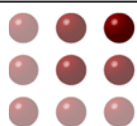


AN EVALUATION OF
THE EFFECTIVENESS OF
BRIDGES IN
MATHEMATICS FOR
DEVELOPING STUDENT
MATH SKILLS

June 2018



SEGMEASUREMENT

BUILDING BETTER ASSESSMENTS / EVALUATING PRODUCT EFFECTIVENESS

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Executive Summary

Overview

During the 2015–2016 and 2016–2017 school years, SEG Measurement conducted a study of the effectiveness of Bridges in Mathematics, a comprehensive, classroom-based PK–5 curriculum, on the math skills of fourth and fifth grade students. Approximately 1,000 students in fourth and fifth grade Colorado classrooms participated in the study. Students who received Bridges instruction showed significantly greater improvement in mathematics skills—about one-fifth of a standard deviation—than students who did not receive Bridges instruction (fourth grade effect size = .19; fifth grade effect size = .18). Teachers felt that Bridges was an effective tool for developing student math skills. These teachers also report that they are likely to recommend Bridges to their colleagues.

Study Design

The study employed both quantitative and qualitative methods. The quantitative approach employed a quasi-experimental design, comparing the growth in mathematics skills between two groups of students: those who received math instruction with Bridges (treatment group) and comparable students who received math instruction with a different curriculum (control group). The two groups were matched statistically to ensure any differences found in math ability at the end of instruction was due to the treatment (instruction with Bridges). The growth in mathematics skills was assessed by comparing results for the 2015–2016 state assessment results before instruction and the 2016–2017 assessment results after instruction.

A qualitative survey was used to collect teacher perceptions of Bridges in Mathematics. The survey gauged overall curriculum effectiveness, the effectiveness of specific Bridges features, and teachers' likelihood of recommending it to colleagues.

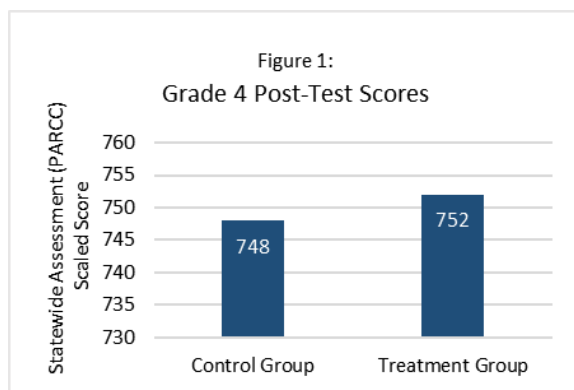
Study Results

Overview

The Treatment and Control group math outcomes were compared using Analysis of Covariance (ANCOVA). The difference in the post-test scores (dependent variable) between the treatment and control groups (independent variable) was examined, controlling for the initial proficiency of the students (covariate). These analyses were run separately for grades 4 and 5.

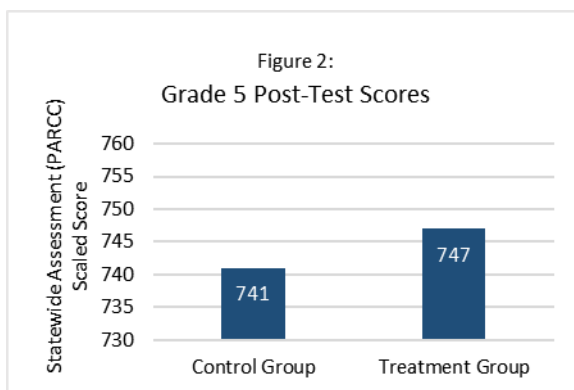
Grade 4 Math Skills Results

Fourth grade students in the treatment group achieved significantly higher scores on the state math assessment than fourth grade students in the control group ($F = 13.119$; $df = 3/538$; $p = .001$). The results show an effect size of .19 for the state assessment. This is equivalent to a gain of 8 percentile points; for a student at the 50th percentile, an effect size of .19 would produce a gain to the 58th percentile. The results are pictured in Figure 1.



