ST Math Early Learning Year-end Report 2015-2016
Keck Pre-K Grant - Los Angeles County
MIND and LAUP Partnership

Executive Summary

The level of math literacy prior to entry into kindergarten is the greatest predictor of children's academic success in elementary school (Duncan et al., 2007). In an education climate of high accountability and emphasis on standards achievement, math proficiency becomes a determining factor in the success—or failure—of a child's academic career. Yet despite pervasive low math proficiency scores and the academic achievement gap that puts our most vulnerable children at risk, math instruction has changed little. Given this stalemate, the MIND Research Institute, with support from the Children and Families Commission of Orange County, applied our interactive, innovative educational approach to the development of a visually-based and developmentally-appropriate math program for pre-K children ages 3 to 5 and enrolled in formal early childhood education programs. MIND, with support of the W.M. Keck Foundation and in partnership with the Los Angeles Universal Preschool (LAUP), set out to address the critical need for high-quality math instruction in early childhood education in Los Angeles County.

The program was implemented during the 2015-2016 school year at 9 sites serving predominantly low-income Hispanic/Latino children with limited or no English Language skills. We implemented the program in Pomona Unified School District, and at other preschools and development centers in Long Beach and El Monte, serving close to 300 children. We gathered data from a subset of 76 children from three sites to include in the analyses presented in this report. As the results indicate, participating children's mathematics skills improved significantly after using MIND's program. Parent surveys also indicate favorable improvements in children's math knowledge and interest in math.

In this report, we first examine the assessment results for three sites that used MIND's program (Arroyo Elementary, Washington Elementary and Fun 2 Learn), and in which tasks to assess math proficiency were conducted prior to and after the program's use. In the second part of this report, we present the findings of parent surveys that were administered at the same three sites, also before and after the program's use.

Study 1: The effects of the pre-K program on measures of math proficiency

Methodology

Sample

A total of 90 participating children were drawn from four (4) classrooms across three different school sites. At Arroyo Elementary, one morning session class of 22 children participated. At Washington Elementary, the participating classroom had a morning and an afternoon session with a total 35 children. At Fun 2 Learn Preschool, 33 children from both the morning and afternoon sessions of two classrooms participated.

For the data analysis, we considered 76 participants for which we had a complete data set. Fourteen (14) participants were excluded because they were not able to adhere to the intervention and/or

testing schedule. A breakdown of participants by school site, session, and gender is provided in Table 1.

Table 1. Participant Breakdown by School Site, Session, and Gender.

	Arroyo	Washington	Fun 2 Learn	Total
Morning Session	14	17	16	47
Boys	9	11	8	28
Girls	5	6	8	19
Afternoon Session		13	16	29
Boys		8	8	16
Girls		5	8	13
Total	**14**	**30**	**32**	**76**

Procedure

Participating children were pre-assessed starting in early-September to early-October 2015. The children were post-assessed after completion of the program in May 2016. To prevent fatigue effects, the assessment was conducted in two short sessions. On average, assessors spent a total of 35 minutes with each child.

Assessors were individuals with experience working with young children and one was bilingual in English and Spanish. We provided training to ensure that the assessments would be administered correctly. In addition, assessors participated in mandatory practice sessions, during which they administered the test items and were trained to code responses to ensure consistent interpretation and coding.

An assessor tested each child in a one-on-one setting, in English and/or Spanish. The language used to assess a child was determined by the child's home language use, teacher's evaluation, and assessor's evaluation. Once a language was determined, the child was assessed predominantly in that language; however, when necessary, the assessors alternated between languages to maximize comprehension. Children's responses were accepted in both languages.

Measures

<u>Modified Tools for Early Assessment in Math (TEAM)</u>
TEAM is a bilingual (English and Spanish) assessment tool designed to measure mathematical knowledge of preschoolers up to second graders along research-based developmental paths known as learning trajectories (TEAM: Tools for Early Assessment in Math Teacher's Guide, 2011). TEAM is divided into two parts, which assess four mathematical strands in the California Preschool Learning Foundations: Number and Operations, Algebra, Geometry and Measurement, and Data Analysis and Probability by focusing on sub-skills such as counting and shape knowledge.

