

Online Appendix

Outsourcing Education: Experimental Evidence from Liberia

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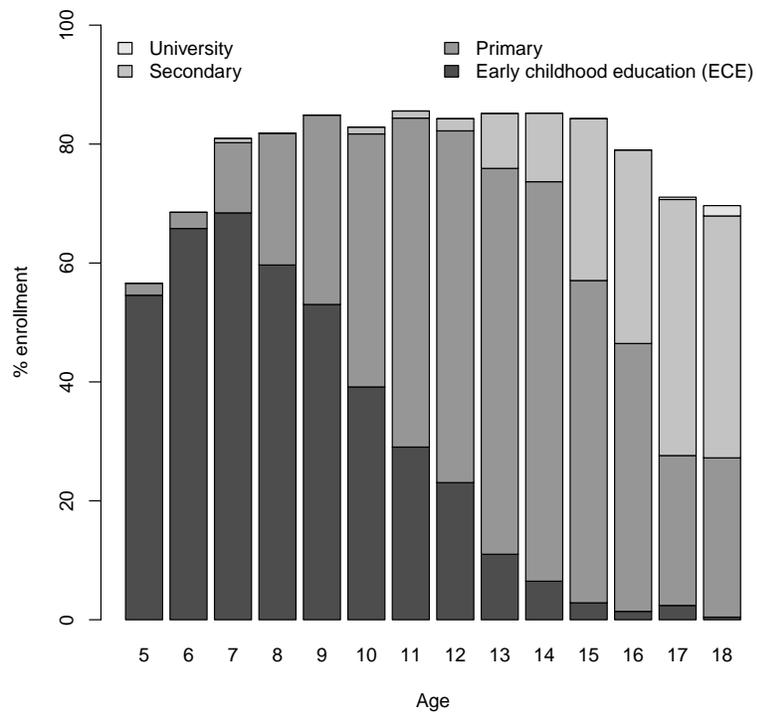
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A Online Appendix

A.1 Additional tables and figures

Figure A.1: Enrollment by age



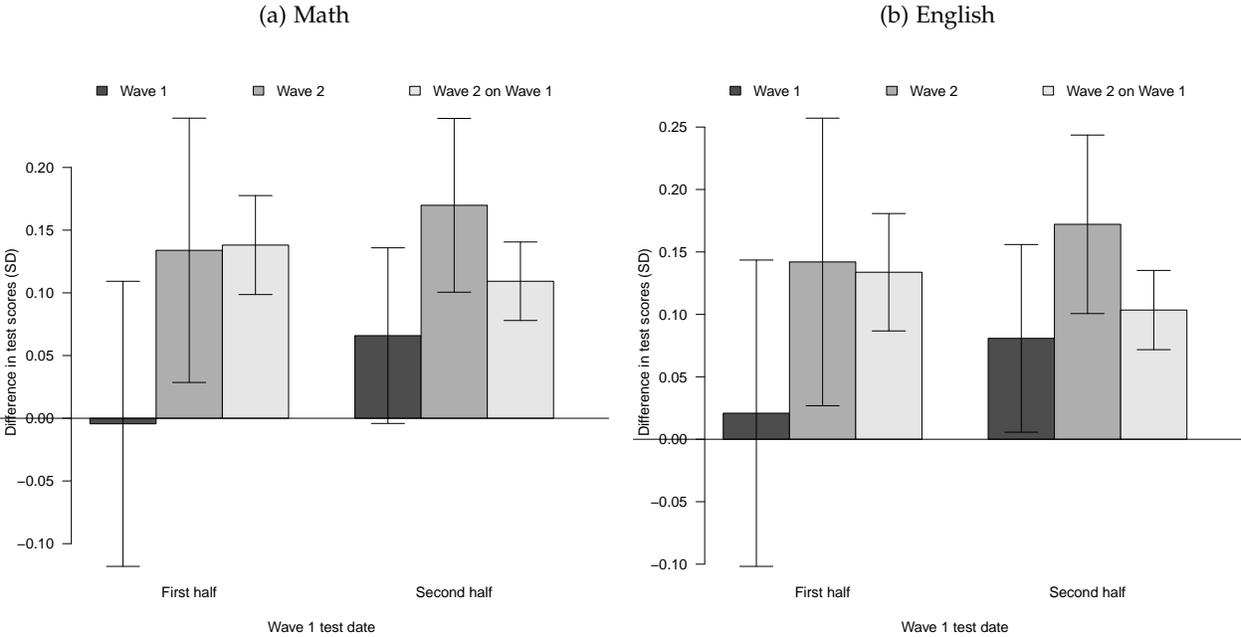
Note: This figure shows the percentage of students enrolled in early childhood education, primary schools, secondary schools, or universities by age. Authors' calculations based on 2014 Household Income and Expenditures Survey.

Figure A.2: Timeline

Research Activities	Year	Month	Intervention Activities
	2016	Jun	Operator selection
Randomization		Jul	
		Aug	
First Wave		Sep	School year begins
		Oct	
		Nov	
		Dec	
	2017	Jan	
		Feb	
		Mar	
		Apr	
Second Wave		May	
		Jun	
		Jul	School year ends

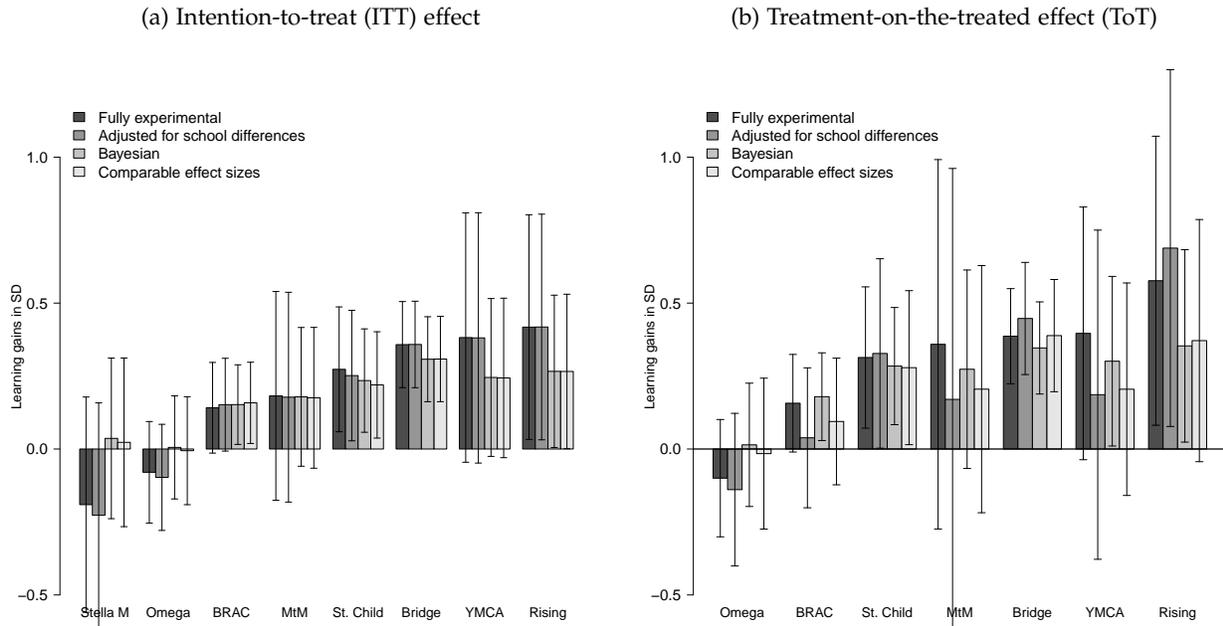
Note: This figure provides a timeline for both research (left most column) and program (right most column) activities. Bridge signed its MOU with the Government of Liberia in March 2016, and thus started preparing for the program earlier than other providers.

