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

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MAKING RESEARCH RELEVANT

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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

Joel Impact Network School

- eLearning Hardware
- Active Curriculum
- Teacher Training
- Weekly Management
- Community Ownership
- School Supplies
- Teacher Stipends
- Solar Electric
- Building Care
- Rural Security

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

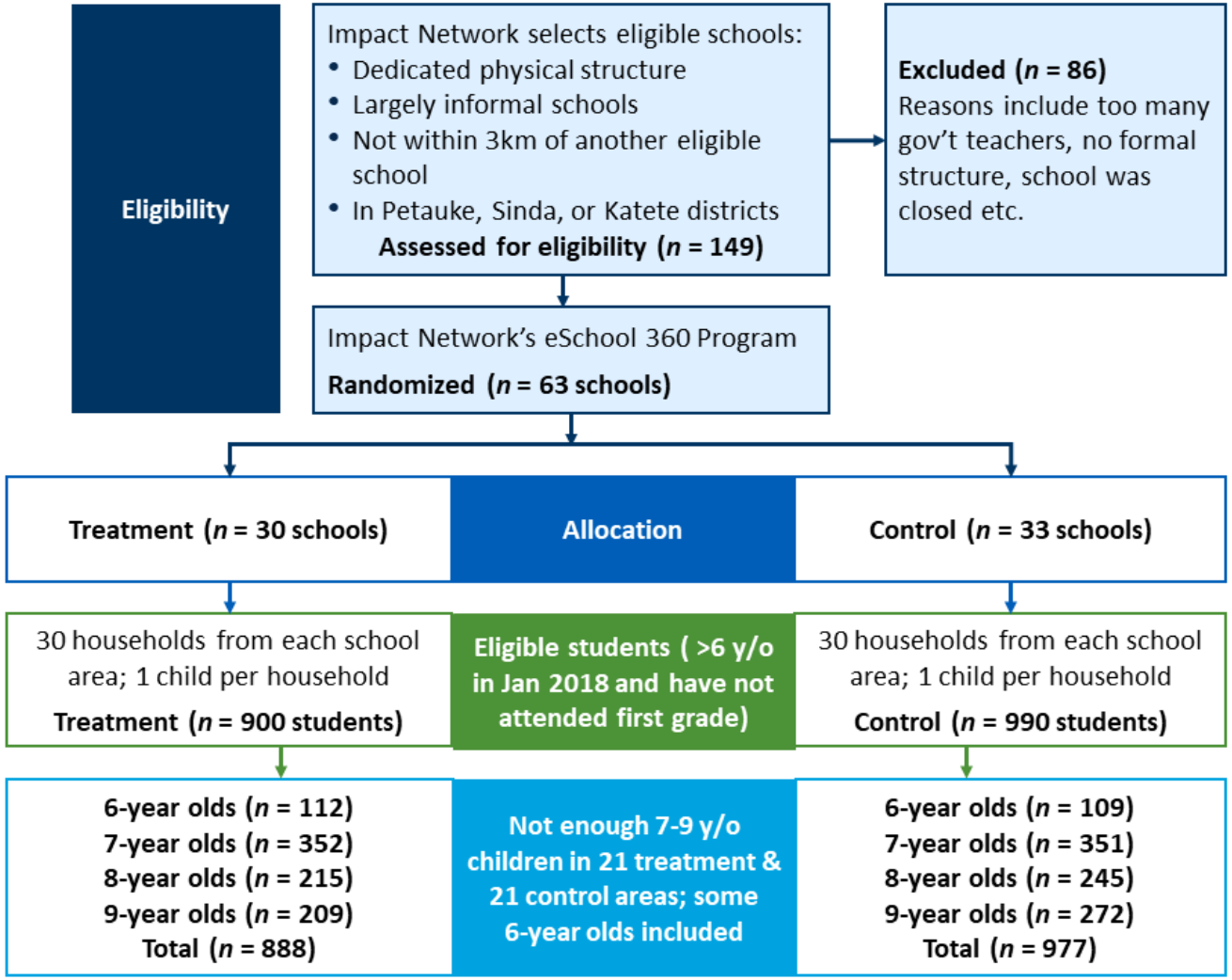
- ↑ child enrollment in school at younger age
- ↑ child attendance
- ↑ support from parents and community
- ↑ teacher time spent in school
- ↑ pre-literacy and literacy skills

Final Outcomes

Learning outcomes

- ↑ numeracy skills
- ↑ language skills
- ↑ cognitive skills
- ↑ grade progression

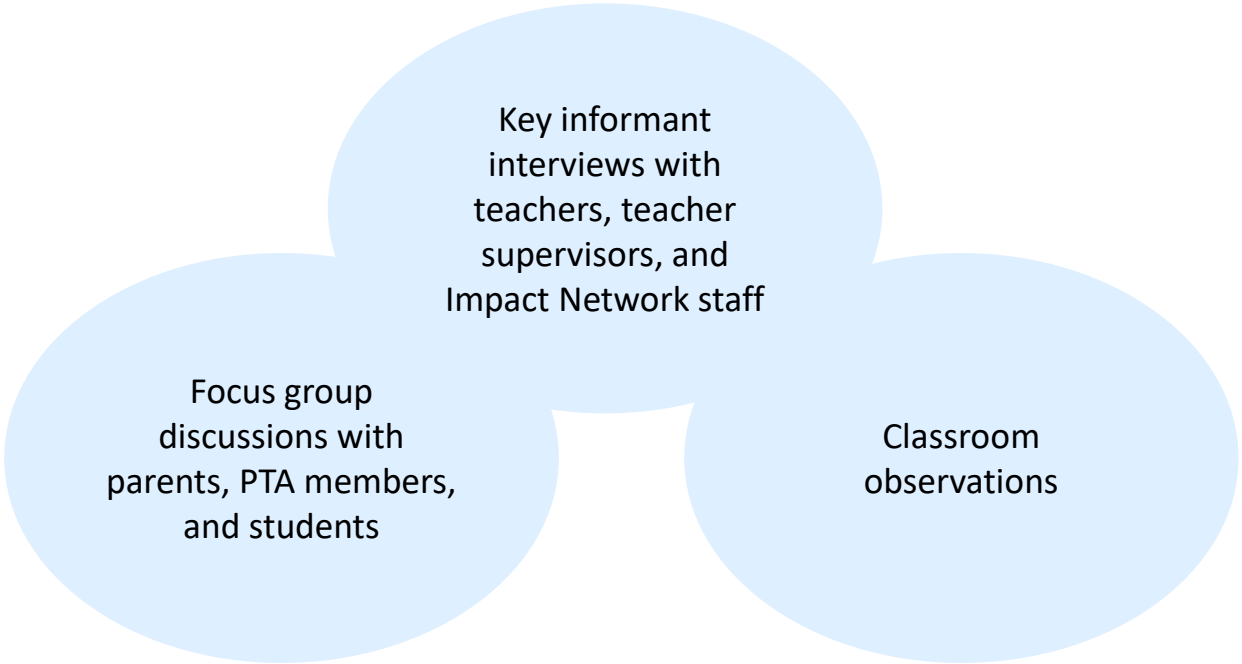
Randomized Controlled Trial Stratified by Region and Age



