Elementary Science Lab Outreach Efforts:

Extending Science Lessons to Support Improvements in Students' Study Skills and Math Performance in Grades 4, 5, and 6

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I. OVERVIEW:

Elementary Science Lab Outreach Efforts was a school-year-long project designed to marry scientific process skills with an effort to improve critical math skills for inner-city student in the 4th, 5th, and 6th grades. Approximately 53 students actively participated in this project: students helped in the design and evaluation of investigation process steps, identified and evaluated study methods, charted outcome data, and acted as subjects in the project. The investigation sought to determine the most effective study methods to improve student competence with 8 multiplication tables. ("Competence" here was understood to be a combination of accuracy and speed with single digit multiplication facts.) SMART Board – based activities became the key and critical motivational support for participants, who understood that their active roles in the project would result in St. Joseph's ability to retain ownership of the SMART Board. To determine final outcomes of this project, standardized test scores from Fall, 2007 and Spring, 2008 were compared, using the Iowa Test of Basic Skills –"ITBS." Various specific and related skills sections of the ITBS data were examined and significant improvements were noted. In many cases, individual students who were performing below grade level and below the National Average showed such significant gains that the project could be considered successful in helping to "close the gap" for targeted skills with these inner-city students.

II. Methods

A total of 53 students participated in the ESLOE project: 15 students in 4th grade, 17 students in 5th grade, and 21 students in 6th grade. For each multiplication table, the project followed the same process, beginning with a pre-test consisting of 169 single-digit multiplication problems. Students were given two minutes to complete as many problems as they were able to complete and an average number of problems per minute ("ppm") was

calculated for each student. A study method was then identified and applied by students for one to two weeks, followed by a post-test measure of growth. A copy of each table's pre-test was subsequently used as that table's post-test in order to maintain consistency in measures.

Student performance data on specific and related math sections of the Iowa Test of Basic Skills ("ITBS") was also considered as a measure of impact, using Fall, 2007 scores as pre-test data, and Spring, 2008 scores as post-test data for this project. ITBS scores are reported in terms of Grade Level Equivalents* for one of the sections examined; for all other sections, student scores are reported in relation to the National Average scores. The following ITBS sections and subtests were examined, the first of which (*"Multiply with Whole Numbers")* being considered the most specific measure of impact for this project:

- Multiply with Whole Numbers
- Math Computation (*reported in Grade Level Equivalents)
- Divide with Whole Numbers
- Problem Solving – Single Step
- Problem Solving – Multi-Step

In the fall of 2007. Students were informed of the project, their participation as investigators and subjects, and the reward for their efforts: the school would maintain ownership of the SMARTBoard. Students began by identifying study methods that they felt would be most effective. Responses were somewhat predictable and represented those common methods typically used to memorize multiplication facts: use of flash cards, repeated writing of facts, and verbal review with a parent. For the most part, a single study method was applied to each multiplication table studied and included the following methods, listed in approximate order of application in the project:

- flash cards – individual study
- flash cards – buddy study
- repetitive writing – longer assignments (each fact of a single table written 10 or more times per assignment)
- repetitive testing (used by the mathematics teacher as part of the curriculum)
- conceptual instruction – using "counting on" method, understanding multiplication as repeated addition

- modified repetitive writing -- only those facts missed on the pre-test
- repetitive writing – more frequent, but shorter assignments (each fact of a single table written 3 to 4 times per assignment)
- using logic to assist memorization – used with the 4x and 8x tables
- using patterns to assist memorization – used with the 9x table
- oral repetition of facts by groups of students

A variety of motivational methods were also included in this project. Strategies used during this investigation include the following, listed in approximate order of their application in the study:

- interactive games: "Baseball Math" (http://www.prongo.com/math/index.html), using the SMARTBoard
- interactive presentation and review of charted group data, using the SMARTBoard
- "30+ Club" membership list – posting names of students and their ppm rate, for performance on timed tests that showed a rate of 30 or more problems per minute
- verbal identification of top performers -- of "all upper school" on single multiplication tables and of each grade level on single multiplication tables
- each student's personal charting of his/her pre- and post-test data
- use of SMARTBoard-based activities in other subject areas
- interactive games: the "Factor Game" by NCTM (*the National Council of Teachers of Mathematics)* (http://illuminations.nctm.org/activitydetail.aspx?ID=12), using the SMARTBoard
- competition promoted between rows of students and between grade levels for oral recitation activity/game

Two measures of impact are presented in this project. Changes in speed and accuracy on the pre- and post-tests for each multiplication table studied are considered short term improvements. As a measure of long-term improvements, this project reviewed changes noted in student performance between the fall and spring ITBS tests administered during this academic year.

