

**P**rogramming  
**R**emediation and  
**I**ntervention for  
**S**tudents in  
**M**athematics



Hamilton-Wentworth Catholic Schools  
*150 years of 'Believing, Achieving, Serving'*

**Tri-Board PRISM Project:**

**RESEARCH OVERVIEW AND RESULTS**

**April, 2006**

Brant Haldimand Norfolk Catholic District School Board  
Halton Catholic District School Board  
Hamilton Wentworth Catholic District School Board

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the Directors and Senior Administrators of the three boards and the principals of the participating schools for their support

all of the teachers and their students who gave of their time and talents and inspired all of us

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## Introduction

The *Report of the Expert Panel on Student Success in Ontario: Mathematical Literacy, Grades 7-12*, describes a vision for mathematics and makes recommendations which will give hope and create a brighter future for students who have not acquired the mathematical skills and understanding they need to succeed and are currently at risk of leaving school without an OSSD or OSSC. In order to reach the target set by Education Minister Kennedy that 75% of all students will be at or above the provincial standard by 2008, it was apparent that much work needed to be done. Teachers are the key. Effective teaching is critical for the improvement of student learning. Teachers' approaches to the teaching of mathematics are a major factor in student success. Teachers of mathematics grades 7 to 10 need a deep conceptual understanding of important mathematical ideas and how they develop. Teachers need to be able to recognize common misconceptions and the mathematical building blocks that help students move beyond their misconceptions.

Recognizing that effective teaching is critical for the improvement of student learning, the focus of this project was to build capacity with mathematics teachers grades 7 to 10. Two research based resources were used: Professional Resources and Instruction for Mathematics Educators (PRIME - researched by Dr. Marian Small at UNB, published by Thomson Nelson) and LessonLab (developed by Dr. James Stigler at UCLA, published by Pearson Professional Learning). These resources allowed us to address one of the main themes that emerged from the work of the Expert Panel:

“Teachers of mathematics need professional learning opportunities that strengthen their competence in both mathematics content and the methodology for teaching it.”... (LMS p.34)

and provided opportunities to

“...work with the Ministry to build teachers' capacity in mathematics content and pedagogy, with a focus on students at risk through ... professional learning initiatives.” (LMS p.90)

A brief description of both resources is presented in Appendix A.

## **Rationale**

This action research project involved three school boards:

- Brant Haldimand Norfolk Catholic District School Board (BHNCDSB),
- Halton Catholic District School Board (HCDSB),
- Hamilton-Wentworth Catholic District School Board (HWCDSB)

The project supports and aligns with the Student Success Action Plans of all three Boards by:

- Providing teachers with a framework to structure the mathematics they are teaching and to understand the developmental phases that children pass through as they learn mathematics concepts and skills.
- Supporting the provision of a continuum of interventions and remediation to enhance school-based transition from elementary to secondary.
- Developing sound pedagogy that will better enable the instructor to assess student needs, based on achievement and then make recommendations for remediation in specific areas of need.

PRIME was chosen because it is a Canadian, research-based continuum of mathematical skills and concepts with a diagnostic component. This research-based product enabled teachers to use a diagnostic assessment to determine the developmental phase of the students and provided the teachers with the tools and strategies to help these students experience greater success.

LessonLab was chosen as it is a scaffolded, modular approach to lesson study. The program reviews critical concepts in mathematics, and provides insight as to how students understand and learn these concepts. Strategies for teaching these concepts are discussed in order to improve teaching and learning.

LessonLab was used to investigate the impact of a Professional Learning Community (PLC) on building teacher content knowledge and utilizing sound pedagogy in lesson planning.

## Research Questions

The project attempted to address the following questions:

1. Were remediation programs more effective for certain students than others?
2. Did the use of a developmental continuum improve student understanding for the weakest students, specifically those enrolled in MAT1L?
3. Did instructional/assessment strategies change following exposure to a developmental continuum?
4. Which influenced teaching practices more:
  - the use of a developmental continuum, or
  - the use of a developmental continuum along with the establishment of professional learning communities through the use of LessonLab?

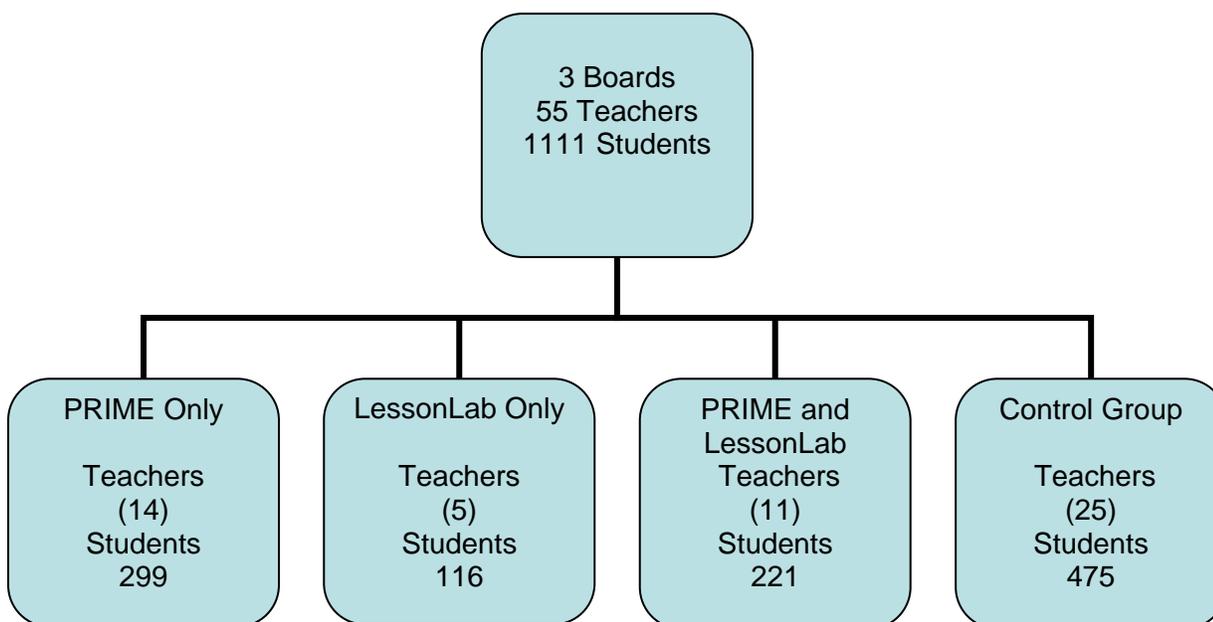
To explore these questions and to gather relevant information, the following procedures were identified for each question:

