

PROGRAM EVALUATION

Internal EOG Analysis, May 2020

Heart Math Tutoring’s mission is to ensure all elementary students develop the strong foundation in math and enthusiasm for academics needed for long-term success, by helping schools use volunteers as tutors. As a matter of strategy, the program prioritizes students who cannot afford private tutoring (economically disadvantaged students, or EDS) and requests that school administration and teachers identify for the program EDS in grades 1-5 who are performing 1-3 years below their grade level in math.

One indicator of progress towards Heart’s mission would be closing the gap between achievement of Heart and non-Heart students by accelerating growth of Heart students. Statistically, this is represented by insignificant differences between Heart and non-Heart students. Further work will determine whether insignificant differences could result from insufficient sample size. Statistical significance or changes in significance indicate that these outcomes likely did not happen by chance but rather, due to specific, outside causes.

We know the following about the initial gap between Heart and non-Heart students:

- We asked teachers to nominate students who are 1-3 years below grade level, and we described the program to schools as Tier II intervention.
- Heart 1st graders begin with lower NWEA MAP scores than non-Heart students during fall of 1st grade, before participation in the program. See Table X to the right. On average, Heart students began 5.5 points behind their non-Heart peers which is a significant difference at $p < 0.01$.
- The EOG scores of Heart 4th and 5th graders in the year prior to Heart’s program are ~0.5 standard deviations below non-Heart students at their schools, which is understood to be around ~2 years of schooling behind (<https://www.issuelab.org/resources/888/888.pdf>).
- Note that Heart students could be more than 2 years below grade level proficiency if the average score at their school is below proficient. On average, Heart students are 4.97 points below grade-specific proficiency prior to program participation, but it varies by school (Figure 3, Excel).

Table X. Difference in MAP scores by Heart status, 1st grade fall scores (pre-Heart)

	(1) Average	(2) 2014	(3) 2015	(4) 2016	(5) 2017	(6) 2018	(7) 2019
Heart	-5.54*** (0.74)	-1.72 (3.37)	-5.03** (1.97)	-7.59** (2.97)	-2.20 (2.09)	-5.45*** (1.33)	-7.50*** (1.33)
2015	3.85*** (1.26)						
2016	5.12*** (1.42)						
2017	2.85** (1.27)						
2018	5.34*** (1.30)						
2019	4.63*** (1.29)						
Constant	152.42*** (1.15)	149.91*** (0.90)	153.46*** (0.69)	154.44*** (0.94)	154.58*** (0.51)	159.57*** (0.46)	157.64*** (0.37)
Observations	5,063	239	445	286	926	1,295	1,872
R-squared	0.01	0.00	0.02	0.02	0.00	0.01	0.02
# Schools	27	2	4	4	12	17	21

Note: all models feature school fixed effects. Model 1 features school and year fixed effects. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The following slides reflect Heart Tutoring’s internal analysis of 30,965 observations collected over six years, using fixed effects regression models by school, year, and grade, or by school-grade-year combinations to determine the program’s impact on closing the gap.

HEART MASTERY AND LATER YEAR COMPARISONS

Appendix Table 6: The table below displays the difference between the EOG scores of students who have participated in Heart in any year prior to but not including the grade listed in the column header and students who have never participated in Heart. Heart students are broken into two groups: those who achieved mastery on less than or at least 60% of the concepts tested on Heart’s post-assessments (grade-level targets or GLTs) and those who achieved mastery of at least 60% of the GLTs.

Third graders who had enrolled in Heart for two prior years (during both 1st and 2nd grade) had EOG scores not significantly different from those of their peers – regardless of their performance within Heart. For other grade levels, students achieving at least 60% mastery of GLTs had EOG scores that were not significantly different than non-Heart students in the year(s) following the program, despite having started lower. However, if students do not master 60% of the GLTs while in Heart, their EOG scores remain significantly lower than non-Heart students in the year(s) following the program. Also, repeating Heart may be most helpful for lower elementary students.