Grade 5 Math Skills Results

Fifth grade students in the treatment group achieved significantly higher scores on the state math assessment than fifth grade students in the control group ($F = 13.311$; $df = 3/490$; $p < .001$). The results show an effect size of .18 for the state assessment. This is equivalent to a gain of 7 percentile points; for a student at the 50th percentile, an effect size of .18 would produce a gain to the 57th percentile. The results are pictured in Figure 2.



Teacher Survey

Teachers from the treatment group were surveyed to assess their perceptions of program effectiveness. Teachers reported that the program was effective and that they were likely to recommend it to their colleagues. They reported that the Bridges materials were more robust than other program materials they used in the past and that the materials were engaging to students. The teachers indicated that the program allowed them to easily identify students needing extra assistance and that the Bridges and helped students solve challenging problems and be better critical thinkers.

Conclusion

Students who receive instruction with Bridges achieved significantly higher assessment scores than students whose instruction does not include Bridges. Gains were both statistically significant and educationally meaningful. In addition, teachers reported that Bridges in Mathematics instruction effectively strengthens student math skills. These findings suggest that Bridges in Mathematics is an effective tool for developing student math performance.

Introduction

This study examines the impact of Bridges in Mathematics on the development of fourth and fifth grade student math skills. Bridges is a comprehensive, classroom-based, PK–5 math curriculum. During the 2015–2016 and 2016–2017 school years, SEG Measurement conducted a mixed-methods evaluation of Bridges using a quasi-experimental design and a qualitative study of teacher perceptions of Bridges effectiveness. Using the state math assessments (PARCC) as an independent measure of math skills, SEG Measurement compared student math skill development in classrooms that used Bridges (treatment group) to math skill development in classrooms that did not use Bridges (control group). Treatment group teachers provided their judgments about Bridges through an online survey at the end of the study.

About Bridges in Mathematics (Treatment)

Bridges in Mathematics by The Math Learning Center is a comprehensive classroom-based, PK–5 curriculum that equips teachers to implement the Common Core State Standards for Mathematics. It is designed to be rigorous, coherent, engaging, and accessible to all learners. The curriculum focuses on developing students’ understandings of mathematical concepts, proficiency with key skills, and ability to solve complex and novel problems. Bridges blends direct instruction, structured investigation, and open exploration, capitalizing on the existing knowledge and intelligence of students. The material presented is rich linguistically, visually, and kinesthetically.

Measures

The Colorado state math assessment was used as an independent measure of math skills. The spring 2015–2016 statewide test results served as the pre-test, and the spring 2016–2017 test results were used for the post-test. Colorado uses the PARCC (Partnership for Assessment of Readiness for College and Careers) Assessment for statewide testing. PARCC is a consortium that works to create and deploy a standard set of K–12 assessments based on the Common Core State Standards. The PARCC assessment is built with robust mathematics problems selected and reviewed extensively by dozens of educators from participating PARCC states. PARCC scale scores range from 650 to 850 for all tests.

Students are presented with multi-step problems that require mathematical reasoning and understanding to solve. The test also asks students to apply mathematical concepts and equations to solve real-world problems. The raw score is weighed against a scale to allow for accurate comparison across test forms and administration years within a grade or course and content area.

The teacher survey was a 21-item measure administered online. The survey contained a wide range of questions examining teacher perceptions of the Bridges program overall, specific program features and its use in instruction. Teachers were asked a series of background information questions. Teacher judgments of effectiveness were collected by asking teachers to respond to statements on a five-point scale from “strongly agree to strongly disagree” or “very ineffective” to “very effective.”