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



Mixed-Methods Design to Determine Impacts on Literacy and Mathematics Outcomes

Quantitative Data

- Cluster-RCT: Child assessments at baseline (2018) and midline (2019) – EGRA, EGMA, ZAT, and Oral Vocabulary administered in Nyanja
- Baseline N=1,865. Midline N=1,700. **No differential attrition**

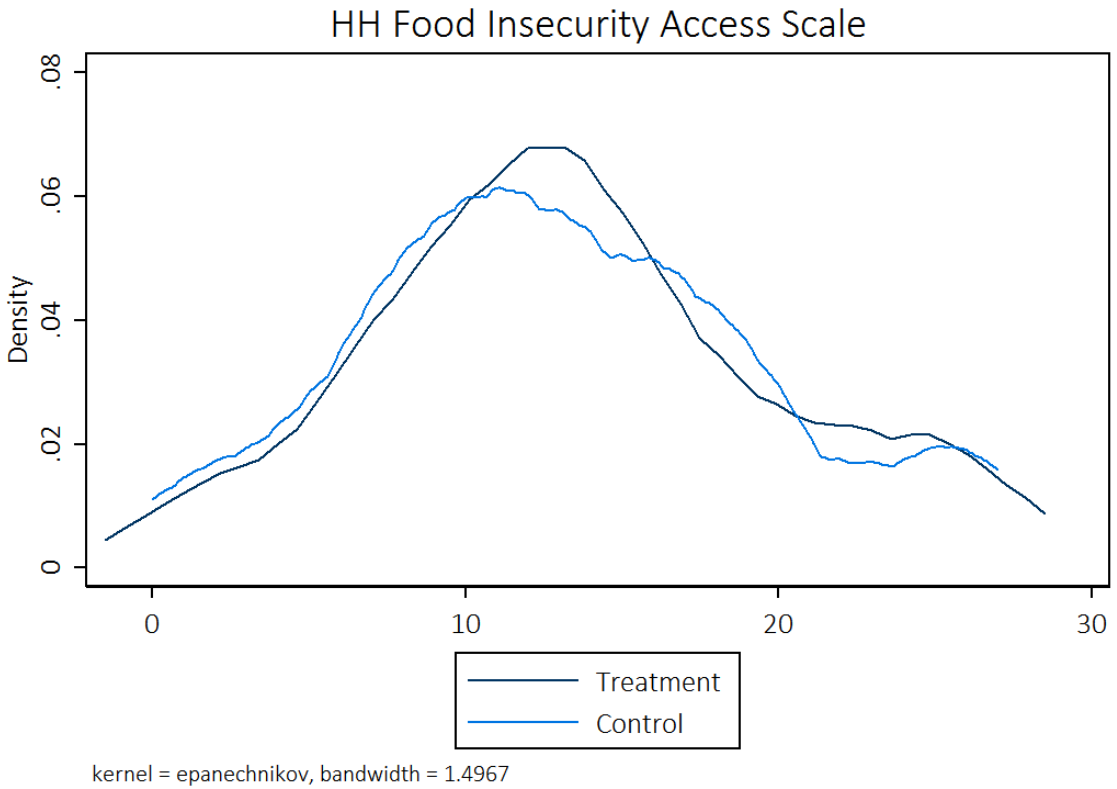
Compares outcomes of eligible children in treatment and control areas at midline

