Project *Make the Way*

Santa Rosa City Schools

CaMSP Cohort 11

Final Local Evaluation Report

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Submitted by:

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Section 1: Introduction

Project *Make the Way* was a Cohort 11 partnership funded by the California Mathematics and Science Partnership (CaMSP) program, which was administered by the California Department of Education's Science, Technology, Engineering and Mathematics (STEM) Office. CaMSP was a federally funded initiative of the US Department of Education's Mathematics and Science Partnership (MSP) Program under Title II of the Elementary and Secondary Education Act (ESEA).

Make the Way included a target of 65 participating teachers in grades K to 8 from Santa Rosa City Schools (SRCS), which reached approximately 4,090 students. SRCS was the lead school district for this partnership (Lead LEA) and partnered with faculty members from Sonoma State University (SSU) –Departments of Mathematics and Statistics, Engineering Science, Literacy Studies and Elementary Education, Curriculum Studies and Secondary Education, and the California Mathematics Project: North Coast (CMP:NC). The IHE faculty provided professional development and focused on developing teachers' understanding of students' conceptual development of mathematics, engineering, and technology as it related to the STEM Maker curriculum. The purpose of Project *Make the Way* was to develop and use Maker Design projects in the classroom as a vehicle for academic achievement and students' mathematical understanding and engagement, dispositions and attitudes towards mathematics and its real-world use.

Make the Way teachers participated in 60 hours of intensive, divided between an annual 30-hour Summer Institute and five Saturday Seminars (30 hours) that took place throughout the school year. *Make the Way's* 24 hours of classroom follow-up were based on a model of Lesson Study developed in previous CaMSP projects and enhanced to incorporate the development of STEM Maker curriculum. Lesson study groups engaged in planning and additional lesson study work during the Saturday seminars. Each group participated in three cycles of lesson study facilitated by peer facilitators, who received additional coaching and training throughout the year.

Project Goals/Outcomes

Project *Make the Way* had the following specific goals:

1) Development and use of Maker Design projects in classroom as a vehicle for academic achievement and students' mathematical understanding and engagement, dispositions and attitudes towards mathematics and its real-world use.
2) Changes in instructional strategies and methods implemented in the classroom by participating teachers.
3) Impact teacher mindset about capacity for students to learn and engage in and access mathematics.
4) Build STEM capacity and engage educational leadership among participating teachers.
5) Impact SRCS and community-based partnerships to implement and sustain policies and practices that support STEM Maker curriculum.

Make the Way Core Partnership

Santa Rosa City Schools (SRCS) was the Core Partnership Lead for the *Make the Way* grant collaborative. In addition to SRCS, the collaborative consisted of several departments at Sonoma State University: Mathematics and Statistics, Engineering Science, Literacy Studies and elementary Education, Curriculum Studies and Secondary Education, and the California Mathematics Project: North Coast (CMP:NC).

Make the Way Regional Collaborative Partnership

In addition to a core partnership made up of the lead Local Education Agency (LEA), participating LEAs, at least one California-based Institution of Higher Education (IHE) and optional additional PD providers, this partnership included Regional partners to serve in an advisory and supportive role with the goal to extend the benefits of the project regionally. Regional partners could include other K-16 partners, business/industry, government, chambers of commerce, County Offices of Education (COE), and community-based organizations.

The Core Partnership was further supported by the Regional Collaborative Partners (RCP), which included the Sonoma County Office of Education, Santa Rosa Chamber of Commerce, Sonoma County Workforce Investment Board, Autodesk, and Maker Media.

About the Evaluation

Through an RFP process initiated by the California Department of Education, Public Works (PW) served as the statewide evaluator and through the Cohort 11 RFA as the local evaluator for the twelve Cohort 11 partnerships funded under this initiative. As the statewide evaluator, PW conducted site visits; phone interviews; an annual survey of participating teachers, core and regional partners; and collected, analyzed and reported on outcomes related to standardized state student assessments in mathematics and science.

Under Cohort 11 guidelines, Santa Rosa City Schools, the lead LEA for the *Make the Way* partnership, contracted with PW to serve as their local evaluator to administer a teacher content assessment and to create customized data collection tools to measure the impact of professional development activities on participating teachers and in classroom instruction. As the local evaluator, PW provided reports to meet state and federal reporting requirements, periodic quarterly reports for the leadership team and a summative evaluation report.

This final local evaluation report reflects activities through October 2017 and includes the following sections: 1) introduction to the partnership, 2) results from the teacher content assessment, annual teacher survey and student outcomes on state assessments, 3) local evaluation instruments, data collection and analysis, and 4) conclusions.

Section 2: State Measures

Teacher Content Assessments

As a US Department of Education initiative funded under the Mathematics and Science Partnership Program of the Elementary and Secondary Education Act (NCLB Title II), the California Mathematics and Science Partnership Program (CaMSP) was required to measure teacher content knowledge as a federal priority for this partnership. Each CaMSP partnership was required to administer one of two teacher content assessments selected by the CDE STEM Office to each participating teacher, depending on its content focus of Mathematics and/or Science.

The Mathematical Knowledge for Teaching Measures (MKT), which was developed by the Learning Mathematics for Teaching (LMT) research consortium of the University of Michigan, School of Education was selected as the measure for this partnership.[1] The MKT, referred to as the LMT, is an online assessment of elementary and secondary mathematics teachers' content knowledge for teaching. Two areas were assessed for CaMSP projects: (1) Number Concepts and Operations and (2) Patterns, Functions, and Algebra. The teacher content assessments were administered for research purposes only and all individual results are kept confidential. Only group results are reported for the purpose of evaluating professional development initiatives.

Each participating teacher completed the content assessment two or three times each year during the grant. Results of the assessment are presented as average scores for the group, in standard deviations above (1.0) or below (-1.0) the national average (0.0)[2] for each content area. The evaluation question was whether teachers who participated in CaMSP professional development increased their mathematics content knowledge for teaching, as measured by gains in standard deviations from the national mean, from the first test to the last. To measure the changes in scores, a paired t-test was conducted. The analysis compares matched scores of participants from the Year 1 pre-assessment (first administration) to the Year 2 post-assessment (last administration).

Teachers participating in the professional development program completed the LMT assessment a total of four times: summer of 2015 (Year 1 pre), winter of 2016 (Year 1 mid), summer of 2016 (Year 1 post/Year 2 pre), and winter or spring of 2017 (Year 2 post). Tables 2.1 and 2.2 below show the overall number of project *Make the Way* and Cohort 11 teachers, including those in this partnership, that took the assessment at each administration, as well as the number of teachers with both valid pre- and post-assessment test scores used in the matched analysis.

Note that all participants completed a pre-assessment and were scheduled to participate in all post-assessment administrations. However, over the course of the project, some participants dropped, were absent or were unable to complete a make-up test at different test administrations. Thus, the number of test takers and possible matched pre- and post-assessments fluctuate throughout the project. See Tables 2.1 and 2.2 for details.

[1] The development of the MKT was funded by the National Science Foundation, and by a subcontract to the Consortium for Policy Research Education (CPRE), and US Department of Education Office of Educational Research and Improvement.
[2] As a condition of use, neither raw scores nor percent correct on the MKT/LMT can be presented in this report.

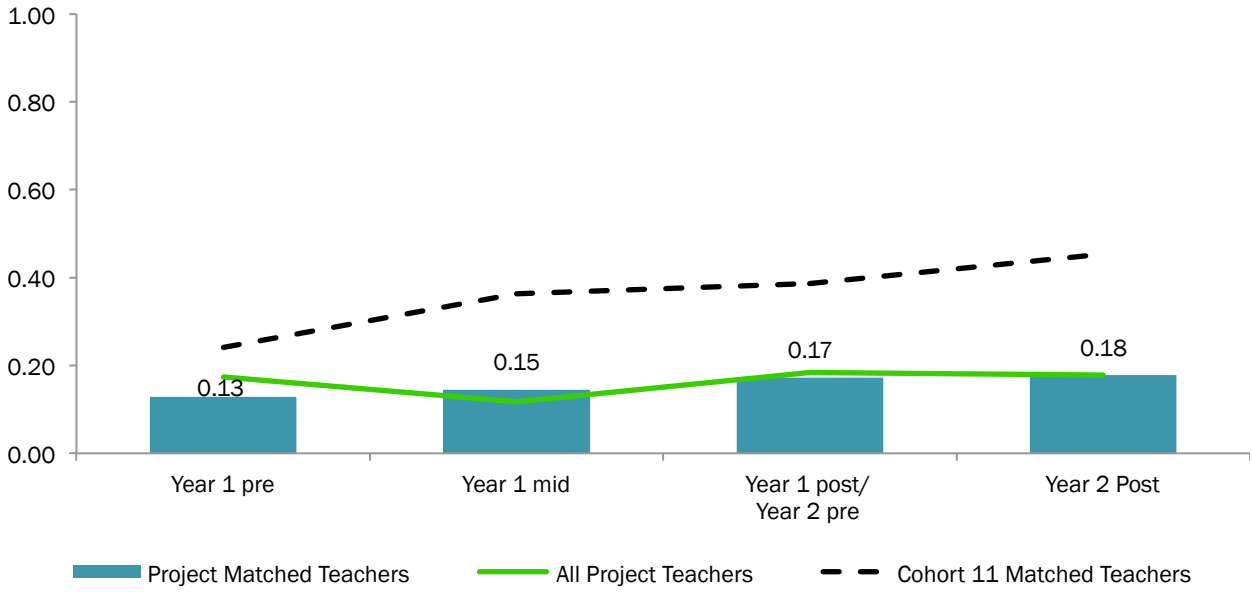
Matched Analysis Results - Elementary

Table 2.1: Number of Teachers Completing the LMT Assessment, by administration

	Year 1 pre	Year 1 mid	Year 1 post/ Year 2 pre	Year 2 post
All *Make the Way* Teachers	47	41	34	28
***Make the Way* Matched Teachers**	28	28	28	28
All Cohort 11 Teachers	233	212	144	129
Cohort 11 Matched Teachers	128	126	125	128

The results for the 28 matched elementary teachers who were administered both the Year 1 pre- and Year 2 post-assessment indicate the teachers made slight gains from the first to last administration on the Number Concepts and Operations section. Figure 2.1 shows the average scores in standard deviations from the national mean of *Make the Way* matched teachers, in comparison to all project teachers and Cohort 11 matched teachers in the same grade span. Results indicated average scores continued to be above the national mean but below the average for all Cohort 11 teachers participating in the grant program, with a 0.05 increase overall. This difference was not statistically significant[3], indicating that there was not a measureable improvement in mathematical content knowledge of participating teachers throughout the program on the Numbers portion of the assessment.

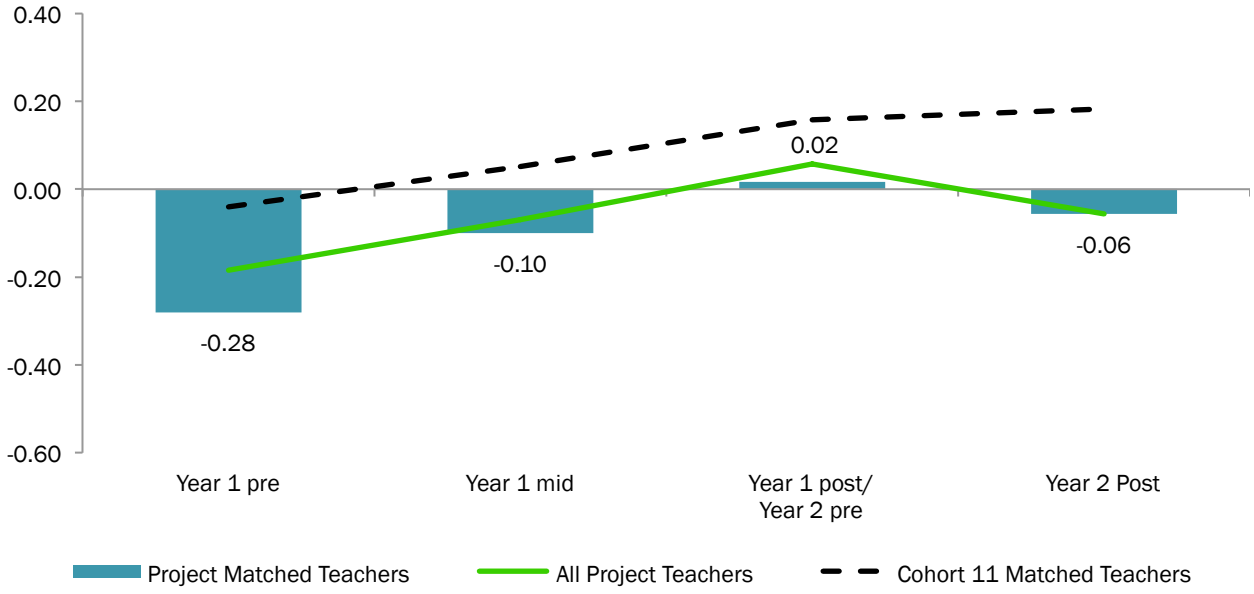
Figure 2.1: LMT Number Concepts and Operations Scores – *Make the Way* teachers with initial Year 1 pre-assessment matched to final Year 2 post-assessment (n=28) compared to all project teachers (max n=47) and Cohort 11 pre-post assessment matched teachers (n=128), by administration



[3] Significance is defined as $p<.05$ on a two-tailed paired t-test between Year 1 pre- and Year 2 post-assessment average standard deviations from the national mean (0.0).