Research Questions

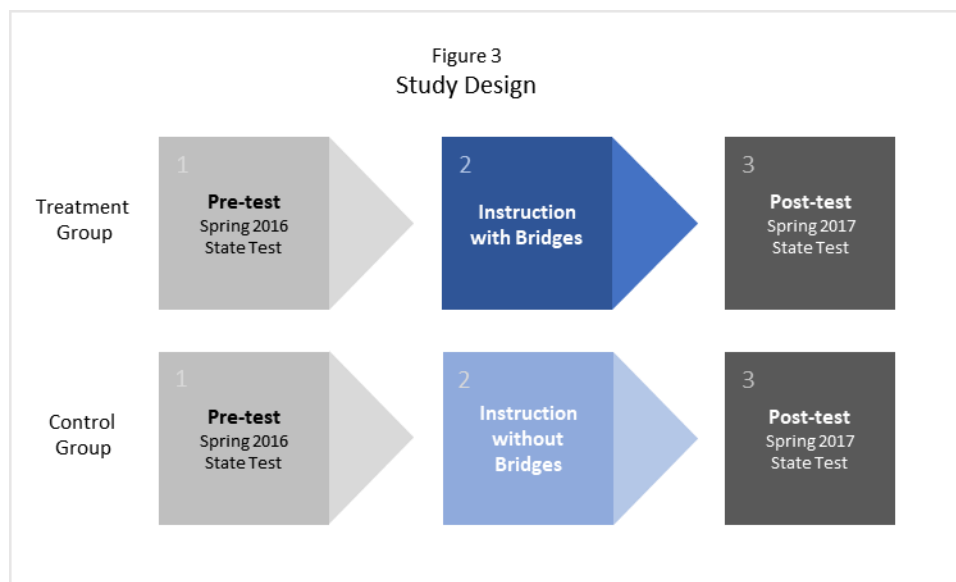
The research questions addressed by this study focused on the effectiveness of Bridges.

- Do students receiving instruction using Bridges show larger gains in mathematics skills than comparable students who receive instruction without Bridges?
- To what extent do teachers who use Bridges feel it is effective?
- To what extent do teachers feel specific features of Bridges are effective?

Quasi-Experimental Study

Study Design

The study employed a quasi-experimental design with matched treatment and control groups. All students were assessed both before receiving instruction and at the end of instruction. The mathematics skills of the treatment group were compared with the control group. Students in the treatment group were matched to students in the control group based on pre-test results (2015–2016 PARCC scores), and then compared based on the post-test results (2016–2017 PARCC scores). The study design is depicted in Figure 3.



Data Collection

The participating school districts provided the de-identified state test performance data for spring 2015–2016 and spring 2016–2017 as well as the gender for each student. In addition, SEG Measurement surveyed participating teachers at the end of the study to gain further insights into the efficacy of Bridges. Treatment group teachers were asked to provide background information as well as their perceptions of the Bridges program and its features, their likelihood of using the program in

the future, and their likelihood of recommending its use to colleagues. Control group teachers provided background information as a basis for comparison with the treatment group.

Participants

Overview

Nine schools in two Colorado districts participated in the study. The treatment group consisted of students in 22 fourth and fifth grade classrooms across four schools. The control group consisted of students in 21 fourth and fifth grade classrooms across five schools.

The final set of 538 fourth grade and 490 fifth grade students were selected using a statistical matching technique called Propensity Score Matching. For each student who received math instruction with Bridges, a matching student who did not receive math instruction with Bridges was identified. Only these matched students were included in the analyses. The use of Propensity Score Matching increased rigor in the analyses by ensuring that the treatment and control groups shared the same level of ability at the beginning of instruction. By matching the two study groups, we can be confident that any differences in students' level of ability at the end of instruction are due to whether the math instruction they received was with Bridges or not with Bridges.

Student mobility, absences, and other factors meant that some students did not take either a pre- or post-test. Only those students who had both pre- and post-test data were included in the analyses.

Teachers were surveyed to determine the amount of time they incorporated Bridges into their math instruction. Only those teachers and their classes who met minimum usage criteria (five or more hours per week) were included within the treatment group.

Grade 4 Participants

The fourth-grade treatment group contained 269 students, and the control group contained 269 students, with one control student matching each unique treatment student. The fifth-grade treatment group contained 245 students and the control group contained 245 students, with one control student matching each unique treatment student.