III. Science Methods – Considerations

It should be noted that the ESLOE project did not attempt to manage all variables, nor did it include a control group for comparison purposes. Presumptions regarding the impact of

this effort should be considered in that light, and the growth and improvement shown cannot accurately be attributed to this effort alone. Nevertheless, ELSOE Team members feel that conclusions regarding the positive impact of this effort are reasonable and prudent.

IV. Motivational Issues: Underlying Keys to Success?

As the ESLOE project progressed, it began to appear that a rather lengthy amount of either oral or written repetition was proving to be necessary for most students' mastery of multiplication facts. Some students actually reported that repetitive writing was indeed the most effective, if least enjoyable method for mastering these tables. By project's end, it was discovered that a reduction in the size of repetitive writing assignments, while increasing their frequency, actually served as motivation for students who had become accustomed to more lengthy assignments. The focus of the project shifted to also investigate the most effective means of maintaining student engagement and motivation.

Earlier motivational strategies that singled out individual performance levels was felt to be rather counterproductive and discouraging for students whose speed was quite a bit slower than the average or higher-performing students. The "30+ Club" and the display of charts containing full-class data (showing unnamed individual data) was terminated during the first months of the project, and other motivational methods were pursued.

It should be noted that the SMARTBoard was *so* very positively regarded by students that the mere reminder of our "prize" for completing this project was sufficient to eliminate moaning that periodically arose when students were asked to complete an activity for this project. SMARTBoard-based activities in other subject areas served to further strengthen the appeal of this technology. Powerpoint presentations, Excel spreadsheets and graphs, computer games, and interactive internet activities were presented in science and language arts classes, in addition to times when the SMARTBoard assisted in this project.

Use of SMARTBoard-based games was probably more limited than was necessary or ideal for student growth. Because each multiplication table was to be studied separately, the Team Leader limited student use of games that incorporated all multiplication facts until further along in the study, when more tables had been presented.

During the final multiplication table studied, the 7x table, students were asked to complete very short repetitive writing assignments on a fairly frequent basis. For this table, each grade also participated in a daily competition between teams of 4 to 5 students, which proved to be extraordinarily effective. Each day, all classes played for a set and equal amount of time, typically 4 to 5 minutes. During play, the project Team Leader called out a random single digit – a factor that should be multiplied by 7. The team at play was to stand and state the full fact and the correct answer, then sit down. Additionally, students were taught memory-joggers for 3 of the table's facts; students added a 4th memory jogger of their own:

- **7x3=21** (students were required to make a flying upward movement with their hands, signifying "21" as the legal age of adulthood, a point of "freedom")
- **7x5=35** (students were required to make rhythmic movements with their hands while stating the fact; they were also required to add a nodding movement of their heads when stating the product)
- **7x7=49** (a particular favorite of the Team Leader, students were required to state the fact, followed by the statement, "Your favorite, Miss Heirigs")
- **7x7=77** (students added the rhyming statement, "All the way to heaven," after stating the fact)

To stimulate competition between grade levels, and to encourage speed and competence with facts, the Team Leader also posted daily scores for each team and each grade level. This competition caused students to push themselves to finish a round quickly and without error, in order to have the greatest number of problems presented and potential points available during the timed game session. (A team "error" was also called when there was less than full participation by all team members.) This format resulted in tremendously

fast-paced rounds of play that periodically set both the students and the instructor into bouts of laughter! All students were deeply engaged and excited each time they were told it was time to play.

V. Outcomes: Comparisons of Pre- and Post-Test Timed Tests

NOTES:

1. The 6x table was inadvertently skipped, except for normal instruction and practice during math class periods.
2. The 9x table was actually presented twice, in both February and May.
3. Performance data for the 4x and 8x tables is markedly different due to two factors: (a) post-test data was not recorded for 5th or 6th graders, and (b) these tables were studied together, not separately. The study method employed for these tables sought to present a memorization strategy whereby students could simply double each 4x table fact to arrive at the 8x table facts. This proved to be a largely ineffective strategy, as reflected in student performance on these tables.

