IMPACT OF E-LEARNING TECHNOLOGY AND ACTIVITY-BASED LEARNING ON LEARNING OUTCOMES: EXPERIMENTAL EVIDENCE FROM COMMUNITY SCHOOLS IN RURAL ZAMBIA

Thomas de Hoop | Hannah Ring | Garima Siwach | Paula Dias | Gelson Tembo | Victoria Rothbard | Anais Toungui
Context – Challenging Education Landscape in Rural Zambia

• Zambia: **Ages 15–24 literacy rates – 58.5% for females and 70.3% for males**, despite an average of 7.7 years and 7.9 years of education (Central Statistical Office, Ministry of Health, & ICF International, 2014; UNICEF, 2015).

• **Large, autonomous community schooling system** – number of community schools increased from 100 schools in 1996 to ~2,325 schools with 473,458 children in 2017 (Ministry of General Education, Republic of Zambia, 2017)

• Community schools often staffed by untrained, underpaid teachers who teach a substandard curriculum and who may lack management skills and school supplies

• Experimental evidence – **technology integration into education** may improve quality of education and learning outcomes but **very limited evidence in rural sub-Saharan Africa**
Impact Network eSchool 360 Model – A Technology in Education Program with Wraparound Services
eSchool 360 Model: Mechanisms to Improve Learning Outcomes

Context

Initial conditions
- Low literacy rates
- Low levels of reading and mathematics achievement
- Community schools funded with < $91 per year per school
- Increasing number of community schools
- Untrained and underpaid teachers, lack management and school supplies

Preparation

Activities
- Engagement with Ministry of Education
- Community outreach
- School renovation
- Teacher recruitment
- School supplies

Outputs
- Improved school infrastructure
- Free education
- Increased demand for education – ↑ school enrollment and attendance; ↓ age at enrollment

Program

Activities
- Improved activity-based curriculum
- Teacher professional development – weekly coaching, monthly training
- Creation of Parent Teacher Associations
- Introduction of e-learning
- Ongoing check-in of implementation, facilities, and materials

Outputs
- Activity-based classroom practices
- Technology-based education
- Improved teacher practices

Outcomes

Intermediate Outcomes
- ↑ child enrollment in school at younger age
- ↑ child attendance
- ↑ support from parents and community
- ↑ teacher time spent in school
- ↑ pre-literacy and literacy skills

Final Outcomes

Learning outcomes
- ↑ numeracy skills
- ↑ language skills
- ↑ cognitive skills
- ↑ grade progression
Randomized Controlled Trial Stratified by Region and Age

Eligibility

Impact Network selects eligible schools:
- Dedicated physical structure
- Largely informal schools
- Not within 3km of another eligible school
- In Petauke, Sinda, or Katete districts

Assessed for eligibility (n = 149)

Excluded (n = 86)
Reasons include too many gov’t teachers, no formal structure, school was closed etc.

Impact Network’s eSchool 360 Program
Randomized (n = 63 schools)

Treatment (n = 30 schools)
- 30 households from each school area; 1 child per household
- Treatment (n = 900 students)
  - 6-year olds (n = 112)
  - 7-year olds (n = 352)
  - 8-year olds (n = 215)
  - 9-year olds (n = 209)
  - Total (n = 888)

Allocation

Eligible students (>6 y/o in Jan 2018 and have not attended first grade)

Control (n = 33 schools)
- 30 households from each school area; 1 child per household
- Control (n = 990 students)
  - 6-year olds (n = 109)
  - 7-year olds (n = 351)
  - 8-year olds (n = 245)
  - 9-year olds (n = 272)
  - Total (n = 977)
Mixed-Methods Design to Determine Impacts on Literacy and Mathematics Outcomes

Qualitative Data

Schools for qualitative data were selected based on school size, distance from district center, and distribution of high/low performing schools based on student learning outcomes from prior years.

- Focus group discussions with parents, PTA members, and students
- Key informant interviews with teachers, teacher supervisors, and Impact Network staff
- Classroom observations
Mixed-Methods Design to Determine Impacts on Literacy and Mathematics Outcomes

Quantitative Data

- Baseline N=1,865. Midline N=1,700. No differential attrition

**ITT**
Compares outcomes of eligible children in treatment and control areas at midline

**TOT**
IV analysis of – 1) Enrollment in treatment school in last year; 2) Attendance in treatment school >3 days in week
Context: High Levels of Food Insecurity and Low Levels of Parental Education
ITT Effects – Improved scores on all primary tests after 14 months. Estimates range from 0.16 SD to 0.40 SD.