Figure A.3: Treatment effects by date tested during the first round of data collection



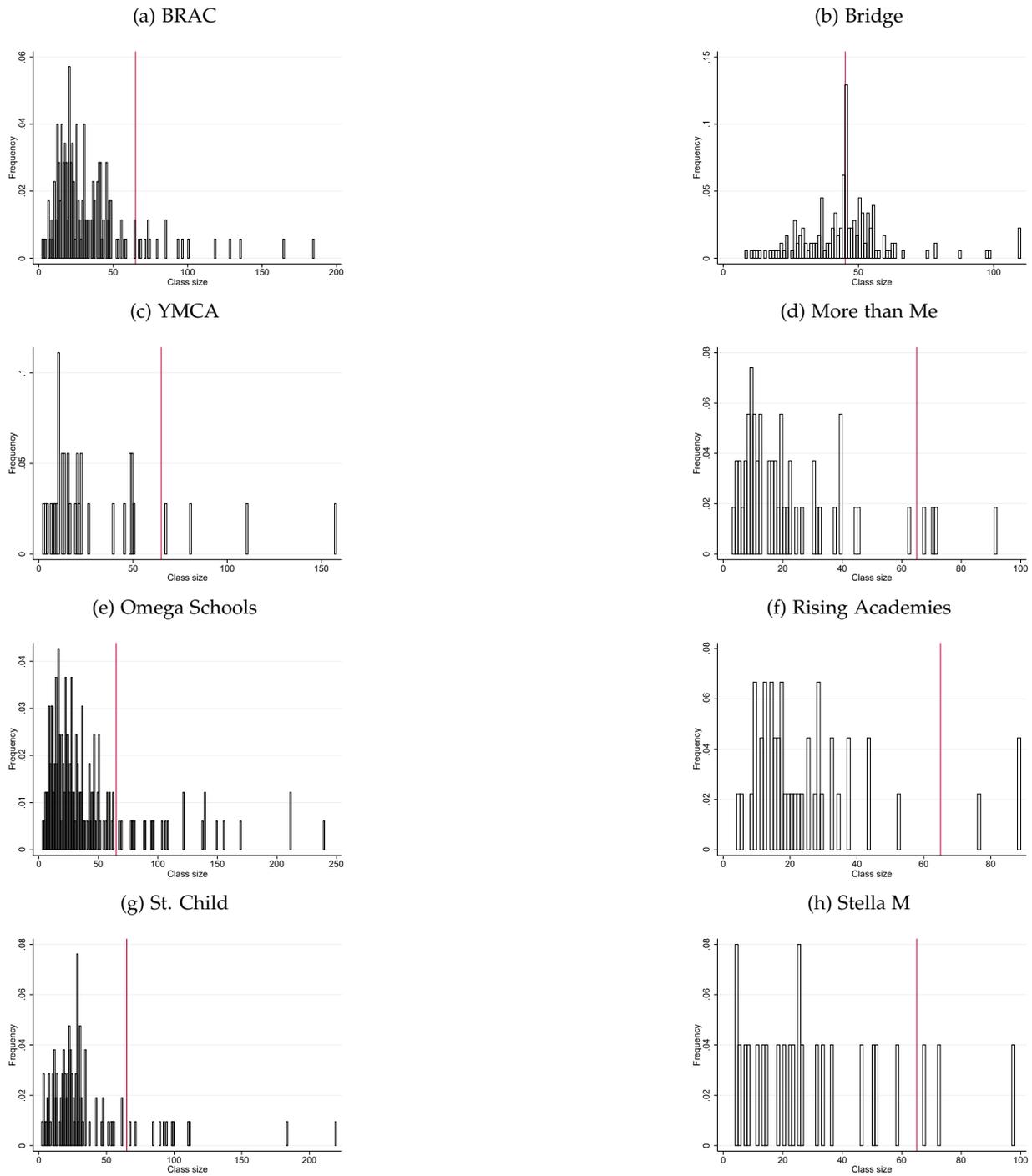
Note: These figures show the intention-to-treat treatment effects on test scores by whether during the first wave of data collection students were tested in the first or the second half of field work. Treatment effects are estimated using test scores from the first and the second wave of data collection. We also estimate the treatment effect during the second wave of data collection controlling for test scores during the first wave of data collection (Wave 2 on Wave 1). The panel on the left shows results for math test scores, while the panel on the right shows English test scores.

Figure A.4: Treatment effects by provider



Note: These figures show the raw, fully experimental treatment effects, the effects after adjusting for differences in school characteristics (before the Bayesian hierarchical model), the effects after applying a Bayesian hierarchical model (but without adjusting for school differences), and the comparable treatment effects after adjusting for differences in school characteristics and applying a Bayesian hierarchical model. Figure A.4a shows the intention-to-treat (ITT) effect, while Figure A.4b shows the treatment-on-the-treated (ToT) effect. The ToT effects are larger than the ITT effects due to providers replacing schools that did not meet the eligibility criteria, providers refusing schools, or students leaving PSL schools. Stella Maris had full non-compliance at the school level and therefore there is no ToT effect for this provider.

Figure A.5: Class sizes and class caps



Note: These figures show the distribution of class sizes in treatment schools during the 2016/2017 academic year, as well as the class cap for each provider. The cap for all providers is 65 students, except for Bridge that has a cap of 45.