As part of the methods for this project, pre- and post-test data was captured by means of a 169-item test of single digit multiplication facts for each multiplication table. This data was sorted in various ways in order to recognize significant individual growth as well as to identify individual student mastery. Appendix A presents individual performance data, showing all students who accomplished at 50% or greater increase in speed when comparing pre-test scores with post-test scores. Higher percentage gains were often seen in students whose beginning rate was relatively low, yet these increases were felt to be notable. Appendix B displays the number of individual students who accomplished a basic level of mastery for each multiplication table. Basic mastery is shown for scores received in either the pre-test or the post-test. (NOTE: This chart presumed "basic mastery" to be represented by a pre- or post-test rate of 20 or more problems per minute -"ppm." This rate, however, is a judgment call by the project team -- there is no particular research to support the claim.) Appendix C displays the top 10 individual performers, all of whom happened to accomplish a minimum *increase* of 20 ppm on a single multiplication table.

Overall data trends suggest that while the 4th grade tended to show the highest percentage increases for each multiplication table studied, the 6th grade tended to record the fastest speeds. Of the top 10 individual performers (Appendix C), when the rating criteria is the highest net increase, 70% are 4th grade students, 30% are 5th grade students, but no 6th grade students are represented. In comparison, when considering the number of students who accomplished basic mastery level on each of the multiplication tables (Appendix B), the percentage of 4th grade students ranges from 19% to 26%, while the percentage of 6th grade students ranges from 38% to 59% of all students who accomplished mastery of individual multiplication tables. These tendencies are somewhat predictable and generally correlate with the level of experience and years of study for the target skills.

VI. Outcomes: Comparisons of Standardized Test Data

The ESLOE project used certain tests and subtests from our Fall, 2007 and Spring , 2008 standardized test data (using the Iowa Test of Basic Skills, or "ITBS") for a measure of long-term impact of this project. The fall data served as our pre-test, and the spring data served as post-test. Specific tests and subtests selected for examination included the following, which represent both the very specific ("Multiply with Whole Numbers") and other tests that the team felt were closely related measures of multiplication skills:

Math Computation
Multiply with Whole Numbers
Divide with Whole Numbers
Problem Solving -- Single Step
Problem Solving -- Multi-Step

ITBS scores are reported in one of two different ways for these tests. For Math Computation only, student scores are reported in terms of grade level equivalents, e.g. a score of 5.3 indicates that a student's performance essentially represents what would be expected in the 3rd month of the 5th grade. When analyzing this data, it is essential to note

that scores considered to be “at or above grade level” on the fall tests are not the same figure required for the spring tests. That is, for a 5th grade student, “at grade level” performance requires a fall score of 5.0 or more, but a spring score of 6.0 or more.

For all other tests, grade level equivalent scores are not available from ITBS. The project team chose to use student scores that are reported in relation to the National Average score—the available reporting option felt to be most comparable to grade level equivalent scores. With this reporting system, a score of 0 indicates that at student is performing at a level equal to the national average, positive scores indicate performance above the national average, and negative scores indicate performance below the national average. For comparison purposes, the project team applied an extended interpretation of this scoring system, and presumed that these measures also suggest students performing at grade level, above grade level, or below grade level, respectively. (For additional information on ITBS scoring, please see details available on the University of Iowa’s website that can be found at: http://www.education.uiowa.edu/itp/itbs/itbs_interp_score.htm.)

In a general overview, Fall, 2007 ITBS data shows that of the 53 students who participated in this project, only 25% were performing at or above grade level in the Math Computation section of the ITBS test; only 43% were performing at or above the National Average on the specific skill “Multiply with Whole Numbers;” and 30% of all subjects were at or above the National Average on the specific skill “Divide with Whole Numbers.” As noted in the chart below, students did in fact show growth in each of these focal areas, particularly in the more specific “Multiply with Whole Numbers” test.

ITBS TESTS:	Percentage of students at or above Grade Level or National Average Fall, 2007	Percentage of students at or above Grade Level or National Average Spring, 2008
Math Computation	25%	33%
Multiply with Whole Numbers	43%	68%
Divide with Whole Numbers	30%	53%

While achievement of grade-level or above-grade level performance might be considered the premier goal for students, positive growth in general should also be noted. The two tables below present percentages of each class who did show positive growth on each of the ITBS tests examined for this study, including related science skills. As noted in the discussion of pre- and post-test measures for each multiplication table (Section V), higher percentages are predictably noted for the 4th grade class in the Multiply with Whole Numbers and Problem Solving: Single Step tests, and on the science tests the team felt might show some benefit of this study: Critical Thinking in Science and Scientific Inquiry. These greater percentages most likely relate to the fact that more 4th graders were being introduced to these math and science skills, while most 5th and 6th grade students were reviewing and refining the skills. Happily, this data reveals that 57% of all students showed positive growth in the Multiply with Whole Numbers test; 55% showed positive growth in Division with Whole Numbers, and between 57% and 62% showed positive growth in the two science-related skills.