1. The PRIME diagnostic tools will be administered to all of the students that form the classes of the participating teachers. The diagnostic tool will be completed twice over the course of the project. Examination for improvement and/or growth would follow, as indicated by changes in the diagnostic scores in the Number and Operations strands, and changes indicated on the Provincial Report Card within the Number Sense strand. From the changes, students who showed significant differences would be identified. Reasons for these differences will be investigated (i.e. age, attitudes, previous marks, homework completion etc.) This will allow us to create a profile of the learner who would benefit the most from this type of intervention.
2. Responses to the PRIME Diagnostic Tool will permit a comparison to be made between students who are Level 1 or below (based on report card data) and all other students in the study. This would be accomplished by examining improvement in the total score as well as interpretation of the total score to determine the appropriate Phase for each student.
3. Input will be obtained through the use of focus groups and evaluations of in-service sessions.
4. Input will be obtained through the use of focus groups and evaluations of in-service sessions.

## Project Design

An overview of the research framework is presented in Figure 1. Our original design included 55 teachers, through attrition and teacher replacement our final number decreased to 54 teachers. The number of students involved in the project was 1111.

**Figure 1**



## Participants

### Teachers

As illustrated in Figure 1, a total of 55 teachers from the Brant Haldimand Norfolk Catholic District School Board, Halton Catholic District School Board and Hamilton-Wentworth Catholic District School Board took part in the joint project. The teachers represented a cross-section from grades 7-10. School boards identified schools based on needs, historical EQAO math assessment results and interest in the project. At the secondary level, the Grades 9 and 10 Foundations of Mathematics (applied) courses and the Locally Developed Compulsory Credit courses were targeted. Nineteen teachers participated from the elementary panel and eleven teachers from the secondary panel.

The 30 teachers who received training were divided into 3 groups:

1. The PRIME group of 14 teachers from all three participating boards received three days of in-service training on PRIME.
2. The LessonLab group of five teachers from HCDSB received five days of in-service training on LessonLab and participated in a half-day book study on "The Teaching Gap" by James Stigler.

3. The “Both” group of 11 teachers from BHCNDSB AND HCDSB received the three days of in-service on PRIME, the five days on LessonLab as well as the half-day book study on “The Teaching Gap” by James Stigler.
4. The remaining 25 teachers from all three boards formed a control group which served as a basis of comparison to ascertain the effectiveness of the use of a developmental continuum and/or participating in a PLC in changing teacher practice.

The breakdown of each group is shown in the following table:

Groups		BHCNDSB	HCDSB	HCDSB	HCDSB
PRIME	# Teachers	4	5		5
	Grade/Course	Grades 6-8	Grade 8		Grade 8
LessonLab	# Teachers		5		
	Grade/Course		Grade 7		
Both	# Teachers	6			5
	Grade/Course	1P/2P/1L			MAT1L/2L
Control	# Teachers	10	5		10
	Grade/Course	Grades 7-10	Grade 7-8		Grades 8-9

The PRIME training took place from Sept. 2005 to Dec. 2005.  
 The LessonLab training took place from Sept. 2005 to Jan. 2006.  
 The “Teaching Gap” book study took place on September 19, 2005.  
 (See Appendix B for the schedule of training dates)

Teachers completed a Consent Form upon agreeing to participate in the project, as well as a Video Consent form which are found in Appendix C.

Teachers completed a survey, at the beginning and end of the study, on beliefs and practices for teaching mathematics, which was designed by Dr. John Ross of OISE and used with permission. General background information such as, number of years teaching and number of years teaching math, was also collected.

Teachers completed evaluations at the end of each in-service session, which allowed them to comment on the effectiveness of the session. (Appendix D)

Some teachers also took part in small focus group sessions. Their responses were coded, summarized and grouped into themes. The focus group questions can be found in Appendix E.

## **Students**

Teachers were given letters of information about the project, which were sent home to the parents in September. As well, a Notice of Collection and Video Consent forms were given to the parents of the students who were taking part in the LessonLab research lesson. (Appendix F)

In the fall of 2005, 1111 students completed a survey about their attitudes and feelings toward mathematics and 770 completed it again in the winter of 2006. The student survey was designed by Dr. John Ross of OISE and used with permission (see LMS web site, KPR PRISM Report). Report card data on Number Sense was collected from the June 2005 and November 2005 assessments for students whose teachers received some form of training. In addition the PRIME diagnostic tool D, for both Numbers and Operations, was administered to students whose teachers received PRIME training. The diagnostic tools were administered in the fall of 2005 at the beginning of the project to collect baseline data and again in the winter of 2006 at the end of the project to look for change. Four hundred and ninety seven students completed the Number diagnostic and 477 the Operations diagnostic at both times in the study. The diagnostic assessment tool provided information on student knowledge and abilities in mathematics. Teachers were given a Student Record Sheet to record the diagnostic scores throughout the project.