<table>
<thead>
<tr>
<th></th>
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<th>OV-SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.158***</td>
<td>0.404***</td>
<td>0.219***</td>
<td>0.251***</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.083)</td>
<td>(0.065)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
</tr>
</tbody>
</table>

Standard errors clustered at school level and reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. 
TOT Effects – Significant increase in test scores for children who were ever enrolled in IN school. Estimates range from 0.26 SD to 0.68 SD.

<table>
<thead>
<tr>
<th>1st Stage</th>
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<th>EGMA- SMD</th>
<th>OV-SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.597***</td>
<td>0.264***</td>
<td>0.677***</td>
<td>0.366***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.088)</td>
<td>(0.131)</td>
<td>(0.100)</td>
</tr>
</tbody>
</table>

Enrolled in IN school
Observations 1,688 1,688 1,688 1,688 1,688

Standard errors clustered at school level and reported in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01.
Mechanisms to Explain Findings – Improvement in enrollment, attendance; Teacher Professional Development

<table>
<thead>
<tr>
<th>Enrolled (yes/no)</th>
<th>Weekly attendance (days)</th>
<th>Age at enrolment (for enrollees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.079**</td>
<td>0.358**</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.158)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,688</td>
<td>1,688</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.021</td>
<td>0.024</td>
</tr>
<tr>
<td>Control mean</td>
<td>0.545</td>
<td>1.915</td>
</tr>
</tbody>
</table>

Standard errors clustered at school level and reported in parentheses. * p < 0.1; ** p < 0.05; *** p < 0.01.

Process evaluation findings:

- Use of tablets and technology motivates students to attend class
- Well-trained and knowledgeable teachers use innovative teaching methods, attend school consistently, and follow up when students are absent → these teacher characteristics were perceived to lead to improvements in student performance

“The teacher is very good. Any time the children come to school there is no time they come back [and say] that the teacher is not there. When the child is absent from school the teacher makes a follow-up to us parents to get the reason the child is absent.” -Parent
Mechanisms to Explain Findings – Improvements in Perceived Quality of Education

- Caregiver satisfaction score (SD)
- HH food security index (SD)
- Child cognitive score (SD)
- Caregiver perception score (SD)
- HH school expenditure (SD)
- Parent aspiration for child’s education (SD)

Process evaluation findings:

• Parents, teacher supervisors, students, and program staff believe Impact Network teachers provide students with high-quality education.

• Observations confirm teachers’ use of active, participatory pedagogical approaches as they were trained to do, such as putting students into small groups and inviting them to actively participate in the lesson.

“The children at this school learned how to read from Grade 1; but you find a child who is in Grade 4 there [in a government school] but does not know how to read.” - Parent
Conclusion & Next Steps

• **Midline results are promising** — multifaceted, integrated technology-aided instruction program can improve literacy and mathematics outcomes in **poorest areas of sub-Saharan Africa**

• Increase in school enrollment and attendance, improvements in the quality of education, and increases in teacher attendance were likely the main drivers of the positive effects

• Despite the positive effects, treatment children scored an average of only 11% correct on EGRA and 24% correct on EGMA assessments

• Endline study will assess the ability of the program to **exponentially increase learning outcomes after 4 years of programming** as well as program cost-effectiveness

• Endline qualitative study will examine the ability of the program to **cope with learning loss after COVID-19**
Appendix slides
Sampling Approach

- Program randomly assigned across schools meeting Impact Network’s eligibility criteria
- Three districts in Zambia’s Eastern Province – Petauke, Sinda and Katete
- Excluded pairs of eligible schools within 3 kms of one another
- **Randomization done in May 2017 across 30 treatment and 33 control schools**, in consultation with Impact Network and Zambian Government
- Study sample: 1,865 children eligible to enroll in first grade and who live near the 64 schools
- Longitudinal panel design following each student for 4 years

*Map of Treatment & Control Schools*
Study Sample

• **Eligible sample**: Children eligible to enroll in first grade and who live near the 64 schools: eSchool 360 model designed to expand to an additional grade each year—only the first-grade cohort will receive the full package in year 1, which will expand to grades 1 and 2 in the year 2, and so on.

• **Study sample**: Randomly sampled 30 households from census-generated sample frame for each of the sample schools
  - For households with more than one eligible child, we selected the oldest child for inclusion in the sample.
  - Initially planned to have a sample of 30 children from the area surrounding each of the 30 treatment and 33 control schools. Eventual sample: 1,865 children (not enough eligible children within area).