Table A.1: External validity: Differences in characteristics of schools in the RCT (treatment and control) and other public schools (based on EMIS data)

	(1) RCT (Treatment and control)	(2) Other public schools	(3) Difference
Students: ECE	142.68 (73.68)	112.71 (66.46)	29.97 (5.77)
Students: Primary	151.55 (130.78)	132.38 (143.57)	19.16 (10.18)
Students	291.91 (154.45)	236.24 (170.34)	55.67 (12.15)
Classrooms per 100 students	1.17 (1.63)	0.80 (1.80)	0.37 (0.13)
Teachers per 100 students	3.04 (1.40)	3.62 (12.79)	-0.58 (0.28)
Textbooks per 100 students	99.21 (96.34)	102.33 (168.91)	-3.12 (7.88)
Chairs per 100 students	20.71 (28.32)	14.13 (51.09)	6.58 (2.38)
Food from Gov or NGO	0.36 (0.48)	0.30 (0.46)	0.06 (0.04)
Solid building	0.36 (0.48)	0.28 (0.45)	0.08 (0.04)
Water pump	0.62 (0.49)	0.45 (0.50)	0.17 (0.04)
Latrine/toilet	0.85 (0.33)	0.71 (0.45)	0.14 (0.03)
Observations	185	2,420	2,605

This table presents the mean and standard error of the mean (in parentheses) for schools in the RCT (Column 1) and other public schools (Column 2), as well as the difference in means across both groups (Column 3). The sample of RCT schools is the original treatment and control allocation. ECE = Early childhood education. MOE= Ministry of Education. Authors' calculations based on [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data. Standard errors are clustered at the school level.

Table A.2: Number of schools by provider

	(1)	(2)	(3)	(4)	(5)	(6)
	Randomly assigned	Noncompliant	Replacement	Outside sample	(1)-(2)+(3)+(4)	Managed
						% compliant in sample
BRAC	20	0	0	0	20	100%
Bridge	23	0	0	2	25	100%
YMCA	4	0	0	0	4	100%
MtM	6	2	2	0	6	67%
Omega	19	2	0	0	17	89%
Rising	5	1	0	1	5	80%
Stella	4	4	0	0	0	0%
St. Child	12	2	2	0	12	83%

The table shows the number of schools originally assigned to treatment (Column 1) and the schools that either did not meet Ministry of Education criteria or were rejected by providers (Column 2). The Ministry of Education provided replacement schools for those that did not meet the criteria, presenting each provider with a new list of paired schools and informing them, as before, that they would operate one of each pair (but not which one). Replacement schools are shown in Column 3. Column 4 contains non-randomly assigned schools given to some providers. Column 5 shows the final number of schools managed by each provider. Finally, the last column shows the percentage of schools actually managed by the provider that are in our main sample.

Table A.3: Balance table: Differences in characteristics of treatment and control schools, pre-treatment year (2015/2016, EMIS data)

	(1) Treatment	(2) Control	(3) Difference	(4) Difference (F.E)
Students: ECE	148.51 (76.83)	136.72 (70.24)	11.79 (10.91)	11.03 (9.74)
Students: Primary	159.05 (163.34)	143.96 (86.57)	15.10 (19.19)	15.68 (16.12)
Students	305.97 (178.49)	277.71 (124.98)	28.26 (22.64)	27.56 (19.46)
Classrooms per 100 students	1.21 (1.62)	1.13 (1.65)	0.09 (0.24)	0.08 (0.23)
Teachers per 100 students	3.08 (1.49)	2.99 (1.30)	0.09 (0.21)	0.09 (0.18)
Textbooks per 100 students	102.69 (97.66)	95.69 (95.40)	7.00 (14.19)	7.45 (13.74)
Chairs per 100 students	18.74 (23.06)	22.70 (32.81)	-3.96 (4.17)	-4.12 (3.82)
Food from Gov or NGO	0.36 (0.48)	0.36 (0.48)	-0.01 (0.08)	-0.01 (0.05)
Solid building	0.39 (0.49)	0.33 (0.47)	0.06 (0.07)	0.06 (0.06)
Water pump	0.56 (0.50)	0.67 (0.47)	-0.11 (0.07)	-0.12 (0.06)
Latrine/toilet	0.85 (0.35)	0.86 (0.32)	-0.01 (0.05)	-0.01 (0.05)
Observations	93	92	185	185

This table presents the mean and standard error of the mean (in parenthesis) for the control (Column 1) and treatment (Column 2), as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including “pair” fixed effects) in Column 4. Authors’ calculations based on [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data.

Table A.4: ITT and ToT effect after one year

	Wave 2			Wave 2 on Wave 1		
	Math (1)	English (2)	Abstract (3)	Math (4)	English (5)	Abstract (6)
Panel A: ITT						
Treatment	0.18 (0.034)	0.18 (0.031)	0.046 (0.038)	0.14 (0.023)	0.13 (0.021)	0.032 (0.036)
No. of obs.	3,492	3,492	3,492	3,492	3,492	3,492
Panel B: ToT						
Treatment	0.22 (0.040)	0.21 (0.037)	0.056 (0.045)	0.17 (0.027)	0.16 (0.025)	0.038 (0.043)
No. of obs.	3,492	3,492	3,492	3,492	3,492	3,492

This table presents the treatment effect on test scores at the end of the schools year. Columns 1-3 use a specification that takes into account the randomization design — i.e., includes “pair” fixed effects — and includes student and school controls. Columns 4-6 also control for test scores collected during the first wave of data collection. Panel A has the intention-to-treat (ITT) effect, while Panel B has the treatment-on-the-treated (ToT) effect. The treatment-on-the-treated effect is estimated using the assigned treatment as an instrument for whether the student is in fact enrolled in a PSL school during the 2016/2017 academic year. Standard errors are clustered at the school level.

Table A.5: Control variables

Student controls	Question	Questionnaire
Wealth index	A1-A7	Student
Age	B1	Student
Gender	B2	Student
Grade (2015/2016)	B6a	Student
School controls		
Enrollment (2015/2016)	C1	Principal
Infrastructure quality (2015/2016)	L1-L3	Principal
Travel time to nearest bank	L6	Principal
Rurality	L7	Principal
NGO programs in 2015/2016	M1-M4	Principal
Donations in 2015/2016	N1A-N3b_a_5	Principal

This table shows the control variables included in specification 2.

Table A.6: Treatment effects across various measures of difference in student ability

	ITT (1)	ToT (2)
Panel A: Base IRT model		
English	0.18 (0.03)	0.21 (0.04)
Math	0.18 (0.03)	0.22 (0.04)
Panel B: Base IRT model standardized by grade		
English	0.23 (0.04)	0.28 (0.05)
Math	0.23 (0.04)	0.27 (0.05)
Panel C: PCA		
English	0.16 (0.03)	0.19 (0.04)
Math	0.24 (0.04)	0.28 (0.05)
Panel D: PCA standardized by grade		
English	0.19 (0.04)	0.23 (0.05)
Math	0.28 (0.05)	0.33 (0.06)
Panel E: % correct answers		
English	2.96 (0.55)	3.56 (0.66)
Math	4.24 (0.71)	5.09 (0.84)
Observations	3,492	3,492

Column 1 shows the intention-to-treat treatment effect estimated with a specification that takes into account the randomization design — i.e., includes “pair” fixed effects — and includes for student and school controls. The treatment-on-the-treated effect (Column 2) is estimated using the assigned treatment as an instrument for whether the student is in fact enrolled in a PSL school during the 2016/2017 academic year. Panel A uses our default IRT model and normalizes test scores using the same mean and standard deviation across all grades. Panel B uses the same IRT model as Panel A, but normalizes test scores using a different mean and standard deviation for each grade. Panel C estimates students’ ability as the first component from a principal component analysis (PCA), and normalizes test scores using a common mean and standard deviation across all grades. Panel D uses the same model as Panel C but normalizes test scores using a different mean and standard deviation per grade. Panel E calculates the percentage of correct responses. Standard errors are clustered at the school level.