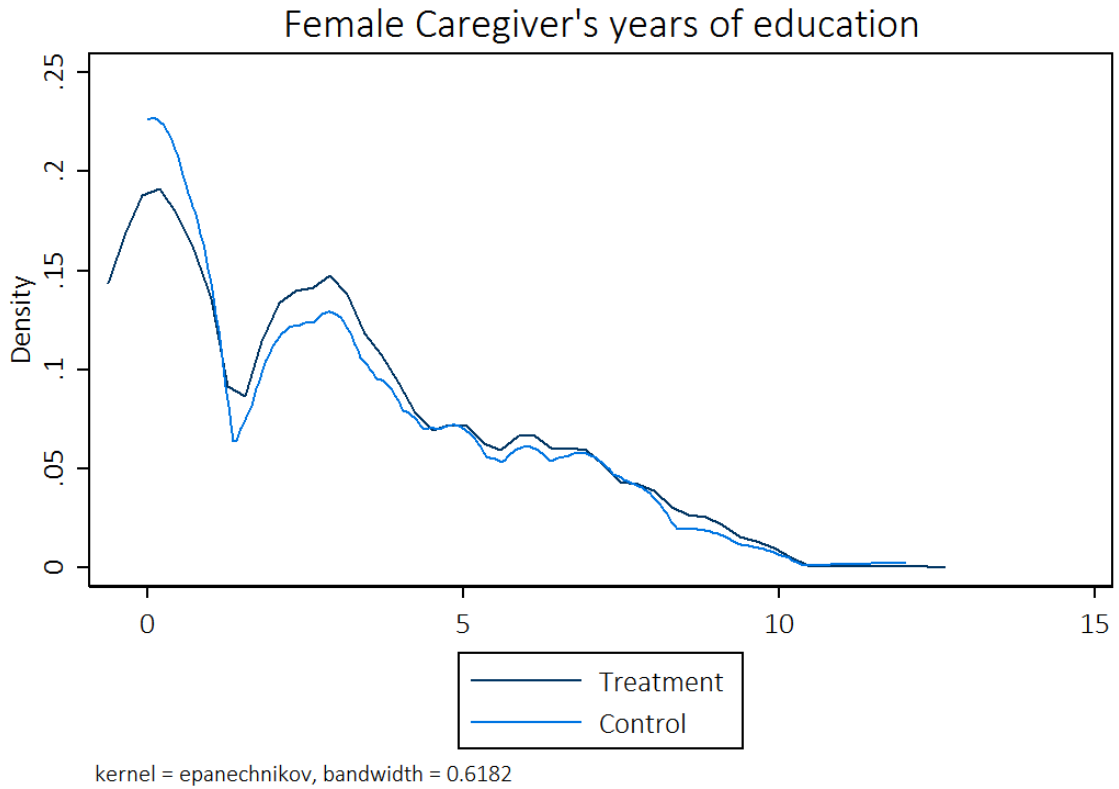
ITT

IV analysis of – 1) Enrollment in treatment school in last year; 2) Attendance in treatment school >3 days in week