## Summary of Results

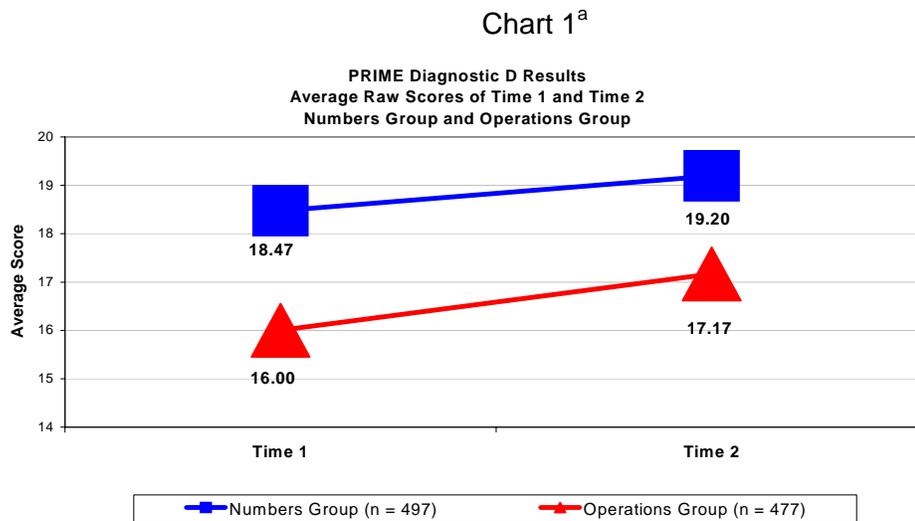
### Student Survey Results

Information was collected on 1111 students at Time 1. Thirty six percent of these students were in grade 7, 34% of the students were in grade 8, 24% of the students were in grade 9, and 6% were in grade 10. At Time 2, there were 770 student responses. Both surveys were to be done on-line, but software problems resulted in the Time 1 survey being done on paper and the results scanned. The second survey was done on-line, which was a challenge for some schools as can be seen by the number of participants at Time 2.

Student attitudinal survey results showed no differences between the first and second survey administration. The majority of students answered most questions by choosing the middle range from a scale of 1 - 6. Students responded to either ends of the scale on the following questions:

- When asked if math problems could be done correctly in only one way, the majority of students felt this was 'not true at all'.
- A slight majority of students responded that it would be 'very true' that it would make them feel very sad if they were to get a low grade in math.
- A slight majority of students said it was 'very true' when asked if they liked mathematics.
- The majority of students felt it was 'very true' that they would need to keep taking mathematics for the kind of job they wanted after leaving school.
- An equal number of students felt it was 'not true at all' and 'very true' that mathematics is boring.

### PRIME Diagnostic Results



<sup>a</sup> Both the Number and Operations raw scores for Diagnostic Tools D range from 0 – 28 and place students in phase 1 (raw score <7), phase 2 (raw score 7 to 16), phase 3 (raw score 17 to 25) or phase 4 (raw score 26 to 28).

A total of 497 students participated in the Numbers diagnostic, while 477 students participated in the Operations diagnostic, due to the inability of one class to complete the second writing within the time frame given. The analysis focused on the raw student scores. The Phase scores were ignored because not enough time had elapsed for a Phase change. The data was analyzed by taking averages of the student results.

Overall, as indicated in Chart 1, the results indicate a very marginal increase in student performance between Time 1 and Time 2 for both the Numbers and Operations diagnostics. The Numbers diagnostic showed an average change of  $\sim 0.72$ , while the Operations diagnostic showed an average change of  $\sim 1.17$ .

### ***Teacher Survey Results***

Of the 54 teachers who participated, the majority (17) had four to seven years of teaching experience. Nine teachers had 12 or more years of teaching. The majority of teachers (17) had also taught mathematics for four to seven years. Nine teachers had taught mathematics for 12 or more years.

At the beginning of the study, teachers provided responses to questions about their attitudes and practices toward teaching mathematics. The results were analyzed using mean scores. Mean scores were calculated from the teacher's responses on a six point scale, where 1 =strongly disagree and 6= strongly agree. Table 1 in Appendix G shows teacher survey mean score responses grouped by dimension<sup>1</sup>. The mean scores of the elementary and secondary teachers were compared.

The survey results were analyzed to see if there were any response differences between the teacher in-service groups. There were no significant differences found in the attitudes and confidence between the groups of teachers who received in-service sessions and the group of teachers who did not participate in any in-service. There was also no significant difference in response between the groups of participants at the beginning of the study, and there was no change in their responses at the end of the study.

The following, though not statistically significant, are highlights of the comparison by dimension:

Discovery: There was stronger agreement among elementary teachers when asked if they let students puzzle things out for themselves instead of answering student's math questions.

Teacher's Conceptions of Math as a Discipline: Secondary teachers disagreed more strongly that a lot of things in math must simply be accepted as true and remembered.

Student Confidence: Both elementary and secondary teachers disagreed quite strongly that you have to study math for a long time before you see how useful it is. Elementary teachers agree more strongly that every student in their class should feel that mathematics is something they can do.

Teachers provided responses about their confidence in teaching mathematics by answering survey questions using a 5 point scale, where 1=nothing and 5= a great deal.

The results were analyzed using mean scores and grouped according to student engagement, instructional strategies, and classroom management. Their results are indicated in Table 2 in Appendix G.

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<sup>1</sup> John A. Ross, Douglas McDougall, Anne Hogaboam-Gray, "A Survey Measuring Elementary Teachers' Implementation of Standards-Based Mathematics Teaching," Journal for Research in Mathematics Education 34 (2003): 344-363.

Of statistical significance are the results of the teacher's perception of efficacy in instructional strategies. Secondary teachers felt more positive than elementary teachers about all areas of efficacy in instructional strategies, particularly with reference to the extent that they could provide an alternative explanation or example when students were confused about mathematics. Both secondary and elementary teachers were less confident about how well they could implement alternative mathematics strategies in their classroom.

Though not statistically significant, secondary teachers felt they had more effect on motivating students who showed low interest, and getting students to believe they can do well in mathematics. Elementary teachers felt they had more effect in assisting families to help their children do well in mathematics. Secondary teachers felt more confident than elementary teachers about controlling disruptive behaviour during mathematics, and establishing a classroom management system for mathematics with each group of students. Elementary teachers were slightly more confident that they could calm a student who is disruptive or noisy during mathematics.

## **Teacher In-service and Focus Group Results**

Teachers were asked to provide an evaluation of each in-service session they attended. Participants provided feedback to questions about what they learned, how they would use the information in class, and what implementation support they needed.

