DISTRICT SCHOOL BOARD OF NIAGARA
MISA/J.O.I.N.
COLLABORATIVE INQUIRY RESEARCH PROJECT

Background

This research study followed Junior Opportunities in Numeracy (J.O.I.N.), a project initiated in January 2008. J.O.I.N. was implemented as a possible school-based model of remediation to help struggling students in the junior grades. Because knowledge of emergent research in mathematics education is not widespread among teachers, the project also held at its centre the goal to develop teacher capacity in mathematics-for-teaching. To this end, the lead teacher (math team member) worked side-by-side in a co-teaching model with the Learning Resource Teacher, allowing both teachers' professional learning to be job-embedded.

Setting

This current research preserved both the collaborative and school-based components of the initial study but infused a research-based intervention program. It was our belief that the *Do The Math* program would allow the J.O.I.N. research to be better understood across the Board and would integrate with the mathematical capacity being developed through our board's main mathematics professional learning initiative, Supporting Understanding in Mathematics (S.U.M.).

Our inquiry centred around the following questions:

- Does the implementation of *Do The Math* build student understanding of the meaning of multiplication?
- In what ways does collaborative and job-embedded professional dialogue among mathematics teachers contribute to teachers' knowledge of mathematics-for-teaching?

Implementation

Four schools were selected because they had:

- a S.U.M. teacher who could serve as a resource and "go to" person in terms of the mathematics,
- a willing special education teacher(s),
- a principal who would support the pilot,
- a willingness to administer the *Do The Math* Beginning-of-Module and End-of-Module Assessments, and
- student groups that could be timetabled to meet during the school day outside of regular numeracy instruction.

The ISP or LR teacher who agreed to participate and the Math Facilitator/SUM teacher met with the math team for a half day to be introduced to the materials, to plan for instruction, and to engage in professional learning with respect to the multiplication continuum. We discussed ways to collect data to document student and teacher learning in the pilot. These data were largely anecdotal in nature. The Principals, as instructional leaders in their school were invited to attend all meetings.

The ISP/LR teacher continued to collaborate with the SUM teacher and that they met informally to solve any problems of practice that occurred. One member of the math team was periodically visited the schools to gather information about the effectiveness of the program, to dialogue about the students' learning, and to co-teach if that was a mutually agreed-upon decision.

There was one seconded half-day in May during which the LR/ISP teacher met with the math team to gather data in preparation for the report to MISA. To wrap up the project, we reconvened the LR/ISP teachers, the SUM teachers, and the math team in June to share both the students' learning and the teachers' learning about teaching using the resource with struggling students. This learning will significantly inform our ongoing work with struggling students.

Student Participant Selection

Student selection (8 students per group) was based on P.R.I.M.E. phases as determined by Number and/or Operations Diagnostic Tool, school data, and professional judgment. Instruction occurred for about 50 minutes roughly every other day. *Do The Math - Multiplication A - Basic Concepts* was chosen as the intervention resource. The program was

implemented by the special education teacher in collaboration with the school S.U.M. teacher. A central staff math team member was also available as a resource.

Data Collection

The pre- and post-test scores from *Do The Math* were gathered to measure students' progress numerically. Anecdotal data was also gathered from students, parents, and classroom teachers. Teachers reported their reflections on the efficacy of the program with their students, ease of use, and recommendations for future implementation through an informal interview with a central math team member.

Results

Quantitative Data

The table below reflects the quantitative results of the pre- and post-test. All data is reported in percentages.

The table shows average group gains by school. If these data are disaggregated to compare the students whose initial score was 70 or below with those whose initial score was 75 or greater (highlighted in yellow), those students having lower initial scores showed average gains of 29.2%. Those students whose initial scores were higher showed average gains of 10.5%.

	School A Struggling students		School M Struggling students		School P Struggling students		School S ISP students	
Student	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	15	70	95	100	85	95	60	90
2	55	70	80	95	70	90	65	95
3	55	80	45	95	60	85	55	95
4	65	90	80	100	85	95	65	90
5	55	85	80	90	85	75	70	100
6	55	70	80	100	85	100	65	95
7	50	60	80	100	50	85	60	95
8	35	45	55	100	80	80	70	100
9	25	50	70	100				
Average	45.6	68.9	73.9	97.8	75.0	88.1	63.8	95.0
Gains	+23.3		+23.8		+13.1		+31.2	

Qualitative Data

These data were clustered and analyzed by topic.

Teacher Considerations

Ease of Use

All four teachers reported that the *Do The Math* materials were extremely easy to use with little preparation needed for each lesson. All of the manipulatives and workbooks were ready to use.

Teacher Knowledge

The lesson plans were very well laid out with well-articulated teacher support both for the individual lessons, for the lesson cluster, and for the entire unit. Content knowledge and knowledge of mathematics-for-teaching was given so that teachers knew how to coordinate discussions. They appreciated the way they had a clearly articulated picture of where the lesson was going and the kinds of questions they could be asking. In addition, the teachers were able to see from the accompanying resource on multiplication exactly how *Do The Math* fit in with a regular program of instruction with typically developing students.

Flexibility

The lessons were short enough that they could be implemented in a 40 minute time frame. One teacher commented that he could sometimes put two lessons together if he had a longer block of time with the students.

Carry-over to Regular Instruction

One participating teacher said that other teachers with whom she worked commented that the students were better able to work productively in their regular programming.

Student Considerations

Pace

All four teachers commented that the pace of instruction was very good. They believed that their students needed the conceptual development of the resource because many of the ideas seemed new to the students. The teachers commented that students had "aha moments" that the teachers did not anticipate them having, particularly around the fundamental quantity building block that repeated addition can be represented by multiplication. The

teachers felt that this occurred as a direct result of the slowed down pace of instruction.