• **Study design**: Longitudinal panel design that follows each sampled child for 3 years

• **Study outcomes**: School attendance and enrollment; preliteracy, literacy, and numeracy outcomes; parent expectations and perceptions about school and education quality; parent aspirations about child’s education, marriage and labor market outcomes
Randomized Controlled Trial Stratified by Region and Age

Eligibility

Impact Network selects eligible schools:
- Dedicated physical structure
- Largely informal schools (mostly community teachers)
- Not within 3 km of another eligible school
- In Petauke, Sinda, or Katete districts

Assessed for eligibility (n = 149)

Impact Network’s eSchool 360 Program
Randomized (n = 63 schools)

Excluded (n = 86)
- Too many govt teachers (n = 18)
- Within 3 km (n = 4)
- No formal structure (n = 11)
- Not enough grades (n = 18)
- Too far from DEBS (n = 15)
- Existing Impact Network school (n = 8)
- School closed (n = 5)
- Other reason (n = 7)

Allocation

30 treatment schools in Petauke, Sinda, and Katete districts
Treatment (n = 30 schools)

33 control schools in Petauke, Sinda, and Katete districts
Control (n = 33 schools)

30 households from each school area;
1 eligible child per household

Treatment (n = 900 students)

Conduct census in areas surrounding sampled schools (1.5 km diameter) to determine eligible students (age 6 years or older in Jan 2018 and have not attended first grade)

Control (n = 990 students)

Stratification by age:
- 7-year olds (n = 358)
- 8-year olds (n = 271)
- 9-year olds (n = 271)

Stratification by age:
- 7-year olds (n = 394)
- 8-year olds (n = 298)
- 9-year olds (n = 298)

Respondents by age:
- 6-year olds (n = 112)
- 7-year olds (n = 352)
- 8-year olds (n = 215)
- 9-year olds (n = 209)
- Total (n = 888)

Respondents by age:
- 6-year olds (n = 109)
- 7-year olds (n = 351)
- 8-year olds (n = 245)
- 9-year olds (n = 272)
- Total (n = 977)

Planned stratification

Data collection: 42 school catchment areas (21 treatment, 21 control) did not have enough 7-9-year old students available at time of visit, so some 6-year olds were included in the sample
Empirical Strategy

- Cluster Randomized Controlled Trial
- Child assessments at baseline (2018) and midline (2019) – EGRA, EGMA, ZAT, and Oral Vocabulary administered in Nyanja
- Baseline equivalence: Control and treatment groups were comparable at baseline
- **ITT analysis** to compare outcomes of eligible children in treatment and control areas at midline (2019)

\[ Y_{i2019} = \alpha + \beta IN_i + \delta S_i + \sigma Y_{i2018} + \mu C_i + \epsilon_i \]

\( IN_i \) is an indicator variable for residing in a treatment area; \( S_i \) is a vector of district FEs; \( Y_{i2018} \) is the baseline value of the outcome of interest; \( C_i \) is a vector of other control variables

- **TOT analysis** with treatment assignment to instrument for – 1) self-reported enrollment in treatment school in last year; 2) self-reported attendance in treatment school more than 3 days in week prior to survey
- SEs clustered at school level; post-stratification weights applied
- Baseline N=1,865. Midline N=1,700. **No differentiated attrition** observed on primary outcomes
Control and treatment groups were comparable at baseline on almost all indicators

**Baseline equivalence on select characteristics**

<table>
<thead>
<tr>
<th></th>
<th>Control Mean</th>
<th>Treatment Mean</th>
<th>Difference</th>
<th>SE</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child was female</td>
<td>0.48</td>
<td>0.44</td>
<td>-0.04</td>
<td>0.02</td>
<td>0.08</td>
</tr>
<tr>
<td>Child was 8 years old or older at baseline</td>
<td>0.53</td>
<td>0.48</td>
<td>-0.06</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Caregiver had attended school</td>
<td>0.60</td>
<td>0.66</td>
<td>0.06</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>Resided in Katete District</td>
<td>0.15</td>
<td>0.17</td>
<td>0.02</td>
<td>0.09</td>
<td>0.87</td>
</tr>
<tr>
<td>Resided in Petauke District</td>
<td>0.60</td>
<td>0.54</td>
<td>-0.06</td>
<td>0.13</td>
<td>0.66</td>
</tr>
<tr>
<td>Resided in Sinda District</td>
<td>0.25</td>
<td>0.29</td>
<td>0.04</td>
<td>0.11</td>
<td>0.72</td>
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<tr>
<td>Household considered itself nonpoor</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.00</td>
<td>0.01</td>
<td>0.61</td>
</tr>
<tr>
<td>Household considered itself moderately poor</td>
<td>0.49</td>
<td>0.51</td>
<td>0.02</td>
<td>0.03</td>
<td>0.44</td>
</tr>
<tr>
<td>Household considered itself very poor</td>
<td>0.49</td>
<td>0.47</td>
<td>-0.02</td>
<td>0.03</td>
<td>0.53</td>
</tr>
<tr>
<td>Household distance from school (km)</td>
<td>0.68</td>
<td>0.88</td>
<td>0.20</td>
<td>0.10</td>
<td>0.06</td>
</tr>
<tr>
<td>Zambian Achievement Test (% correct)</td>
<td>0.45</td>
<td>0.44</td>
<td>-0.02</td>
<td>0.02</td>
<td>0.48</td>
</tr>
<tr>
<td>Early Grade Reading Assessment (% correct)</td>
<td>0.05</td>
<td>0.05</td>
<td>0.00</td>
<td>0.00</td>
<td>0.99</td>
</tr>
<tr>
<td>Early Grade Mathematics Assessment (% correct)</td>
<td>0.08</td>
<td>0.06</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Oral vocabulary (% correct)</td>
<td>0.62</td>
<td>0.59</td>
<td>-0.03</td>
<td>0.02</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Mixed-Methods Design to Determine Impacts on Literacy and Mathematics Outcomes