A small sample of 14 teachers participated in focus group sessions at the conclusion of the study. Teachers who participated in the three in-service training sessions (PRIME, LessonLab, and Both) provided opinions about their experiences and the effect on their teaching practices and confidence level.

In general, all teachers felt the in-service sessions they received were very useful and made a positive difference in the way they taught mathematics. As expressed by one LessonLab participant: "You can make a difference. Math is fun!" Following is a summary of the themes that arose from the feedback.

### ***Theme 1: Use of Manipulatives and Activities***

Teachers felt that the in-services had changed their way of teaching mathematics:

*"The biggest thing I am walking away with is the fact that the way that math is being taught has to change. Rather than being procedural it needs to be the kids actually investigating, coming up with the formulas themselves so that they actually understand it". PRIME/LL teacher*

Teachers mentioned that they learned several ways to engage their students in learning about mathematics. One of the ways of engaging students was by using more activities and manipulatives in the classroom. They learned how to use manipulative stations effectively and that manipulatives can be used for all levels of student ability. They will use manipulatives to teach mathematical concepts on a concrete level and allow students to use them to discover new ideas. All students, including students at-risk, were able to participate in investigations by using manipulatives. Teachers felt at-risk students benefited from using manipulatives because it allowed them to answer questions creatively.

Teachers were introduced to the concept of the rich task or problem, and how they could incorporate it into their daily lessons. Teachers feel they will now use rich tasks instead of procedure to teach mathematics. They will first assess what students know and look at different ways that students understand mathematics. They will prepare themselves for questions from students, and in return prepare higher order questions for students.

They will use more manipulatives and visuals such as pictures, diagrams, games, flyers, and stations, and various strategies such as pair-share more often in their teaching of mathematics to help students visualize and understand key concepts deeply:

"I now encourage students to draw their answers in a diagram (to use diagrams to explain their reasoning)". *LessonLab participant*

Some teachers mentioned specifically that they would teach fractions, ratio, and cross multiplication differently now that they have a better understanding of what their students need:

"Instead of doing cross multiplying with my class because I'm guilty of it in the past, I can apply different ways of solving proportions. Now that I have a better idea of what my students don't understand, I can address these issues in my class". *LessonLab participant*

As a result of what the teachers learned from the in-service sessions, they had shifted their teaching from procedural to investigative. They were encouraging students to problem solve, use manipulatives, and find answers through investigation. Teachers said that they no longer answered student questions immediately, as they were encouraging students to find their own answers and helping students to look critically at their work. Although students initially complained when the teacher did not answer their questions, teachers began to see that allowing students to find solutions for themselves increased their confidence and attitude toward mathematics. Teachers also found it interesting to see the different solutions students produced, as it allowed them to understand student thinking and therefore teach more effectively.

Teachers felt they had become more reflective in their own teaching, allowing them to question the purpose of the mathematics activities they were using. This reflection helped them to focus on using methods that were meaningful and effective:

"I learned how my students could be better engaged in thinking about mathematics as opposed to memorizing and applying rules." *PRIME participant*

Teachers felt that involving students in their own learning created a positive environment where students were not just looking for the right answer, but communicating ideas.

## ***Theme 2: Use of Student Investigation***

Teachers also learned how to engage their students through improved communication and understanding. Many mentioned that they learned how to recognize different ways that students learn. Teachers learned how to teach a mathematics concept using fewer teacher-initiated questions, and to start with a big question rather than a small one. They learned how to initiate discussion from students in order to encourage student investigation, and give students more time to respond. They were going to create more discussion in their class and let students discover possible solutions without providing them with the answers immediately:

"I will wait and I won't be so willing to give the answer". *LessonLab participant*

Once students had found a solution, teachers would question them about their answers, asking them to explain and show the steps involved in their solutions. Teachers would be more open to accepting many student responses to a mathematics question:

"I will use different open tasks in my class to build confidence in my room and give the students a chance to share their solutions". *PRIME participant*

Teachers learned that these techniques would promote reflection and planning so that their students would gain a deeper conceptual understanding of mathematics. Teachers were very eager to apply the information they learned from the in-service. Many teachers mentioned that they were going to involve their class in more mathematics investigation.

## ***Theme 3: Use of Student Assessment Information***

Teachers felt the PRIME diagnostic tool was useful for student assessment, and that giving the diagnostic test on the first day of school would help focus their lesson planning. Teachers found it interesting to see the results of the diagnostic, and then use the strategies to move students along

the continuum. They mentioned that it took more time to assess, but it gave valuable information about student needs and was more informative than just following the curriculum. It also gave the teachers positive reinforcement that they were making a difference:

"This diagnostic testing for me not only as a tool to help me find where they are but as a positive reinforcement for me that I am accomplishing something, that probably was the best thing that came out of the PRIME training for me".

Some teachers mentioned that the training caused them to realize that there are more types of assessment than pencil and paper. Teachers began assessing their students by observation, taking note of what students were doing, how they were using manipulatives, and what concepts they seemed to grasp.

Part of the LessonLab experience involved teachers preparing expected student responses prior to giving the lesson. Teachers said that it was a revealing exercise because many of the actual student responses were not what teachers expected. This led to a change in teacher attitude about student thinking and how to develop questions for students.

#### ***Theme 4: Teachers' Perception of Their Knowledge of Mathematics***

Teachers expanded their knowledge of mathematics. They mentioned learning specific information about patterns, repeating decimals and fractions, and ratio and proportion. Primarily, they learned different ways of teaching ratio and proportion, and the common misunderstandings associated with the topic.

Teachers felt the in-service sessions were an excellent way to improve their knowledge of mathematics. All teachers felt they had learned something about mathematics from the experience, including a better understanding of how to teach students to solve problems by themselves. They felt that in order for students to feel successful, teachers needed to have confidence in teaching mathematics and this program (PRIME and LessonLab) increased their comfort and confidence levels. They felt that intermediate teachers would especially benefit from the in-service because many do not have university training in mathematics. There was a general agreement that resistant teachers would definitely benefit from the training, if it were made mandatory. The key was getting teachers to be open to change; something that focus group participants felt was difficult to do, particularly at the secondary school level.