Table A.7: Treatment effect on instruction time by subject

	Hours per week			% time per week		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.70 (0.11)	0.34 (0.13)	0.34 (0.13)	0.87 (0.26)	-0.38 (1.20)	-0.38 (1.20)
Math or English	2.08 (0.13)	1.71 (0.16)		8.74 (1.10)	7.47 (1.60)	
Treatment \times Math or English		0.71 (0.26)			2.50 (2.18)	
Math			0.34 (0.075)			-0.86 (2.02)
English			3.08 (0.30)			15.8 (2.09)
Treatment \times Math			0.65 (0.17)			7.63 (2.72)
Treatment \times English			0.77 (0.47)			-2.63 (2.83)
No. of obs.	4,299	4,299	4,299	4,299	4,299	4,299

This table presents the treatment effect on instruction time by subject. The outcome is hours per week in Columns 1-3. The outcome in Columns 4-6 is fraction of time per week. The unit of observation is at the grade-subject level. All regressions take into account the randomization design (i.e., include "pair" fixed effects). Standard errors are clustered at the school level.

Table A.8: Heterogeneity by student characteristics

	Male (1)	Top wealth quartile (2)	Bottom wealth quartile (3)	Grade (4)
Treatment	0.20 (0.047)	0.18 (0.035)	0.17 (0.035)	0.16 (0.10)
Treatment \times covariate	-0.021 (0.068)	0.029 (0.066)	0.061 (0.050)	0.0050 (0.020)
No. of obs.	3,492	3,492	3,492	3,492

The outcome variable is the test scores at the end of the school year. All regressions include "pair" fixed effects and include student and school controls. Each column shows the interaction of a different covariate with treatment. Standard errors are clustered at the school level.

Table A.9: Student selection

	(1)	(2)	(3)
	Same school	Same school	Same school
Treatment	0.061 (0.082)	0.012 (0.026)	0.021 (0.019)
Treatment \times Age	-0.0042 (0.0064)		
Treatment \times Male		-0.011 (0.028)	
Treatment \times Asset Index (PCA)			-0.0059 (0.011)
No. of obs.	3,487	3,487	3,428

The outcome variable is whether the student is enrolled at the end of the 2016/2017 school year in the same schools he or she was enrolled in the 2015/2016 school year. All regressions include "pair" fixed effects. Standard errors are clustered at the school level.

Table A.10: ITT treatment effects, by whether class size caps are binding without including adjacent grades

	(1)	(2)	(3)	(4)
	Δ enrollment	% same school	% in school	Test scores
Constrained=0 \times Treatment	5.37 (1.15)	4.41 (1.43)	1.67 (0.67)	0.14 (0.036)
Constrained=1 \times Treatment	-8.92 (6.26)	-16.8 (8.01)	-0.051 (4.15)	0.41 (0.14)
No. of obs.	1,635	3,637	3,485	3,490
Mean control (Unconstrained)	-0.70	81.63	93.45	0.12
Mean control (Constrained)	-7.62	87.14	94.12	-0.07
$\alpha_0 =$ Constrained - Unconstrained	-14.29	-21.20	-1.72	0.27
p-value ($H_0 : \alpha_0 = 0$)	0.04	0.01	0.68	0.07

This table mirrors Table 5, but adjacent grades are not included in the calculation of the constrained indicator. Column 1 uses school-grade level data. Columns 2 - 4 use student level data. The independent variable in Column 4 is the composite test score. The sample is the original treatment and control allocation. There were 216 constrained classes at baseline (holding 35% of students), and 1,448 unconstrained classes at baseline (holding 65% of students). Standard errors are clustered at the school level.

Table A.11: Intensive margin effect on teacher attendance and classroom observation with Lee bounds

	(1) Treatment	(2) Control	(3) Difference	(4) Difference (F.E)	(5) 90% CI (bounds)
Panel A: Spot check (N = 929)					
% on schools campus	68.15 (46.64)	52.40 (50.00)	15.75 (4.45)	14.17 (3.75)	2.67 27.96
% in classroom	50.96 (50.04)	41.05 (49.25)	9.91 (4.78)	9.96 (3.86)	-1.21 24.26
B: Classroom observation (N = 143)					
Active instruction (% class time)	38.12 (28.93)	30.13 (32.11)	7.98 (4.86)	7.62 (4.75)	-4.75 19.92
Passive instruction (% class time)	16.24 (17.18)	12.80 (19.83)	3.44 (2.95)	4.72 (3.23)	-4.93 9.62
Classroom management (% class time)	20.82 (21.06)	10.67 (14.83)	10.16 (2.85)	10.33 (3.32)	0.77 16.99
Teacher off-task (% class time)	24.82 (32.65)	46.40 (41.09)	-21.58 (5.92)	-22.66 (6.26)	-40.24 -10.32
Student off-task (% class time)	55.06 (31.23)	57.60 (34.87)	-2.54 (5.26)	-5.19 (4.88)	-16.05 12.63
Panel C: Inputs (N = 143)					
Number of seats	20.64 (13.33)	20.58 (13.57)	0.06 (2.21)	0.58 (1.90)	-7.22 5.36
% with students sitting on the floor	2.41 (15.43)	4.23 (20.26)	-1.82 (2.94)	-1.51 (2.61)	-7.48 2.76
% with chalk	96.39 (18.78)	78.87 (41.11)	17.51 (5.29)	16.58 (5.50)	9.47 27.85
% of students with textbooks	37.08 (43.22)	17.60 (35.25)	19.48 (6.33)	22.60 (6.32)	-1.21 34.87
% of students with pens/pencils	88.55 (19.84)	79.67 (30.13)	8.88 (4.19)	8.16 (4.10)	1.36 20.98

This table presents the mean and standard error of the mean (in parenthesis) for the control (Column 1) and treatment (Column 2) groups, as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including “pair” fixed effects) in Column 4. Column 5 shows the 90% confidence interval using Lee (2009) bounds. Panel A provides results from the spot check using the Ministry of Education - Republic of Liberia (2015-2016) data on teachers as a baseline, and treating teachers who no longer teach at school as attriters. Panel B and C provide the classroom observation information without imputing values for schools not in session during our visit, and treating the missing information as attrition. Standard errors are clustered at the school level.