In Figure 2.2, teachers' average scores on Patterns, Functions, and Algebra also remained below or similar to the national mean, as well as below the average for all Cohort 11 teachers. Results showed slight gains from the Year 1 pre- to Year 2 post-assessment of 0.22. This difference was not statistically significant[4], indicating there was nota measureable improvement in mathematical content knowledge of participating teachers on the Algebra portion of the assessment over the course of the grant. Average scores of all participating *Make the Way* teachers at each administration show more extreme fluctuations, possibly due to outlier scores of teachers who had either left the project or did not take the first assessment.

Figure 2.2: LMT Patterns, Functions, and Algebra Scores – *Make the Way* teachers with initial Year 1 pre-assessment matched to final Year 2 post-assessment (n=28) compared to all project teachers (max n=47) and Cohort 11 pre-post assessment matched teachers (n=128), by administration



Matched Analysis Results - Secondary

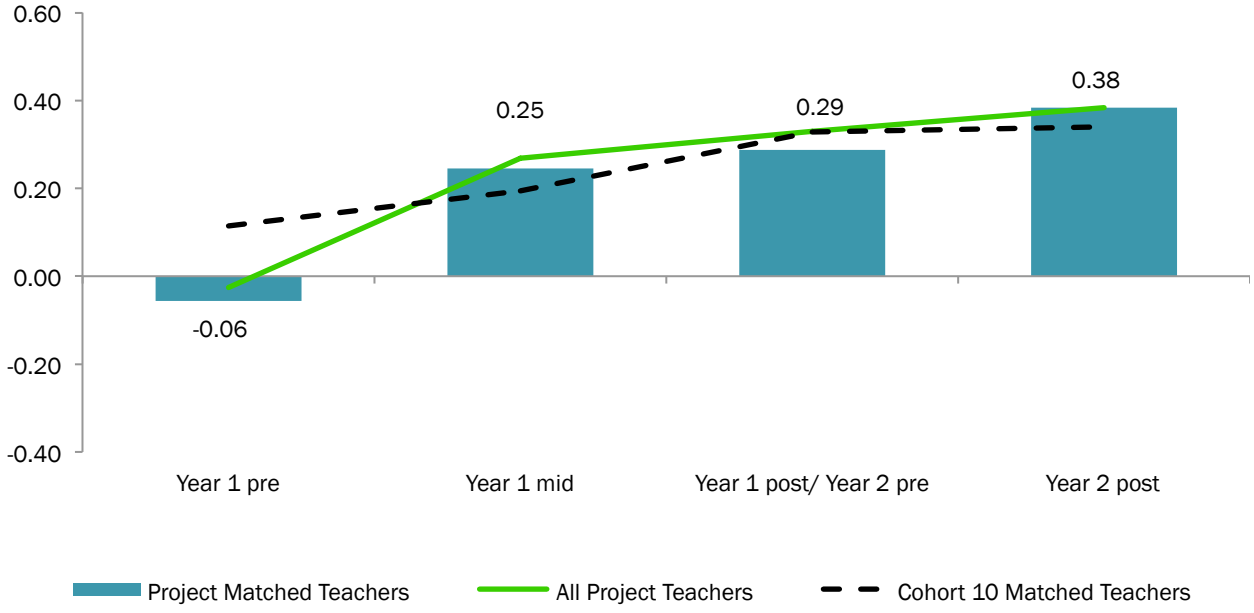
Table 2.2: Number of Teachers Completing the LMT Assessment, by administration

	Year 1 pre	Year 1 mid	Year 1 post/ Year 2 pre	Year 2 post
All *Make the Way* Teachers	22	19	18	15
***Make the Way* Matched Teachers**	15	14	14	15
All Cohort 11 Teachers	156	141	123	97
Cohort 11 Matched Teachers	96	94	94	96

[4] Significance is defined as $p<.05$ on a two-tailed paired t-test between Year 1 pre- and Year 2 post-assessment average standard deviations from the national mean (0.0).

The results for the 15 matched secondary teachers who were administered both the Year 1 pre- and Year 2 post-assessment indicate the teachers made gains from the first to last administration on the Number Concepts and Operations section. Figure 2.3 shows the average scores in standard deviations from the national mean of *Make the Way* matched teachers, in comparison to all project teachers and Cohort 11 matched teachers in the same grade span. Results indicated average scores continued to be above the national mean as well as the average for all Cohort 11 teachers after the first administration, with an increase of 0.44 overall. This difference was statistically significant[5], indicating that there was a measureable improvement in mathematical content knowledge of participating teachers throughout the program on the Numbers portion of the assessment.

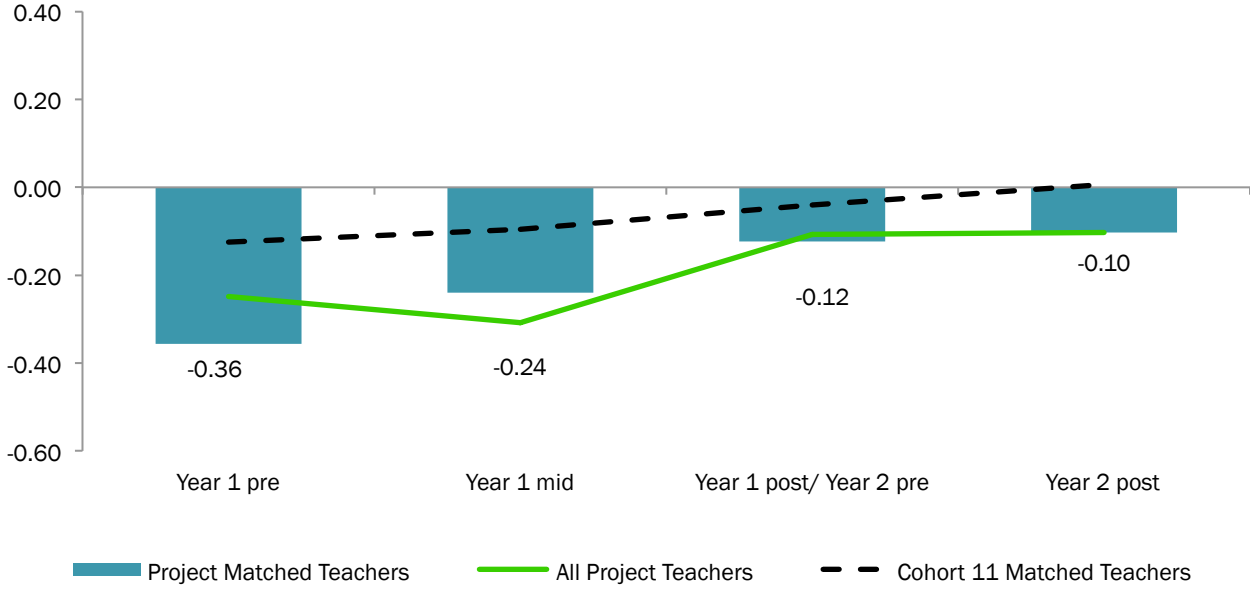
Figure 2.3: LMT Number Concepts and Operations Scores – *Make the Way* teachers with initial Year 1 pre-assessment matched to final Year 2 post-assessment (n=15) compared to all project teachers (max n=22) and Cohort 11 pre-post assessment matched teachers (n=96), by administration



In Figure 2.4, teachers' average scores on Patterns, Functions, and Algebra remained below the national mean, as well as below the average for all Cohort 11 teachers. However, results showed slight gains from the Year 1 pre- to Year 2 post-assessment, with an increase of 0.25 overall. This difference was not statistically significant[6], indicating there was not a measureable improvement in mathematical content knowledge of participating teachers on the Algebra portion of the assessment over the course of the grant. Average scores of all participating *Make the Way* teachers at each administration show more extreme fluctuations, possibly due to outlier scores of teachers who had either left the project or did not take the first assessment.

[5] Significance is defined as $p<.05$ on a two-tailed paired t-test between Year 1 pre- and Year 2 post-assessment average standard deviations from the national mean (0.0).
[6] Significance is defined as $p<.05$ on a two-tailed paired t-test between Year 1 pre- and Year 2 post-assessment average standard deviations from the national mean (0.0).

Figure 2.4: LMT Patterns, Functions, and Algebra Scores – *Make the Way* teachers with initial Year 1 pre-assessment matched to final Year 2 post-assessment (n=15) compared to all project teachers (max n=22) and Cohort 11 pre-post assessment matched teachers (n=96), by administration



Analysis of Project *Make the Way* CaMSP Teacher Survey

In the spring of 2016, Public Works administered the CaMSP Participating Teacher Survey to Cohort 11 partnerships focusing on teacher perspectives about the effectiveness of the partnership to provide support to improve Science, Technology, Engineering and Mathematics (STEM) teaching and learning in the classroom. Project *Make the Way* teachers that participated in at least one hour of professional development during the respective grant year were asked to complete a survey. The majority of the teachers responded to the survey, as shown in Table 2.3, and about three-quarters of responding teachers reported they would return for Year 2 of the project. The CaMSP Teacher Survey was not required in spring of 2017 therefore results do not include Year 2 and changes from Year 1 to 2 could not be assessed.

Table 2.3: Teacher Survey Response Rates

Grant Year	Number Administered	Responded (n & %)		Returning Next Year (n & % of responses)	
2015 – 16 (Year 1)	70	60	86%	43	72%

Project *Make the Way* teachers were asked about their satisfaction with the overall quality of the professional development. The teacher responses were given on a Likert Scale for 1 "not satisfied" to 4 "very satisfied" with the option of teachers selecting "don't know."[7] Overall, teachers were satisfied with the quality of the professional development. However,

[7] Mean scores do not include "don't know" or "not applicable" responses.

teachers were most satisfied with: the quality of the trainers, the overall quality of the summer activities, and the quality of the coaching.

Table 2.4: Satisfaction of the Professional Development Mean Scores by Year

Items	2015 - 16	
	n	Mean
Quality of the trainers	58	3.3
Overall quality of summer activities	58	3.1
Quality of the coaching	56	3.0
Overall rating of professional development	59	2.9
Impact of the training on my own teaching	58	2.9
Focus on aligning teaching with standards	58	2.9
Content of professional development	59	2.9
Pedagogy or instructional methods covered	58	2.8
Overall quality of school year activities	58	2.8

Teachers were also asked about the extent that the training was helping them professionally (Table 2.5). Responses were provided on a Likert Scale from 1 "not at all" to 4 "a lot" with the option for either "don't know" or "not applicable." Teachers reported that the training has helped them some professionally, with most of the items rated on average "somewhat helpful." Teachers reported the professional development helped them the most in: convincing teachers of the importance of hands-on learning; teaching about lesson study; understanding the use of modeling or real world application in teaching; providing instructional strategies, techniques, or pedagogical approaches; and increasing content knowledge. Providing credits to attain a minor or major in math or science, and helping teachers earn a masters degree had low response rates as many teachers selected "don't know" or "not applicable."

Table 2.5: Training Helps Professionally Mean Scores by Year

Items	2015 - 16	
	n	Mean
Convinced me of the importance of hands-on learning	54	3.3
Taught me about lesson study	54	3.2
Helped me understand the use of modeling or real world applications in my teaching	55	3.1
Provided me with instructional strategies, techniques, or pedagogical approaches	59	3.0
Increased my content knowledge	58	3.0
Helped me align instruction to the NGSS	56	2.8
Helped me align instruction to the CA Math Standards or CCSS-M	57	2.7
Helped me align instruction to NGSS Engineering Practices	55	2.7
Helped me re-commit to teaching	53	2.6
Taught me how to implement project based learning	58	2.6
Helped me use electronic resources or technology	56	2.6
Exposed me to STEM careers	52	2.3
Provided me with credits to attain a minor or major in math or science	36	1.6
Helped me earn a masters degree	34	1.2

Table 2.6 below shows items focused on how the professional development training might be helpful to improve student achievement in the STEM areas. Responses were again provided using a Likert Scale from 1 "no help" to 4 "helped a lot" with the option of "don't know" or "doesn't apply." Teachers reported, on average, that the training has helped student achievement some, but more so in: increasing student interest in math or science, and students ability to investigate STEM through real life problems and integrate STEM skills across disciplines. The achievement items had lower response rates and were rated on average lower as compared to previous items, possibly because Cohort 11 projects have not yet seen student outcomes.

Table 2.6: Training Helped Student Achievement Mean Scores by Year

Items	2015 - 16	
	n	Mean
Increase student interest in math or science	57	3.5
Students ability to investigate STEM through real life problems	56	3.1
Ability of students to integrate STEM skills across disciplines	56	3.0
Understanding of CA Math Standards or Common Core State Standards, Mathematics	56	2.9
Understanding of Next Generation Science Standards (NGSS)	56	2.8
Student grades in mathematics/science	54	2.7
Achievement on the CCSS-Mathematics Smarter Balanced Assessment Consortium (SBAC) Assessment	42	2.6
Student interest in STEM for a post secondary degree	33	2.5
Achievement on the Science CST	30	2.3
Experience STEM careers through field trips, mentorships, job shadowing and internships	33	2.2

Lastly, teachers were asked about their opinions related to their efficacy on various aspects of teaching (Table 2.7). Responses were provided on a Likert Scale with 1 "strongly disagree" to 4 "strongly agree." The items that the teachers rated highest on average were: being able to handle most discipline problems that arise in the classroom, the belief that they are making a difference in the students' lives, the ability to effectively teach English Learners in the classroom, confidence in content knowledge to be creative with instructional strategies, the ability to teach all students to high achievement levels, and effectively integrating technology into students' learning experience.