#### ***Theme 5: Teacher Collaboration***

Teachers felt that the in-service sessions they attended were effective because they were implementing what they learned in the classroom and were sharing their experiences with other teachers. Both experienced and inexperienced math teachers felt that working with a team of colleagues made this professional development more beneficial than any other they had received. Teachers commented on the value of collaboration with colleagues:

"The real benefit with the PRIME and the LessonLab was coming back and seeing the same people every other week; you start to build a comfort level where you can speak openly".

The professional dialogue between groups of teachers helped them to increase their comfort level and helped them to realize the depth of teaching mathematics. They felt it was a positive experience to work with professionals from other school boards.

Teachers would like to continue collaborating with their colleagues on their new learning. They would like time to participate in grade team planning or with other teachers in their school to generate ideas and discussion.

## **Theme 6: Teacher Support and Professional Development**

Teachers had a lot of questions about the support needed to implement the change in teaching, and had various questions about additional professional development including:

- How could teachers re-learn a lot of the strategies?
- How would teachers learn the conceptual information that they are lacking in math?
- How to assess students in this new way of teaching?
- How to adapt these problems to students with Individual Education Plans?
- How will this training spread throughout the Board?

When asked what they would like to see happen as a follow up to this in-service to help implement their new learning, teachers replied that they needed more time. Specifically, they needed more time to study the resources and more time to plan lessons. Teachers mentioned they would have liked more professional development time, perhaps structured into their working day.

Overall, teachers liked the PRIME in-service. They liked the length of the training and the multiple sessions spread over time. This allowed teachers to learn, apply information in class, and come back to consult with colleagues about their experiences. They felt that they would need a follow-up session at the end of the school year to help them plan for September.

Teachers who did the demonstration lessons would like to follow up with their colleagues to discuss the implementation of the LessonLab lesson in their classrooms. Teachers mentioned that since this is an on-going project, they would like to be able to dialogue more with colleagues and teach less in isolation.

Teachers offered suggestions for the implementation of LessonLab in their boards. They felt the training was a worthwhile experience but wondered about how to in-service all teachers because the training involved a lot of time out of the classroom. They agreed that it was important for teachers to complete a certain number of days of training because it was the process that transformed their teaching. Some teachers felt the timing of the program was not well placed during the school year as it was too early in September. One teacher liked the early start of the session because it helped bring the concept of using manipulatives into the classroom at the beginning of the year. All teachers felt the training would be better if started in earlier grades. Although teachers generally liked the program, they felt it would be a challenge to implement with some teachers because of their traditional attitudes and approaches to teaching:

"Teaching is a very cultural activity, we really have to learn to change the way we teach, and that's not going to be an easy thing".

## Reflections

The following is a discussion of the findings for the research questions.

### 1. Were remediation programs more effective for certain students than others?

Upon analysis of the PRIME diagnostic scores, improvements were marginal for most students. This is not unexpected, given the short time frame of three months for the study and that change takes time. It was not possible to identify individual students who significantly out-performed the group. Aggregate report card data scores showed a decrease for November 2005 when compared to June 2005. The decrease is unexpected but can probably be attributed to the different timing of the report cards. June grades are reflective of an entire year of learning, whereas the November grade is based on 10 weeks of learning compounded by the loss of knowledge which occurs during the mathematically inactive summer vacation. As such, it was not possible for us to determine the profile of the learner who would benefit most from this type of intervention.

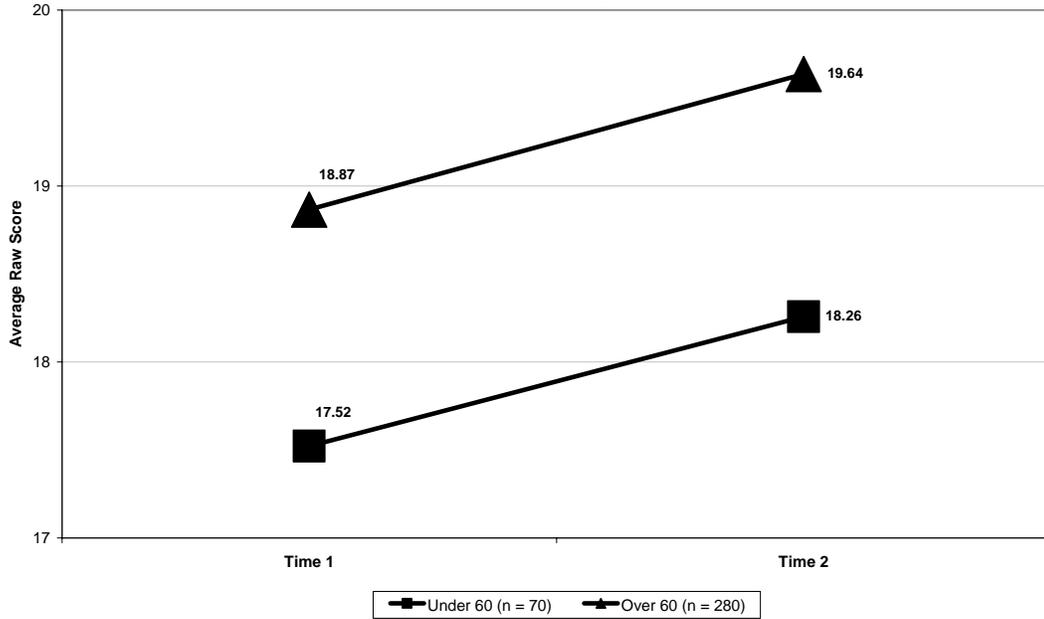
### 2. Did the use of a developmental continuum improve student understanding for the weakest students, specifically those enrolled in MAT1L?

The June report card grade in number sense was used to identify students at risk (marks below 60%) and those not at risk (marks 60% or above). The pre-pilot and post-pilot PRIME diagnostic scores for both Number and Operations were compared. Both groups increased marginally in the Number diagnostic score (Chart 2). The not-at-risk group saw their raw Operation diagnostic scores increase by 2.25 points whereas the at-risk grouping scores increased by 1.75 (Chart 3). Therefore, the raw scores have improved marginally for the at-risk students, but not by a factor statistically significant from any other student. There was a marginal improvement in understanding for all students that could be attributed to PRIME or to regular classroom instruction. This is not possible to determine.

