per child was about US$ 93 while the ICER was US$ 14. If we compare these estimates with our ICER, it turns out that the ICER for treatment package T2 for public and APBET ECDE centres is still the lowest value. We therefore argue that combining the training of the SCECDCs, teacher support, books and teachers’

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\(^8\) This could be estimated as the ratio between the treatment effect (effectiveness of the intervention) and average cost per child.

\(^9\) The teacher incentives intervention was a program rolled out in 1998 in Western Kenya that rewarded teachers based on students’ exam scores by providing in-kind prizes such as suit, plates, glasses, cutlery, tea set, bed linens and blankets. The program was implemented by International Child Support in Busia and Teso districts (Western Kenya) in schools where students were in grades 4-8. The same Dutch non-profit organization provided textbooks to 25 rural Kenyan primary schools.
4. Conclusions

Investment in early childhood development education has been shown to yield a high return and is a catalyst for human capital formation. Nevertheless, in Kenya in public and APBET ECDE centres there is scarcity of qualified ECDE teachers, low quality of play and learning materials, and lack of clear supervision of ECDE teachers from the SCECDCs. We posit that a combination of the training of the SCECDCs, teacher support, books and teachers’ guides could be cost-effective. The costing and cost-effectiveness analyses of the current study provide several findings.

First, results of the study suggest that with regards to public and APBET ECDE centres, the training of staff who implemented the intervention either in T1, T2, or T3 was the main driver of the total cost. Though this cost component may be expensive, this activity could be the main driver of success of the Tayari pre-primary program in Kenya. Furthermore, in public and APBET ECDE centres our findings indicate that T2 is the most expensive treatment package. This result is not surprising when we consider how the intervention was implemented and resources used in each treatment package. From the financial report, the yearly expenditures related to supervision activities showed that these expenses in T2 are substantially higher than those in T3. This is in line with the number of SCECDCs in T2 which is greater than the number of SCECDCs in T3. The data also indicate that in public ECDE centres, the number of children reached in T2 far exceeds the number of children reached in T3. All these eventually increase the total cost of T2.

Second, our key findings suggest that treatment package T2 has the lowest ICER either for public or APBET ECDE centres. Thus, for every extra US$ 1 spent on T2 package, policymakers could enhance the learning score by 0.16 percentage points in public ECDE centres over two years of participation. This will eventually cost US$ 14.83 per child. Similarly, in APBET ECDE centres, results suggest that for every additional US$ 1 spent on T2 treatment package, policymakers could enhance the learning score by 0.36 percentage points, implying a cost of US$ 17.01 per child. Our comparison with existing educational programs conducted in Kenya and Malawi suggests that treatment package T2 of the Tayari pre-primary program is cost-effective. We therefore suggest
that combining the training teachers, SCECDCs, teacher support, books and teachers’ guides could be scaled-up in different counties of Kenya.
Table 1: Treatment packages of *Tayari* pre-primary program in Kenya

<table>
<thead>
<tr>
<th>Treatment package</th>
<th>Activities</th>
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</thead>
<tbody>
<tr>
<td>First treatment package (T1)</td>
<td>- Sub-County ECD coordinators’ training</td>
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<tr>
<td></td>
<td>- Teacher training</td>
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<td></td>
<td>- Teacher classroom instructional support</td>
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<tr>
<td>Second treatment package (T2)</td>
<td>- Sub-County ECD coordinators’ training</td>
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<td></td>
<td>- Teacher training</td>
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<td></td>
<td>- Teacher classroom instructional support</td>
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<td></td>
<td>- Books and teachers’ guides</td>
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<tr>
<td>Third treatment package (T3)</td>
<td>- Sub-County ECD coordinators’ training</td>
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<td></td>
<td>- Teacher training</td>
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<td></td>
<td>- Teacher support classroom instructional support</td>
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<td></td>
<td>- Books and teachers’ guides</td>
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<td></td>
<td>- Health support</td>
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</tbody>
</table>

Notes: In APBET ECDE centres, staff supporting ECDE teachers are called instructional coaches.
<table>
<thead>
<tr>
<th>Treatment package</th>
<th>Meeting with the MoE and stakeholders within Kenya</th>
<th>Training of staff (training of trainers, SCECDCs, instructional coaches, teachers, CHAs and CHVs)</th>
<th>Supervision activities</th>
<th>Other consumables (materials such as language and mathematic workbooks)</th>
<th>Capital (items whose lifespan was more than one year)</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: Public ECDE centres</td>
<td></td>
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<tr>
<td>T1</td>
<td>273.67</td>
<td>273.67</td>
<td>273.67</td>
<td>273.67</td>
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<tr>
<td>Activities allocation for T1 (%)</td>
<td>0.18</td>
<td>0.06</td>
<td>0.13</td>
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<tr>
<td>T2</td>
<td>126743.12</td>
<td>295991.31</td>
<td>20945.57</td>
<td>32494.58</td>
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<tr>
<td>Activities allocation for T2 (%)</td>
<td>89.76</td>
<td>63.21</td>
<td>68.68</td>
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</tr>
<tr>
<td>T3</td>
<td>13686.36</td>
<td>112499.20</td>
<td>22.77</td>
<td>14936.85</td>
<td></td>
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</tr>
<tr>
<td>Activities allocation for T3 (%)</td>
<td>NA</td>
<td>22.77</td>
<td>15.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost</td>
<td>141200.20</td>
<td>468281.45</td>
<td>7.81</td>
<td>208069.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel B: APBET ECDE centres</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>273.67</td>
<td>273.67</td>
<td>273.67</td>
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<td></td>
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<tr>
<td>Activities allocation for T1 (%)</td>
<td>0.62</td>
<td>0.35</td>
<td>0.35</td>
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<tr>
<td>T2</td>
<td>35918.60</td>
<td>52245.66</td>
<td>3696.28</td>
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<td>Activities allocation for T2 (%)</td>
<td>88.80</td>
<td>66.63</td>
<td>4.45</td>
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<tr>
<td>T3</td>
<td>4105.91</td>
<td>16425.58</td>
<td>4.45</td>
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<tr>
<td>Activities allocation for T3 (%)</td>
<td>NA</td>
<td>19.80</td>
<td>21.73</td>
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</tr>
<tr>
<td>Total cost</td>
<td>40447.30</td>
<td>78406.05</td>
<td>7.29</td>
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</tbody>
</table>