Table 2.7: Teacher Efficacy Mean Scores by Year

Items	2015 - 16	
	n	Mean
I can handle most discipline problems that arise in my classroom	55	3.5
I am making a difference in my students' lives	55	3.5
I am confident in my ability to effectively teach English Learners in my classroom	55	3.5
I am confident in my content knowledge to be creative with my instructional strategies	54	3.4
I have the ability to teach all students to high achievement levels	56	3.3
I can effectively integrate technology into my students' learning experience	56	3.1
I am confident in my ability to integrate curriculum across STEM disciplines	54	2.9
I can integrate Engineering Practices into my classroom	54	2.9
I am confident in my ability to help students understand STEM post secondary and career options	42	2.5
My students' peers influence their motivation and performance more than I do	56	2.5
Most of a student's performance depends on home environment	56	2.4
When my students fail, it is because they do not apply themselves	53	2.1

Student Outcome Results

As a US Department of Education initiative funded under the Mathematics and Science Partnership Program of the Elementary and Secondary Education Act (ESEA Title II), the California Mathematics and Science Partnership Program (CaMSP) was required to analyze student content knowledge as a federal priority for this program. Under the program guidelines, Public Works designed a student outcome study that utilized statewide assessment results from both mathematics and science tests depending on the discipline focus of the professional development activities of the partnership and the supported grade levels of participating teachers. The student outcome data presented in this report reflect two years of implementation and include results from 2015-16 and 2016-17.

This partnership identified mathematics as a core discipline and student outcomes have been measured using the mathematics Smarter Balanced Assessment Consortium (SBAC) assessment. SBAC is a research consortium funded by the US Department of Education that developed an assessment system based on the new Common Core State Standards (CCSS) in mathematics and English language arts. In California, the SBAC is administered to all students enrolled in 3rd through 8th grades, and in 11th grade and is used to measure standards-aligned mathematics content knowledge. The test items are based on standards for each grade level in elementary and middle school, while the high school test is separated by subject-matter concept (e.g. Number and Quantity, Algebra, Geometry).

For the student outcome study, PW designed a matched comparison student outcome study. Participating teachers who completed the required 84 grant hours (60 intensive hours and 24 hours of follow-up each year) are referred to as the treatment group. After the treatment group was identified at the conclusion of each year professional development activities, Public Works identified a control group of teachers matched by years of teaching, grade level taught, and educational level within the partnership participating LEAs.[8] PW requested student rosters of the treatment and control teachers and combined this information with student demographic data and SBAC results. Comparisons of mean scaled scores for students of the treatment and control teacher groups were tested for statistically significant differences using t-tests. To compare performance at each of the achievement or proficiency levels for these tests, statistically significant differences between treatment and control groups were tested using chi-squared tests. The student content assessments were analyzed for research purposes only and all individual results were kept confidential by the Public Works state evaluation team. Only pooled results are reported for the purpose of evaluating professional development initiatives, not individual teachers.

Results of the student outcome studies for this partnership are presented below. Results include summaries of the SBAC student outcome study in 2015-16 (Year 1) and all results from 2016-17 (Year 2). Because participating teachers were assigned different sets of students each year and a new control group of teachers and students were selected based on the teachers completing professional development hours (treatment group), growth from year-to-year for the partnership has not been analyzed or presented in this report.

[8] In some partnerships where only a small number of control group teachers were available, additional control teachers were identified and matched from geographically close districts participating within the same cohort of CaMSP partnerships.

Matching Procedures

Since students from the two groups (treatment and control) vary in terms of several demographic variables that are known to affect academic achievement, PW used a matching procedure called "Coarsened Exact Matching," or CEM, to create analytic sub-samples of treatment and control students from each partnership and at each grade level. These sub-samples were considerably smaller than the entire population because they included only matched control students who were "virtual twins" of treatment students. The sub-samples were matched in terms of:[9]

- Ethnicity,
- Language classification,
- Socioeconomically disadvantaged status,
- Special education designation,
- Prior achievement on the SBAC

Short of random selection and assignment to treatment and control groups, this matching method is the most robust way to account for group differences associated with achievement levels. The matched samples were used for analysis of differences between treatment and control groups.

Student Outcome Study – Mathematics

Summary of results from 2015-16 (Year 1)

SBAC mathematics results from 2015-16 provide a baseline measure for student outcomes from the first year of implementation. The Public Works matched comparison analysis of the SBAC included 1,159 students of 35 *Make the Way* teachers compared to nearly 2,400 students of 56 non-participating teachers, with a final matched analysis of 865 students in each group. These results indicated that there were no significant differences between the 5th, 7th and 8th grade treatment and control SBAC scores or achievement levels. However, 3rd and 4th grades *Make the Way* students outperformed the control group. There were too few 6th grade students to run a comparison analysis.

Results from 2016-17 (Year 2)

Academic performance and demographic data were collected for students of both treatment and control teachers, producing a database of nearly 2,800 students before matching. The matched comparison analysis included over 1,200 students of 27 participating teachers compared to nearly 1,500 students of 37 non-participating teachers, with a final matched analysis of 687 students in each group. The composition of this student population is shown in Table 2.8, along with the smaller matched subsamples, which were evenly balanced in terms of all of the matching criteria.

[9] Iacus, Stefano M., Gary King and Giuseppe Porro. 2008. "Matching for Causal Inference Without Balance Checking." http://gking.harvard.edu/files/abs/cem-abs.shtml.

Table 2.8: Demographic Profile of Treatment Students and Control Students 2016-17

	Before Matching % Students (N=2,723)		After Matching % Students (N=1,374)	
	Treatment (n=1,241)	Control (n=1,482)	Treatment (n=687)	Control (n=687)
Male	50	54*	52	52
Female	50	46	48	48
Hispanic	70***	54	73	73
African American	2	2	0	0
White	18	30***	21	20
English Only	35	51***	38	38
Limited English Proficient	31***	23	29	29
Special Education	16	21***	17	17
Socioeconomically disadvantaged	72***	54	69	69
2015-16 Mathematics SBAC met or exceeded standards	23	28**	24	24

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

On average, Project *Make the Way* treatment students outperformed the matched control students at the lower grade levels and the reverse was true among 7th and 8th grade students. In particular, a statistically significant percentage of 4th grade treatment students met or exceeded state standards. Although 7th and 8th grade control students had higher average scaled scores and achievement levels, only 7th graders average scaled scores were statistically higher among the control students (Table 2.9 & Figure 2.5).[10]

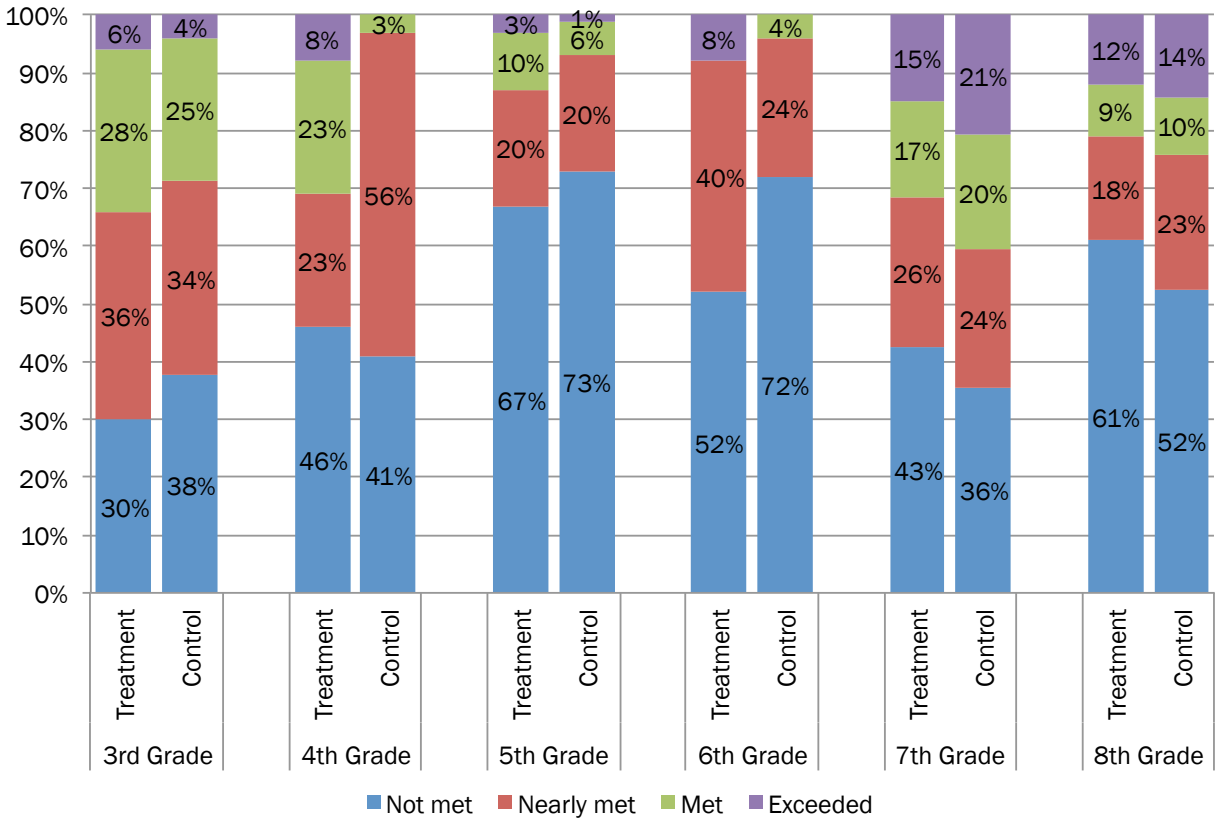
Table 2.9: SBAC Mathematics, Matched Treatment to Control, Scaled Scores and Percent Met or Exceeded Standard, 2016-17

		Average Scaled Scores			% At or Exceeded Standards		
Grade Levels	*n* (per group)	Treatment	Control	Difference	Treatment	Control	Difference
3th	80	2,407	2,400	7	34%	29%	5%
4th	39	2,426	2,400	26	31%	3%	28%**
5th	70	2,433	2,413	20	13%	7%	6%
6th	25	2,453	2,422	31	8%	4%	4%
7th	278	2,503	2,524	-21*	32%	40%	-8%*
8th	195	2,482	2,497	-15	21%	25%	-4%

*$p \leq .05$, **$p \leq .01$, ***$p \leq .001$

[10] Note that percentages in tables and figures may be slightly different due to rounding.

Figure 2.5: SBAC Mathematics, Matched Treatment to Control Achievement Levels, 2016-17



Section 3: Local Evaluation Data Collection and Analysis

The local evaluation plan includes the instruments listed below for the collection of data, analysis, and reporting during the Year 2 performance cycle (2016-17) with comparisons to Year 1 where applicable. A brief description of each instrument is included in the analysis section that describes its development, data collection timeline, status (i.e., pilot, locally designed, research-based), and use within the project's overall evaluation plan. A brief summary of findings to date can be found in Section 4 of this report. Next steps for data collection in the evaluation conclude this report.

Project *Make the Way* utilized Maker Design projects in the classroom as a vehicle for academic achievement and students' mathematical understanding and engagement, dispositions and attitudes towards mathematics and its real-world use. This section of the report focuses on:

- PW Professional Development Feedback Survey
- Teacher Attitudes Surveys
- Teacher Reflective Feedback
- Lesson Study and Portfolio Evaluation
- Student Attitudes Towards Mathematics (Surveys and Interviews)
- Ongoing Classroom Culture Survey: "Tiny Measures"
- Let's Go Learn Assessments
- Additional Analysis of SBAC Outcomes

Teacher Findings

Public Works Professional Development Feedback Survey

Each year, teachers participated in a summer institute. Feedback about this experience was collected through a survey of teacher opinions about PD activities and the quality of specific aspects of the training for the institutes held in 2015 and 2016. Teacher feedback on the professional development received in this project was consistently high. A brief summary of the feedback survey from summer 2015 and all of the 2016 results are provided below. Where relevant, comparisons between the two years are also provided.

After the Year 1 summer institute in 2015, 66 Project *Make the Way* participating teachers responded to the CaMSP professional development (PD) survey. Teachers provided their opinions about the specifics of the PD on a 4-point Likert scale ranging from "strongly disagree" to "strongly agree." Nearly all (89% to 97%) agreed to all of these items, and over half of teachers strongly agreed that the Professional Development elevated their enthusiasm for teaching (61%) and that they intended to implement new strategies learned from the training in their classrooms (58%). The individual components of the 2015 summer PD were rated excellent by between 41% and 52% of participating teachers.

Teachers also provided opinions about how prepared they were to deliver different forms of instruction. Essentially all teachers either "agreed" or "strongly agreed" that they felt prepared in these areas. However, teachers reported they felt most prepared to "understand

math concepts addressed in the standards" (45% strongly agreed) and "encourage student discussion round math concepts" (50% strongly agreed). Teachers indicated that they felt least prepared to "integrate relevant, real-life examples of mathematics into my teaching" (27% strongly agreed).