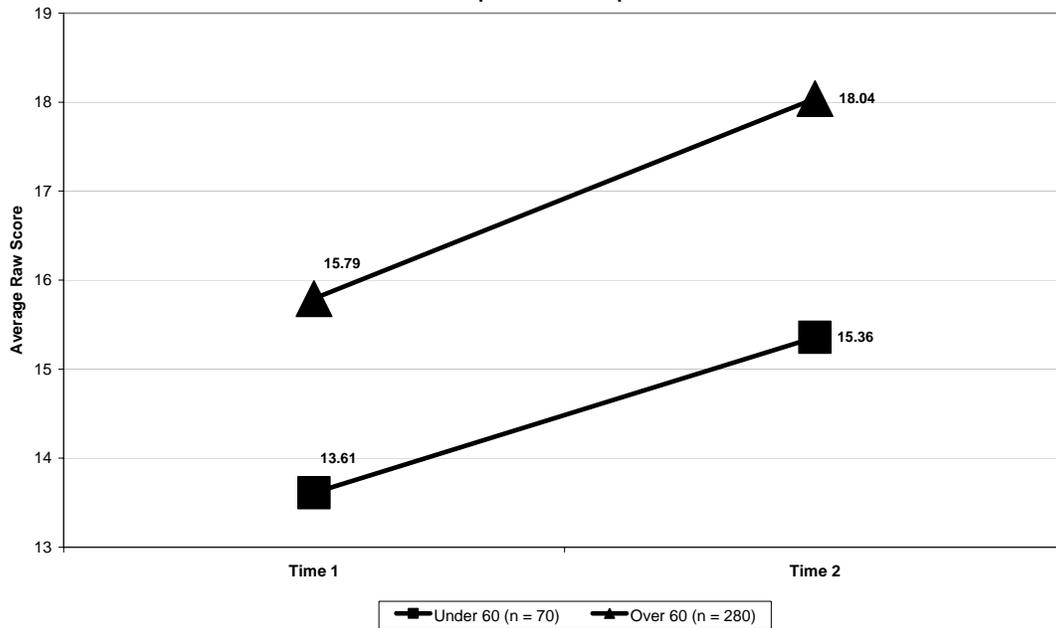
### 3. Did instructional/assessment strategies change following exposure to a developmental continuum?

Teachers felt that they learned more about how students learn and could better empathize with students and understand their needs. As a result of the introduction of new instructional strategies provided by PRIME, teachers began to understand the importance of allowing students to construct their own understanding of concepts. Teachers were more open to using manipulatives and allowing students to explore and share different approaches to the same question. They felt the manipulatives were a tremendous asset for both students and teachers as they helped explain concepts that were previously just learned by procedure. This also caused some teachers to change the way in which they were assessing students. They began to place more emphasis on observation, taking note of what students were doing and saying about the mathematics.

**Chart 2**  
**PRIME Diagnostic Results**  
**Students who Achieved Under 60% and Over 60% on June 2005 Report Cards**  
**Average Raw Scores of Time 1 and Time 2**  
**Numbers Group**



**Chart 3**  
**PRIME Diagnostic Results**  
**Students who Achieved Under 60% and Over 60% on June 2005 Report Cards**  
**Average Raw Scores of Time 1 and Time 2**  
**Operations Group**



4. Which influenced teaching practices more:

- the use of a developmental continuum, or
- the use of a developmental continuum along with the establishment of professional learning communities through the use of Lesson Lab?

All groups felt that they have improved their teaching practice. There is no evidence to support one treatment over another. The teachers in the PRIME group learned how to diagnose the Phase a student is operating at and how to identify activities that would move that student along the continuum. The teachers who attended LessonLab only, do not have that training. It could be said then, that the teachers who received both programs have learned more about how to assess their student's thinking and had several opportunities to discuss student understanding within a PLC. It cannot be determined however, if this has translated into more improvement in practice.

### **LessonLab versus PRIME**

In general, teachers liked the PRIME program because it focused on using manipulatives. Some teachers felt that PRIME was not as useful at the secondary level and was better suited for the intermediate students. Teachers felt they would need support to implement the program including;

- They would like the PRIME program aligned with the curriculum and their current teaching and assessment practices.
- They would like a core set of lessons created that would compliment the in-service training.
- They felt that special education teachers and teaching assistants would benefit from the PRIME training as well.

Teachers felt LessonLab was beneficial because it allowed teachers to reflect on their own teaching practices. Teachers enjoyed the opportunity to watch other teachers teach a lesson although they felt that some teachers would not want to be observed in class. Teachers mentioned that LessonLab was similar to the training they received in teacher's college. They enjoyed getting feedback from other teachers about the lesson they taught.

### **Lessons Learned and Recommendations**

There were numerous lessons learned and consequent recommendations to make throughout the entire action research project. They warrant sharing, should another group decide to embark on a similar venture. Many questions arose throughout the process, some of which were anticipated and some of which were not. It is recommended and required that much thought and care be taken in attempting to answer these questions in order to increase the effectiveness, efficiency, and sustainability in planning a similar project.

- Ensure that in-service dates do not conflict with reporting times.
- Time.... how many months or perhaps years will be allocated to start and complete the project? This project was short in duration, with insufficient time to indicate growth of the students.
- A Standardized Teacher Evaluation Form should be developed prior to the initial session so that all participants complete the identical form in order to be able to analyze the data.
- It is easy to get caught up in the demands of delivering the in-service. Someone needs to keep tabs on the research goals and data collection process.