Table A.12: Treatment effect on schools' good practices

	(1) Treatment	(2) Control	(3) Difference	(4) Difference (F.E)
Maintains an enrollment log	0.90 (0.30)	0.80 (0.40)	0.10 (0.05)	0.10 (0.05)
Log contains student name	0.89 (0.31)	0.82 (0.39)	0.08 (0.05)	0.08 (0.05)
Log contains student grade	0.94 (0.25)	0.84 (0.37)	0.10 (0.05)	0.10 (0.05)
Log contains student age	0.65 (0.48)	0.64 (0.48)	0.00 (0.07)	0.00 (0.07)
Log contains student gender	0.89 (0.31)	0.83 (0.38)	0.07 (0.05)	0.06 (0.05)
Log contains student contact information	0.26 (0.44)	0.13 (0.34)	0.13 (0.06)	0.13 (0.06)
Enrollment log is clean and neat	0.39 (0.49)	0.26 (0.44)	0.13 (0.07)	0.13 (0.07)
Maintains official schedule	0.98 (0.15)	0.89 (0.31)	0.09 (0.04)	0.09 (0.03)
Official schedule is posted	0.84 (0.37)	0.70 (0.46)	0.14 (0.06)	0.14 (0.06)
Has a PTA	0.99 (0.10)	0.98 (0.15)	0.01 (0.02)	0.01 (0.02)
Principal has PTA head's number at hand	0.41 (0.49)	0.26 (0.44)	0.15 (0.07)	0.15 (0.06)
Maintains expenditure records	0.14 (0.35)	0.09 (0.28)	0.05 (0.05)	0.05 (0.05)
Maintains a written budget	0.26 (0.44)	0.22 (0.41)	0.04 (0.06)	0.04 (0.06)
Observations	93	92	185	185

This table presents the mean and standard error of the mean (in parentheses) for the control (Column 1) and treatment (Column 2) groups, as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including "pair" fixed effects) in Column 4. Standard errors are clustered at the school level.

Table A.13: Treatment effect on household expenditure

	(1)	(2)	(3)	(4)
	Treatment	Control	Difference	Difference (F.E)
Fees (USD/year)	5.68 (10.16)	8.06 (9.73)	-2.38 (0.97)	-2.95 (0.62)
Tutoring (USD/year)	0.34 (1.20)	0.38 (1.34)	-0.04 (0.09)	-0.04 (0.08)
Textbooks (USD/year)	0.61 (1.44)	0.86 (1.65)	-0.25 (0.13)	-0.22 (0.09)
Copy books (USD/year)	1.02 (1.96)	1.08 (1.93)	-0.06 (0.14)	-0.07 (0.13)
Pencils (USD/year)	3.23 (3.05)	2.95 (2.88)	0.28 (0.31)	0.21 (0.16)
Uniform (USD/year)	9.25 (6.31)	11.46 (5.19)	-2.20 (0.63)	-1.95 (0.43)
Food (USD/year)	43.00 (71.02)	46.33 (75.85)	-3.33 (6.90)	-1.46 (3.91)
Other (USD/year)	3.42 (4.56)	3.06 (4.28)	0.36 (0.34)	0.32 (0.27)
Observations	595	520	1,115	1,115

This table presents the mean and standard error of the mean (in parentheses) for the control (Column 1) and treatment (Column 2) groups, as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including “pair” fixed effects) in Column 4. Standard errors are clustered at the school level.

Table A.14: Treatment effect on household engagement

	(1)	(2)	(3)	(4)
	Treatment	Control	Difference	Difference (F.E)
Attended school meeting	0.76 (0.43)	0.77 (0.42)	-0.01 (0.04)	0.03 (0.02)
Made cash donation	0.12 (0.33)	0.11 (0.31)	0.02 (0.02)	-0.00 (0.02)
Made in-kind donation	0.03 (0.17)	0.04 (0.20)	-0.01 (0.01)	-0.02 (0.01)
Donated work	0.13 (0.34)	0.15 (0.35)	-0.01 (0.03)	-0.00 (0.02)
Helped with homework	0.58 (0.49)	0.61 (0.49)	-0.03 (0.04)	-0.04 (0.03)
Observations	619	543	1,162	1,162

This table presents the mean and standard error of the mean (in parenthesis) for the control (Column 1) and treatment (Column 2) groups, as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including “pair” fixed effects) in Column 4. Standard errors are clustered at the school level.

Table A.15: Baseline differences between treatment schools and average public schools, by provider

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BRAC	Bridge	MtM	Omega	Rising	St. Child	Stella M	YMCA	p-value
Students	31.94 (27.00)	156.19 (25.48)	-23.03 (49.01)	35.49 (27.69)	-0.83 (53.66)	31.09 (34.74)	-19.16 (59.97)	-22.53 (59.97)	.00092
Teachers	1.23 (0.70)	2.72 (0.66)	1.42 (1.28)	1.70 (0.72)	1.16 (1.40)	0.59 (0.90)	1.13 (1.56)	0.76 (1.56)	.66
PTR	-4.57 (3.27)	5.77 (3.09)	-8.47 (5.94)	-5.45 (3.36)	-6.02 (6.50)	2.34 (4.21)	-10.62 (7.27)	-7.29 (7.27)	.079
Latrine/Toilet	0.18 (0.08)	0.28 (0.07)	0.26 (0.14)	0.25 (0.08)	0.23 (0.16)	0.22 (0.10)	0.06 (0.17)	0.18 (0.17)	.96
Solid classrooms	0.63 (0.75)	2.81 (0.71)	2.64 (1.36)	-0.11 (0.77)	1.85 (1.49)	1.59 (0.97)	-1.95 (1.67)	1.30 (1.67)	.055
Solid building	0.28 (0.08)	0.22 (0.07)	0.19 (0.14)	0.09 (0.08)	0.26 (0.15)	0.19 (0.10)	0.23 (0.17)	0.23 (0.17)	.84
Nearest paved road (KM)	-9.25 (2.03)	-10.86 (1.91)	-7.13 (3.67)	-8.22 (2.08)	-4.47 (4.01)	-7.13 (2.60)	-4.56 (4.48)	-7.79 (4.48)	.78

This table presents the difference between public schools and the schools operated by each provider. The information for all schools is taken from the [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data, and therefore is pre-treatment information. Column 9 shows the p-value for testing $H_0 : \beta_{BRAC} = \beta_{Bridge} = \beta_{YMCA} = \beta_{MtM} = \beta_{Omega} = \beta_{Rising} = \beta_{St.Child} = \beta_{StellaM}$. Standard errors are clustered at the school level. The sample is the original treatment and control allocation. Since some providers had no schools with classes above the class caps, there is no data to estimate treatment effects over constrained classes. Standard errors are clustered at the school level.