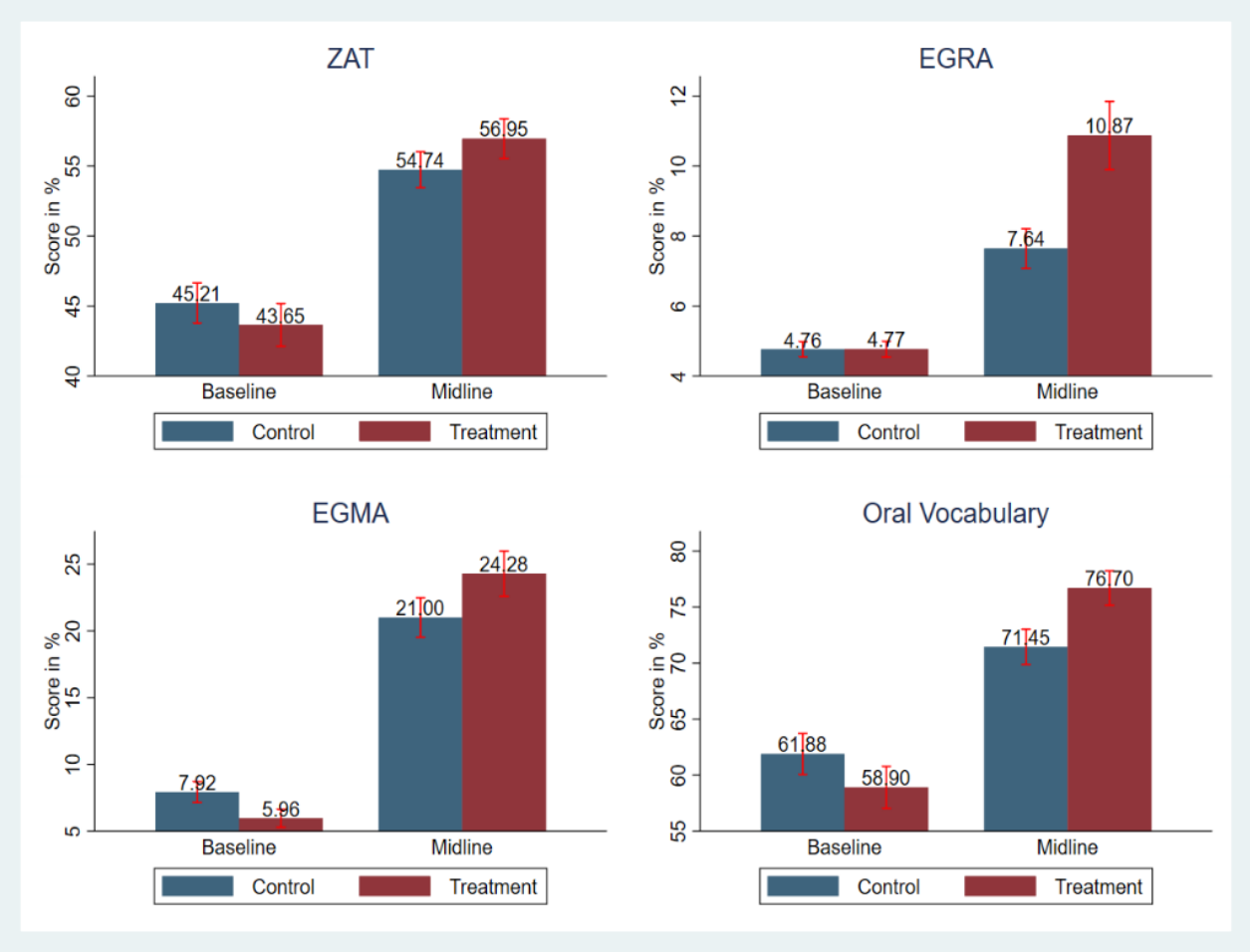
TOT

Context: High Levels of Food Insecurity and Low Levels of Parental Education





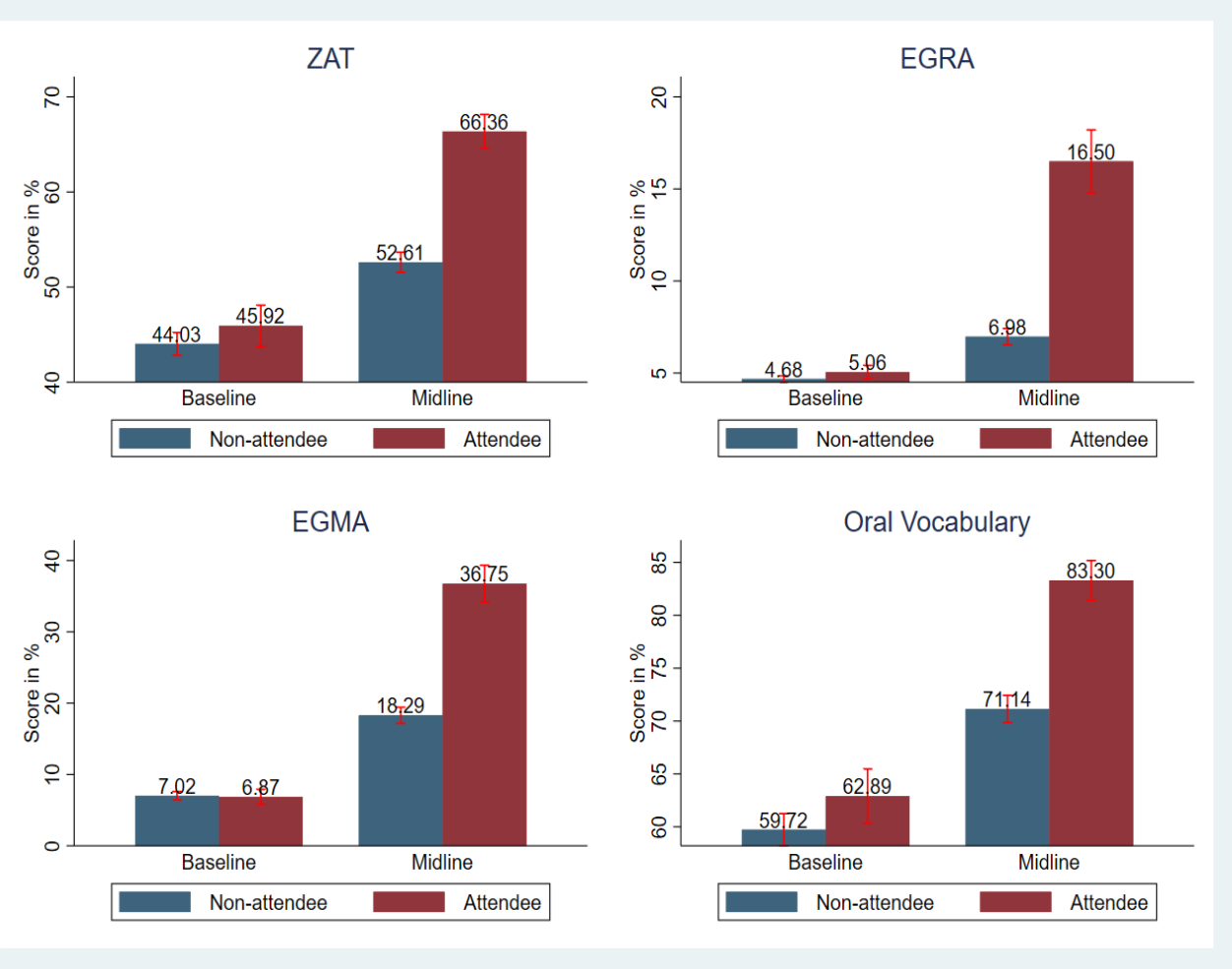
ITT Effects – Improved scores on all primary tests after 14 months. Estimates range from 0.16 SD to 0.40 SD.



	ZAT- SMD	EGRA-SMD	EGMA-SMD	OV-SMD
Treatment	0.158***	0.404***	0.219***	0.251***
	(0.056)	(0.083)	(0.065)	(0.053)
Observations	1,688	1,688	1,688	1,688

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

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.



	1st Stage	ZAT- SMD	EGRA-SMD	EGMA-SMD	OV-SMD
Treatment	0.597***				
	(0.030)				
Enrolled in IN school		0.264***	0.677***	0.366***	0.420***
		(0.088)	(0.131)	(0.100)	(0.087)
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

	Enrolled (yes/no)	Weekly attendance (days)	Age at enrolment (for enrollees)
Treatment	0.079**	0.358**	-0.096**
	(0.038)	(0.158)	(0.038)
Observations	1,688	1,688	979
R-squared	0.021	0.024	0.800
Control mean	0.545	1.915	9.044