- Setting up meeting dates for all of the project leaders to dialogue was a challenge as three boards were involved. Travel time and location of meetings should be considered. This tri-board proposal, however, allowed for neighbouring boards to network with each other, which was very valuable.
- Group sizes are a consideration. There are pro's and con's to smaller and larger groups.
- Participants...volunteer or volunteered? Participant drop out occurs.
- Missing data or incomplete data is a reality. Some students wrote the Pre but not Post, or vice versa, ill or absent students and/or teacher participants, students and/or teachers moving, maternity leaves, retirements.
- **Scorer reliability of diagnostic tools was a factor to consider thus data may have been inaccurate to some extent. Consider more training in marking of the diagnostic tools prior to implementation or have a group of expert markers who score all of the diagnostic tests.**
- Linking of data should be done from the onset with the aid of IT for report card data and OEN. Also the question arose as to which mark from the report card should be considered, particularly at the secondary level where the grade 9 mark is not solely based on Number Sense and Numeration.
- Reality of joint ventures with multi-boards and time commitment required was underestimated. Delegating responsibilities at the onset is recommended.
- Due to the number of current initiatives, the same people were coordinating the project and doing the training. Consider the time commitment for these people in light of full-time board-related responsibilities.
- Level of readiness to participate in lesson study is higher than that of initiatives which explore content areas. The teachers with a higher level of readiness will get more out of the process.

## Next Steps

### Sustainability and Building Capacity

Since the participants from all three boards found both LessonLab and PRIME to be a valuable professional development experience, it is the intention of each of the three boards to offer further training for teachers in the board, beginning with those teachers who formed the control groups for this project. The timing, details of the delivery and funding of this training is yet to be determined but will be part of the Student Success professional learning plan to support mathematical literacy.

Lesson study is a process which should be implemented to the fullest extent possible, whether through the use of LessonLab or another process. LessonLab has the advantage of not requiring a knowledgeable other, due to its on-line component. Teachers who described the greatest transformation in their approach to teaching related it to the lesson study experience:

*“It gave everyone an opportunity to work with other individuals and take everyone’s strengths and put them all together. It gave us an opportunity to see the positive outcome after all of the work that we put into the lesson. It also gave us an opportunity to take time to reflect on our teaching, which is absolutely essential and I don’t think many of us do because we’re so busy all the time.” LessonLab participant*

In order for the experience to be as rich as possible, an attempt should be made to identify master teachers for as many groups as possible. This teacher should have a deep understanding of mathematics, be well-versed in the use of manipulatives to teach mathematics and have thorough knowledge of good questioning techniques. On-going improvement through lesson study will require that each group not only have a master teacher, but also the time to meet to plan effective lessons.

The Background and Strategies book within PRIME is an excellent resource for all intermediate teachers, elementary or secondary. Knowledge of the developmental map will help teachers plan more effective lessons, especially through the awareness that a student cannot master the concepts or skills in a particular phase unless they have passed through the prior phases.

Each board will develop long term action plans to create in-service programs which address the needs identified by teachers in the focus groups and from the evaluation forms. The following in-service needs were identified:

- to incorporate opportunities for teachers to improve their own conceptual understanding of mathematics (Theme #6);
- to develop the teachers’ ability to provide alternate explanations (Teacher Survey);
- to develop the teachers’ ability to use alternate instructional and assessment strategies (Teacher Survey);
- to further develop teachers’ comfort level with the use of a variety of manipulatives (Theme #1);
- to provide opportunities for teachers to plan collaboratively (Theme #5)
- ;to extend PRIME training to Special Education Teachers (Focus Group);
- to provide opportunities for participants in this project to consolidate, sustain and extend their in-service experiences (Theme #6);
- to develop assessment practices which correspond to revised instructional practice (Theme #6).

In order to affect authentic changes in the way teachers teach mathematics, appropriate funding needs to be provided to boards for support staff to sustain the use of these valuable research based materials. There also needs to be consideration given to teacher workload, since being a truly reflective teacher takes time.

## Suggestions for Further Research and Study

When studying report card data in comparison to PRIME diagnostic scores, it was noted that some classes had averages in the 70's but diagnostic scores which indicated Phase 3. These averages were unexpectedly high, but could be attributed to a difference in the two types of assessments. The PRIME diagnostic is looking for conceptual understanding, as well as procedural knowledge, as opposed to just procedural knowledge of a particular concept or skill. Typically, classroom assessments test only knowledge of concepts, which would enable students who have memorized a procedure to score well on their report card, but not as well as on the PRIME diagnostic. This issue should be investigated further as there may be a link between the type of assessment questions used in the classroom and a student's ability to move through the phases of a developmental continuum. In fact, some assessments may actually impede a student's ability to learn a concept; if memorization of a process will earn a good standing then there is no incentive to gain a deeper understanding. Specifically, it would be beneficial to learn which type of assessment questions may enable students to move more quickly through the phases as well as gain a deeper understanding of each concept and skill.

Many teachers indicated that they will not approach teaching in the same manner as a result of this project; pedagogically speaking, they have been transformed. However, it is unlikely that assessment practices will change as they were not specifically addressed through the use of a developmental continuum or lesson study. While this project has reformed math education for those involved, assessment will probably remain unchanged. Students' academic achievement cannot move forward unless assessment radically changes. Perhaps it is time to convene a provincial expert panel on assessment and evaluation.

One of the concerns about lesson study was that it requires many days of in-service. An analysis of how lesson study can be tied to other board/provincial initiatives could be undertaken. An important background piece in lesson study is the content exploration; an effective lesson cannot be planned without this piece. Could PRIME or content book studies such as John Van de Walle's *Elementary and Middle School Mathematics: Teaching Developmentally* or one of Catherine Twomey-Fosnot's works provide the necessary background information? What is the most effective way to select participants for lesson study? Would it be beneficial to choose based on the level of interest of teachers who had taken part in content exploration as above? Would there be a benefit in creating an Ontario database of public research lessons, which could be analyzed by participants prior to the writing of their own research lesson?

Many students become at-risk of not graduating when they fail to get their grade 9 math credit. In many cases this is due to the fact that the student is not placed in the math course which best suits their abilities. Perhaps the PRIME diagnostic raw scores could be correlated with grade 9 math marks in order to determine if there is a relationship between a student's phase and success in a particular grade 9 math course. Assuming such a relationship exists, it might then be possible to determine a recommended raw score which would guarantee successful completion of each grade 9 math course. For example: HWCDSB is currently creating a database of PRIME diagnostic test scores for all students enrolled in grade 9 mathematics (Semester 2 2006); at the close of the semester final grades in the math courses will be added to the database. The data will be analyzed to determine average raw scores/minimal raw score for all students who received a credit in the course. HWCDSB hopes to use this data to help grade 8 students select the grade 9 math course which best suits their skills. Further study into developing tools to assist with the correct placement of students in grade 9 would be useful.