The fourth-grade treatment and control group participants were comparable. The mean PARCC pre-test scores for the treatment and control group differed by less than one point, indicating that they were of similar ability at the beginning of the study. The gender distribution was nearly identical. The profile summaries of the grade 4 participants are provided in Tables 1 and 2.

Table 1:
Grade 4 Pre-Test Scores

Study Group	N	Mean	Std. Deviation
Control	269	755.132	31.2143
Treatment	269	754.086	30.8693

Table 2:
Grade 4 Gender Distribution

Study Group	Female	Male	Total
Control	130	139	269
Treatment	131	138	269
Total	261	277	538

Grade 5 Participants

The fifth-grade treatment and control group participants were comparable. The mean PARCC pre-test scores for the treatment and control group differed by less than one point, indicating that they were of similar ability at the beginning of the study. The gender distribution for both groups was similar, though there was a somewhat higher percentage of female students in the treatment group. The profile summaries of the grade 5 participants are provided in Tables 3 and 4.

Table 3:
Grade 5 Pre-Test Scores

Study Group	N	Mean	Std. Deviation
Control	245	746.782	26.4711
Treatment	245	746.127	25.9887

Table 4:
Grade 5 Gender Distribution

Study Group	Female	Male	Total
Control	117	128	245
Treatment	128	117	245
Total	245	245	490

Analysis and Findings

Overview

The mathematics knowledge and skills of the treatment group was compared to the control group. Separate comparisons were made for each of the two grades.

Using Analysis of Covariance (ANCOVA), we examined the difference in the post-test scores (dependent variables) between the treatment and control groups (independent variables), controlling for the initial proficiency of the students (covariate). The spring 2015–2016 score was used as the covariate to place students from both groups on the same baseline. The propensity score matching of the two groups achieved a very close match in ability; the ANCOVA removed the effect of any remaining differences in initial ability.

Grade 4 Math Skills Results

Fourth grade students in the treatment group achieved significantly higher scores on the PARCC Assessment of math skills than students in the control group ($F = 13.119$; $df = 3/538$; $p = .001$). The results show an effect size of .19 for the PARCC Assessment. This is equivalent to a gain of 8 percentile points; for a student at the 50th percentile, an effect size of .19 would produce a gain to the 58th percentile. The results are summarized in Tables 5 and 6.

Table 5:
Analysis of Covariance for Grade 4 Post-Test Scores

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	275704.196 ^a	2	137852.098	620.698	0.001
Intercept	35431.941	1	35431.941	159.537	0.001
Pre-Test	272790.620	1	272790.620	1228.278	0.001
Study Group	2913.576	1	2913.576	13.119	0.001
Error	118819.209	535	222.092		
Total	302917532.000	538			
Corrected Total	394523.405	537			

Table 6:
Descriptive Statistics Comparison for Grade 4 Post-Test Scores
(Adjusted for Pre-Test Performance)

Study Group	N	Mean	Std. Deviation
Control	269	747.546	26.8209
Treatment	269	752.201	27.2373

Grade 5 Math Skills Results

Fifth grade students in the treatment group achieved significantly higher scores on the PARCC Assessment than students in the control group ($F = 13.311$; $df=3/490$; $p < .001$). The results show an effect size of .18 for the PARCC Assessment. This is equivalent to a gain of 7 percentile points; for a student at the 50th percentile, an effect size of .18 would produce a gain to the 57th percentile. The results are summarized in Tables 7 and 8 below.

Table 7:
Analysis of Covariance for Grade 5 Post-Test Scores

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	278385.163 ^a	2	139192.581	504.871	0.001
Intercept	2339.020	1	2339.020	8.484	0.004
Pre-Test	274715.202	1	274715.202	996.430	0.001
Study Group	3669.961	1	3669.961	13.311	0.001
Error	134265.615	487	275.699		
Total	271694397.000	490			
Corrected Total	412650.778	489			

Table 8:
Descriptive Statistics Comparison for Grade 5 Post-Test Scores
(Adjusted for Pre-Test Performance)

Study Group	N	Mean	Std. Deviation
Control	269	741.331	28.5455
Treatment	269	746.804	29.3480

Qualitative Study

SEG Measurement conducted a qualitative study of Bridges in Mathematics to complement and expand upon the quantitative, quasi-experimental study of effectiveness. Treatment group teachers were surveyed at the conclusion of the study to understand their perceptions of the effectiveness of Bridges in Mathematics.