Number of Students Who Showed Positive Growth on ITBS Tests:
Fall, 2007 vs. Spring, 2008 Class Trends

MATH SKILLS

	Multiply with Whole Numbers		**Divide with Whole Numbers**		**Problem Solving: Single Step**		**Problem Solving: Multi-Step**	
	# of students	% of class	# of students	% of class	# of students	% of class	# of students	% of class
4th Grade	13	87%	6	40%	8	53%	5	33%
5th Grade	9	53%	8	47%	4	24%	9	53%
6th Grade	8	38%	15	71%	5	24%	8	38%
TOTALS All Grades Combined	30	57% of all students	29	55% of all students	17	32% of all students	22	42% of all students

SCIENCE SKILLS

	Critical Thinking in Science		Scientific Inquiry	
	# of students	% of class	# of students	% of class
4th Grade	11	73%	10	67%
5th Grade	9	53%	7	41%
6th Grade	13	62%	13	62%
TOTALS All Grades Combined	33	62% of all students	30	57% of all students

Individual performance data for the Math Computation and the Multiply with Whole Numbers tests, presented in Appendices D-1 through D-6, also shows that most students show positive growth in each of these tests. In a few cases, zero- or negative-growth is evidenced. For some of these, team members' knowledge of and experience with the particular students tends to confirm an atypically low performance. For others, the team might confirm that growth was in fact limited.

Appendices E-1 and E-2 contain charts displaying individual performance for all students who showed positive growth in the Multiply with Whole Numbers and the Divide with Whole Numbers tests. Appendix F presents individual gains in the Math Computation test for all students who accomplished at least a full academic year's growth. This table shows that 29 out of 53 students (55%) improved at or above the ideal level of growth. In 9 cases, students achieved an impressive two or more years' worth of growth during this single school year, with one student accomplishing 3.8 years' growth.

Appendices G-1 and G-2 continue presentation of top performing students. G-1 displays individual student scores that were at or above the national average for the Fall,

2007 Multiply with Whole Numbers test, including a total of 23 students. In the Spring, 2008 data, the number of students scoring at or above the national average on this test rose to 30 students, as shown in Appendix G-2.

Appendices H-1 (Fall, 2007 data) and H-2 (Spring, 2008 data) present all 53 students' scores on the Multiply with Whole Numbers test. It is firstly important to note that the norms applied to each of the test dates are different, according to ITBS. Of particular note when comparing patterns revealed in these charts, the negative distance (gap) from the national average has been reduced from 30 students with an average of 25 percentage points to 16 students with an average of 22 percentage points below the national average.

Finally, Appendix I presents ITBS data using class averages and percentages. These tables include measures for all mathematics tests and subtests examined, and also presents related science skills tests. Appendix I contains additional ITBS data that is not fully discussed in this section, but is addressed to a greater degree in Section VII.

VII. Conclusions, Final Reflections

In analyzing the ITBS data, the project team expected to see the most significant improvements in the "Multiply with Whole Numbers" test, and believed these improved skills would also have some impact on the remaining tests examined. The team further hoped that students might be able to improve to a degree that would suggest this project had helped to "close the performance gap" that many of our students experience. These expectations were both realized and exceeded in the Spring, 2008 ITBS data.

For tasks as grueling as rote memorization can be, the ESLOE team members have arrived at a general conclusion that motivation appears to be the key factor in determining a student's level of success. While some individuals seem to benefit from either an inherent, internally based desire to succeed, or they enjoy sufficient motivation from home, there are

also those students who cannot seem to summon nor activate sufficient engagement necessary to master critical, foundation-level skills such as those that became the focus of ESLOE.

The critical factor and key determinant of success with this project is, therefore, believed to be one of motivation. ESLOE team members are convinced that the introduction and use of SMARTBoard technology created instant and lasting motivation through the life of this investigation. Students were so thrilled with this hardware that merely turning the system on was sufficient to capture attention and interest. Even when the SMARTBoard was used simply for its projection-not its interactive capabilities- students seemed no less motivated to pay attention.