Earlier work by MIND with a similar population indicated that the standard administration within the TEAM instrument prevented a fine-grained assessment that is necessary for the current project. Therefore, in order to capture performance on each of the sub-skills covered by the pre-K curriculum, selected sections of the TEAM were administered individually. Table 2 describes each of the units within the pre-K curriculum and the corresponding section within the TEAM. The standard administration rule was altered in that the ceiling rule of two consecutive incorrect answers[1] was applied *to each of the four TEAM sub-sections* administered: Counting, Comparing and Ordering Numbers, Features of Shapes, and Patterns and Pre-Algebraic Thinking. This means that the assessor stopped each sub-section and moved on to the next after the children provided incorrect answers to two consecutive questions.

Table 2. Curriculum Coverage and Corresponding TEAM Assessment.

Game	Category	MIND Objective	Assessment
2	Geometry	Getting to know JiJi	TEAM: Shapes
3	Geometry	Focus Building	TEAM: Shapes
4	Geometry	Shape Features	TEAM: Shapes
5	Geometry, Algebra	Intro to Patterns	TEAM: Patterns
6	Number & Operations	Number Sense to 3	TEAM: Counting
7	Geometry	Grid, Sorting, Classifying	TEAM: Shapes; Patterns
8	Number & Operations	Number Sense to 7	TEAM: Counting
9	Number & Operations	Subitizing to 3	TEAM: Counting
10	Geometry	Spatial Position	TEAM: Shapes
11	Geometry	Two-Dimensional Grids	TEAM: Shapes; Patterns
12	Number & Operations	Number Sense to 10	TEAM: Counting
13	Number & Operations	Subitizing to 5	TEAM: Counting
14	Geometry, Number and Operations	Geometry	TEAM: Shapes; Patterns
15	Number & Operations	Comparing Quantities	TEAM: Comparing
16	Measurement	Measurement	TEAM: Comparing; Patterns
17	Number & Operations	Addition & Subtraction	TEAM: Counting; Comparing
18	Geometry, Algebra	Patterns	TEAM: Counting; Comparing; Patterns

[1] The TEAM manual suggests the ceiling rule of four consecutive incorrect answers to be applied to each part of the assessment. Each part of the standard TEAM includes a mix of questions focusing on two sub-skills (Part A: Counting, Comparing and Ordering Numbers and Part B: Patterns and Pre-Algebraic Thinking and Features of Shapes)

The assessment was hands-on, allowing the child to manipulate objects and number/quantity cards, in addition to verbalizing the answers to demonstrate their knowledge and understanding. The assessor read scripted statements/questions aloud and set up the materials for each test item by following the instructions printed on the assessment flipbook of the TEAM. There were specific instructions on which type of responses to consider as correct, partially correct or incorrect. For each subsection within the TEAM, a total score was calculated for each child at pre- and at post-test. One point was awarded for every correct answer; no points were awarded for incorrect answers. Questions that were partially correct were given a fractional credit of 0.5. The scores for items 37, 41, and 42 were calculated using the different weighed values as described by the TEAM Teacher's Guide. These total scores represented the total number correct for the four TEAM areas: Counting, Comparing and Ordering Numbers, Features of Shapes, and Patterns and Pre-Algebraic Thinking.

Figure 1. A task from the Comparing and Ordering Numbers sub-section of the TEAM. The child rearranged the number cards to order the numerals from least to greatest.

Number Sets

Understanding the quantity of small sets of numbers and how these quantities compare to named numerals has been shown to be related to later math achievement (Geary, 2011). To assess this skill, the number sets task from Geary (2011) was modified for a brief administration. Pairs of objects or numbers were presented in a domino-like fashion using laminated cards (Figure 2). After a training period familiarizing the child with how to recognize pairs that add up to 2, a large foam board with 12 pairs of numbers was presented to the child. The child was instructed that the task would be similar to the one completed, but that they should identify pairs that equaled three. Of the 12 pairs on the board, five pairs equaled three (were correct) and seven pairs added up to either

two or four. The identity of each selected card, whether it was a card that equaled three, and the order in which it was selected were recorded by the assessors. Each child was given a score for the task by subtracting the total number of cards they incorrectly identified from the total number of cards they correctly identified.