The qualitative study addressed the following areas:

- Demographics
- Usage
- Overall effectiveness
- Component effectiveness

Data Collection

Both control and treatment group teachers completed an anonymous online survey in the spring of 2016–2017. This survey assessed teachers’ perceptions of the effectiveness of Bridges in Mathematics. Of the 22 treatment group teachers, 15 completed the survey. Of the 21 control group teachers, 7 completed the survey.

Teacher Background Information

Grade level

Teachers from both fourth and fifth grade responded to the survey. About two thirds taught fourth grade and the remaining third taught fifth grade. See Table 9.

Table 9:

Grade Level Taught

Grade Level	Treatment Group	Control Group
Fourth grade	67%	43%
Fifth grade	33%	57%

Experience

Participating teachers reported that the number of years spent in the classroom ranged from 1 year to more than 16 years. More than half (60%) of treatment group teachers reported having less than 10 years of teaching experience. Less than half (43%) of control group teachers reported the same. Conversely, control group teachers reported more frequently of having more than 10 years of classroom experience (57% vs 40%). See Table 10.

Table 10:
Years of Teaching Experience

Experience	Treatment Group	Control Group
First year teaching	0%	0%
1 to 5 years	27%	14%
6 to 10 years	33%	29%
11 to 15 years	7%	43%
16 to 20 years	33%	14%
21 or more years	0%	0%

Highest Degree Earned

The vast majority of teachers from both control and treatment groups have a master’s degree (77% overall). More than four fifths of treatment group teachers (87%) reported having a master’s degree, while the remaining 13% reported having a bachelor’s degree. See Table 11.

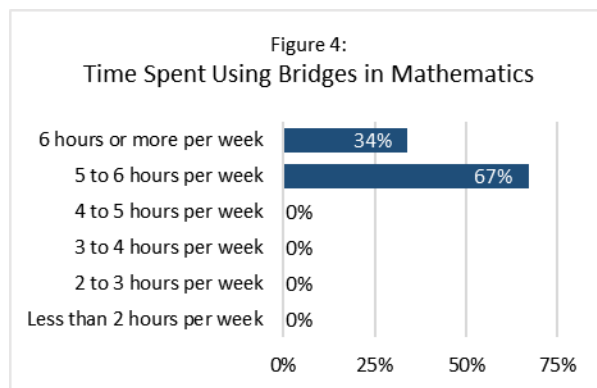
Table 11:
Highest Degree Earned

Degree	Treatment Group	Control Group
Bachelor's degree	13%	43%
Master's degree	87%	57%
Ph.D or Ed.D	0%	0%