Table A.16: Comparable ITT treatment effects by provider

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BRAC	Bridge	MtM	Omega	Rising	St. Child	Stella M	YMCA	p-value
Panel A: Student test scores									
English (standard deviations)	0.19 (0.08)	0.24 (0.08)	0.17 (0.14)	0.00 (0.12)	0.23 (0.16)	0.18 (0.11)	0.01 (0.18)	0.30 (0.18)	0.087
Math (standard deviations)	0.12 (0.09)	0.33 (0.09)	0.18 (0.15)	0.01 (0.11)	0.26 (0.16)	0.22 (0.11)	0.03 (0.17)	0.20 (0.16)	0.025
Composite (standard deviations)	0.16 (0.08)	0.31 (0.09)	0.18 (0.15)	-0.01 (0.11)	0.27 (0.16)	0.22 (0.11)	0.02 (0.18)	0.24 (0.17)	0.035
Panel B: Changes to the pool of teachers									
% teachers dismissed	-8.74 (6.37)	50.63 (7.03)	14.33 (11.05)	-5.87 (6.66)	0.78 (11.86)	-2.27 (8.89)	-7.52 (12.97)	11.81 (12.95)	<0.001
% new teachers	38.06 (11.14)	70.90 (13.09)	47.84 (18.73)	22.76 (11.88)	20.76 (19.98)	36.37 (15.15)	-8.23 (26.11)	35.94 (21.04)	0.0060
Age in years (teachers)	-5.50 (1.71)	-9.12 (2.18)	-7.80 (2.57)	-5.75 (1.73)	-8.07 (2.74)	-6.53 (2.08)	-5.99 (2.72)	-3.50 (3.51)	0.16
Test score in standard deviations (teachers)	0.12 (0.13)	0.24 (0.14)	0.23 (0.18)	0.17 (0.13)	0.17 (0.18)	0.23 (0.16)	0.17 (0.18)	0.05 (0.23)	0.46
Panel C: Enrollment and access									
Δ enrollment	31.91 (25.45)	7.80 (26.78)	12.63 (32.57)	28.93 (25.01)	16.24 (32.75)	25.38 (28.81)	15.79 (33.86)	27.52 (34.02)	0.49
Δ enrollment (constrained grades)	41.57 (44.13)	-29.66 (14.58)	41.64 (44.24)	-3.45 (36.91)	41.30 (44.03)	22.33 (46.95)	- (-)	- (-)	0.48
Student attendance (%)	18.45 (6.59)	12.77 (7.54)	20.72 (9.14)	17.55 (6.67)	19.01 (8.98)	19.36 (7.95)	16.65 (9.49)	17.44 (9.09)	0.48
% students still attending any school	-1.98 (3.38)	1.27 (3.68)	-4.78 (5.90)	-2.03 (3.64)	-3.82 (5.62)	-1.97 (4.26)	-3.21 (5.35)	-3.18 (5.60)	0.36
% students still attending same school	0.55 (1.75)	2.34 (1.91)	0.39 (2.53)	0.65 (1.87)	0.76 (2.55)	0.27 (2.22)	0.33 (2.58)	0.20 (2.72)	0.45
Panel D: Satisfaction									
% satisfied with school (parents)	11.75 (6.32)	10.97 (6.39)	3.72 (8.45)	1.72 (6.32)	2.59 (9.00)	-0.37 (8.36)	9.96 (9.36)	8.51 (9.14)	0.24
% students who think school is fun	4.08 (3.90)	2.73 (3.66)	2.49 (5.42)	3.25 (4.05)	3.47 (5.59)	2.59 (4.65)	0.01 (6.67)	4.75 (6.12)	0.59
Observations	40	45	8	12	38	10	24	8	

This table presents the ITT treatment effect for each provider, after adjusting for differences in baseline school characteristics, based on a Bayesian hierarchical model. Column 9 shows the p-value for testing $H_0 : \beta_{BRAC} = \beta_{Bridge} = \beta_{YMCA} = \beta_{MtM} = \beta_{Omega} = \beta_{Rising} = \beta_{St.Child} = \beta_{StellaM}$. Table 10 has the raw experimental treatment effects by provider. Standard errors are shown in parentheses. Estimation is conducted on collapsed, school-level data.

Table A.17: Descriptive statistics by provider and treatment

(1) Provider	(2) Treatment	(3) Schools	(5) Teachers				(8) Classes		(9) Enrollment		(11) Enrollment in constrained classes		
			(4) 2015/2016	2016/2017	(6) Dismissed	(7) New	2015/2016	2016/2017	(10) 2015/2016	2016/2017	(11) Constrained classes	(12) 2015/2016	(13) 2016/2017
BRAC	0	20	141	148	41	48	180	5,694	5,107	10	780	703	
BRAC	1	20	141	209	33	101	180	5,684	5,872	11	1,130	1,138	
Bridge	0	22	177	174	38	35	198	7,110	6,610	61	3,969	3,648	
Bridge	1	23	236	212	174	150	207	9,788	8,282	72	6,909	3,475	
YMCA	0	4	20	22	1	3	36	729	727	2	142	120	
YMCA	1	4	27	40	6	19	36	908	1,068	2	217	238	
MtM	0	6	52	41	21	10	54	1,140	1,312	2	155	167	
MtM	1	6	46	64	20	38	54	1,145	1,223	2	171	159	
Omega	0	19	132	130	33	31	171	4,895	5,200	12	1,255	1,232	
Omega	1	19	151	196	26	71	171	5,764	6,841	19	1,953	2,446	
Rising	0	5	47	43	23	19	45	1,209	1,308	2	202	185	
Rising	1	5	36	47	11	22	45	918	1,134	1	87	89	
St. Child	0	12	88	68	29	9	108	3,094	2,794	7	738	557	
St. Child	1	12	81	100	22	41	108	3,351	3,506	9	877	797	
Stella M	0	4	20	20	8	8	36	765	683	1	73	45	
Stella M	1	4	31	27	9	5	36	958	978	3	213	192	

This table shows the total number of teachers and students in treatment (=1 in Column 2) and control (=0 in Column 2) schools for each operator. Teachers in 2015/2016 are taken from the [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data, while teachers in 2016/2017 are taken from our first-year follow-up data. “Dismissed” refers to the number of teachers in the [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data who are not working at the school at the end of the 2016/2017 academic year. “New” is the number of teachers working at the school at the end of the 2016/2017 academic year who are not in the [Ministry of Education - Republic of Liberia \(2015-2016\)](#) data. “Constrained classes” are those with more students in 2015/2016 than the class size cap.

Table A.18: Simulated treatment effects without some providers

	(1) Raw	(2) Comparable
All operators	.18 (.032)	.18 (.044)
Without Stella M and Omega	.27 (.035)	.23 (.046)
Without Bridge	.12 (.037)	.16 (.045)
Without Stella M, Omega, and Bridge	.21 (.042)	.2 (.054)
Without Stella M, Omega, Bridge, MtM, and YMCA	.21 (.047)	.19 (.063)

This table presents the average treatment effect of the program by taking an inverse-variance weighted average across providers. Column 1 presents the overall treatment effect from the raw treatment estimates. Column 2 presents the overall treatment effect from the comparable treatment effects after adjusting for differences in school characteristics and applying a Bayesian hierarchical model. The additional uncertainty for the comparable treatment effects (i.e., larger standard errors) comes from assuming a non-informative prior for the standard deviation of true effects.