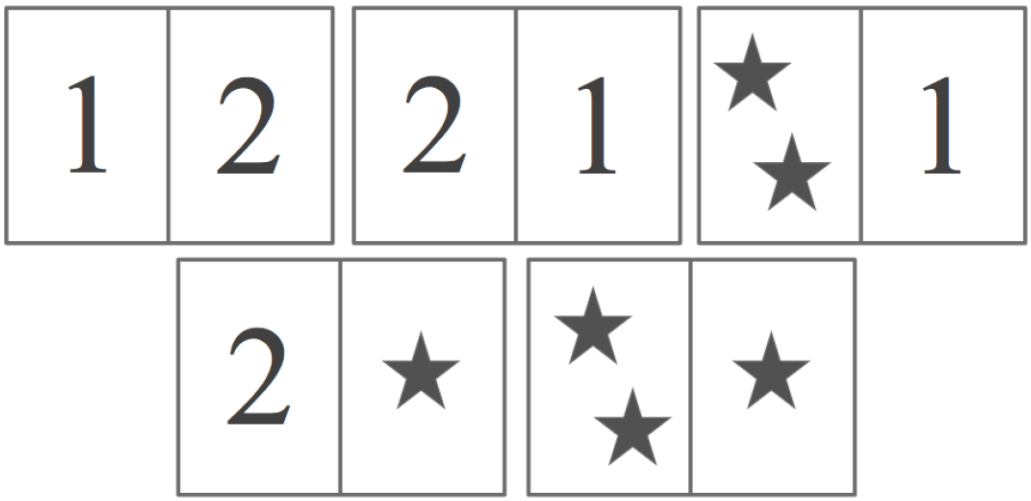

Figure 2. Five sets of the number pairs are displayed above. All these sets equal the target three.

Data Analysis

Summary statistics were calculated for each of the scores of the TEAM and the Number Sets task. T-tests were conducted to examine whether pre- to post-test gains were statistically significant.

Results

On average, children at all school sites made statistically significant ($p<.05$) gains from pre- to post-test on all measured TEAM sub-section tasks. However, only children at Arroyo Elementary showed significant gains from pre- to post-assessment of the Number Sets task. Although the children at Washington improved numerically in this task, the gain was not statistically significant. The Number Sets scores at Fun 2 Learn Preschool showed a slight decrease from pre- to post-assessment. Summary statistics displaying scores at pre- and post-test and calculated gains for each school are shown in Tables 3 through 7.

Table 3. Counting Skills: Pre-Post Differences Broken Down by School.

	Pre-Test				Post-Test				Change
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Arroyo (N = 14)	7.00	5.36	0	15	11.64	4.22	6	17	4.64
Washington (N = 30)	4.63	4.06	0	15	10.63	4.96	0	17	6.00
Fun 2 Learn (N = 32)	3.84	3.20	0	12	9.25	4.28	3	16	5.41

Table 4. Comparing & Ordering Numbers: Pre-Post Differences Broken Down by School.

	Pre-Test				Post-Test				Change
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Arroyo (N = 14)	2.5	2.14	0	8	4.57	2.79	0	10	2.07
Washington (N = 30)	2.83	1.72	0	7	4.53	2.67	2	11	1.70
Fun 2 Learn (N = 32)	2.03	1.31	0	6	3.69	2.31	1	10	1.66

Table 5. Patterns & Pre-Algebraic Thinking: Pre-Post Differences Broken Down by School.