Appendix Table 6. Association between EOG scores and pre-grade Heart years, below or at least 60% post-test mastery

	Grade 3			Grade 4			Grade 5		
	(1) Average	(2) Below 60%	(3) At least 60%	(4) Average	(5) Below 60%	(6) At least 60%	(7) Average	(8) Below 60%	(9) At least 60%
1 Heart year	-1.81** (0.83)	-3.98*** (0.99)	2.87* (1.49)	-1.27* (0.72)	-3.16** (1.53)	-0.69 (0.83)	-1.96** (0.89)	-4.06*** (1.41)	-0.69 (1.15)
2+ Heart years	-0.39 (1.67)	-0.43 (2.01)	0.63 (3.04)	-2.15** (0.95)	-3.48*** (1.16)	1.71 (1.86)	-3.66*** (1.27)	-3.63** (1.42)	-3.50 (3.32)
Constant	447.95*** (0.58)	447.97*** (0.58)	447.95*** (0.58)	448.12*** (0.61)	448.17*** (0.62)	448.21*** (0.62)	447.35*** (0.60)	447.41*** (0.60)	447.51*** (0.60)
Observations	7,289	7,220	7,125	7,556	7,332	7,387	7,491	7,354	7,347
R-squared	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Number of Schools	60	55	41	75	64	64	73	56	60

Notes: raw EOG score used as outcome. All models include school and year fixed effects. Includes Heart students with previous Heart years but not in Heart during the grade displayed in the column header. Models in second and third column (by grade) compare students with post-test mastery below or atleast 60% to non-Heart students. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Note - We do not yet know the threshold of GLT mastery that would result Heart students scoring significantly higher on EOGs than non-Heart students in year(s) following the program. This data also does not isolate a single cohort through multiple years to measure a fade effect.

HEART GROWTH AND EOG GROWTH

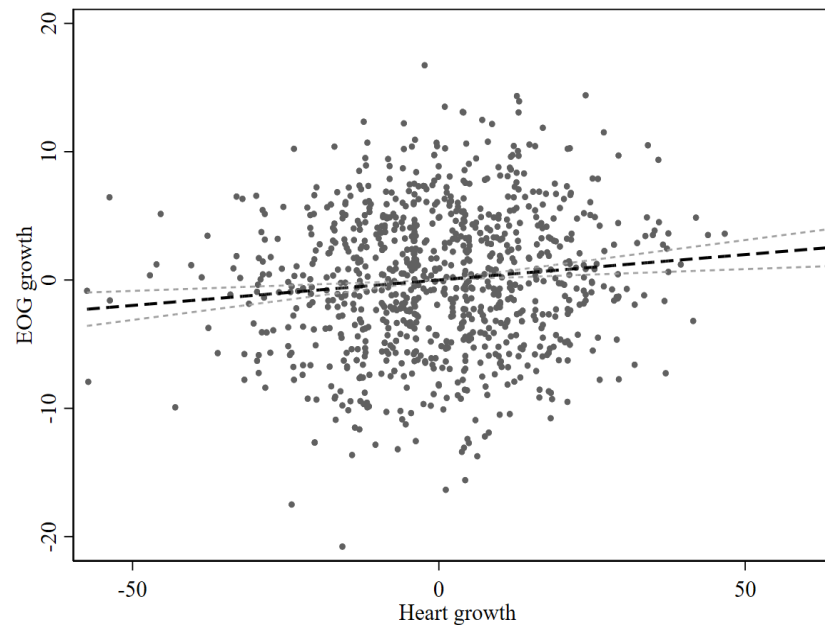
Growth on Heart pre/post assessments (“Heart growth”) is significantly associated with EOG growth.

Heart growth is defined as the difference between proportion of GLTs mastered on Heart’s post-assessment and pre-assessment tests.

On average, a 1-point increase in Heart growth is associated with a .04-point increase in EOG growth, controlling for student grade, school, and year. Alternatively, 25 points of Heart growth is associated with 1 point of EOG growth. The strength of this association has increased over time, likely due to increased sample size.

The scatterplot below visualizes the above association. The dashed line represents the linear association between Heart growth and EOG growth. It rises continually from left to right.

Figure 4. Association between Heart growth and EOG Growth



Notes: Figure represents association between EOG growth and Heart growth, controlling for school, grade, and year. Coefficient = .04, $p < .05$. Dashed gray line represents 95% confidence interval [.01, .06].