Project *Make the Way* teachers responded to a general open-ended question about the benefits of the institute that the presentations encouraged learning communities to be a safe environment for teachers and that the activities presented generated interest in using Maker ideas and projects to use in math/science or in the classroom. Teachers also valued hands on learning, collaboration with other teachers, learning and reviewing the "Five Dimensions of the Mathematical Classroom," and discussing leadership and the relationship to agency, authority and identity.

On the final day of Project *Make the Way* Year 2 summer institute in 2016, 65 participating teachers were administered the CaMSP PD survey. The following results provide the percentage of teachers that responded to each item regarding the specifics of the PD. Table 3.1 below shows that most of the *Make the Way* participating teachers agreed that the PD was useful. Most teachers strongly agreed that the Professional Development elevated their enthusiasm for teaching and that they intended to implement new strategies learned from this training into their classrooms. The lowest levels of agreement were with the statements that "this training provided me with useful information about teaching math to students with a range of math skill levels," and " in this training, the presentation of teaching pedagogy was effective."

Table 3.1: Opinions on the Professional Development from Year 2 Summer Institute (n=65)

	Strongly Disagree	Disagree	Agree	Strongly Agree
The Professional Development met my expectations	3%	8%	52%	37%
The materials distributed were relevant and useful	3%	2%	55%	41%
The Professional Development elevated my enthusiasm for teaching	3%	3%	32%	62%
The training provided me with useful information about teaching math to students with a range of math skill levels	3%	5%	63%	29%
What I learned during this training will shape how I teach math next year	3%	0%	55%	42%
I intend to implement new strategies learned from this training in my classroom	3%	0%	38%	58%
This training increased my interest in establishing a professional learning community at my school	3%	6%	61%	30%
In this training, the presentation of math content was effective	3%	6%	61%	30%
In this training, the presentation of teaching pedagogy was effective	3%	8%	61%	28%

Participating teachers also rated the quality of certain aspects of the training using a 4-point Likert scale ranging from "poor" to "excellent." In Table 3.2 below, most of the teachers rated the training as "good" or "excellent," with 48% of the teachers rating the training as excellent overall. The pedagogy or instructional methods covered were rated lowest whereas the content of the PD and the quality of the presentations were rated highest by *Make the Way* teachers.

Table 3.2: Quality of the Training at the Year 2 Summer Institute in 2016 (n=65)

	Poor	Fair	Good	Excellent
Content of professional development	0%	8%	40%	52%
Pedagogy or instructional methods covered	0%	6%	52%	42%
Relevance to the classroom	0%	12%	35%	52%
Quality of the presentations	0%	8%	51%	42%
Overall rating of training sessions	0%	5%	48%	48%

Ratings from the 2016 professional development experience were nearly identical to those from 2015. In all cases, responses were within two percentage points between the two annual feedback surveys. Open-ended responses are fairly specific to the content delivered, but teachers expressed enthusiasm for the PD experience with the most feedback related to the value of collaboration with colleagues and how to create a mathematically empowering classroom.

Teacher Attitudes Surveys

Year 1 (2015-2016) Baseline Survey: At the beginning of Project *Make the Way*, project leadership created and distributed a survey to 57 teachers to assess teacher confidence in teaching mathematics and their backgrounds related to mathematics instruction. Results were used to inform the Summer Institute development process and ongoing project activities. This initial survey indicated that *Make the Way* teachers believed they were providing mathematical instruction that was less procedural, with the belief that everyone can excel in math and that there is variation in mathematics, there is room for expanding one's math content knowledge, and that one can use many representations to solve math problems. High percentages of teachers indicated being interested in student learning, helping teachers develop teaching practices that engage the potential of each student to understand mathematics, helping teachers think more deeply about the mathematics and science they teach, and interest in understanding the Maker Movement as important potential professional outcomes from participating in the project.

Year 2 (2016-2017) Pre-Post Survey: Teachers' responses on the initial survey indicated strong agreement with most statements and very little room for growth to be observed using that instrument. Thus, for Year 2 a survey was developed that dug more deeply into attitudes towards struggle and perseverance in the mathematics classroom. The Year 2 teacher survey was administered online by Public Works twice during the 2016-17 school year. The first administration was at the beginning of the 2016 Summer Institute and the follow-up survey was given online during the month of May 2017. The survey consisted of three sections: classroom scenarios, ranking of various classroom behaviors, and degree of agreement with various statements. Forty-four teachers participated in the survey at both administrations

Three different classroom scenarios were presented and teachers were instructed to allocate 100 possible points based on the strength of agreement with their own thinking. The scenarios described: 1) cognitively demanding tasks in mathematics, 2) how they teach mathematics, and 3) the type of classroom culture that is most conducive to student learning mathematics. Full descriptions of each scenario and average results of how the teachers allocated their 100 points are presented in Table 3.3 below.

Results of the scenario section of the teacher survey indicate that teachers recognized the value of productive struggle, exploration, and growth mindset. The statements that teachers indicated they most agreed with were:

- *Regarding cognitively demanding tasks in mathematics…* The most important thing in learning mathematics is productive struggle. I help students understand the context and then students explore problem situations, try different methods – right or wrong.

- *Regarding teaching mathematics….* Exploring is the key to learning mathematics. If students explore problems, make conjectures – right or wrong—and discover things for themselves, they will understand the mathematics and how it is used.

- *Regarding classroom culture…* It is all about a growth mindset. I let students know I expect them to make mistakes and if students believe that they can learn from their mistakes, they will learn more mathematics than students with fixed mindsets.

Teachers indicated the least agreement with statements that described traditional mathematics education such as skills development, explanations, practice, and correcting wrong answers.

Teacher responses on the post-survey were very similar to those on the pre-survey; in many cases nearly identical point distributions were observed. The only scenario response with a large shift was one related to productive struggle in cognitively demanding tasks. Teachers awarded 14 more points on the post-survey than the pre-survey (57 vs. 43, respectively) to the statement "The most important thing in learning mathematics is productive struggle. I help students understand context and then students explore problem situations, try different methods - right or wrong." Most (8) of the points allocated to this response on the post-survey came from the statement "Cognitively demanding tasks must be scaffolded in order to reduce confusion and frustration. When students are confused and frustrated they easily give up and are unable to see the big mathematical idea of the task." Because the Year 2 PD activities focused on the concept of productive struggle, it was not surprising to see participating teachers embracing this concept.

Table 3.3: Teacher responses to various classroom scenarios Year 2 (n=44)

Thinking about cognitively demanding tasks in learning mathematics……	Pre-survey n=44	Post-survey n=44	Post-Pre Change
"I do cognitively demanding tasks at the end of the unit after I have taught all of the prerequisite skills to be successful. This lets me know who understands what I have taught"	17	13	-4
"The most important thing in learning mathematics is productive struggle. I help students understand context and then students explore problem situations, try different methods - right or wrong"	43	57	+14
"Cognitively demanding tasks must be scaffolded in order to reduce confusion and frustration. When students are confused and frustrated they easily give up and are unable to see the big mathematical idea of the task"	24	16	-8
"When implementing cognitively demanding tasks, I clarify any ambiguity before they begin. This will help them get started on the task. Then I can walk students that need additional help through the task"	17	16	-1
Thinking about teaching mathematics……			
"Exploring is the key to learning mathematics. If students explore problems, make conjectures - right or wrong- and discover things for themselves, they will understand the mathematics and how it is used"	37	42	+5
"The most important thing in learning mathematics is to develop logical reasoning. Once students learn how to reason logically they can see how one mathematical idea relates to another. Thus it helps them to understand mathematics."	30	31	+1
"Mathematics is about being able to solve real-world problems. In order to be able to solve these problems students should first master the prerequisite facts and skills. Mathematics should emphasize the application of facts and skills."	19	18	-1
"In learning mathematics students have to practice, practice, and practice. It's like playing a musical instrument -- they have to practice until they get it down pat."	14	9	-5
Thinking about classroom culture……			
"It's all about a growth mindset. I let students know I expect them to make mistakes and if students believe that they can learn from their mistakes, they will learn more mathematics than students with fixed mindsets."	45	49	+4
"I allow my students to explore math problems in any which way they choose - whether they get the answer correct or incorrect. When they see students present the correct solutions I expect them to revise their method."	22	26	+4
"I present my students problem solving strategies. My students work together in groups to practice solving problems using the strategies we have learned. At the end of the session I present the solutions so that they know whether they have solved the problems correctly."	19	18	-1
"My students learn from their mistakes. I let my students know when they have an answer incorrect and I expect them to correct their answers."	14	10	-4

An additional component of each question asked teachers to give open-ended thoughts to each scenario. Analysis of these responses revealed a great variety of opinions, but some common themes emerged in each area.

Teacher views regarding implementing cognitively demanding math tasks were primarily focused on specific classroom strategies such as review, practice, modeling, and chunking. The only theme that emerged from the responses was identified by use of the term frustration, which teachers recognize must be avoided in order for students to benefit from struggle. On the pre-survey responses, 12 of 43 teachers described the avoidance of frustration during cognitively demanding math tasks as an important goal. Importantly, on the post-survey open-ended responses about classroom culture, no teachers utilized any

form of the word frustration; rather they discussed struggle within the concepts of communication, collaboration, correcting mistakes, and respect for the learning process.

Forty-two teachers included open-ended responses when asked to "Please tell us about your views regarding how students learn mathematics." Many participating teachers (12 of 42 on pre-survey and 7 of 44 on post-survey) used variations of the word "explore" in their responses indicating that this teacher group recognized the value of time for exploration in their math classrooms. Other responses surrounding this concept incorporated terms such as creativity, curiosity, thinking, and learning through trial and error.

Of the teachers who elaborated on their views regarding classroom cultures that are most conducive to students' learning of mathematics there were a great variety of responses. The most commonly mentioned were: making mistakes, creating a safe, trusting place for risk taking, and the importance of a growth mindset. Other cultural aspects mentioned included: group work, heterogeneous groups, relevance, re-engagement lessons, fun, and providing a variety of experiences.

Two teachers summed up their growth during the *Make the Way* project particularly powerfully in the following statements:

> "Struggle not funnel... the most amount of growth from my students came when they struggled with different concepts in math. If it was to solve for area or perimeter of a large polygon, they developed strategies for finding the total amount of a large number. They worked with their friends and respected other strategies. They loved the idea of challenges that would GROW their brains! The youcubed challenges and maker challenges were not easy, but had access points for all. My views have changed since being a part of this collaborative. I was one of the teachers who believed you HAD to scaffold the heck out of any learning task so that all students could have access to the material. I'm sorry to say I was also one of those teachers who funneled their student to the correct answer because they had to get it right so they would do well on the test...how boring and short sighted I was. I was not helping my students to become independent thinkers and doers. I will continue to challenge myself and my students."

> "Students need to be able to explore math concepts to make the ideas and skills their own. Memorization is only a short-term solution that will eventually be lost over time. Exploration and deep understanding will strengthen ones logical reasoning which in turn allows students to internalize the math concept and make it their own allowing them to hold on to the idea longer."

Participating teachers were also asked to rank the order in which they valued various characteristics in their classrooms. Ranking results were nearly identical at both survey administrations indicating that teacher opinions regarding these characteristics did not change during Year 2 of *Make the Way*. Perseverance was the most valued classroom trait and finding the correct answer quickly was the least valued, but the remaining characteristics did not show a lot of variability between them. Classroom characteristics are listed in order of decreasing importance below. The mid-range statements had nearly identical ranking calculations and only very subtle differences so they are listed without specific ranking orders.

1) Perseverance
2) Multiple attempts towards finding a solution

3) Students responding to each others' ideas
   Students recognizing errors
   Students' mistakes and errors
   Non-routine solutions to problems
   Fluency with math facts
8) Procedural fluency
9) Finding the correct answer quickly

Interestingly, although 72% and 63% (pre- and post- survey, respectively) of teachers responded that perseverance was the most or the second most important classroom characteristic, 12% and 9% (pre- and post-survey, respectively) of the teacher group responded that perseverance is the least important classroom characteristic. Conversely, although over 70% of teachers indicated that finding the correct answer quickly was of very low importance in their classrooms, an additional 16% of teachers responded that this was either most or second most important characteristic in their classrooms at both survey administrations.

Participating *Make the Way* teachers were asked to indicate the extent to which they believed various statements. Responses were given on a seven point Likert Scale ranging from 1= Not true at all to 7 = Very true. Table 3.4 presents the results of this portion of the teacher survey listed in decreasing order of agreement as indicated by mean responses on the seven-point scale on the post-survey. *Make the Way* teachers clearly recognized the value of perseverance and productive struggle in order to learn mathematics. They were also in agreement that students are able to change their basic mathematics abilities and that there can be multiple ways to solve math problems. There was very little change in teacher responses between the pre- and the post-surveys, with the exception of 0.4 points of increasing agreement on the statement "While problem solving, it is productive to try several strategies until you find one that works." Conversely, there was a subtle decrease in agreement with the statement "People that do not struggle to understand new mathematical concepts have more math ability." The focus of Year 2 activities surrounded the concept of productive struggle so growth in these areas of teacher beliefs was an expected result.

Table 3.4: Teacher beliefs and attitudes about mathematics in Year 2 (n=44).