A.2 Tracking and attrition

A potential issue with our sampling strategy is differential attrition at each round of data collection. In the first round, enumerators were instructed to sample 20 students from the 2015/2016 enrollment logs, track them, and test them. However, if a student had moved to another village, had died, or was impossible to track, the enumerators were instructed to sample another student. Thus, even at the first round an endogenous sampling problem arises if treatment makes students easier or harder to track in combination with enumerator shrinkage. To mitigate this issue, enumerators participated in additional training on tracking and its importance and were provided with a generous amount of tracking time. Students were tracked to their homes and tested there when not available at school. As Table A.19 shows, we have no reason to believe that this issue arose. The effort required to track students was different between treatment and control (it is easier to track students at the school), yet the total number of students sampled, to obtain a sample of 20 students, is balanced between treatment and control (see Table A.19).

Table A.19: Tracking and sampling in the first wave of data collection

	(1) Treatment	(2) Control	(3) Difference	(4) Difference (F.E)
Number of students sampled	24.8 (5.74)	24.6 (5.10)	0.13 (0.81)	0.035 (0.81)
Found at the school	18.2 (2.30)	16.7 (4.70)	1.49 (0.55)	1.555 (0.54)
Found at home	1.73 (2.12)	2.91 (3.97)	-1.18 (0.48)	-1.223 (0.47)
Interviewed	19.9 (0.89)	19.6 (2.23)	0.32 (0.25)	0.344 (0.27)
Observations	88	90	178	171

This table presents the mean and standard error of the mean (in parentheses) for the control (Column 1) and treatment (Column 2) groups, as well as the difference between treatment and control (Column 3), and the difference taking into account the randomization design (i.e., including “pair” fixed effects) in Column 4. The table shows the average number of students we sampled (and tried to track), the number of students we were able to track at the assigned school or at home, and the total number of students we tracked and found during the first round of data collection. Standard errors are clustered at the school level.

A.3 Test design

Most modules follow the Early Grade Reading Assessment (EGRA), Early Grade Mathematics Assessment (EGMA), Uwezo, and Trends in International Mathematics and Science Study (TIMSS) assessments. For the first wave of data collection the test contained a module for each of the following skills: object identification (like the Peabody Picture Vocabulary Test), letter reading (adapted from EGRA), word reading (adapted from EGRA), a preposition module, reading comprehension (adapted from Uwezo), listening comprehension (adapted from EGRA), counting (adapted from Uwezo), number discrimination (adapted from Uwezo), number identification (adapted from EGMA), addition (adapted from Uwezo and EGMA), subtraction (adapted from Uwezo and EGMA), multiplication (adapted from Uwezo and EGMA), division (adapted from Uwezo and EGMA), shape identification, fractions, and word problems in mathematics.

For the second round of data collection the test did not include the following modules: Prepositions, shape identification, and fractions. These modules were excluded given the low variation in responses in the first wave of data collection and to make space for new modules. Instead, new modules were introduced, including letter, word and number dictation, and a verb and a pronoun module. Additionally, we included some “conceptual” questions from TIMSS released items (items M031317 and M031316) that do not resemble the format of standard textbook exercises but rather test knowledge in an unfamiliar way. The number identification module remained exactly the same across rounds of data collection (to

provide us with absolute learning curves on these two items), while every other module was different. In addition, the word and number identification modules were identical to the EGRA/EGMA assessments used in Liberia previously (for comparability with other impact evaluations taking place in Liberia, most notably USAID’s reading program (Piper & Korda, 2011) and the LTTP program (King et al., 2015)), but during the first round of data collection they were different. Two of the reading comprehension questions were taken from the Pre-Pirls released items (L11L01C and L11L02M) and one of the word problems was taken from TIMSS released items (M031183). Finally, we added a Raven’s style module to measure the students’ abstract thinking abilities.

A.4 Cost-benefit analysis

To compute the net benefit of the PSL program, we must place a financial value on test score gains.²⁸ To map test score gains onto existing estimates of the Mincerian returns to schooling, we translate them into “equivalent years of schooling” (EYOS) following Evans and Yuan (2017). This calculation assumes the value of schooling is captured by test score gains. In the control group, an extra year of schooling is associated with average test score gains of $.3\sigma$ across subjects. Thus, the ToT treatment effect of $.22\sigma$ on test scores is roughly 0.74 EYOS.

We estimate whether the lifetime benefits accruing to students outweigh the costs of the program by estimating the net present value (NPV) of the investment. We make four key assumptions: 1) every extra year of schooling increases income by 8.6% (Millennium Challenge Corporation, 2013); 2) the discount rate is 10%;²⁹ 3) pupils’ counterfactual adult earnings are equal to Liberia’s GDP per capita of USD 694.3 in 2017 (World Bank, 2017); and 4) students work for 40 years (starting in ten years time). The NPV of investing USD 50 in the PSL program is positive, at ~USD 110; if we take into account the cost of additional teachers, the NPV is ~USD 90. NPV becomes negative when the investment is above ~USD 160, which is the case for some providers in the short run.

How sensitive are these estimates to our assumptions? A lower discount rate of, say, 4%³⁰ would raise the minimum threshold cost to achieve positive NPV to USD 570 (still below the expenditure for some providers in the short run).

²⁸We ignore non-pecuniary returns to education.

²⁹This is the discount rate used by the World Bank to estimate Net ODA (World Bank, 2013).

³⁰For reference, the deposit interest rate was 3.8 in 2016 (World Bank, 2016) and the latest auction of treasury bills from the Central Bank resulted in an average discount rate of 3.69% (see <https://www.cbl.org.lr/2content.php?sub=191&related=33&third=191&pg=sp&pt=Treasury%20Bills>)

A.5 Provider's details

Table A.20: Provider's characteristics

Provider	For-profit	Local	Website	Mission/vision/values
BRAC	No	No	www.bracinternational.nl	Our Vision: A world free from all forms of exploitation and discrimination where everyone has the opportunity to realise their potential. Our Mission: Our mission is to empower people and communities in situations of poverty, illiteracy, disease and social injustice. Our interventions aim to achieve large scale, positive changes through economic and social programmes that enable men and women to realise their potential. Our Values: Integrity. Innovation. Inclusiveness. Effectiveness.
Bridge	Yes	No	www.bridgeinternationalacademies.com	At Bridge, our mission is to provide millions of children with a life-changing education. We are committed to helping achieve United Nations Sustainable Development Goal 4: to ensure inclusive and quality education for all and promote lifelong learning. We believe every child has the right to education. To realise this, we work in partnership with governments, communities, teachers, and parents to deliver great schools and high-quality education for primary and pre-primary pupils. By providing a life-changing education to children in underserved communities, we help put children, their families, and their countries on a better development path. Education is one of the most effective ways to end the cycle of poverty; enabling growth, peace, and prosperity. It reduces conflict, enhances stability, and strengthens nations.
MtM	No	No	www.morethanme.org	It All Started with a Girl: At 11 years old, she was selling herself for clean drinking water, when all she really wanted was to go to school. More Than Me was founded to meet her needs. We opened a school, the MTM Academy, for 150 girls and saw major progress. Then Ebola hit. The world didn't act quickly enough, and we knew we had to fight to save her life. After spending six months on the front lines fighting Ebola and seeing three students lose their families (and many other children lose their own lives), we realized that our girls would never be safe, never truly thrive, until Liberia thrives. The first step to rebuilding Liberia is education for all. Our Mission: More Than Me uses education as a catalyst for transformative social change for every girl in Liberia. Our Vision: Every girl empowered.