What difference did this study make for the students of St. Joseph Catholic School? Perhaps this question is best answered by reviewing data contained in Appendix I. Here, class average scores are presented for each ITBS test examined: comparing fall and spring measures, calculations of net changes, and percentages of each class that arrived at a level that matched or exceeded the national average score. ESLOE team members are thrilled by the number of students who are now positioned at a level that is more competitive with their peers. While the greatest gains appear in the most closely related ITBS tests, some growth is also noted in other test scores.

An interesting difference in readiness is suggested by the data chart for Math Skill: Multiply with Whole Numbers, found in Appendix I. At the end of the 2007-2008 school year, 53% of the 4th grade class is ready to enter 5th grade performing at or above grade level on this skill. A glance at the Fall, 2007 data for 5th grade shows that this class began their 5th grade year with only 29% of the students at or above grade level on this test. Moreover, the 4th grade enjoyed a 40% increase in grade level performance—the highest percentage

improvement of any grade level on this skill. Because multiplication is a key skill to be mastered during 4th grade, this class may enjoy the greatest benefit of the ESLOE study.

Continuing with the topic of skills and the grade level during which they are expected to be mastered, division with whole numbers is expected to be mastered during the 5th grade. The chart for Math Skill: Divide with Whole Numbers contained in Appendix I shows that the 6th grade class began the 2007-2008 school year with 57% of the students below grade level on this skill. By the conclusion of the ESLOE study, with its focus on the correlated skill of multiplication, the 6th grade class exits with a mere 9% of its students who have not yet arrived at the national average score on this skill. The 6th grade net gains were greatest of any class average gains in division.

The ITBS data suggests that the least impacted skills in math were those of single and multiple step problem solving. Summaries contained in Appendix I indicate the greatest positive growth in the 4th grade class on single-step problem solving, with an average net change of slightly over 15 percentage points. This score was accomplished by 8 individual students who showed positive net changes ranging from 26 to 93 percentage points. The gains were not extended to the skill of multi-step problem solving, however: the 4th grade showed the lowest gains of any class in that skill.

VIII. Recommendations and Next Steps

1. In an effort to keep study methods focused on single multiplication tables, this study did not utilize as many internet-based resources as we would otherwise recommend. The following websites each contain marvelous activities to support and extend competence with multiplication tables. (We will ABSOLUTELY utilize these in the coming school year!):

http://www.prongo.com/math/index.html
http://illuminations.nctm.org/activitydetail.aspx?ID=12

http://www.arcademicskillbuilders.com/games/meteor/meteor.html
http://www.brainormous.com/
http://www.gamequarium.com/multiplication.html
http://quizhub.com/quiz/f-multiplication.cfm
http://www.playkidsgames.com/mathGames.htm
http://www.bigbrainz.com/#ScrollStart (free base version)
http://www.programmingart.com/free/games/multiply/
http://www.dositey.com/addsub/memorymult.html
http://www.quia.com/jfc/66145.html
http://www.netrover.com/~kingskid/MulTab/Applet.html
http://www.mathsisfun.com/games/mathionaire-multiplication-quiz.html
http://www.mathsisfun.com/sphider/search.php?query=multiplication&search=1

2. Problem solving skills: Because the ESLOE study did not focus directly on problem solving skills, the limited impact shown in ITBS scores for single- and multi-step problem solving was disappointing across the board, but not surprising. As team members have discussed the outcomes of this study, our thoughts and planning have moved to the capabilities represented by SMARTBoard technology, when specifically targeting problem solving skills in math. Imagining an instructional period that includes problem solving strategies, but using whiteboard interactivity as a means to create and manipulate concrete images, relational maps, and other visual approaches is beyond thrilling to these two instructors! To also be able to save, copy, and print the day's illustrations for use and review as a study guide, for individualized review with students who need additional help, or to allow a departmentalized teacher to instantly move from the focus of the last 4th grade class period to the focus of the last 6th grade class period....these capabilities are all packaged and ready-to-go: they ARE our SMARTBoard! We are hopeful that this splendid technology will help us pursue another effort for "closing the gap" in problem solving skills in mathematics, continuing to help us make a difference for the children at St. Joseph's Catholic School.