Please indicate the extent to which you believe the following statements:	Pre-survey n=44	Post-survey n=44	Post-Pre Change
Students must persevere through productive struggle in order to gain a deep understanding of mathematics.	6.1	6.1	0
While problem solving, it is productive to try several strategies until you find one that works.	5.5	5.9	+0.4
In mathematics you can be creative and discover things by yourself.	5.8	5.8	0
In mathematics a solution is either right or it's wrong.	3.0	3.3	+0.3
People that do not struggle to understand new mathematical concepts have more math ability.	2.1	1.8	-0.3
The best way to do well in math is to memorize all of the formulas.	2.0	1.8	-0.2
To solve math problems you have to be taught the right procedure, or you can't do anything.	1.8	1.7	-0.1
Math problems can be done correctly in only one way.	1.4	1.3	-0.1
You have a certain amount of math ability, and you really can't do much to change it.	1.3	1.3	0
You can learn new things, but you can't really change your basic math ability.	1.3	1.3	0

When asked to indicate their agreement with the statement that "In mathematics a solution is either right or it's wrong," the mean agreement level was 3 (pre-survey) and 3.3 (post-survey) on a scale of 7. Unlike most of the other statements where the mean described a relatively small amount of variation in teacher responses, responses to this statement show great variability in teacher agreement on both survey administrations (Table 3.5). By the time of the post-survey, one teacher was describing that statement as "very true."

Table 3.5: Agreement with the statement that "in mathematics a solution is either right or it's wrong" (n = 44)

	1 Not at all True	**2**	**3**	**4**	**5**	**6**	**7 Very True**
Pre-Survey	18.2% n = 8	25.0% n = 11	25.0% n = 11	15.9% n = 7	4.6% n = 2	11.4% n = 5	0% n = 0
Post-Survey	15.9% n=7	27.3% n=12	15.9% n=7	11.4% n=5	13.5% n=5	13.6% n=6	2.3% n=1

Teacher Reflective Feedback

After each of the intensive sessions, *Make the Way* teachers were asked to reflect on the session and the ongoing lesson development process. This feedback was most useful to the leadership team as it provided session-specific comments as well as informing future PD activities and sessions. In addition to session-specific prompts, the reflections comprised open-ended responses to the following:

- I learned……

- I valued …….
- I would like more information ……
- Comments:

Overall, the Year 1 feedback was extremely positive. Negative comments were primarily logistical in nature and, although perhaps warranting attention, were not relevant for the evaluation process. Significant themes included the following:

- Useful learning about NGSS
- Useful learning about the Maker Project and Maker activities
- Teachers clearly appreciated that their time was valued and the sessions were well planned and organized.
- Teachers valued time to work within their grade levels and work on their group Maker activities.
- Teachers expressed a desire for more information about the alignment of state standards with Maker activities.
- Comments regarding specific presenters were overwhelmingly positive and enthusiastic.

Responses from the Year 2 intensive sessions were also very positive. Participating teachers took the opportunity to provide specific feedback seriously as response rates were typically high and detailed responses were common. However, the feedback was usually closely tied to the specific daily activities. This feedback was critical for the project leadership and their planning purposes and it was also useful for obtaining a general sense of teacher satisfaction for evaluation purposes. A summary of themes that emerged from the teacher responses is provided below with an emphasis on those aspects most closely related to the mathematics education and the goals of the *Make the Way* project.

Daily feedback during the 2016 Summer Institute suggested that teachers greatly appreciated the content and experiences provided during the intensive experience. When the session focused on ELL and SDAIE strategies, the majority of teachers greatly valued the reminders about the importance of SDAIE instruction and the experience of learning in Spanish and how it feels to struggle in another language. Nearly all of the participating teachers valued the field trip to Autodesk and the opportunity to learn to use Tinkercad and Circuit.io. Teachers had many questions about how to incorporate the field trip experience into specific classroom experiences. Other common themes focused on the tremendous value that teachers saw in opportunities for collaboration with their *Make the Way* colleagues, lesson study groups, and school groups. The importance of fostering creativity in the mathematics classroom and building cognitive demand in students was frequently mentioned. Several teachers requested additional practice time for developing classroom skills that increased cognitive demand in students. Teachers also requested information on specific Maker tasks and project logistics that provided useful information to the project leadership.

Teacher reflective feedback from the Saturday sessions during Year 2 indicated that teachers valued the discussion surrounding productive struggle and its importance in the

mathematics classroom. Specific questioning strategies and how to use questioning for student learning were mentioned by a large number of teachers. Many teachers also commented on the value of having time to collaborate with colleagues while engaging in the Maker activities. Teachers indicated that they appreciated this time partially for the logistical ease of collaboration, but most comments cited the value of sharing information and experience as the main benefit of the time for collaboration.

Project leadership asked many questions about the desire and logistics related to a possible extension of the *Make the Way* project for an additional year. An overwhelming (85%) of participating teachers responded that they would be interested in continuing their participation if funding became available. Additional details on how that extension would develop were collected and provided critical information to the planning.

At the conclusion of the final Saturday Intensive session, the project director conducted teacher interviews in order to capture some of the teachers' thoughts about what they had learned during the project. Teachers were asked to respond to the following prompts:

- What do you understand differently about how students learn?
- Describe your experience in Make the Way.

Highlights and representative comments from these videos were complied into a short video that also includes images of the teachers and project activities (https://www.youtube.com/watch?v=d-nEFQOO-lU). Teachers' responses included "A lot of it has been about me thinking differently about my instruction," "I feel like I realized a lot more potential in student learning than I did before," and "My students think at a deeper level than I have given them credit for." Overall, teachers were impressively reflective as they spoke about the idea of providing rich, cognitively demanding tasks and letting students explore and discover without expecting all students to be successful at completing the task correctly in the beginning. Teachers explained the importance of students experiencing productive struggle and that they need to provide a safe space for that struggling.

Lesson Study and Portfolio Evaluation

Year 1 (2015-2016): During Year 1 teachers participating in *Make the Way* created portfolios of artifacts to document their own learning about the Maker mindset, Maker projects, student engagement in Mathematical Practices and students' evolving mathematical agency, authority and identity. Lesson study teams created Power Point presentations to present at a Share Case for the April 2016 PD session. Portfolio artifacts were used in these presentations as evidence to support claims regarding the lesson study process and implementation of Maker Project activities. Lesson study teams gave presentations in order for participants to watch and learn from their colleagues. Presentations were archived and also reviewed by the project director and Public Works staff.

Because the lesson study groups covered different grade levels and projects, it was difficult to directly compare the teacher experiences with the lesson study revision process. The following summary addresses broad themes revealed after watching the eleven presentations. Because the *Make the Way* project had a goal of portfolio development, analysis, and evaluation, the project's experience with different portfolio platforms is also summarized in this section.

All of the lesson teams recognized the value of creating built-in time for students to think about their approach to the challenge before they engaged in teamwork. This revision allowed the students sufficient time to consider the challenge and to consider a solution to share with the group. When this revision was made between lesson study implementations, the teachers observed more equal engagement among group participants in the latter sessions. Most groups also noted that the students were more actively engaged during the project activities than during typical classroom sessions.

The primary focus on the *Make the Way* project during Year 1 was to increase students' mathematical agency, authority and identity. The presentations and ensuing teacher discussions included many statements that agency/authority had increased because of Maker Project activities. These statements were typically accompanied by video clips showing students engaged in group work and tackling projects. However, these opinion claims were typically quite vague and there was no calibration that allowed for quantitative analysis of an increase in agency and/or authority. Future investigations related to the claim of increased mathematical agency, authority and identity would benefit from evaluation before and after the Maker Project experience and teacher calibration around these observations.

Although lesson study groups were asked to include evidence of mathematical practices in their presentations, few of the groups did so. A few groups included unsubstantiated claims that the activities showed students creating mathematical arguments while showing clips of students engaged in group work. When lesson study groups made statements about lesson study "success" they tended to focus on creation of successful products. For example, when building towers with marshmallows and toothpicks, a successful project was considered to be production of a standing tower. One goal of the *Make the Way* project was to change teacher beliefs and attitudes so that the definition of success included experiential learning and the ability to use new experiences as an important component of learning mathematical content.

During Year 1, teachers were introduced to the portfolio expectation so that teachers would be mindful about collecting evidence and documenting their lesson study experiences. There was no required format for the portfolio component and project leadership continued to grapple with effective incorporation of this aspect of the professional development.

Year 2 (2016-2017): A culminating task for the teachers in Project *Make the Way* was to summarize and share their learning with peers during the last Saturday intensive seminar, which occurred on April 22, 2017. Lesson study groups created short PowerPoint presentations that were expected to embed videos to provide evidence for student learning.

Ideally, the presentations were to focus on evidence from the different iterations of the lessons in order to highlight evidence of student struggle.

The following common themes were identified after review of the presentations and accompanying video:

1) It is important for teachers to focus on the challenge of the mathematical task and minimize other challenges related to logistics and classroom implementation. Productive struggle needs to be on the math task, not the logistics (such as cutting and taping). The less complicated the build task, the more the students were able to focus on the math and the content.
2) There is always a need for more time, which always seemed to go faster than teachers expected. Overplanning can result in rushing and ultimately less time for real struggle and real learning.
3) Students who are "good" at math often struggled with these open-ended, exploratory activities, whereas students who are "less good" at math were able to engage with the projects and do the math successfully. It is important to find the delicate balance between challenge and frustration.
4) Teachers found it challenging to support students who need extra help without giving away the answer to more capable students. This is a big concern in project based learning as teachers find their way guiding and leading, but doing less telling and talking than they have been accustomed to.
5) Don't Panic – especially over noise and student engagement in the classroom! What looks like poor classroom management can often be the sign of success in project based mathematics classrooms.

A major goal of the *Make the Way* Project was focused on attending to students' agency and authority in both mathematics learning and Maker activities. Teachers improved in their ability to use concepts about agency and authority in describing their learning, successes and challenges. In all of the presentations, teachers mentioned students' development or exercise of agency; over half alluded to the Maker challenge being a conduit for activating the students' mathematical agency. When referencing agency teachers discussed the students' willingness to engage with both the maker task and follow-up math lesson. The concept of agency was referenced in mainly binary terms - students either having or not having agency – which indicated that these teachers understood the concept but not the gradations that students likely exhibit in real life. One lesson study group highlighted the teacher role to be purposeful in the formation of collaborative groups so that students have the opportunity to develop a positive mathematical identity.

The Year 2 PD experience also emphasized the concept of productive struggle and maintaining cognitive demand during the Maker Challenges. Most of the presentations identified specific points in the lesson where students had to make meaning of the mathematics and come to agreement about a mathematical idea. Two fourth grade groups who implemented the same Maker Challenge but came to different conclusions provide an interesting illustration regarding the struggle that occurred in the learning cycle. The mathematics in the fourth grade task required students to find the area of shapes that had been cut out of dot paper with centimeter scale. It was designed to be a conceptual lesson in which students built a deep understanding of a square unit and the meaning of area measurement. Both lesson study groups encountered students erroneously counting dots to

measure area. The first group interpreted this as an unnecessary difficulty and in later iterations replaced the dot-paper with graph paper so that students could more easily count the pre-identified squares. Whereas the second group saw this as a means for students to confront their idea of counting dots with their definition of square units. This second group of teachers decided their role was to provide space where students had the opportunity to debate the competing ideas and use established mathematical terms to come to an agreement.

The teachers' noticing and discussion of productive struggle indicated that the teachers understood that productive struggle allowed opportunities for students to see themselves as problem solvers and therefore create positive mathematical identities. Project *Make the Way* asserted that students develop mathematical agency and authority through supportive engagement of cognitively demanding tasks where productive struggle is normalized. By the Year 2 presentations, none of the teachers indicated that they wanted to eliminate the mathematical struggle. Rather, they wanted to provide the right amount of struggle to push students' mathematical development.

Teachers improved in their ability to ask questions that supported student learning and maintained cognitive demand. One teacher reflected, "different types of questions result in different types of student responses." Ideally, students responded to questions that required mathematical arguments and developed understanding of the underlying mathematics. In general, the teachers discussed the importance of anticipating student responses in order to prepare good questions ahead of. However, there was no indication that teachers were revising their questions and questioning strategies during the lesson cycles themselves.

Student Findings

Student Attitudes Towards Mathematics (Surveys and Interviews)

Year 1 (2015) Student Surveys: Public Works administered a survey to students of teachers participating in Project *Make the Way* focusing on student attitudes towards mathematics. The intention was to provide a baseline measure to inform the professional development process about specific strategies and lessons that most resonated with students. Students were then interviewed at the end of the school year to examine any attitude changes towards mathematics after exposure to new strategies. *Make the Way* included teachers and students in the K-8 grade range, however students in grades K-2 were not administered a written survey due to the logistics of their readiness for a written survey. Students responded to a series of statements on a four point Likert Scale from strongly disagree to strongly agree. Mean responses are presented in Table 3.6 and show that students had overwhelmingly positive attitudes towards math and math learning at the onset of the project.