	Pre-Test				Post-Test				Change
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Arroyo (N = 14)	1.14	1.10	0	3	2.86	1.17	1	5	1.72
Washington (N = 30)	1.43	1.63	0	5	2.43	1.22	0	5	1.00
Fun 2 Learn (N = 32)	0.69	1.20	0	4	2.25	1.16	0	4	1.56

Table 6. Features of Shapes: Pre-Post Differences Broken Down by School.

	Pre-Test				Post-Test				Change
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Arroyo (N = 14)	8.65	2.61	5.55	14.75	12.66	1.92	9.75	16.75	4.01
Washington (N = 30)	7.86	2.06	5.55	13.05	10.31	2.60	6.3	15.30	2.45
Fun 2 Learn (N = 32)	7.32	1.92	5.40	15.25	9.81	2.09	5.55	13.5	2.49

Table 7. Number Sets: Pre-Post Differences Broken Down by School.

		Pre-Test				Post-Test				Change
		Mean	SD	Min	Max	Mean	SD	Min	Max	
Arroyo (N = 14)	Correct	1.50	1.83	0	5	2.79	1.76	0	5	1.29
	Incorrect	3.50	2.03	1	7	2.71	1.98	1	7	-0.79
	Correct - Incorrect	-2	1.30	-4	1	0.07	1.98	-3	4	2.07
Washington (N = 30)	Correct	3.37	1.67	0	5	1.40	1.25	0	5	-1.97
	Incorrect	4.7	2.05	1	7	2.07	1.31	0	4	-2.63
	Correct - Incorrect	-1.33	0.99	-3	1	-0.67	1.94	-3	2	0.66
Fun 2 Learn (N = 32)	Correct	1.72	1.53	0	5	1.03	1.06	0	5	-0.69
	Incorrect	2.88	1.88	1	7	2.25	1.48	0	7	-0.63
	Correct - Incorrect	-1.16	1.05	-3	1	-1.22	1.45	-3	1	-0.06

Figure 3 compares the changes on each TEAM sub-skill that children demonstrated at three sites. Arroyo displayed the most amount of change compared to the other sites except for the Counting sub-section. A reason for this outcome could be to the much higher pre-test mean score achieved in this sub-section by the children at Arroyo compared to Washington and Fun 2 Learn. Both Washington and Fun 2 Learn showed comparable average gains in all the TEAM sub-sections. As seen in Figure 4, the progress percentage over time during the spring of 2016 was the lowest for Fun 2 Learn compared to the other two sites. By mid-June, the average progress for Arroyo was 95%, Washington was 83% and Fun 2 Learn was 51%.