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Table A.20 – continued from previous page

Provider	For-profit	Local	Website	Mission/vision/values
Omega	Yes	No	www.omega-schools.com	The enterprising poor, in huge numbers, are voting with their feet. They are sacrificing their meager earnings to put their wards into low-cost private schools. Omega Schools has responded with an innovative Pay-As-You-Learn model — a chain of low cost private schools with specialized curriculum, assessment, technology and management modules that are benefiting the poor and empowering aspirations of low income families and their communities. Founded by Ken & Lisa Donkoh, and James Tooley in 2008, and backed by Pearson’s Affordable Learning Fund, Omega Schools is a social enterprise on a mission to deliver quality education at the lowest cost on a grand scale. The model has proven to be extremely attractive to parents, enabling its schools to be full within 10 days of opening. Currently the chain has 38 schools educating over 20,000 students and seeking to double that number in a year.
Rising	Yes	No	www.risingacademies.com	Our mission is to create schools that open doors and change lives. We expect every student to leave Rising ready for further study, for a good job, and to become a role model in society. Founded in Sierra Leone in 2014, we provided emergency education to children kept out of school by the Ebola Epidemic before opening our first school in April 2015. Today, we run 29 government schools in rural Liberia under the LEAP (formerly the Partnership Schools for Liberia) initiative, and 10 schools in Sierra Leone serving families looking for a high quality education at an affordable cost.
St. Child	No	No	www.street-child.co.uk	Every child deserves the chance to go to school and learn. Who We Are: 121 million school-aged children are currently out of education world-wide. Millions more children are in school but failing to learn. Street Child believes that achieving universal basic education is the single greatest step that can be taken towards the elimination of global poverty. Where We Work: Street Child prides itself on being willing to go to the world’s toughest places where others won’t, including remote, hard-to-reach areas and fragile, disaster-affected states. What We Do: We recognise that the barriers to education are complex and interlinked, and our projects focus on a combination of education, child protection and livelihood support to address the social, economic and structural issues that underpin today’s education crisis. Wherever we work we partner with local organisations and communities and take an outcome-led approach. We use evidence to drive learning and the constant refinement and scale-up of programmes that create maximum impact for the most children at the lowest cost.

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Table A.20 – continued from previous page

Provider	For-profit	Local	Website	Mission/vision/values
Stella M	No	Yes	www.smp.edu.lr/index.html	<p>The Stella Maris Polytechnic is an Institution of higher learning own and operated by the Catholic Archdioces of Monrovia. With main campus situated on Capitol Hill in Monrovia the Polytechnic boasts of four colleges with over 2,500 enrollment. The almost 570 graduates of the 13th commencement convocation exercises in 2012 was the largest number of graduates ever produced by the polytechnic since its establishment. Moreover, it was delightful to see that there were a number of honored students as compared to previous classes. Stella Maris Polytechnic formerly Don Bosco Polytechnic received its Charter from the National Legislature on August 15, 1988. With the change of name to Stella Maris Polytechnic a Bill to amend the charter was presented to the National Transitional Legislative Assembly and was approved on November 18, 2005. Stella Maris Polytechnic is recognized by the Ministry of Education, Republic of Liberia, the Commission on Higher Education in the Republic of Liberia as a founding member of the Association of Liberian Universities (ALU) it accepts the credits, (within guidelines: please see Transfer students) from Cuttington University, United Methodist University, African Methodist Episcopal University, African Methodist Episcopal Zion University, and the University of Liberia. Due to the over-crowdedness of the undergraduate school, the University of Liberia presently accepts only students from Stella Maris Polytechnic for the graduate school. Internationally, Stella Maris Polytechnic (Mother Patern College of Health Sciences) partners with AGEH/Cologne Germany, Kyper College, Calvin College, Columbia University, USA and the Phillipan Women Universities System, Manila, and has been recognized by the Wolrd Education Service (WES) based in the United States of America. The Nursing Program is accredited by Liberia Board of Nursing and Mid-wifery Stella Maris Polytechnic (Bishop John Collins Teacher College partners with Ministry of Education in the production of textbooks and in the training of teachers.</p>

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Table A.20 – continued from previous page

Provider	For-profit	Local	Website	Mission/vision/values
YMCA	No	Yes	www.umovementliberia.org	<p>Founded in 2011, Youth Movement for Collective Action is a registered non-governmental, non-political and non-for-profit organization, which strongly believed that a good education is the key to breaking the cycle of poverty and can create a better future for children and their families. That is why we promote girl’s education by facilitating sponsorship for students who otherwise would not have a chance to attend. Our programs complement the effort of the Ministry of Education and the Sustainable Development Goals (SDGs) — 3: Good health and well-being for people 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all and 5: Achieve gender equality and empower all women and girls with equal access to education, health care, decent work, and representation in political and economic decision-making processes which fuel sustainable economies and benefit societies and humanity at large. The Core Programs of UMOVEMENT are Education, Health Promotion and Disease Prevention, Democracy and Livelihoods. Mission: Our mission is to increase positive change among children and young people through standardized and sustainable youth hands-on programs/projects for social change. Goal: Our goal is to ensure that children and youth ‘empowered’ as agents of change to secure a better future for themselves and their communities. Program Objectives: To advocate for children and women rights to be prompted, protected and respected by all persons. To improve the living standard of community youth through basic livelihoods activities in order to be self-employed and autonomy for a better living environment. To facilitate access to Sexual Reproductive Health (SRH) services, including sanitation and hygiene services for children and youth at the local community levels. To promote vocational training and credit mechanisms for entrepreneurship and employment for adolescents. To undertake community project for the creation of a healthy and safe community. To advance health, education and development for children and youth through sports and play activities. To increase the capacity of children and youth to prevent, reduce and cope with conflict and promote peace. To organize democratic initiatives (civic education, voter education, etc.) to enhance peace promotion across Liberia. To provide psychosocial support for less fortunate children and widows To foster peace and unity among young people and organize academic excellence programs among young people in various communities. Vision: Youth Movement for Collective Action envisages advance health, education and development for children and youth through collective action -Community engagement.</p>

Note: Providers Mission/vision/values were taken from their website on Jan 28th, 2019.

Youth Movement for Collective Action began the evaluation as “Liberian Youth Network”. The group has since changed its name.