APPENDIX A:

Greatest Individual Increases between Pre- and Post-Test Scores for Each Multiplication Table Studied

<u>Students who accomplished a 50% or greater increase in speed</u>

- All students combined
- "ppm" indicates "problems per minute"

3x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
56%	20.5	32.0
58%	16.5	26.0
58%	13.0	20.5
72%	38.0	65.5
90%	20.5	39.0
117%	3.0	6.5
136%	11.0	26.0
187%	11.5	33.0
264%	7.0	25.5
1800%	2.5	47.5

4x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
84%	9.5	17.5
150%	5.0	12.5

5x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
63%	12.0	19.5
93%	14.0	27.0
120%	12.5	27.5
142%	15.5	37.5
1400%	0.5	7.5

7x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
37%	19.0	26.0
51%	29.5	44.5
55%	21.0	32.5
59%	8.5	13.5
59%	16.0	25.5
60%	24.0	38.5
66%	19.0	31.5
73%	16.5	28.5
76%	23.0	40.5
88%	21.0	39.5
89%	13.5	25.5
93%	14.0	27.0
95%	11.0	21.5
100%	13.0	26.0
107%	22.0	45.5
110%	5.0	10.5
117%	9.0	19.5
129%	8.5	19.5
138%	4.0	9.5
170%	11.5	31.0
177%	6.5	18.0
179%	7.0	19.5
216%	15.5	49.0
257%	7.0	25.0
280%	5.0	19.0
350%	4.0	18.0
500%	2.0	12.0

8x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
50%	19.0	28.5
70%	11.5	19.5
85%	13.0	24.0
117%	9.0	19.5
116%	21.5	46.5
124%	19.0	42.5

129%	3.5	8.0
242%	6.0	20.5

9x Table

Net Change/ Percentage Increase	**Pre-Test Speed** *(in ppm)*	**Post-Test Speed** *(in ppm)*
50%	13.0	19.5
50%	16.0	24.0
51%	18.5	28.0
54%	6.5	10.0
55%	5.5	8.5
56%	12.5	19.5
66%	26.5	44.0
71%	17.0	39.0
71%	14.0	24.0
71%	24.5	42.0
75%	2.0	3.5
89%	9.0	17.0
105%	9.5	19.5
115%	13.0	39.0
120%	5.0	11.0
140%	2.5	6.0
156%	4.5	13.0
213%	4.0	12.5
225%	6.0	19.5

APPENDIX B:
"Basic Mastery Level" Accomplishments for Each Multiplication Table Studied

Students who accomplished a rate of 20 ppm or greater in either Pre-Test or Post-Test Scores

- All students combined
- "ppm" indicates "problems per minute"

Multiplication Tables	Number of Students with 20 ppm or greater accuracy	
	in Pre-Test Scores	***in Post-Test Scores***
3x Table	32	38
5x Table	26	32
7x Table	26	38
9x Table	17	33

NOTE: Information on the 4x and 8x tables is not shown, due to incomplete data available.

Distribution of Students who accomplished "Basic Mastery Level" by class/grade:

	Percentage of 4th Grade Students Represented in		Percentage of 5th Grade Students Represented in		Percentage of 6th Grade Students Represented in	
	Pre-Test	*Post-Test*	*Pre-Test*	*Post-Test*	*Pre-Test*	*Post-Test*
3x Table	13%	19%	28%	37%	59%	45%
5x Table	19%	28%	42%	34%	38%	38%
7x Table	19%	29%	42%	21%	50%	50%
9x Table	18%	15%	35%	33%	53%	52%

APPENDIX C:
Top 10 Students - Greatest Individual Gains
(Pre-Test vs. Post Test Data)

Students who accomplished an increase of 20 ppm or more when comparing Pre-Test vs. Post-Test data

- All students combined
- "ppm" indicates "problems per minute"

Net Gains **of 20 ppm or more** *(in ppm)*	***FROM:*** **Student's Pre-Test Score** *(in ppm)*	***TO:*** **Student's Post-Test Score** *(in ppm)*
45.0	2.5	47.5
33.5	15.5	49.0
27.5	38.0	65.5
26.0	13.0	39.0
25.0	21.5	46.5
23.5	22.0	45.5
23.5	19.0	42.5
22.0	15.5	37.5
22.0	17.0	39.0
21.0	11.5	33.0

Distribution of Top Performers by class/grade:

number of 4th graders shown:	7
number of 5th graders shown:	3
number of 6th graders shown:	0