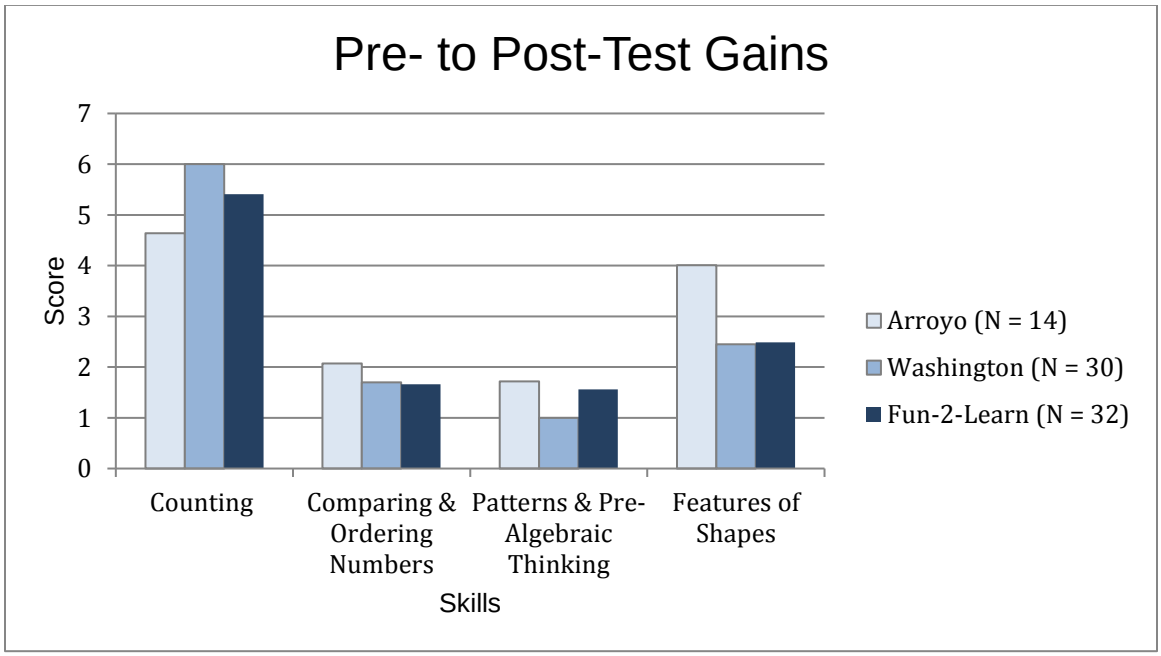

Figure 3. Change on each sub-skill from pre- to post-test by school.