Table 3.6: Student Interest and Attitudes Towards Mathematics at the beginning of the *Make the Way* Project (n=887)

	Average
It is important that I understand why math works and makes sense.	3.6
We solve problems in more than one way.	3.6
Knowing about mathematics is important to me.	3.5
My teacher gives us time to think to ourselves before we answer.	3.5
Our class learns how math works through projects and other hands-on activities.	3.3
When one student responds to a question, my teacher continues to ask the class for other ideas.	3.3
It is important in my class that I can explain to my classmates how I solve math problems.	3.3
I am actively involved in classroom activities in my math class.	3.2
There are many chances for me to get involved in our math class.	3.2
My teacher asks us to discuss with classmates before we answer.	3.2
I like to work on math problems.	3.1
I have many opportunities to express my ideas, methods, options, and ways to solve problems when we study math.	3.1
A handful of students answer most of the math problems in our class.	3.0
I am comfortable talking about math problems with other students.	3.0
Other students respect or value my ideas about math in class.	2.9
I am interested in having a job or career that uses math.	2.8
It is important in my class that we find the right answer quickly.	2.5

Year 1 (2016) Student Interviews: Because the survey to assess student interests and attitudes showed fairly positive opinions towards mathematics and did not allow for significant room for growth, the leadership team recognized that more relevant information could be obtained in other ways. Student interviews were conducted at the end of Year 1 to better understand student mathematical identity and beliefs about learning mathematics. A convenience sample of 44 students of participating teachers was asked what makes a "good" math student. The most common responses were related to teacher comments and indicators such as test performance and seeing students levels in classroom curriculum (Table 3.7). Other common responses were related to classroom behavior and how quickly

questions were answered. Infrequently mentioned responses included references to natural ability, perseverance, and concentration.

Table 3.7: Student responses regarding what makes a good math student (n = 44)

	Number of Mentions
Outside agent: explicit teacher feedback, level indicators, test performance	22
Classroom Behavior: paying attention, eye contact, asking questions, explaining to other students, following directions, taking careful notes	16
Speed: quick responses, first to raise hand, automaticity with math facts, always having the right answers	13

Representative student comments included:

- "He passes every test. When we are doing a times test- he did them all"
- "She listens really well and understands it really quickly"
- "Our teacher tells us good job you got 100 percent or else that we need to do more"
- "She is amazing at math because she knows things instantly"

Most students refered to their teachers as the primary source of confirmation about who is a good math student and whether or not they have done well while working on math problems. Interestingly, a large number of students indicated that they recognized "good" math students as those who did their problems quickly or were the first to raise their hands in class. Yet, when asked if it is important that they solve math problems quickly in their classes, most students responded "no." Participating teachers can play an important role in noticing, praising, and developing other mathematical competencies to help shift these contradictory beliefs about speed.

Students described beliefs that struggle is a hindrance to learning mathematics and that students who struggle with mathematics are not good math students. As a result of this feedback, focusing on engaging students in productive struggle and the role that struggle plays in the process of learning became a focus of Year 1 PD activities. The student interviews also revealed an interesting disconnect between student perceptions regarding the value of explaining their answers during their math classes. Although students relied on teacher feedback to know if they have done their math well, they recognized the value of being able to explain math to their classmates. From the interviews it was also clear that students were referring to computational explanations and not conceptual or problem solving ones. When asked about checking their work, students spoke to the accuracy of the computations and not whether the operation makes sense, whether the answer is reasonable for the context or consider other methods for "checking" their work. These classroom practices all pointed towards students having procedural orientations towards doing mathematics, which provided important opportunities for teachers to help students see the bigger picture of "non-traditional" mathematical thinking.

Year 2 (2016-17) Student Surveys: Results from the interviews provided glimpses into students' thoughts about what it means to be successful in mathematics and had important

implications for professional development and training teachers to support student success. These results informed the survey development for the streamlined Year 2 student survey, which was administered as a pre- and post- survey.

The student attitudes survey was administered in the classrooms of participating *Make the Way* teachers at the beginning and at the end of the 2016-17 school year. Elementary and secondary surveys were fairly similar, but the secondary students responded to significantly more questions. Characteristics of student respondents are summarized in Table 3.8. For the elementary survey, respondents were nearly half girls and half boys (49% and 51%, respectively) at both administrations. Students were approximately one-third each 4th and 6th graders, with slightly lower numbers of 3rd and 5th graders. The secondary level survey was administered to 7th and 8th grade students. Proportionally more 8th graders took the fall survey and more 7th graders responded in the spring. Boys outnumbered girls in this student group. Students in grades K-2 were not surveyed.

Table 3.8: Student Characteristics

	Elementary Survey		Secondary Survey	
	Pre n=587	Post n=560	Pre n=171	Post n=177
Gender				
Boy	51%	51%	54%	57%
Girl	49%	49%	57%	43%
Grade Level				
3rd	13%	15%		
4th	33%	33%		
5th	21%	22%		
6th	33%	30%		
7th			44%	64%
8th			56%	36%

Students were given a list of aspects of math learning and they were asked to identify the item that they think is most important and the one that they think is least important. Responses that garnered at least 10% of student answers are summarized in Table 3.9 below. Regarding the most important aspect of math, for both grade level groups the largest percentage of students agreed that the most important thing when they do math is "That I keep trying even when it is hard." There was a slight downward shift in percentage of elementary respondents indicating this was the most important aspect from the fall to the spring surveys.

"Finding the answer quickly" was ranked as the least important aspect of math learning at all grade levels. Over the course of the 2016-17 school year, responses among elementary students regarding this question increased from 65% to 75%. Seventh and eighth graders also indicated that finding the right answer quickly was the least important aspect of math, but they also had moderate numbers of responses regarding showing answers in multiple ways, collaborative work, and finding mistakes.

Table 3.9: Student responses to what aspects of math are most and least important. Only statements with over 10% of student responses are indicated (Year 2: Elementary Pre n=587, Post n=560; Secondary Pre n=171, Post n=177).

Which Aspect of Math do you Think is *MOST* Important				
	3rd-6th Graders		**7th-8th Graders**	
	Pre	Post	Pre	Post
Finding the answer quickly				
Remembering my math facts	19%	20%	18%	14%
Remembering the rules			13%	13%
That I keep trying even when it is hard	51%	46%	40%	39%
That I can show my answer in multiple ways				
That my group can help each other				
Finding my mistakes	11%	13%	13%	16%
Which Aspect of Math do you Think is *LEAST* Important				
	3rd-6th Graders		**7th-8th Graders**	
	Pre	Post	Pre	Post
Finding the answer quickly	65%	75%	60%	62%
Remembering my math facts				
Remembering the rules				
That I keep trying even when it is hard				
That I can show my answer in multiple ways			11%	12%
That my group can help each other				12%
Finding my mistakes			12%	

Students were asked to indicate their agreement with a series of statements using the response options "Yes," "No," and "Kind Of." Seventh and eighth graders were asked more questions than the elementary students so results are presented separately in Tables 3.10 and 3.11.

Elementary students indicated the highest levels of agreement with "I like math" and "When I get stuck working on a math problem it means that I am learning." These students had the lowest levels of agreement with "If I have to struggle to figure out a math problem it means that I am not good at math" and "There is usually only one way to solve a math problem." The largest shift over the 2016-17 school year among elementary students was an 8% decrease in the percentage of students who agreed that students have to memorize many facts and rules to be good at math. This finding is in good alignment with the objectives of the PD training that these teachers have received through Project *Make the Way*.

Table 3.10: Elementary student agreement with statements about math (Year 2)

	Pre n=587			Post n=560		
Do you agree with the following statements?	**Yes**	**Kind of**	**No**	**Yes**	**Kind of**	**No**
Students who are good at math learn new math ideas quickly.	35%	50%	15%	32%	53%	15%
When I get stuck working on a math problem it means that I am learning.	57%	25%	18%	55%	32%	13%
I like math.	60%	31%	9%	55%	30%	15%
Students have to memorize many facts and rules to be good at math.	51%	34%	15%	43%	39%	18%
I enjoy working on challenging math problems.	43%	42%	15%	42%	38%	21%
If I have to struggle to figure out a math problem it means that I am not good at math.	8%	19%	73%	7%	17%	75%
It is important in math to be fast.	10%	24%	66%	9%	23%	68%
There is usually only one way to solve a math problem.	13%	17%	70%	11%	18%	71%

Secondary students had the highest levels of agreement with the following statements "It takes effort to be successful in math" and "I believe that I can do well in math." Large percentages of the secondary students did not agree that "There is usually only one way to solve a math problem." Over half of this student group did not agree that "If I have to struggle to figure out a math problem it means that I am not good at math" and "It is important in math to be fast."

Table 3.11: Secondary student agreement with statements about math (Year 2)

	Pre n=171			Post n=177		
Do you agree with the following statements?	**Yes**	**Kind of**	**No**	**Yes**	**Kind of**	**No**
I believe that I am a good math student.	34%	55%	11%	48%	40%	11%
Students who are good at math learn new math ideas quickly.	39%	43%	18%	39%	48%	13%
Students who are good at math do not struggle when they learn new ideas.	15%	43%	42%	20%	33%	47%
When I get stuck working on a math problem it means that I am learning.	42%	42%	16%	41%	41%	18%
I like math.	31%	45%	24%	41%	41%	18%
Students have to memorize many facts and rules to be good at math.	35%	42%	24%	38%	39%	23%
I am quick to understand math.	18%	50%	32%	17%	52%	31%
I enjoy working on challenging math problems.	27%	33%	40%	25%	38%	37%
In math, answers are either right or wrong.	41%	39%	20%	40%	39%	22%
People who really understand math will get an answer quickly.	37%	40%	23%	45%	37%	18%
Math is confusing to me.	26%	52%	22%	17%	51%	32%
In math, it is important to think hard about ideas.	54%	37%	9%	53%	36%	11%
In math, it is important to remember lots of methods.	58%	37%	5%	60%	34%	6%
I can tell in my answers in math make sense.	30%	55%	14%	41%	44%	15%
If I have to struggle to figure out a math problem it means that I am not good at math.	12%	33%	55%	10%	25%	65%
I believe that I can do well in math.	59%	27%	13%	62%	28%	10%
I feel bad when I make a mistake in math.	22%	32%	46%	23%	28%	49%
Math is creative.	31%	43%	26%	34%	42%	24%
It is important in math to be fast.	14%	28%	58%	13%	29%	58%
It takes effort to be successful in math.	74%	22%	4%	79%	16%	5%
It is helpful to talk about math with others.	58%	31%	12%	66%	25%	9%
There is usually only one way to solve a math problem.	9%	19%	72%	9%	22%	70%
I like to solve complex problems.	21%	38%	41%	25%	40%	35%

Secondary students showed some impressive shifts that are well aligned with what their teachers were learning in their PD experiences. As shown in Figure 3.1, there were large increases in the percentage of students who responded "yes" to statements that "I believe that I am a good math student," "I like math," and "I can tell if my answers in math make sense." Figure 3.2 shows the positive finding that large percentages of students shifted

towards "no" responses related to "Math is confusing to me," and "If I have to struggle to figure out a math problem that means I am not good at math."

Figure 3.1: Secondary student agreement with statements about mathematics showing large increases in "yes" responses between fall and spring surveys (n= 171 and n = 177, respectively)