Appendix Table 5: Students who grew 25-75 points between pre/post Heart assessments achieved significantly higher growth on EOGs compared to students who grew 0-25 points on Heart assessments. Growing 50-75 points was associated with higher EOG growth than growing 25-50 points. In other words, higher Heart growth predicts higher EOG growth, as shown on the previous slide. Sample size across the years limits findings for students growing 75-100 points on Heart pre/post assessments.

Appendix Table 5. Average difference in EOG growth by 25-point Heart growth groupings

	(1) All years	(2) 2015	(3) 2016	(4) 2017	(5) 2018	(6) 2019
25-50	1.05** (0.42)	-1.23 (1.53)	0.52 (1.26)	1.22 (0.98)	1.62* (0.84)	1.40** (0.67)
50-75	2.23*** (0.76)	3.41 (2.96)	1.50 (2.49)	4.06** (1.97)	1.55 (1.60)	2.18* (1.13)
75-100	5.38 (4.04)			4.66 (5.66)	8.74 (6.04)	
Constant	7.84*** (1.58)	0.58 (1.52)	2.65 (3.50)	4.59 (2.98)	9.40*** (3.42)	102.08*** (1.95)
Observations	880	53	94	155	238	340
R-squared	0.97	0.14	0.06	0.06	0.06	0.06
Number of Schools	27	4	7	10	17	20

Notes: Models 1 includes school, grade, and year fixed effects. Models 2-6 include grade fixed effects. Models do not include students with negative Heart growth scores (n=123). Constant represents the average EOG score of students with Heart growth 0-25. Groups include lower bound (i.e., greater than or equal to 25 but less than 50). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

As noted, this model does not include students with negative Heart growth. The following slide includes students with negative Heart growth in the quartile groupings and a similar association with EOG growth is present.

HEART GROWTH AND EOG GROWTH (CONTINUED)

Appendix Table 4: Heart students who achieved growth in the 2nd, 3rd and 4th quartile achieved significantly higher growth on EOG scores than their peers who scored in the 1st quartile. The table to the right shows the sample average growth for each quartile. Because the distribution of Heart growth varies by year, it is reasonable to use historical maximums as cut scores that help predict student EOG growth. For example, a Heart student who achieves a growth score of 34 points will make at least 1.1 point more growth than a Heart student with 0 Heart growth. This association appears to strengthen in later years, but it may be based on sample size.

Appendix Table 4. EOG growth by Heart growth quartile

	(1) All years	(2) 2015	(3) 2016	(4) 2017	(5) 2018	(6) 2019
2nd quartile	1.10** (0.47)	1.24 (1.90)	0.13 (1.61)	-0.70 (1.12)	2.18** (0.89)	1.35* (0.72)
3rd quartile	1.38*** (0.51)	0.51 (1.77)	0.35 (1.46)	0.70 (1.22)	2.29** (1.03)	1.63* (0.83)
4th quartile	2.15*** (0.69)	0.35 (2.44)	0.46 (1.68)	3.46* (1.96)	2.90* (1.52)	2.22** (1.13)
Constant	6.92*** (1.57)	-0.12 (1.78)	2.75 (3.61)	5.14* (2.99)	8.13** (3.40)	101.87*** (1.97)
Observations	925	59	105	160	259	342
R-squared	0.97	0.08	0.05	0.06	0.07	0.07
Number of Schools	27	4	7	10	17	20

Notes: Model 1 includes school, grade, and year fixed effects. Models 2-6 include grade fixed effects. Quartiles created within years. Constant represents the average EOG score of a Heart student whose Heart growth is in the first quartile. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 4b. Minimum, maximum, and mean Heart growth by quartile

	Quartile 1			Quartile 2			Quartile 3			Quartile 4		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2014	0	11	3	22	34	25	40	60	48	37	100	82
2015	-42	8	-7	9	22	17	23	40	34	41	100	58
2016	-34	11	11	12	22	20	23	40	32	41	100	56
2017	-42	11	5	12	25	21	33	42	35	44	100	57
2018	-34	11	2	12	25	21	33	42	37	45	100	61
2019	-25	20	10	22	33	27	34	45	40	50	100	65
Sample average	-42	20	4	9	34	23	23	60	37	41	100	60

Notes: Quartiles defined by year.