- **Cluster-RCT**: Child assessments at baseline (2018) and midline (2019) – EGRA, EGMA, ZAT, and Oral Vocabulary administered in Nyanja

- **ITT analysis** to compare outcomes of eligible children in treatment and control areas at midline (2019)

- **TOT analysis** with treatment assignment to instrument for – 1) self-reported enrollment in treatment school in last year; 2) self-reported attendance in treatment school >3 days in week prior to survey

- Baseline N=1,865. Midline N=1,700. **No differential attrition**

- Qualitative data collection approaches in treatment schools in each of the three districts:
  - Key informant interviews (KII) with teachers, teacher supervisors, and Impact Network staff
  - Focus group discussions (FGD) with parents, PTA members, and students
  - Classroom observations

- Schools for qualitative data were selected based on school size, distance from district center, and distribution of high/low performing schools based on student learning outcomes from prior years
## Attrition at Midline

- **Challenges during midline data collection** – 1) limited access to areas due to poor road conditions and heavy rains; 2) poor network connectivity; and 3) some households migrated after the baseline.

- **No differentiated attrition** observed on primary outcomes:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nonattrited</th>
<th>Attribted</th>
<th>Difference Test</th>
<th>Std. Mean Difference</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>N1</td>
<td>Mean</td>
<td>N2</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.48</td>
<td>1,700</td>
<td>0.46</td>
<td>165</td>
</tr>
<tr>
<td>ZAT (% correct)</td>
<td>0.44</td>
<td>1,700</td>
<td>0.46</td>
<td>165</td>
</tr>
<tr>
<td>EGRA (% correct)</td>
<td>0.05</td>
<td>1,700</td>
<td>0.05</td>
<td>165</td>
</tr>
<tr>
<td>EGMA (% correct)</td>
<td>0.07</td>
<td>1,700</td>
<td>0.07</td>
<td>165</td>
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<tr>
<td>Oral Vocabulary (% correct)</td>
<td>0.60</td>
<td>1,700</td>
<td>0.64</td>
<td>165</td>
</tr>
</tbody>
</table>
ITT Effects – Improved scores on all primary tests after 14 months. Estimates range from 0.16 SD to 0.40 SD.

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<thead>
<tr>
<th></th>
<th>ZAT- % Score</th>
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<tr>
<td>Treatment</td>
<td>0.031***</td>
<td>0.158***</td>
<td>0.035***</td>
<td>0.404***</td>
<td>0.049***</td>
<td>0.219***</td>
<td>0.060***</td>
<td>0.251***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.056)</td>
<td>(0.007)</td>
<td>(0.083)</td>
<td>(0.015)</td>
<td>(0.065)</td>
<td>(0.013)</td>
<td>(0.053)</td>
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<td>Unadjusted p-value</td>
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<td>0.006</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
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<tr>
<td>Adjusted p-value (RI)</td>
<td>0.007</td>
<td>0.007</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Observations</td>
<td>1,688</td>
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<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.054</td>
<td>0.054</td>
<td>0.056</td>
<td>0.056</td>
<td>0.068</td>
<td>0.068</td>
<td>0.047</td>
<td>0.047</td>
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<tr>
<td>Control mean</td>
<td>0.548</td>
<td>0.0766</td>
<td>0.5690</td>
<td>0.210</td>
<td>0.710</td>
<td></td>
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</tbody>
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<th>EGMA- % Score</th>
<th>EGMA- SMD</th>
<th>OV- % Score</th>
<th>OV- SMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.597***</td>
<td>(0.030)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enrolled in IN school</td>
<td>0.052***</td>
<td>0.264***</td>
<td>0.058***</td>
<td>0.677***</td>
<td>0.082***</td>
<td>0.366***</td>
<td>0.101***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.088)</td>
<td>(0.011)</td>
<td>(0.131)</td>
<td>(0.022)</td>
<td>(0.100)</td>
<td>(0.021)</td>
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<tr>
<td>Observations</td>
<td>1,688</td>
<td>1,688</td>
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<td>1,688</td>
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<tr>
<td>R-squared</td>
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<td>0.095</td>
<td>0.122</td>
<td>0.122</td>
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<tr>
<td>Control mean</td>
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<td>0.0689</td>
<td>0.181</td>
<td>0.707</td>
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ITT Impacts on Intermediate Outcomes: Channels
# Impact on School Enrollment & Attendance