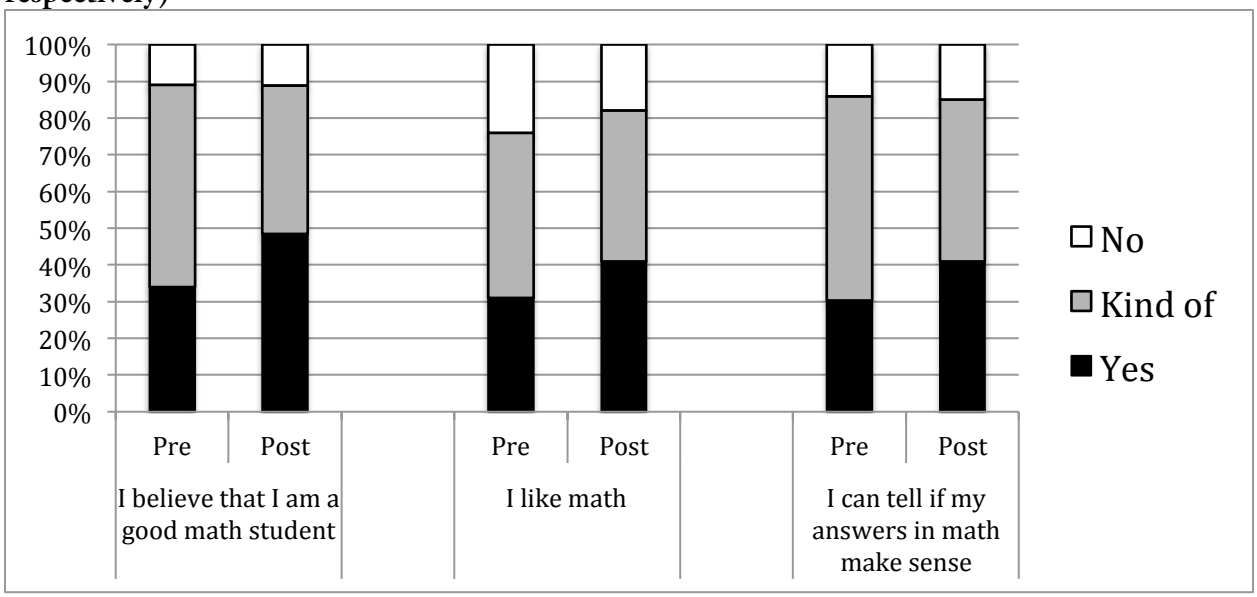
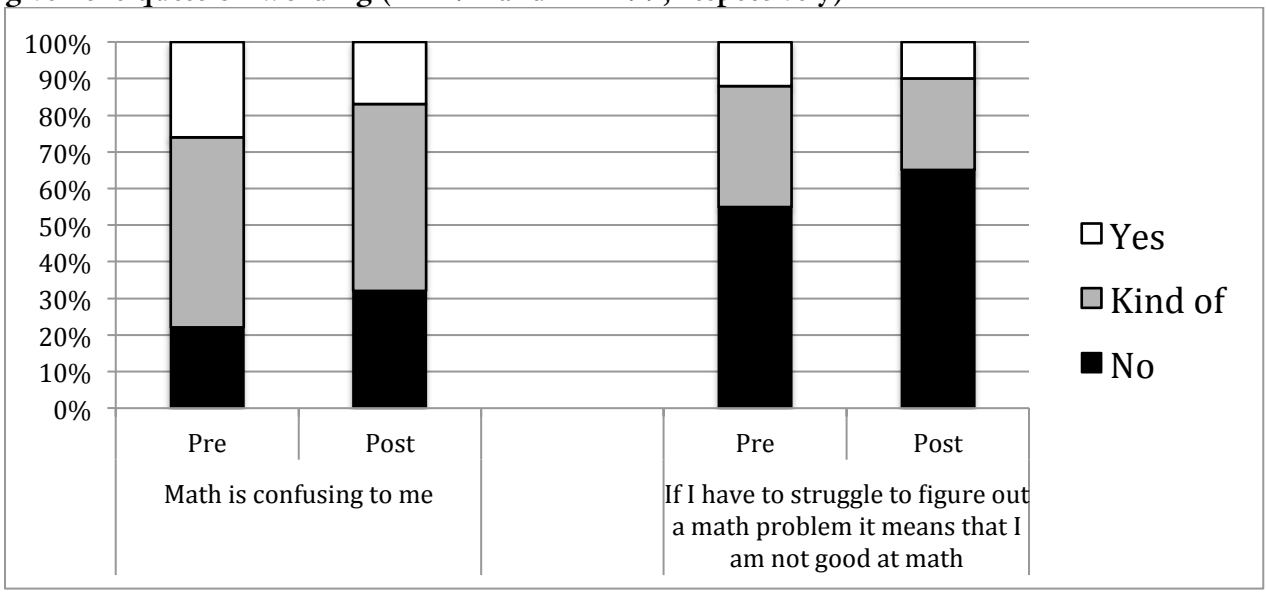


Figure 3.2: Secondary student agreement with statements about mathematics showing large increases in "no" responses between fall and spring surveys, which was a positive finding given the question wording (n= 171 and n = 177, respectively)



Ongoing Classroom Culture Survey: "Tiny Measures"

In order to monitor potential changes in classroom culture and student attitudes, project leadership developed a short survey to be administered multiple times during the 2016-17 school year. The "Tiny Measures" Survey asked students whether or not they participated in various classroom activities on that particular day. Surveys were administered in October, December, January, March and April; they were given on paper and results were analyzed by Public Works.

Data is presented as the percentage of students who responded "yes" to the five yes/no statements. Data averaged across all grade levels is presented in table 3.12 below. Frequencies of all grade levels for each of the administrations are presented in the appendix. When all months are averaged, it is clear that approximately three-quarters of the students in *Make the Way* classrooms were engaged in innovative learning strategies and had high levels of comfort with mathematics. In most cases, the majority of students in the classrooms of participating *Make the Way* teachers were working collaboratively and sharing ideas with their groups and classmates. When students found the material difficult, the large majority of them continued working and trying to understand

Table 3.12: Frequency data from the "Tiny Measures" surveys. Data is presented as the percentage of students who responded "yes" to the yes/no statements.

	Oct	Dec	Jan	Mar	April	*Average*
	n=678	n=619	n=517	n=503	n=394	
I worked with other students to solve math problems today.	74%	80%	74%	83%	77%	***78%***
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	64%	67%	57%	64%	68%	***64%***
I learned something because of something another student said during math class today.	69%	67%	69%	70%	65%	***68%***
I was comfortable sharing my thinking in math class today.	67%	68%	61%	61%	66%	***65%***
I found parts of today's math problem(s) difficult but continued to try to understand.	76%	71%	77%	77%	70%	***74%***

No clear trends can be seen between the five survey administrations or when data is analyzed by grade level. The number of students participating in the survey decreased with each administration from 678 in October to 394 in April. Teacher participation in the project did not decline significantly over the school year, so it is likely that the declining response rate results from "survey fatigue" on the part of either the teachers or the students.

When assessing differences between grade levels, it is likely that the data reflect particular classroom experiences on the day of the surveys. For instance, in October and March, 92% of 8th graders indicated that "I worked with other students to solve math problems today", yet in January only 42% of 8th graders said yes to the same question. This variation likely

reflects curricular and pedagogical choices of the teachers that day more than specific impacts of the PD experience among this teacher group.

The value of having teachers periodically ask their students about their mathematics learning cannot be determined. Regularly being asked how they felt about mathematics and how they behaved in their math classes exposed students to this type of pedagogical questioning. It is likely that these regular surveys had some positive long-term effects on this teacher and student group.

Let's Go Learn Assessments

Santa Rosa City Schools utilized the Let's Go Learn (Adaptive Diagnostic Assessment of Mathematics K-7) assessment in their elementary and middle school classes. The mathematics assessment was given two times district-wide during the 2015-16 school year.

This online adaptive test assesses a student's complete mathematical understanding and provides a comprehensive picture of each student's strengths and weaknesses. The test presents students with items across a wide range of constructs within five distinct strands: 1) Numbers and Operations; 2) Algebra; 3) Geometry; 4) Data Analysis; and 5) Measurement. Scores reflect grade level, so the results are most useful when looked at as single grade level results.

Students in participating *Make the Way* teachers' classrooms were compared to other district students' results. Results from Grade 8 students are not included because the assessment is optimized for K-7 students. Furthermore, because the first year of the *Make the Way* Project focused on measurement related projects, the results from the measurement strand of this assessment were the most relevant.

Let's Go Learn Assessment Data from Year 1 are presented in Table 3.13. Column A indicates the number of students who took the assessment in participating teachers' classrooms and non-participating teachers' classrooms for each grade level. Column B summarizes the overall annual change of those students in the classrooms of participating *Make the Way* teachers across all strands. Column C summarizes the change between the two administrations and shows the net change between participating students and non-participating students. Columns D and E focus on the measurement strand of the assessment; column D summarizes the annual change between fall and spring assessment administrations for the students in participating classrooms. Column E presents the net change between students in participating classrooms from those in other classrooms between the fall and the spring.

Table 3.13: Let's Go Learn Assessment results for K-7 students in participating *Make the Way* teachers' classrooms and other teachers in the Santa Rosa City School District (Year 1).

Column	A	B	C	D	E
				Measurement Strand	
Grade Level	n MtW/ non-MtW	MtW overall annual change over all strands	Net Change: MtW vs. Non MtW annual change across all strands	MtW participants annual change	Net change: MtW vs. non-MtW annual change
Grade K	61/434	0.43	0.06	0.17	-0.05
Grade 1	119/637	0.83	0.13	0.5	0.02
Grade 2	78/644	0.87	0.13	0.87	0.25
Grade 3	127/478	0.68	0.11	0.61	0.61
Grade 4	177/523	0.7	0.14	0.59	-0.02
Grade 5	112/513	0.43	-0.12	0.33	-0.19
Grade 6	299/331	0.51	-0.03	0.48	0.59
Grade 7	271/550	0.21	-0.04	0.17	-0.12

Although LGL was a new assessment for this district, some interesting conclusions were drawn from these results. Students in classrooms of participating *Make the Way* teachers showed approximately half a year of academic growth in mathematics across all strands across all grade levels. This result was to be expected with a full school year between the fall and the spring assessments.

Students in other classrooms where the teachers were not participating in *Make the Way* also showed growth in all strands across all grade levels (not shown in Table 3.13). When the results of students in participating teachers' classrooms were compared to other students in the district there was a suggestion of greater relative improvement among the younger grade levels. Grades K-4 showed greater improvement across all strands in the classrooms of participating teachers, whereas students in grades 5, 6 and 7 showed somewhat greater relative improvement in the classrooms of non-participating teachers.

When isolating the measurement strand of the Let's Go Learn Assessment, students in classrooms of participating *Make the Way* teachers showed growth over the course of the school year ranging from a low of 0.17 grade level (in K and 7th grades) to a high of 0.87 grade level in Grade 2. When students in participating classrooms were compared to other students in the district for the measurement strand only, no strong conclusions could be drawn.

Although the assessment was also utilized in 2016-17, there was no consistency in how teachers incorporated it into their school year. Furthermore, Year 1 results were of limited value even when isolated for the measurement strand, which was aligned with Year 1PD activities. Year 2 PD activities emphasized productive struggle, which is a more general concept in mathematics education. Therefore, project leadership and Public Works did not analyze these results after Year 1.

Additional Analysis of SBAC Outcomes

In order to further investigate any possible student results that might reflect learning gaps related to socioeconomic or ethnic status, project leadership and the IHE partner asked Public Works to undertake additional analysis of the 2016 SBAC outcomes. To investigate possible differences observed in Socioeconomically Disadvantaged (SED) and English Learner (EL) students, results for these groups of students within *Make the Way* classrooms and other non-participating classrooms in the district were compared. Methodology and matching criteria were done as described above in the Student Outcome section of Section 2 of this report. Although no significant differences were observed at the program level (Table 3.14), some differences were discerned when data was disaggregated by grade level (Tables 3.15 – 3.16).

Table 3.14: SBAC Mathematics for EL and SED Students All Grade Levels, Matched Treatment to Control, Scaled Scores and Percent Met or Exceeded Standard, 2015-16

		Average Scaled Scores			% At or Exceeded Standards		
Subgroup	*n* (per group)	Treatment	Control	Difference	Treatment	Control	Difference
EL	402	2401	2397	4	9%	6%	3%
SED	708	2437	2438	-1	12%	12%	0%

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table 3.15: SBAC Mathematics for EL Students by Grade Level, Matched Treatment to Control, Scaled Scores and Percent Met or Exceeded Standard, 2015-16

		Average Scaled Scores			% At or Exceeded Standards		
Grade Levels	*n* (per group)	Treatment	Control	Difference	Treatment	Control	Difference
3rd	115	2385	2382	3	21%	13%	8%
4th	79	2402	2380	22*	8%	5%	3%
5th	67	2417	2404	14	4%	1%	3%
7th	64	2407	2426	-19	6%	5%	1%
8th	77	2405	2407	2	1%	1%	0

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table 3.16: SBAC Mathematics for SED Students by Grade Level, Matched Treatment to Control, Scaled Scores and Percent Met or Exceeded Standard, 2015-16

		Average Scaled Scores			% At or Exceeded Standards		
Grade Levels	*n* (per group)	Treatment	Control	Difference	Treatment	Control	Difference
3rd	127	2386	2381	5	23%	13%	10%*
4th	98	2412	2390	22*	11%	8%	3%
5th	102	2432	2423	9	7%	8%	-1%
7th	181	2467	2486	-18*	15%	16%	-1%
8th	198	2455	2464	9	6%	13%	-7%*

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Despite relatively small sample sizes in some grade levels, these results suggest some interesting differences in student outcomes that might be related to SED or EL status.

- Among 4th graders, EL and SED students in *Make the Way* had significantly higher average scaled scores when compared to the 4th grade EL and SED control students.
- A significantly higher proportion of 3rd grade and 8th grade SED students met or exceeded standards as compared to 3rd and 8th grade control SED students
- Seventh grade SED students in *Make the Way* classrooms had significantly lower average scaled scores when compared to 7th grade SED control students.

Curriculum Products

With a goal of at least two lesson plans per grade level over nine grades (K-8), Project *Make the Way* had plans to ultimately create 36 Maker Project lessons. These lessons were completed by the groups of participating teachers and provided to project leadership and the IHE partner. The IHE partner (Sonoma State University) plans to finalize the lesson studies and use them to improve the mathematics integration to the Maker component. The IHE plans to post the lessons online for distribution and sharing.

Section 4: Conclusions

Project *Make the Way* was a Cohort 11 partnership funded by the California Mathematics and Science Partnership (CaMSP) program. The lead agency (LEA) for this partnership was Santa Rosa City Schools (SRCS), which partnered with faculty members from several departments at the lead Institute of Higher Learning (IHE) Sonoma State University (SSU). Forty-four mathematics teachers in grades K-8 completed the two-year program, which served approximately 4,090 students from one school district. The purpose of Project *Make the Way* was to develop and use Maker Design projects in the classroom as a vehicle for academic achievement and students' mathematical understanding and engagement, dispositions and attitudes towards mathematics and its real-world use. Using intensive learning surrounding mathematics content and pedagogy and lesson study cycles, participating teachers improved their understanding of students' conceptual development of mathematics, engineering, and technology as it related to the STEM Maker curriculum.

The CaMSP grant included two annual cycles and results from the local evaluation are cumulative. The complete annual report includes all data, analyses, tables and figures; this section reflects a summary of the findings and important lessons from the evaluation.