Materials

Three of the teachers reported that their students very much enjoyed having their own workbooks and took very good care of them. They felt that the workbooks had the look and feel of text-books and were age-appropriate in terms of the visual design of the activities. The workbooks also served as a record of previous learning which the students could look back to as needed. However, one teacher reported that her students did not like the workbooks because they seemed too juvenile.

Number of Students

All of the participating teachers found that 8 students per group (the number of workbooks in each kit) seemed to be the optimum number, allowing for both discussion with individuals and allowing enough diversity to allow productive large group discussions.

Games

All of the teachers commented that the students really enjoyed the games; the teachers found the games to be a good way to practice skills.

Confidence

Three of the teachers found that their students developed increased confidence in their ability to do math and really looked forward to their math time in the pilot. One teacher noticed that it was especially the girls in her group who became more confident, raising their hands more frequently. However, one teacher commented that her students felt that they had been centred out by the pilot and did not look forward to going to their math group.

Parents

Two of the four teachers reported that the parents of the children with whom they were working were grateful that their students were receiving the extra help. One teacher commented that parents noticed increased levels of confidence.

Structural Challenges

Two of the four teachers reported structural challenges with respect to the time that students were withdrawn from regular programming. Because

the pilot began mid-year, there was not necessarily a well-planned time for students to participate. This resulted in resistance from some classroom teachers when students were pulled from programming. In one case, students were also resistant because they were pulled from computer time during which they were to complete an assignment. Some students were pulled from their regular math class, in spite of the expectation in the beginning that this not occur. In short, some classroom teachers were unwilling to rearrange timetables and alter expectations to accommodate the remediation for some of the students.

Teacher Collaboration

Collaborative levels were high in the schools. The following are three quotations from teachers:

Collaborative and job-embedded professional dialogue among mathematics teachers contributes to teachers' knowledge of mathematics-for-teaching by giving teachers ideas to try to enhance what they may already be doing. More importantly, it builds confidence in the teacher thereby affecting the children in the same way.

Being able to collaborate with other mathematic teachers transforms the mathematic classroom into a place where children can explore math. They learn by doing, talking, investigating and synthesizing what they are experiencing when solving math problems. No longer is the teacher the sole provider of solutions to problems. Children listen to children, children learn from children. Teachers listen to teachers, teachers learn from teachers. Overall, [it's] a win-win situation.

Collaborative professional dialogue among teachers allows for seamless sharing of math knowledge. When teachers are working together, especially on common teaching practices, they are able to share their personal successes and challenges. They are able to problem solve together [to find] strategies for more effective mathematic instruction.

Wishing for more

All of the teachers commented that they wished that they had had access to subsequent *Do The Math* kits. They felt that the work they had done to improve conceptual development in mathematics was good, but that they

wished that they could have gone into higher numbers and more complex problems with their students. The teachers also wished they could start earlier in the year and progress through all 3 of the *Do The Math* kits over the course of the year. They felt confident that the gains would have been substantially higher.

Conclusions and Recommendations

Usher and Pajares (2008) confirm support for the theory that "mastery experience is a powerful source of self-efficacy" (p. 34). Michaelides (2008) states:

> In school mathematics, research has shown that perceived self-efficacy contributes to academic performance irrespective of the level of intellectual ability, and correlates strongly with academic outcomes, such as performance in problem solving, attitudes towards mathematics and math anxiety. It has also been shown to be a better predictor than ability or acquired skills, and that it mediates the influence of other determinants of academic outcomes, such as skills and past performance. (p. 222)

Past performance for the students with whom the teachers worked was not high and therefore it is important that they access tasks of academic mastery that may break the cycle of increasingly poor performance in mathematics. The teachers' implementation of Do The Math – Multiplication A contributed to student achievement as measured by test scores and thorough anecdotal data. Many students realized an increase in confidence because of their success. The resources used in the pilot may help teachers to set up such experiences.

The ease with which the teachers were able to implement the project and the way that the kit includes detailed lesson plans, clearly articulated mathematics pedagogy and teaching sequences, and all of the resources needed for all lessons and games makes *Do The Math* a good choice for remediation programs of all kinds. It is recommended that the full 3 kits for each topic be supplied to remediation teachers so that students may build conceptual understanding and mastery of concepts in a way that approaches grade level competency, where it is appropriate to individual students.

The pilot proved to be successful with virtually all of the students, with the students with the greatest learning gaps making the most progress. However, because we only had the entry level kit, it may be that those students with higher initial scores did not truly have their learning needs addressed. For this reason, we recommend administering the pre-test as a second level of screening; those students with lower scores should benefit most from participation in remediation with the A kit. It may then be appropriate to add students to the group as they move from kit A to kit B and C.

The teacher collaboration level was not as high as we anticipated. Nevertheless, the teachers felt that it was really good to have someone to whom they could go if they had an issue. They also are regularly part of a collaborative math team at the school level, so that there was a school-wide support of the entire mathematics initiative in the schools. Even the teacher resistance that some teachers reported could have been relieved by planning appropriate instructional time for remediation early in the year.

References

Michaelides, M. (2008). Emerging themes from early research on self-efficacy beliefs in school mathematics. In *Electronic Journal of Research in Educational Psychology*, N. 12, Vol. 6(1), pp. 219-234.

Usher, E.L. and Pajares, F. (2008). Sources of self-efficacy in mathematics: A validation study. In *Educational and Psychological Measurement*, Vol. 68, No. 3, pp. 443-463.