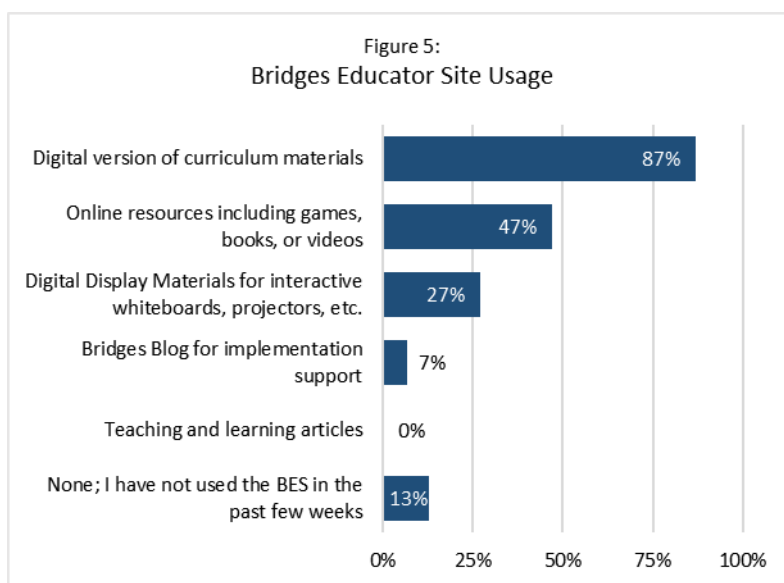
Findings

Bridges Usage

Teachers were asked a series of questions to understand the extent to which they used Bridges in Mathematics and the components of the program. Two thirds of the teachers (67%) indicated that they used Bridges 5 to 6 hours per week, while the remaining third used the program 6 or more hours per week (See Figure 4).

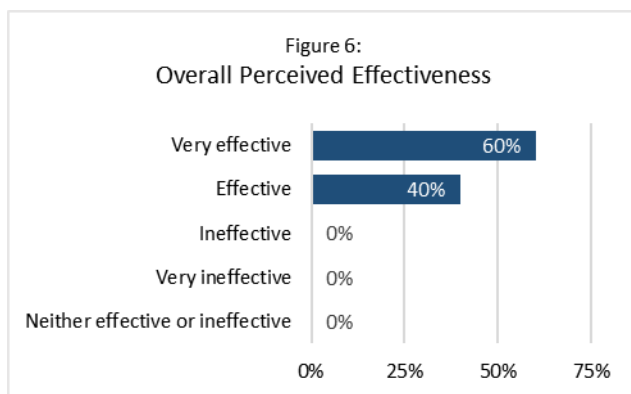


More than four fifths of the teachers indicated that they used the digital version of the curriculum materials. Nearly half (47%) of the teachers indicated that they used the online resources, such as games, books, or videos. Another quarter (27%) reported using the Digital Display Materials. See Figure 5.

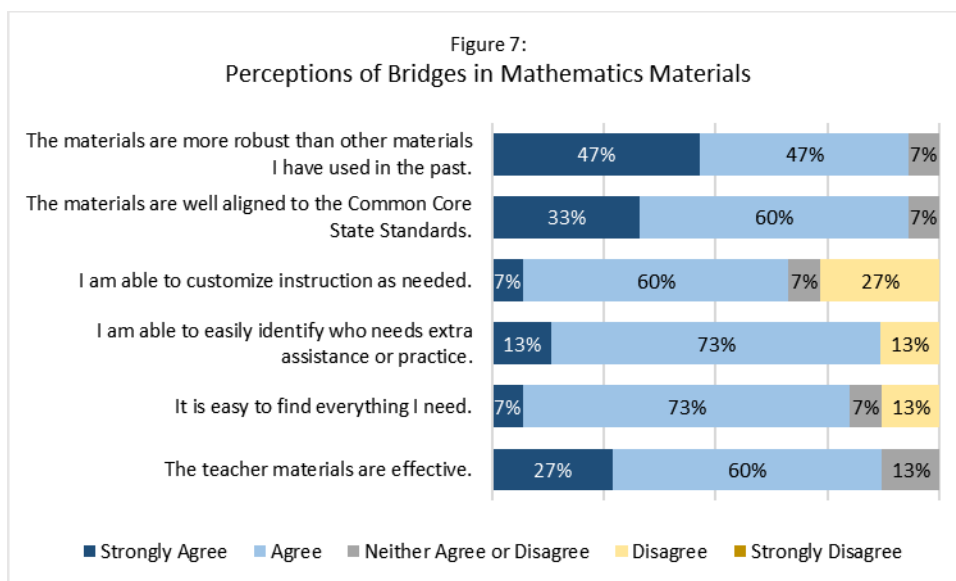


Perceived Effectiveness of Bridges in Mathematics

Treatment group teachers were asked to rate the effectiveness of Bridges in Mathematics on a five-point scale ranging from “very ineffective” to “very effective.” Three fifths (60%) of the teachers said the program was “very effective,” while the remaining two fifths (40%) rated the program as “effective” (see Figure 6).