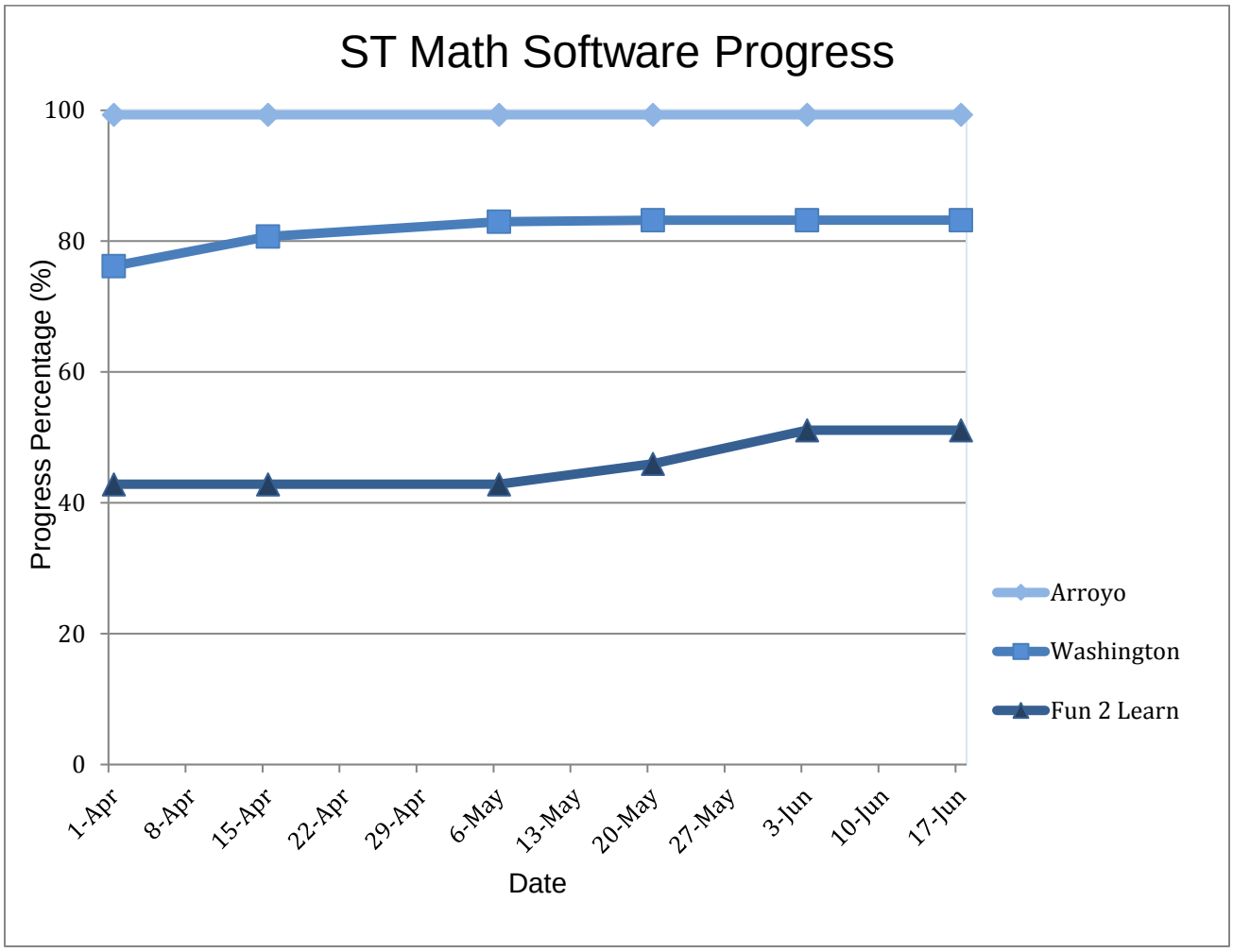

Figure 4. ST Math software progress over time during the spring of 2016 as a function of school.

Study 2: The effects of the Pre-K program as measured with parent surveys

Parent survey data was gathered to provide insights into the impact that ST Math Early Learning has on children's math knowledge beyond what was measured with the TEAM and the Number Sets task, such as the skill to divide an even set equally into two groups and the ability to use numbers on a regular basis in conversation. These data also allowed for a better understanding of how the program affected parents and children's perception of math. Surveys were collected from the same three sites, where the ST Math Early Learning Program was fully implemented.

Methodology

Sample

A total of 72 parents volunteered across the three sites - Arroyo Elementary, Washington Elementary and Fun 2 Learn Preschool - to complete a survey before their children participated in the ST Math Early Learning Program. Out of the 72 parents who filled out the survey before the start of the program, 56 returned a survey distributed at the end of the intervention. Surveys were then excluded if they were incomplete or contained errors, such as selecting two answers per question where only one was requested. The analysis discussed in this section includes the data of 46 surveys. A detailed breakdown per school site is provided in Table 8.

Table 8. Breakdown of Number of Surveys Obtained From Different Participating Sites.

	Number of Returned Pre-Surveys	Number of Returned Post-Surveys	Number of Deleted Surveys due to Errors and Missing Information	Number of Surveys Included in the Analysis
Arroyo	13	13	2	11
Washington	33	27	3	24
Fun 2 Learn	26	16	5	11
Total	**72**	**56**	**10**	**46**

Procedure

Identical surveys available in both English and Spanish were distributed to parents in October 2015 and in May 2016. The classroom teachers helped with the distribution and collection of the surveys. Teachers helped to inform parents of the purpose of the surveys and how to fill out the form correctly.

Survey

The surveys had a total of 16 questions, divided into three sections. The first section consisted of 5 questions about the child's current math performance. The answers were selected on a scale of 1 (never) to 5 (always) with the option to select "Does Not Apply", coded with a 0 value. The second section included 6 questions about children's perception of math and the last section had 5 questions about parents' perception of math and competency. For both the second and last sections, parents could select answers on a scale from 1 (strongly disagree) to 6 (strongly agree).

Data Analysis

For both surveys– one before the intervention and one after the intervention– an average for each section was calculated, yielding three values. These values represented the average across all questions for each section: Parents' Evaluation of their Child's Math Knowledge, Child's Perception of Math, and Parents' Self Perception of Math and Competency.

Summary statistics were calculated for each of these values. Then, a t-test was conducted to detect whether the first to second survey gains were statistically significant.

Results

Table 9 presents the descriptive statistics of three separate sections on the surveys across all three participating sites. The improvements parents observed in their child's math knowledge and perception of math were statistically significant ($p<.05$). However, the changes in parents' perception of math and competency in math did not reach statistical significance.

Table 9. Descriptive Statistics of Parents' Pre-Post Ratings on Three Measures Across 3 Sites.