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Enrolled (yes/no)</th>
<th>(2) Enrolled (SMD)</th>
<th>(3) Number of Days Attended</th>
<th>(4) Number of Days Attended (SMD)</th>
<th>(5) Age at Enrollment</th>
<th>(6) Age at Enrollment (SMD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.079** (0.038)</td>
<td>0.159** (0.075)</td>
<td>0.358** (0.158)</td>
<td>0.162** (0.071)</td>
<td>-0.096** (0.038)</td>
<td>-0.094** (0.037)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>1,688</td>
<td>979</td>
<td>979</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.021</td>
<td>0.021</td>
<td>0.024</td>
<td>0.024</td>
<td>0.800</td>
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<tr>
<td>Control group mean</td>
<td>0.545</td>
<td>1.915</td>
<td>9.044</td>
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</table>
## Impact on Other Intermediate Outcomes

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<tbody>
<tr>
<td></td>
<td>Child Development Scale</td>
<td>Child Development Scale (SMD)</td>
<td>Caregiver Satisfaction Scale</td>
<td>Caregiver Satisfaction Scale (SMD)</td>
<td>Caregiver Perception/Engagement Scale</td>
<td>Caregiver Perception/Engagement Scale (SMD)</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.242 (0.174)</td>
<td>0.084 (0.061)</td>
<td>0.299** (0.121)</td>
<td>0.284** (0.114)</td>
<td>0.845*** (0.239)</td>
<td>0.316*** (0.089)</td>
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<td>1,688</td>
<td>878</td>
<td>878</td>
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<td>$R$-squared</td>
<td>0.037</td>
<td>0.037</td>
<td>0.047</td>
<td>0.047</td>
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<tr>
<td>Control group mean</td>
<td>17.94</td>
<td>1.189</td>
<td>7.729</td>
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## Impact on Other Intermediate Outcomes

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<tbody>
<tr>
<td></td>
<td>Years</td>
<td>SMD</td>
<td>Yes/No</td>
<td>SMD</td>
<td>Zambian Kwacha</td>
<td>SMD</td>
<td>Index Scale</td>
<td>SMD</td>
<td>Zambian Kwacha</td>
<td>SMD</td>
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<tr>
<td>Treatment</td>
<td>-0.081</td>
<td>-0.019</td>
<td>-0.023</td>
<td>-0.046</td>
<td>-490.963 (346.806)</td>
<td>-0.105</td>
<td>1.129** (0.479)</td>
<td>0.201** (0.085)</td>
<td>-13.878** (6.160)</td>
<td>-0.161** (0.072)</td>
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<td>1,619</td>
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<td>1,109</td>
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<tr>
<td>$R^2$</td>
<td>0.042</td>
<td>0.042</td>
<td>0.026</td>
<td>0.026</td>
<td>0.033</td>
<td>0.033</td>
<td>0.048</td>
<td>0.048</td>
<td>0.026</td>
<td>0.026</td>
</tr>
</tbody>
</table>
Process Evaluation (Qualitative)

• Qualitative data collection approaches in treatment schools in each of the three districts of Katete, Petauke, and Sinda:
  o Key informant interviews (KIIs) with teachers, teacher supervisors, and Impact Network staff
  o Focus group discussions (FGDs) with parents, PTA members, and students
  o Classroom observations
• Schools were selected based on observable characteristics including school size, distance from district center, and distribution of high/low performing schools based on student learning outcomes from prior years
• Qualitative data coded and analyzed in NVivo
Context: Potential for Floor Effects because of Low Baseline Learning Outcomes

Early Grade Math Assessment (percentage correct)

Zambian Achievement Test (percentage correct)

kernel = epanechnikov, bandwidth = 0.0054

kernel = epanechnikov, bandwidth = 0.0505