Notes: NA means not available since these activities were not implemented. SCECDCs, CHAs and CHVs stand for the Sub-County ECD Coordinators, community health assistants and community health volunteers, respectively. MoE is the Ministry of Education.
Table 3: Unit cost and incremental cost-effectiveness ratio for the Public and APBET ECDE centres

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>Total cost</th>
<th>Number of learners</th>
<th>Treatment effect (percentage point)</th>
<th>Standardized effect size</th>
<th>Cost per learner</th>
<th>Cost-effectiveness ratio (based on treatment effect)</th>
<th>Cost-effectiveness ratio (based on standardized effect size for 0.1 standard deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>141200.20</td>
<td>16839</td>
<td>1.65</td>
<td>0.10</td>
<td>8.39</td>
<td>5.08</td>
<td>8.39</td>
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<tr>
<td>T2</td>
<td>468281.45</td>
<td>31574</td>
<td>2.35*</td>
<td>0.13*</td>
<td>14.83</td>
<td>6.31</td>
<td>11.41</td>
</tr>
<tr>
<td>T3</td>
<td>208069.67</td>
<td>9593</td>
<td>1.05</td>
<td>0.06</td>
<td>21.69</td>
<td>20.66</td>
<td>36.15</td>
</tr>
<tr>
<td>Panel A: Public ECDE centres</td>
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<tr>
<td>T1</td>
<td>40447.30</td>
<td>4604</td>
<td>0.73</td>
<td>0.04</td>
<td>8.79</td>
<td>12.03</td>
<td>21.96</td>
</tr>
<tr>
<td>T2</td>
<td>78406.05</td>
<td>4610</td>
<td>6.04***</td>
<td>0.36***</td>
<td>17.01</td>
<td>2.82</td>
<td>4.72</td>
</tr>
<tr>
<td>T3</td>
<td>76250.90</td>
<td>5059</td>
<td>5.17***</td>
<td>0.31***</td>
<td>15.07</td>
<td>2.92</td>
<td>4.86</td>
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<tr>
<td>Panel B: APBET ECDE centres</td>
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<td></td>
</tr>
</tbody>
</table>

Notes: *p < 0.10, **p < 0.05, ***p < 0.01. The treatment effect is computed using a multilevel model with the learners at level-1, schools at level-2 and we controlled for the baseline characteristics such as the age of the teacher, teacher’s education, gender of the teacher, gender of the learner, class size, language of instruction, as well as the phase and baseline TSRI scores which were aggregated at the school level. All estimates are in US$. 

Table 4: Comparison of the ICER of Tayari pre-primary program with other studies (US$)

<table>
<thead>
<tr>
<th>Pre-primary program</th>
<th>Cost per learner</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tayari pre-primary program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public ECDE centres-T2</td>
<td>14.83</td>
<td>11.41</td>
</tr>
<tr>
<td>APBET ECDE centres-T2</td>
<td>17.01</td>
<td>4.72</td>
</tr>
<tr>
<td>Prior educational program in Kenya</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher incentives (in-kind prizes for high scores)</td>
<td>11.50*</td>
<td>16.43*</td>
</tr>
<tr>
<td>Textbooks</td>
<td>7.73*</td>
<td>19.32*</td>
</tr>
</tbody>
</table>

Notes: *These estimates were adjusted using the gross domestic deflator and 2016 base year cost. With regards to the cost per learner, the unadjusted estimates are US$ 3.33, US$ 2.24 for teacher incentive, textbooks, respectively. In the same vein, concerning the ICER, the unadjusted estimates are US$ 4.77, US$ 5.61 for teacher incentive, textbooks, respectively. The base year used for teacher incentives and textbooks program is 2002. We also use the cost-effectiveness ratio based on standardized effect size for 0.1 standard deviation to allow for comparisons.
References


van der Meer, A. L., & Van Der Weel, F. (2017). Only three fingers write, but the whole brain works†: A high-density eeg study showing advantages of drawing over typing for learning. *Frontiers in psychology, 8*, 706.
