"I PROGRAM MY OWN VIDEOGAMES":

A snapshot of Bootstrap's student and teacher outcomes

January 2016

Bootstrap
+ computing creatively
thriving mathematically

McClanahan Associates, Inc.
Evaluation for Progress

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BACKGROUND

Today, too few students in the United States are prepared for or pursuing careers in science, technology, engineering and math (STEM) fields, despite growing demand for these skills in the labor market. As a country, we have recognized this challenge, and the past decade has seen an increasing focus on preparing students for careers in these areas. One such program that is geared to doing just that is Bootstrap.

Bootstrap is a curricular module that teaches algebraic and geometric concepts through computer programming, integrating math and computing education to enable access to and success in both subjects for all students in grades 6 to 12. Since 2006, Bootstrap's training, curricula, pedagogy, and software have been designed with teachers in mind—reflecting a core belief in the value of human teachers. Bootstrap trains teachers to implement its curricula in math and computer science classes, as well as in out-of-school programs,[1] offering in-person teacher training and comprehensive lesson plans and student activities on its website. As a growing data-driven program, Bootstrap set out to better understand the strengths and weaknesses of its model and implementation to determine if the program was achieving its goals, and to illuminate where the program should be tweaked to better meet teachers' and students' needs. McClanahan Associates (MAI), in partnership with Bootstrap, conducted an eighteen-month evaluation of the Bootstrap program to achieve these goals. Data for the evaluation was gathered systematically from both teachers and students in the form of a teacher survey and student algebra assessment. Over 300 teachers attempted to complete the Bootstrap survey at some point during the evaluation, and ninety-six were eligible for inclusion in the study and completed the survey, and 378 students who participated in the Bootstrap program provided algebra assessment data (representing twelve different Bootstrap teachers).[2]

FINDINGS SUMMARY: Overall, the study found that teachers in varying settings (including those in middle and high schools and private, magnet, selective enrollment and public schools alike) and with different backgrounds (including those whose primary teaching assignment is math or computer science) are successfully implementing Bootstrap, and that students who participate are achieving meaningful gains in targeted algebra skills.

The remainder of this brief presents a snapshot of highlights taken from a more comprehensive research report (McClanahan et al., 2016); more information about the study and findings can be found there.

STUDY HIGHLIGHT #1: Students of Committed Bootstrap Teachers Experience Growth in Their Knowledge of Key Algebraic Concepts

A core finding of this evaluation is that students experience growth in their knowledge of the key algebraic concepts[3] taught through the Bootstrap curriculum. While the number of teachers who provided student assessment data was small (twelve teachers in total), overall student assessments showed that students made significant improvements in their knowledge of algebra between the pre- and

[1] This study focused on in-school implementation only.

[2] although the sample of teachers who submitted student assessment data is a unique sample of teachers who were motivated to provide assessment data to Bootstrap, their backgrounds (when it came to gender, type of school in which they teach, grade level of school in which they teach, degree type, and the number of years they have been teaching) *were* similar to the teachers who did not provide student assessment data. The two samples differed only when it came to age and having a connection to a Bootstrap partnership organization.

[3] The specific algebraic concepts are function composition, matching representations of functions, and word problems.

post-assessments. This study was not designed to assess whether these gains could be attributed to Bootstrap; however, additional analyses revealed that gains were as robust among middle school students, who were less likely to be simultaneously enrolled in an algebra course, as they were among high school students.

Table S-1: Correct Responses on Student Pre- and Post-Assessments

Assessment Item	Number Correct on Pre-Assessment	Number Correct on Post-Assessment	Significance Level of Student Improvement on Paired T-Test
Overall (of 39 problems)	10.1	18.3	***
Composition (of 8 problems)	3.9	5.7	***
Matching (of 4 problems)	2.3	2.9	***
Word Problems (of 27 problems)	4.1	9.7	***
Word Problems – Part C Only (of 9 problems)	2.1	4.3	***

*** p<.01, *** p<.001*

STUDY HIGHLIGHT #2: Committed Teachers with Varying Educational Backgrounds and in Different School Settings Can Successfully Teach Bootstrap

Students made achievement gains between the pre- and post-assessments irrespective of the substantive educational background of their Bootstrap teacher, demonstrating that that it is not necessary to have a math or a computer degree to successfully teach the Bootstrap curriculum.[4] Despite the variation in their educational backgrounds, all but one of the teachers who provided student assessment data noted a primary teaching assignment of either math or computer science. Again, students whose teachers specialized in various disciplines all experienced gains in their math skills, suggesting that it is possible to implement Bootstrap in a variety of classes.[5] Strong gains were documented where the main teaching assignment was math at a level below algebra one, suggesting that accrued gains may be attributable to the Bootstrap curriculum and not to other math that is being taught concurrently.

Bootstrap can be implemented successfully by committed teachers across a wide variety of school environments. Bootstrap teachers who provided student assessment data come from different educational settings. Notably, significant gains in algebra skills were demonstrated among students at schools that are attended by a majority of racial and ethnic minority and low income students, and were documented at public, magnet, selective enrollment, and private schools. Finally, students in both middle and high schools experienced gains in their algebra skills.