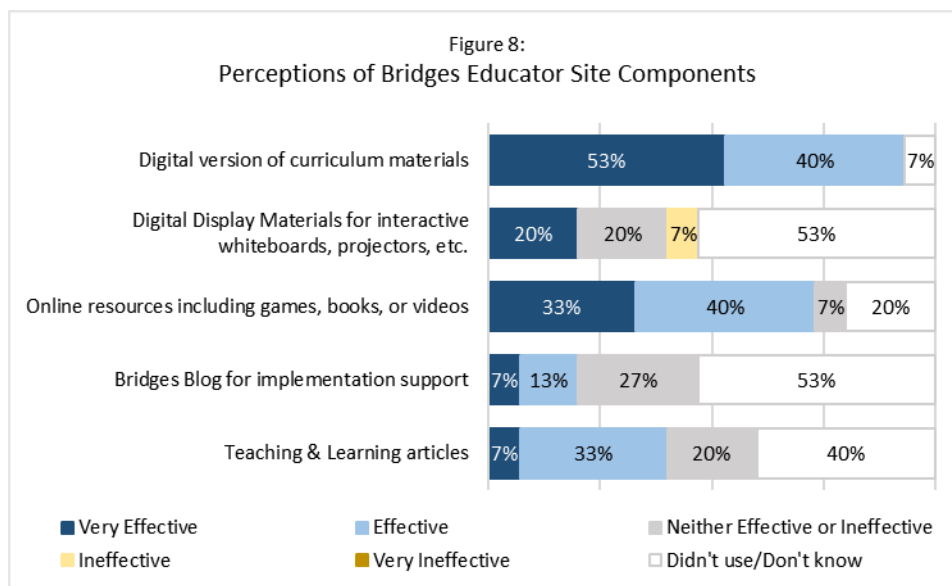


To shed further light on the overall effectiveness ratings, the treatment group teachers were asked to provide their perceptions of specific aspects of Bridges materials. More than four fifths (87%) of the teachers indicated that they “strongly agreed” or “agreed” that the Bridges materials were more robust than those they used in the past and that the materials were well aligned to Common Core State Standards. Similarly, about four fifths of the teachers reported that the teacher materials are effective and that, by using Bridges, they were able to easily identify students who need extra assistance or practice. See Figure 7.



Perceived Effectiveness of the Bridges Educator Site

Nearly all (93%) of the teachers rated the digital version of the curriculum materials as “very effective” or “effective.” And two thirds of the teachers (67%) rated the online resources such as games, books and videos as “very effective” or “effective.” However, fewer than half of the teachers reported either the Bridges Blog, Teaching & Learning articles, or Digital Display Materials as effective. See Figure 8.



Teachers were also asked to provide additional comments to further explain their effectiveness ratings. Teachers were overwhelmingly positive about Bridges. Below are some of the comments provided by treatment group teachers.

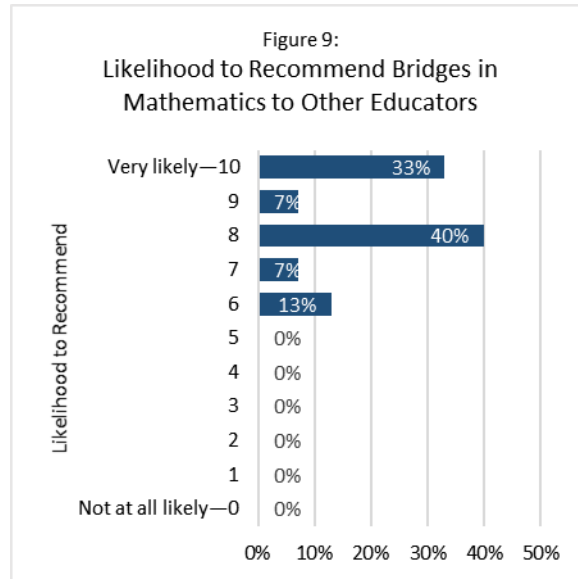
- “I love Bridges. I think the interactive lessons make our students become critical thinkers and problem solvers.”
- “It teaches students many strategies for solving problems—an important skill in our ever-changing world.”
- “I like the problem strings and the ‘I do, we do, you do,’ practice opportunities. Bridges gives multiple strategies to solve math problems using different operations, and this honors the diverse learning style of students in the classroom. The majority of the games are fun and afford students the opportunity to apply skills and concepts addressed in the main lesson.”
- “I really like the conceptual approach that Bridges uses.”
- “I love the problem solving and collaboration aspects to the curriculum. The fact that so many different strategies are taught helps students of all learning styles to be successful in the curriculum.”
- “Bridges has truly helped the students at our school learn in a way that is best for them. The variety of strategies taught makes the content accessible to all students.”