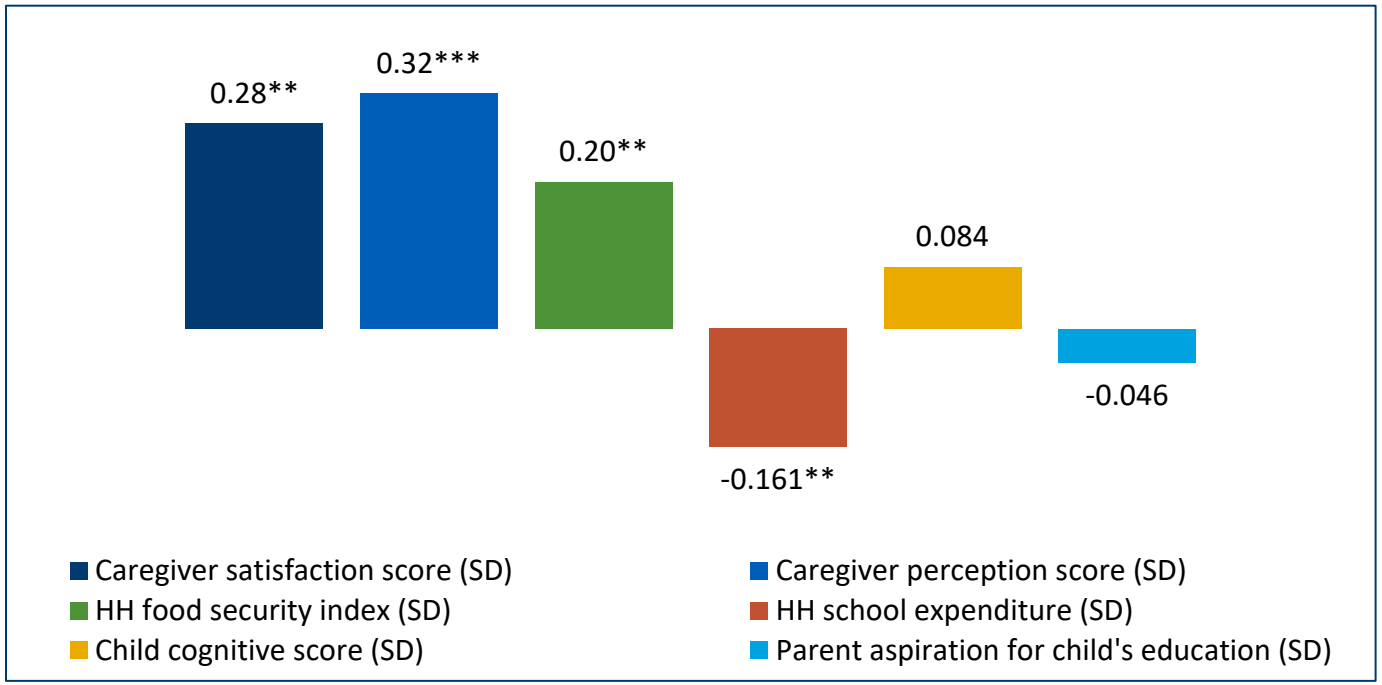
Standard errors clustered at school level and reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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



* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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**

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THANK YOU

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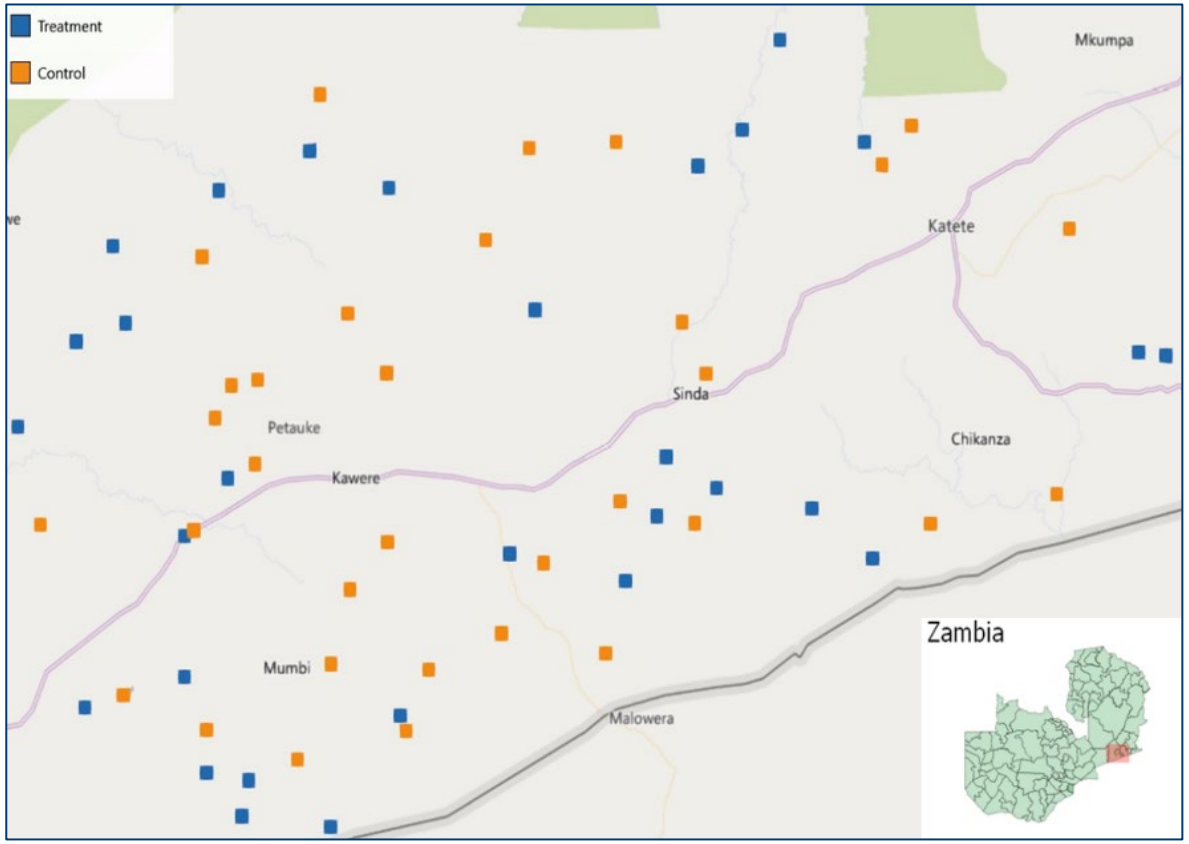
Appendix slides

