

# 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 the outcomes of Heart and non-Heart students. Further work will determine whether insignificant differences could result from insufficient sample size. Statistical 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 1<sup>st</sup> graders begin with lower NWEA MAP scores than non-Heart students during fall of 1<sup>st</sup> grade, before participation in the program. See Table 1 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 4<sup>th</sup> and 5<sup>th</sup> 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 (<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 1, see Excel).

**Table 1. 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

Table 2: The table below displays the difference between the EOG scores of students who 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. Below, Heart students are broken into two groups: those who achieved mastery on less than 60% of the concepts tested on Heart’s post-assessments (grade-level targets or GLTs) and those who achieved mastery on at least 60% of the GLTs.

Third graders who had enrolled in Heart for two prior years (during both 1<sup>st</sup> and 2<sup>nd</sup> 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, as confirmed by first grade MAP data. However, Heart students who mastered less than 60% of the GLTs while in Heart had significantly lower scores than their non-Heart peers in the year(s) following the program. Also, repeating Heart may be most helpful for lower elementary students.

**Table 2. Difference in achievement by number of Heart years and 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 at least 60% to non-Heart students. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# HEART GROWTH AND EOG GROWTH

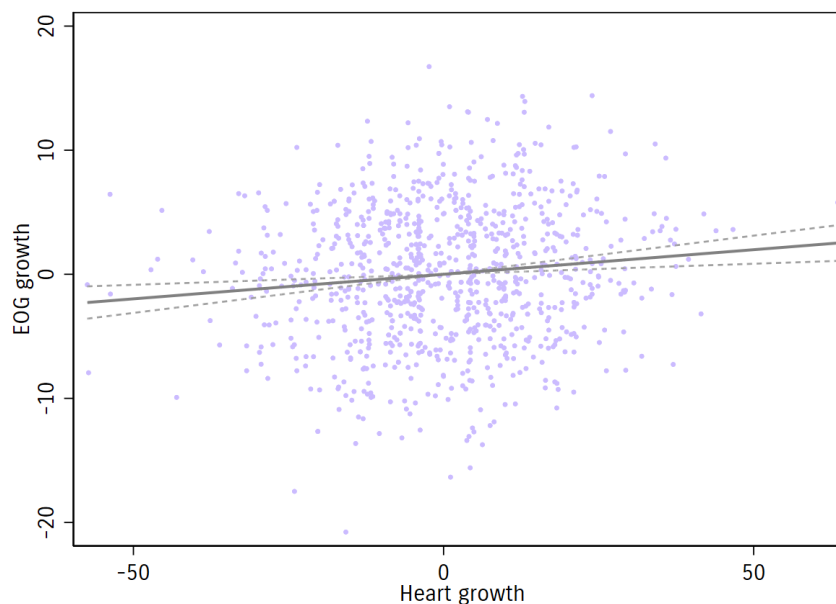
Growth on Heart pre/post assessments (“Heart growth”) is positively and significantly associated with EOG growth.

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 2. 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].

Table 3: On average, 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.

As noted below, 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.

**Table 3. 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

# HEART GROWTH AND EOG GROWTH (CONTINUED)

Table 4.1: Heart students who achieved growth in the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> quartile achieved significantly higher growth on EOG scores than their peers who scored in the 1<sup>st</sup> quartile. Table 4.2 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 is expected to make about 1.1 points 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.

**Table 4.1. 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

**Table 4.2. 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.