Likelihood of Recommending Bridges in Mathematics

One important indicator of teacher-perceived effectiveness is the teachers’ likelihood of recommending Bridges to colleagues in other districts. Teachers were asked how likely they would be to recommend the Bridges to their colleagues in other districts, on a 0–10 scale ranging from “not at all likely” to “very likely.” All responses ranged from 6 to 10. Four fifths of the teachers

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(80%) provided a rating of 8 or higher, indicating they are very likely to recommend Bridges. See Figure 9.



Summary and Conclusion

During the 2015–2016 and 2016–2017 school years, SEG Measurement studied the effectiveness of Bridges in Mathematics for developing student math skills. Teachers and students in Colorado fourth and fifth grade classrooms participated in a mixed-methods study.

First, a quasi-experimental study was conducted, comparing the skills growth of students in classroom that used Bridges (treatment group) with students in classrooms that did not use Bridges (control group). Students in the treatment group were matched statistically to students in the control group to ensure the two groups were similar in ability and gender. The students were tested before receiving instruction (pre-test) and at the end of instruction (post-test) using the state math assessment (PARCC).

The treatment group in both fourth and fifth grade showed significantly greater improvement in their math skills than their counterparts in the control group (effect size for fourth grade = 0.19; effect size for fifth grade = 0.18). These effect sizes—about one-fifth of a standard deviation—reflect educationally meaningful gains. These effects exceed the mean effect size of 0.15 reported by Cheung and Slavin (2013) in their review of 84 studies examining the effects of educational technology applications on mathematics achievement in K–12 classrooms.

Second, a qualitative study was conducted examining teacher perceptions of Bridges in Mathematics usage and effectiveness. Teachers from the treatment group reported Bridges to be an effective tool for increasing student math skills, and that it helped students solve challenging problems and be better critical thinkers. Teachers indicated that the core components of Bridges are effective and engaging to students, and that they are more robust than materials used in other programs. However, some teachers indicated that some of the peripheral components (e.g., Bridges Blog) to be less useful. Treatment group teachers reported that Bridges allowed them to easily identify students in need of extra assistance. Overall, all teachers in the treatment group reported being likely to recommend Bridges to colleagues in other school districts.

The results of this study indicate that students who receive instruction that includes Bridges significantly outperform students who receive instruction without Bridges. Taken with the positive evaluation of the program by teachers, these findings suggest that Bridges is an effective tool for improving student math skills.

References

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- Lipsey, M.W., Puzio, K., Yun, C., Hebert, M.A., Steinka-Fry, K., Cole, M.W., Roberts, M., Anthony, K.S., Busick, M.D. (2012). *Translating the Statistical Representation of the Effects of Education Interventions into More Readily Interpretable Forms*. (NCSE 2013-3000). Washington, DC: National Center for Special Education Research, Institute of Education Sciences, U.S. Department of Education

Participating Districts and Schools

Weld RE-4 School District

1. Range View Elementary School
2. Mountain View Elementary School
3. Skyview Elementary School
4. Grandview Elementary School

Harrison School District Two

1. Stratmoor Hills Elementary School
2. Sand Creek Elementary School
3. Wildflower Elementary School
4. Oak Creek Elementary School
5. Soaring Eagles Elementary School