Partnership Strengths

Based on information collected through the local evaluation, Public Works identified the following strengths and impacts of this partnership's work:

- The dedicated project director ensured a continuity of experiences throughout the professional development activities and coherent content. Project leadership reacted nimbly to concerns and processes in order to adapt to teacher and evaluation needs. The teacher group was engaged and committed to the project and rethinking how they provided mathematics instruction.
- Prior interactions between the partners established a foundation of strong communication and collaboration. Teachers were appreciative of opportunities to visit community and regional partners during the PD.
- Alignment of Maker activities, content instruction, and grade level standards and needs improved during the course of the project and showed great promise as curricular support for the expansion of Maker labs and other initiatives in the region.

Teacher Findings

Measuring Project Impact on Teachers: Teacher findings included in this section are based on analysis of data collected using several different evaluation tools including surveys, feedback from the summer professional development, and teacher reflections regarding the lesson study process. In addition, teachers participating in the program were required to complete an assessment of teacher content knowledge that was matched from pre to post.

Teacher Content Assessment: CaMSP partnerships were required to administer one of two teacher content assessments selected by the CDE STEM Office to each participating teacher, depending on its content focus of Mathematics and/or Science. *Make the Way* teachers were administered the Mathematical Knowledge for Teaching Measures (MKT)

developed by the a research consortium at the University of Michigan School of Education referred to as the Learning Mathematics for Teaching (LMT), a total of four times over the course of the grant. There were two portions of this assessment for all teachers, Number Concepts and Operations; and Patterns, Functions, and Algebra. Overall, *Make the Way* secondary teachers showed significant gains over time on the Number Concepts and Operations portion and all *Make the Way* teachers' average scores were above the national mean, after the first administration. However, only slight gains were seen on the Patterns, Functions and Algebra portion of the LMT. All teachers' scores were below or similar to the national mean (0.0) and the average for all Cohort 11 participating in the grant program.

Professional Development Experience: Based on information collected through annual surveys and teacher reflective feedback, teachers had high levels of satisfaction and very positive responses for all aspects of the Professional Development experiences, pedagogical and instructional methods covered, and how to encourage student engagement in math concepts. Teachers were highly satisfied with the quality of the presenters and the overall quality of the summer activities. Teachers indicated that the project activities helped to convince them of the importance of hands-on learning and taught them about the lesson study process. Teachers particularly noted increase in student interest in math as an outcome of their PD learning. Teachers expressed gratitude for the time and experience for valuable collaboration with colleagues and how to create a mathematically empowering classroom. Integration of Maker activities into supporting the implementation of state standards for mathematics and science was identified as an area for improvement.

Teacher Attitudes Towards Math Education: Each year of the project, teachers were surveyed to assess teacher confidence in teaching mathematics and their backgrounds related to mathematics instruction. In the first year, results were used to inform the Professional Development content and activities. During the second year the survey dug more deeply into teacher attitudes towards struggle and perseverance in the mathematics classroom. Responses from the first year surveys indicated that *Make the Way* teachers were very experienced mathematics instructors who provided mathematical instruction that was creative and less procedural than traditional math education. Teachers expressed the beliefs that everyone can excel in math, there is room for expanding one's math content knowledge, and that one can use many representations to solve math problems. Because the teacher attitudes survey in the first year did not allow for significant growth over the duration of the project, the second year survey explored teacher responses to various classroom scenarios. Results of the scenario section of the teacher survey indicated that teachers recognized the value of productive struggle, exploration, and growth mindset. Teachers indicated the least agreement with statements that described traditional mathematics education such as skills development, explanations, practice, and correcting wrong answers.

Lesson Study Experience: Lesson Study teams in *The Make the Way* project collaborated to modify Maker Project activities for their own grade levels and students. Neither the lesson study process nor the modified lessons were critically evaluated, but participating teachers created portfolios and presented material to their colleagues to share successes and challenges. Common themes from this collaborative learning process are included in this

evaluation. Lesson study teams recognized the value of creating built-in time for students to think about their approaches to mathematical challenges before engaging in group problem-solving activities. Teacher opinions of "successful" projects tended to be focused on traditional definitions of success rather than recognizing the value of problem solving, mathematical fluency, and creative solutions to problems. Teachers learned that there is always a need for more time, but that overplanning often resulted in rushing the lesson and ultimately having less time for real struggle and real learning in their students. Teachers observed that oftentimes students who are "good" at math often struggled with these open-ended, exploratory activities, whereas students who are "less good" at math were able to engage with the projects and do math successfully. It is important to find the delicate balance between challenge and frustration.

Student Findings

Measuring Project Impact on Students: The summary of student findings included in this section is based on analysis of statewide assessment data of a treatment and control group of students and data collected from and data collected through the locally developed tools including an attitude and confidence survey, student interviews, and district mathematics assessments.

Student Outcomes: For the student outcome study, PW designed a matched comparison study that was conducted each year of implementation. Academic performance and demographic data were collected for students of treatment and control teachers at the conclusion of each year. SBAC mathematics results from 2015-16 indicated that there were no significant differences between the 5th, 7th and 8th grade treatment and control SBAC scores or achievement levels. However, 3rd and 4th grades *Make the Way* students outperformed the control group. There were too few 6th grade students to run a comparison analysis.

Results from 2016-17 included a database of over 1,200 students of 27 participating teachers compared to nearly 1,500 students of 37 non-participating teachers, with a final matched analysis of 687 students in each group. On average, Project *Make the Way* treatment students outperformed the matched control students at the lower grade levels and the reverse was true among 7th and 8th grade students. In particular, a statistically significant percentage of 4th grade treatment students met or exceeded state standards. Although 7th and 8th grade control students had higher average scaled scores and achievement levels, only 7th graders average scaled scores were statistically higher among the control students.

Student Attitudes: In order to assess student attitudes and behaviors towards mathematics, project leadership and Public Works utilized a variety of methods including surveys, student interviews, and periodic assessment of ongoing classroom culture. When feasible, student attitude and behavior data was analyzed to explore possible changes related to the professional development experience of participating teachers. Students in mathematics classes engaged in *Make the Way* activities reported baseline attitudes that indicated fairly positive opinions towards math and their math classes. Most students agreed that the most important thing when they did math was "That I keep trying even when it is hard." "Finding the answer quickly" was ranked as the least important aspect of math

learning at all grade levels, which is in alignment to the changes observed in teachers. Interviews with students in the classrooms of teachers participating in *the Make the Way* project indicated that students developed opinions about their own mathematical ability and success, as well as those of other students, primarily from direct teacher feedback and classroom behaviors. Interviewed students perceived struggling with math problems a negative characteristic of math learning and answering questions as evidence of fellow students' mathematical abilities. Monthly surveys to monitor changes in classroom culture and student attitudes did not reveal any significant trends, however the value of monthly reflection on math class activities may have unknown positive value for these students.

District Assessments in Mathematics: Santa Rosa City Schools utilized the Let's Go Learn assessment in their elementary and middle school classes. Students in participating *Make the Way* teachers' classrooms were compared to other district students' results. Results indicated improvement across all areas across all grade levels among both students in participating teachers' classrooms and district-wide. Slightly greater net improvements were seen in grades K-4 than in the higher grades. Only Year 1 data were analyzed and there were no consistent differences between participating students and non-participating students; this analysis was therefore discontinued in Year 2. However, when comparing the 2016 SBAC results among English Learners and Socioeconomically Disadvantaged Students in *Make the Way* to their contemporaries in other classrooms, there were indications that these students outperformed the control groups at 3rd, 4th, and 8th grade levels.

Lessons Learned

Evaluation of the *Make the Way* Project revealed several important points related to the evaluation process and growth of teachers through the professional development. The *Make the Way* evaluation focused on measuring changes in math teaching and learning using both established measures and project-customized instruments such as a teacher scenario survey, student interviews, and lesson study portfolio and reflections.

Most aspects of the evaluation process were relatively straightforward and utilized online surveys and feedback forms. During the second year of implementation, some of the evaluation instruments were modified or streamlined while others remained the same throughout the project and fit the needs of the leadership team well.

Exploring teacher attitudes around their mathematics confidence and teaching was interesting. A fairly standard self-efficacy survey administered in the first year showed high levels of confidence without much room for growth. A survey was developed for second year that allowed teachers to express their thoughts on what they valued in the mathematics classroom. Teachers indicated that they recognized the value of productive struggle, exploration, and growth mindset more than they valued traditional aspects of mathematics education such as skills development, explanation, and practice. However, many teachers still included emphasis on correct answers and speed as a component of their mathematics education beliefs. This disconnect was identified throughout the *Make the Way* Project and could be an important area for future teacher growth.

Students of participating teachers were surveyed early in the 2015-16 year in what was intended to be a pre- post-survey to assess changes in student attitudes and behaviors over the year. Although slightly different surveys were given to 3-5 graders from those given to 6-8 graders, teacher feedback indicated that the surveys for the younger grade levels required a deeper level of understanding and reading ability than those students were capable of. Survey results indicated that most students had positive opinions towards most aspects of their mathematics learning. It was determined by project leadership that there was not sufficient room for growth in this area and survey questions needed to be refined. Furthermore, the focus in the first year of this project was on student agency, authority, and identity within mathematics. The survey did not sufficiently get at this aspect of mathematics learning among the students. Thus, it was decided that more valuable information could be obtained with student interviews regarding mathematics learning than by administering a dedicated post-survey to students. The student interviews in the spring yielded useful and important information regarding student learning.

In order to continue to explore meaningful student opinions related to their mathematics learning, a simplified student survey was developed and was administered as a pre-post survey in the second year. Project emphasis for this year surrounded the concept of productive struggle, so students were asked about how they responded to difficult problems and if they saw struggling as a positive experience in the mathematics classroom. Although students indicated that they kept trying even when math is hard, they identified successful math students as those who got the correct answer quickly and knew their math facts.

During the second year students were also surveyed monthly with a very simple five-question, yes-no format surrounding their classroom culture on that particular day. Although this frequent mini-survey had great potential regarding student activities in their math classes, the results showed no systematic changes in activities or attitudes. Furthermore, the response rate declined steadily during the year suggesting that survey fatigue and logistical complications may have prevented consistent, successful data collection.

Assessment of the lesson study process by using information contained within online teacher portfolios proved more difficult than anticipated. Participating teachers struggled to gain comfort with the online portfolio system and recording the process aspects of their lesson study experience in this way proved cumbersome. Presentation of the lesson studies at the Spring Showcases and teacher reflections yielded sufficient information regarding the lesson study process for evaluation purposes.

Appendix

Results from Monthly "Tiny Measures" Surveys in Year 2 of Project *Make the Way*

		Grade Level					
OCTOBER	**Avg**	**3**	**4**	**5**	**6**	**7**	**8**
	n=678	n=82	n=185	n=125	n=164	n=52	n=64
I worked with other students to solve math problems today.	74%	80%	63%	66%	80%	81%	92%
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	64%	68%	63%	59%	65%	52%	84%
I learned something because of something another student said during math class today.	69%	67%	64%	71%	66%	77%	84%
I was comfortable sharing my thinking in math class today.	67%	80%	62%	62%	68%	48%	84%
I found parts of today's math problem(s) difficult but continued to try to understand.	76%	80%	85%	74%	77%	52%	67%
DECEMBER	n=619	n=66	n=178	n=76	n=167	n=52	n=75
I worked with other students to solve math problems today.	80%	83%	66%	70%	93%	88%	81%
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	67%	79%	60%	55%	69%	69%	81%
I learned something because of something another student said during math class today.	67%	65%	60%	59%	69%	71%	85%
I was comfortable sharing my thinking in math class today.	68%	68%	60%	62%	77%	65%	75%
I found parts of today's math problem(s) difficult but continued to try to understand.	71%	71%	80%	70%	66%	67%	71%
JANUARY	n=517	n=28	n=145	n=94	n=148	n=40	n=57
I worked with other students to solve math problems today.	74%	89%	79%	80%	78%	65%	42%
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	57%	64%	63%	54%	55%	60%	44%
I learned something because of something another student said during math class today.	69%	79%	79%	66%	68%	48%	58%
I was comfortable sharing my thinking in math class today.	61%	57%	54%	72%	61%	58%	58%
I found parts of today's math problem(s) difficult but continued to try to understand.	77%	68%	84%	78%	74%	73%	74%

MARCH	n=503	n=47	n=149	n=116	n=115	n=42	n=25
I worked with other students to solve math problems today.	83%	77%	79%	81%	88%	95%	92%
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	64%	70%	52%	65%	71%	79%	72%
I learned something because of something another student said during math class today.	70%	62%	76%	61%	75%	66%	84%
I was comfortable sharing my thinking in math class today.	61%	81%	49%	54%	71%	62%	76%
I found parts of today's math problem(s) difficult but continued to try to understand.	77%	85%	82%	77%	69%	71%	84%
APRIL	n=394	n=62	n=114	n=26	n=92	n=64	n=31
I worked with other students to solve math problems today.	77%	74%	72%	88%	75%	82%	87%
I contributed to my groups (or to the class) by offering an idea about how to solve a problem today.	68%	58%	73%	69%	64%	66%	81%
I learned something because of something another student said during math class today.	65%	65%	74%	58%	72%	49%	52%
I was comfortable sharing my thinking in math class today.	66%	66%	65%	50%	67%	66%	68%
I found parts of today's math problem(s) difficult but continued to try to understand.	70%	70%	76%	58%	78%	56%	48%