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

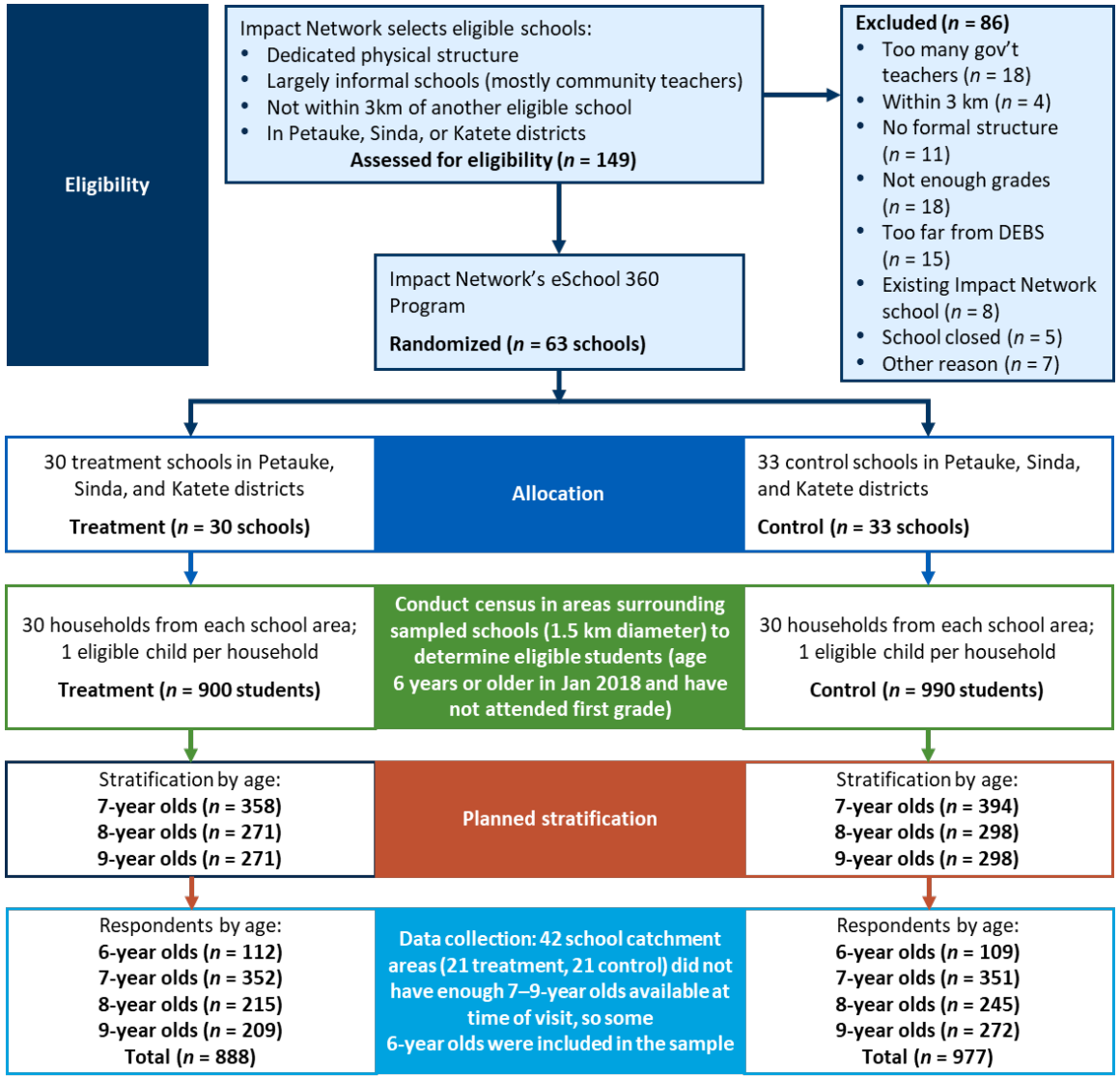


Map of Treatment & Control Schools

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



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

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

Mixed-Methods Design to Determine Impacts on Literacy and Mathematics Outcomes

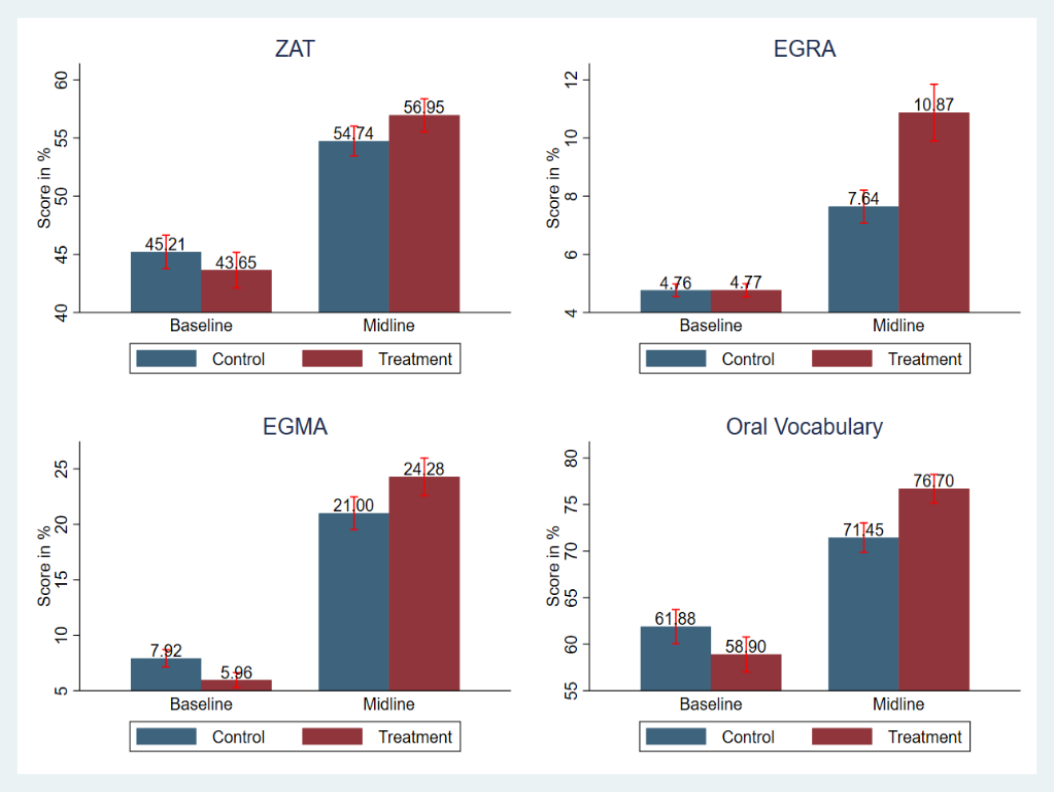
- Cluster-RCT: Child assessments at baseline (2018) and midline (2019) – EGRA, EGMA, ZAT, and Oral Vocabulary administered in Nyanja
- **ITT analysis** to compare outcomes of **eligible children in treatment and control areas** at midline (2019)
- **TOT analysis** with treatment assignment to instrument 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 (KIIs) with teachers, teacher supervisors, and Impact Network staff
  - Focus group discussions (FGDs) 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:

Variables	Nonattrited		Attrited		Difference Test			Std. Mean Difference
	Mean	*N*1	Mean	*N*2	Diff	SE	*p*-Value	
Treatment	0.48	1,700	0.46	165	-0.02	0.07	0.81	-0.03
ZAT (% correct)	0.44	1,700	0.46	165	0.01	0.02	0.53	0.05
EGRA (% correct)	0.05	1,700	0.05	165	0.00	0.00	0.75	0.02
EGMA (% correct)	0.07	1,700	0.07	165	0.00	0.01	0.83	0.02
Oral Vocabulary (% correct)	0.60	1,700	0.64	165	0.03	0.03	0.29	0.11

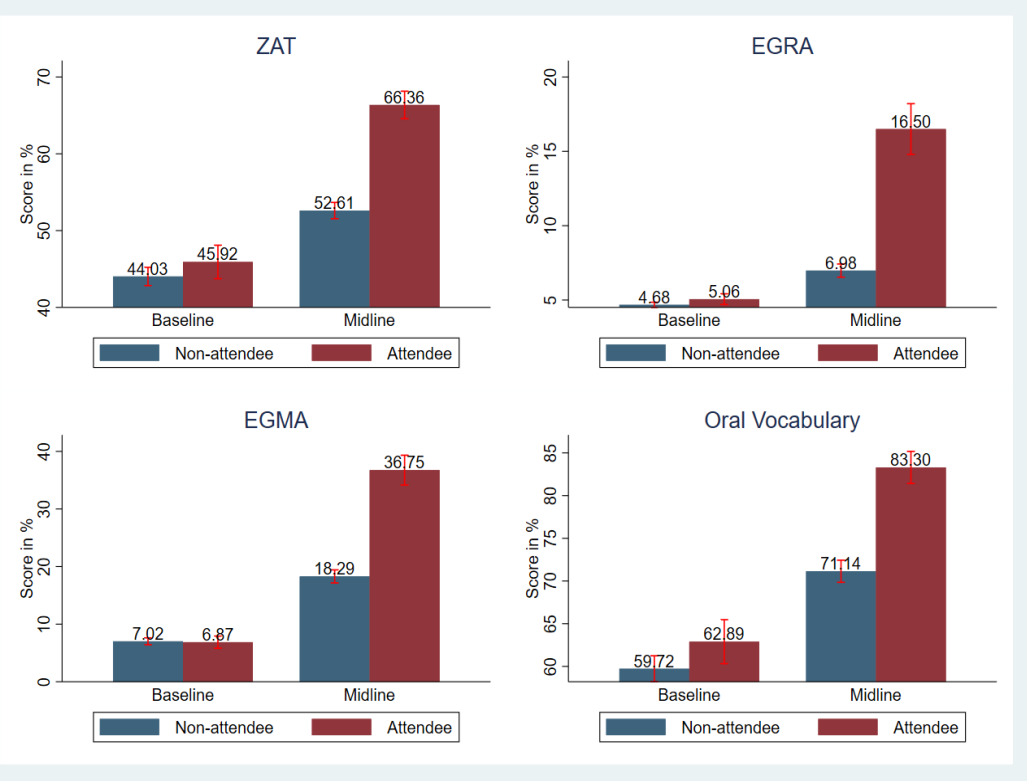
ITT Effects – Improved scores on all primary tests after 14 months. Estimates range from 0.16 SD to 0.40 SD.



	ZAT- % Score	ZAT- SMD	EGRA- % Score	EGRA- SMD	EGMA- % Score	EGMA- SMD	OV- % Score	OV-SMD
Treatment	0.031*** (0.011)	0.158*** (0.056)	0.035*** (0.007)	0.404*** (0.083)	0.049*** (0.015)	0.219*** (0.065)	0.060*** (0.013)	0.251*** (0.053)
Unadjusted *p*-value	0.006	0.006	0.000	0.000	0.001	0.001	0.000	0.000
Adjusted *p*-value (RI)	0.007	0.007	0.000	0.000	0.001	0.001	0.000	0.000
Observations	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688
R-squared	0.054	0.054	0.056	0.056	0.068	0.068	0.047	0.047
Control mean	0.548		0.0766		0.210		0.714	