	Pre-Survey				Post-Survey				Change
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Child's Math Knowledge	3.1	1.26	0	5	3.93	0.81	2.2	5	0.83
Child's Perception of Math	4.11	1.08	1.5	6	4.57	1.05	2	6	0.46
Parents' Own Perception of Math and Math Competency	5.09	0.85	1.8	6	5.13	0.71	3	6	0.04

Discussion

Children from all three participating sites showed significant gains in all sub-skills assessed by the TEAM: Counting, Comparing and Ordering Numbers, Features of Shapes, and Patterns and Pre-Algebraic Thinking. For the Number Sets task, Arroyo Elementary showed a statistically significant improvement. Washington Elementary displayed some improvement, though not significant, where as Fun 2 Learn Preschool results indicated a slight decline. The latter also showed a considerable lower program progress percentage compared to the other school sites. The variance in progress percentage could be one of the factors leading to the difference in the gains from pre- to post-test across these sites.

The parent surveys yielded significant, positive changes in how parents rate their child's math knowledge, along with their perception and interest in math. Though there was not a significant change in the parents' rating of their own perception of math and competency, the analysis revealed that parents' interest in math and their math competency remained high with an overall average of 5.09 out of 6 for the survey given before the intervention and 5.13 out of 6 for the survey given after the intervention. Overall, data gained provided a strong indication that ST Math Early Learning program is a promising tool for improving children's math knowledge and enhancing their interest in math.

Overall Study Summary

MIND Research Institute would like to thank the W.M. Keck Foundation for funding the ST Math: Early Learning Program pilot in Los Angeles County schools. It has been extremely beneficial for us to gain insight and make improvements to the program based on data analysis and teacher feedback. Startup processes have been improved and game levels have been refined. Professional development training sessions have been updated to address areas where implementation could be improved.

We also appreciate LAUP for providing the technology for schools and for their support with training and implementation of the program. The iPads that LAUP loaned out to the schools and supported over the years was instrumental to student access to the program's software component.

Not only did teachers receive a beneficial tool for teaching math, but also professional development support for both ST Math implementation and math, in general. Students gained a deeper understanding of the math that is a prerequisite for success in Kindergarten math concepts.

The data gathered over the past three years supports positive results for four year-olds in the pre-K classroom. However, with the transitional kindergarten programs now mandated by the state, many classrooms are adding three year-olds to complete enrollments. This led to reduced numbers of four year-old students using ST Math in pre-K over the past two years.

The districts and schools in the pilot have enjoyed using ST Math and feel that their students benefited from this unique approach to teaching math. The most successful implementations were with fully credentialed pre-K teachers, while certificated teachers required a great deal more support and assistance to implement with fidelity.

Schools that exhibited supportive leadership from Early Learning Coordinators received tremendous encouragement and coaching, which in turn led to a positive, notable impact on the implementation of ST Math in their classrooms. Early Learning administrators with strong program buy-in worked closely with MIND Education Consultants to provide program training and on-site curriculum coaching to pre-K teachers. This relationship proved effective in the program implementation in Pomona Unified School District (USD).

Parents and teachers in Pomona USD, in particular, are excited to see pre-K students continue the ST Math legacy in kindergarten and years beyond. Kindergarten teachers appreciate the idea of pre-K students coming in with an ST Math background. Our hope is to one day receive funding to carry out a longitudinal study to measure the impact of ST Math on pre-K pilot students in math in the years following their pre-K math experience.

Students love JiJi and are excited to continue using ST Math in elementary school. Eight of the nine pilot sites were interested in continuing the ST Math Early Learning Program. At the time of this report, however, it is likely that we will lose some LAUP-supported sites as they are facing school closures due to lack of funding. Pomona USD, the only public school district in this study, has two new sites that would like to use ST Math, but does not have sufficient funding at this time to acquire the program. Both MIND and the district are looking for sources of funding to assist Pomona USD in bringing the early learning program to more students and teachers.

Again, we are grateful for the Foundation's partnership in this project. The pilot has provided lessons learned that help us improve our program offering for this young, yet critical age as students build the foundations of learning and loving math for years to come.

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