[4] In the current sample, there is student assessment data for only a single teacher with a math degree. The students in this class *did* show overall gains on the assessment. However, because the sample included only twelve students, the gains appear only marginally significant despite being comparable to gains documented for students whose teacher had a computer science degree.

[5] While it cannot be deemed certain that student assessment data came from a class within the teacher's main teaching assignment, this assumption has been made for the purposes of this analysis.

Table S-2: Growth in Student Assessment Performance by Teacher Background

Teacher/Teaching Characteristic	Teachers	Number of Assessed Students	Average Change in Number Correct on Assessment From Pre-Assessment to Post-Assessment (max=39)
Educational Background			
MATH DEGREE	1	12	3.8+
COMPUTER DEGREE	3	105	4.1***
NEITHER MATH NOR COMPUTER DEGREE	8	261	10.0***
Main Teaching Assignment			
COMPUTER SCIENCE	4	104	9.8***
MATH AT ALGEBRA 1	3	140	6.3***
MATH BELOW ALGEBRA 1	4	129	9.0***
OTHER	1	5	5.0+

*+ p<.10, *** p<.001*

Table S-3: Growth in Student Assessment Performance by School Characteristics

Student Body Characteristic	Teachers	Number of Assessed Students	Average Change in Number Correct on Assessment From Pre-Assessment to Post-Assessment (max=39)
Type of School			
NON-PUBLIC	2	91	6.7***
TRADITIONAL PUBLIC	7	204	10.2***
PUBLIC MAGNET OR SELECTIVE ENROLLMENT	3	83	5.0***
Highest Grade in School			
MIDDLE SCHOOL	6	276	9.2***
HIGH SCHOOL	6	99	5.4***
Minority Representation in School			
MORE THAN 50 PERCENT OF STUDENTS IDENTIFY AS BLACK OR HISPANIC	6	131	5.8***
Economic Status of Student Body[6]			
MORE THAN 50 PERCENT OF STUDENTS RECEIVE FREE OR REDUCED PRICE LUNCH	6	153	7.8***

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[6] The economic status could not be classified for one school with 76 tested students.

STUDY HIGHLIGHT #3: Bootstrap Trainings and Support Resources Are of High Quality

Bootstrap's primary method of disseminating its curricula is through in-person trainings, and in order to reach teachers who cannot attend an in-person training, or for teachers who need additional support, Bootstrap offers a wide array of other resources to its teachers, including its website, on-demand technical assistance, and other supports. A clear finding that emerged is that teachers perceive the Bootstrap in-person trainings and support resources to be of high quality, indicating that the in-person trainings were very useful in preparing them to teach Bootstrap, and that the resources effectively supported them in the overall implementation of the curriculum.

STUDY HIGHLIGHT #4: Teachers Feel that Bootstrap is an Effective Program That Has Impacted Their Teaching

Teachers are the key element in the implementation of Bootstrap, and are critical to igniting students' interest in STEM subject areas. Accordingly, it is important to consider their assessments of Bootstrap. Ninety-four percent of teachers indicated that Bootstrap is an effective curriculum for teaching programming skills, while 93 percent indicated that Bootstrap is an effective curriculum for teaching math skills. The vast majority of Bootstrap teachers also reported that they would teach Bootstrap again (80 percent of teachers) in the future and they would recommend Bootstrap to a fellow teacher (90 percent of teachers). Lastly, the majority of Bootstrap teachers indicated that teaching Bootstrap made an impact on their teaching, particularly on their commitment to teaching math or programming, followed by a better understanding of the strengths and challenges schools face in teaching math and programming courses. Importantly, about one in five (21 percent) teachers indicated that Bootstrap affected their teaching skills to a "great extent."

Table S-4: The Impact of Teaching Bootstrap on the Teacher

Area of Impact	Extent of Impact on the Teacher from Teaching Bootstrap		
	Not at all/very little	*Somewhat*	*To a great extent*
Commitment to teaching math and/or programming (n=63)	11.1%	46.0%	42.9%
Awareness of the needs and resources of students and families served by your school (n=61)	31.1%	45.9%	23.0%
Understanding of the strengths and challenges of schools in teaching math and programming (n=60)	10.0%	55.0%	35.0%
Ability to work as a member of a "team teaching" environment (n=63)	41.3%	42.9%	15.9%
Overall teaching skills (n=62)	24.2%	54.8%	21.0%

PUTTING IT ALL TOGETHER

Bootstrap is an innovative model for teaching computer programming and math skills to middle and high school students. First, students in the Bootstrap evaluation demonstrated significant and meaningful

gains in their algebra skills, and while these gains cannot be definitively linked to Bootstrap, some evidence suggests that the gains may be attributed to the curriculum. More research is needed to determine conclusively if Bootstrap improves student's knowledge of algebra. Second, teachers from different backgrounds, and types of schools were successful in implementing Bootstrap; it can be implemented successfully by math or computer teachers alike, as well as by teachers in a variety of educational settings. Third, teachers believe that Bootstrap training and resources prepare them for implementing the curriculum, and they feel that Bootstrap is effective and has positively affected their own skills and knowledge. To learn more about Bootstrap or to view the report in its entirety visit *www.bootstrapworld.org*.

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