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

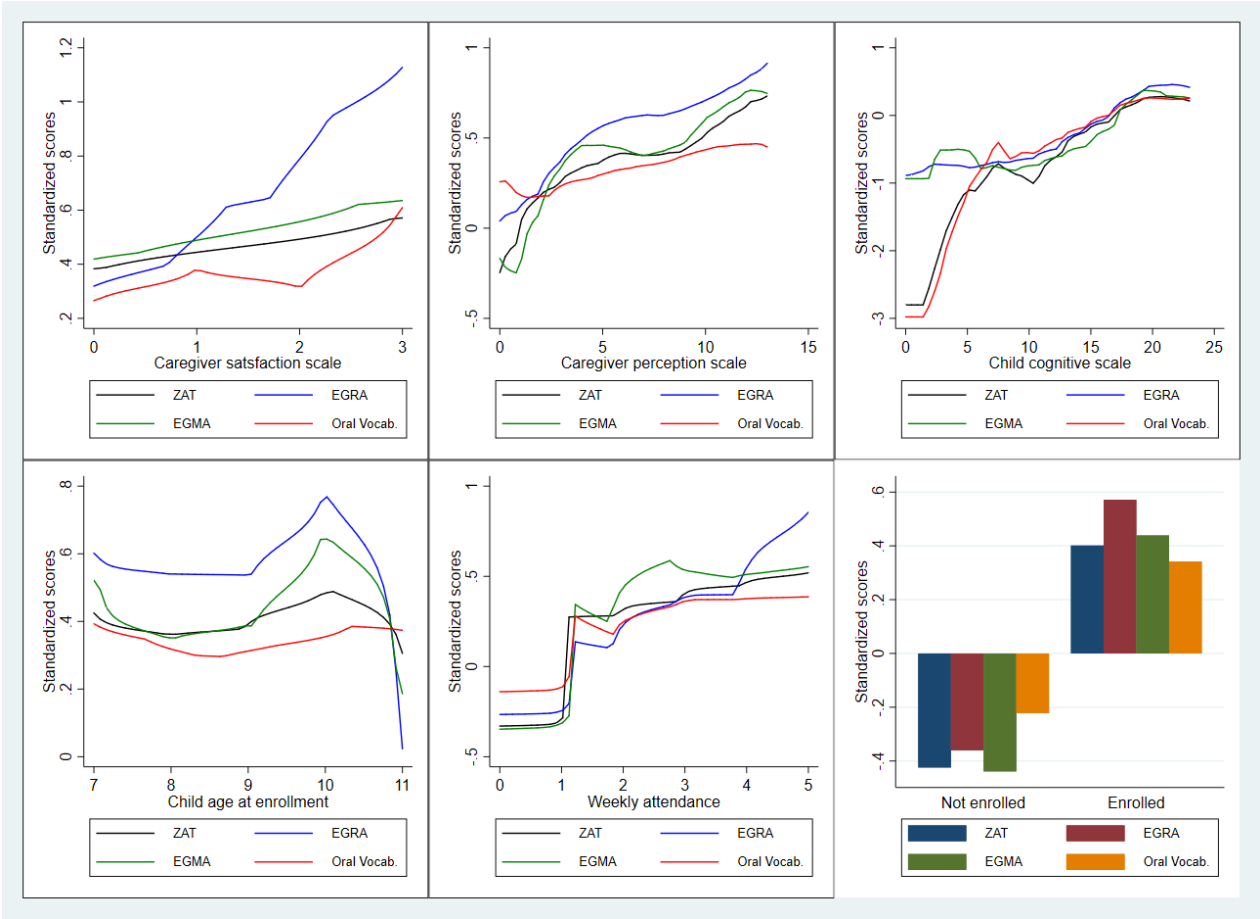
TOT Effects – Significant increase in test scores for children who were ever enrolled in IN school. Estimates range from 0.26 SD to 0.68 SD.



	1st Stage	ZAT- % Score	ZAT-SMD	EGRA- % Score	EGRA-SMD	EGMA- % Score	EGMA-SMD	OV- % Score	OV-SMD
Treatment	0.597***								
	(0.030)								
Enrolled in IN school		0.052***	0.264***	0.058***	0.677***	0.082***	0.366***	0.101***	0.420***
		(0.017)	(0.088)	(0.011)	(0.131)	(0.022)	(0.100)	(0.021)	(0.087)
Observations	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688	1,688
R-squared	0.435	0.095	0.095	0.122	0.122	0.130	0.130	0.079	0.079
Control mean		0.526		0.0689		0.181		0.707	

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

ITT Impacts on Intermediate Outcomes: Channels



Impact on School Enrollment & Attendance

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Enrolled (yes/no)	Enrolled (SMD)	Number of Days Attended	Number of Days Attended (SMD)	Age at Enrollment	Age at Enrollment (SMD)
Treatment	0.079**	0.159**	0.358**	0.162**	-0.096**	-0.094**
	(0.038)	(0.075)	(0.158)	(0.071)	(0.038)	(0.037)
Observations	1,688	1,688	1,688	1,688	979	979
R-squared	0.021	0.021	0.024	0.024	0.800	0.800
Control group mean	0.545		1.915		9.044	

Impact on Other Intermediate Outcomes

VARIABLES	(1) Child Development Scale	(2) Child Development Scale (SMD)	(3) Caregiver Satisfaction Scale	(4) Caregiver Satisfaction Scale (SMD)	(5) Caregiver Perception/ Engagement Scale	(6) Caregiver Perception/ Engagement Scale (SMD)
Treatment	0.242 (0.174)	0.084 (0.061)	0.299** (0.121)	0.284** (0.114)	0.845*** (0.239)	0.316*** (0.089)
Observations	1,688	1,688	878	878	878	878
R-squared	0.037	0.037	0.047	0.047	0.033	0.033
Control group mean	17.94		1.189		7.729	

Impact on Other Intermediate Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Ideal Age for Marriage		Child Aspired to study beyond 12th Grade		Expected Bride Price		Household Food Security		Household School-Related Expenditure	
VARIABLES	Years	SMD	Yes/No	SMD	Zambian Kwacha	SMD	Index scale	SMD	Zambian Kwacha	SMD
Treatment	-0.081	-0.019	-0.023	-0.046	-490.963	-0.105	1.129**	0.201**	-13.878**	-0.161**
	(0.249)	(0.059)	(0.038)	(0.077)	(346.806)	(0.074)	(0.479)	(0.085)	(6.160)	(0.072)
Observations	1,625	1,625	1,619	1,619	696	696	1,109	1,109	1,109	1,109
R-squared	0.042	0.042	0.026	0.026	0.033	0.033	0.048	0.048	0.026	0.026

Process Evaluation (Qualitative)

- Qualitative data collection approaches in treatment schools in each of the three districts of Katete, Petauke, and Sinda:
  - Key informant interviews (KIIs) with teachers, teacher supervisors, and Impact Network staff
  - Focus group discussions (FGDs) with parents, PTA members, and students
  - 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