## **Appendices**

Appendix A: Resources

Appendix B: Schedule of Training Dates

Appendix C: Teacher Consent Form and Video Release

Appendix D: Workshop Evaluation Form

Appendix E: Focus Group Questions

Appendix F: Parent Information Letter, Release and Consent

Appendix G: Teacher Survey Results

## **Appendix A - Resources**

### ***Professional Resources and Instruction for Mathematics Educators - PRIME***

Thomson Nelson Publishing

PRIME is a research-based Canadian professional learning initiative. PRIME is a developmental continuum which outlines the phases of development for key concepts and skills. The developmental maps summarize the research conducted to determine how students learn mathematics.

The guide to using the developmental maps is designed to help teachers understand how students learn developmentally in each mathematics strand and provide specific information about how to enhance and differentiate instruction to promote growth. Included are: descriptions of each phase, representative student responses and strategies to prepare student for the next phase.

The diagnostic tests can be used to determine a student's placement on the map. Detailed scoring guides and sample responses are included.

The background and strategies books are designed to increase teacher knowledge and understanding of key mathematics concepts, skills and processes. They include: explanations of critical concepts and skills; approaches to teaching, learning and assessing key mathematical concepts and skills; sample student responses that help to illustrate key pedagogical and mathematical ideas; guidance on tailoring instruction to the strand and to the student.

PRIME contains 5 strands – Number and Operations, Patterns and Algebra, Data Management, Geometry, Measurement.

The number and operation strand was chosen for this project as the concepts and skills contained in the maps were common to all intermediate grades as well it was felt that a solid grounding in number sense is necessary for success in secondary school.

### ***LessonLab – BreakThrough Mathematics – Pearson***

The LessonLab Research Institute was developed by James Stigler to aid in the transfer of Lesson Study to a North American context.

BreakThrough Mathematics is a series of professional development courses designed to introduce and scaffold the lesson study process in a way that makes it accessible to all districts and schools, regardless of prior knowledge and experience.

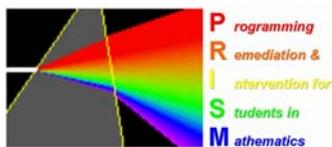
Each course has three phases: content exploration, lesson analysis and lesson development and links to practice. Each course aims to deepen a teacher's content knowledge by analyzing and developing a lesson. Through videos, reading, mathematical tasks and discussion, teachers learn about the mathematics and make it visible in a way that promotes analysis. This allows participants to reflect deeply on how students learn and how teachers teach.

## Appendix B - Schedule of Training Dates

Schedule of Training Dates		
Type of Training	Description	Date of Training
The Teaching Gap Book Study (Lesson Lab)	The "Teaching Gap"	Sept. 19 <sup>th</sup> , 2005
PRIME Session 1	Overview of the developmental maps and the diagnostic tools	Sept. 26 <sup>th</sup> , 2005 Sept. 26 <sup>th</sup> , 2005 (HCDSB)
LessonLab Session 1	Content exploration	Oct. 11 <sup>th</sup> , 2005
PRIME Session 2	Open and choice activities, fractions, integers	Oct. 24 <sup>th</sup> , 2005
LessonLab Session 2	Lesson Analysis	Nov. 7 <sup>th</sup> , 2005
PRIME Session 3	Problem solving, games for practice, students significantly behind phase, planning a unit	Nov. 21 <sup>st</sup> , 2005
LessonLab Session 3	Lesson Writing and Peer Analysis	Dec. 5 <sup>th</sup> , 2005
LessonLab Research Lesson Planning	Individual groups met to complete their lessons and prepare for delivery.	Jan. 10 <sup>th</sup> , 2006 (HWCDSD) Jan. 12 <sup>th</sup> , 2006 (HCDSB)
LessonLab Session 4	Lesson delivery, reflection, revision	Jan. 16 <sup>th</sup> , 2006

Note: The LessonLab training for all 3 boards took place together. The teachers in the HCDSB PRIME group received their training separately as the board was participating in a Secretariat project also involving PRIME and therefore combined the training for both projects.

## Appendix C: Teacher Consent Form and Video Release



### Leading Math Success: Professional Development Project: PRISM

#### CONSENT FORM

Teacher Name: \_\_\_\_\_

School Name: \_\_\_\_\_

School Board: \_\_\_\_\_

Dear Teacher and Colleague,

The Ministry of Education and Training is supporting professional development activities through the PRISM initiative. We are part of a tri-board grouping in southwestern Ontario. The purpose of the professional development is to help teachers increase their understanding of how students learn mathematics and to offer teachers the opportunity of expanding their repertoires of strategies for helping students at risk in mathematics to learn. Some teachers will be learning how to use the developmental continuum PRIME in the teaching of mathematics. Some teachers will be supported with a professional learning community through the use of LessonLab. Some teachers will be using both PRIME and LessonLab.

The training portion of the project will take place between September 2005 and January 2006. Teachers who are serving as the comparison group may be given the opportunity to receive similar training once the project is complete.

In order to help us determine the effectiveness of the professional learning experience, teachers will be asked to complete a survey on attitudes and practices to teaching math. In addition teachers will participate in a focus group session toward the end of the project to assist in collecting qualitative data on the effectiveness of the professional development.

The information generated from the survey **will not** be used to evaluate teachers' knowledge of mathematics, or students' knowledge of mathematics. Instead, we will be examining responses from groups of teachers in the hope of learning what types of activities contribute to professional learning. Individual teacher responses will not be shared with anyone outside the research group. All questionnaires will be coded to ensure confidentiality and no teacher or school board will be identified based on responses.

If you have any questions about this project please do not hesitate to contact any of the individuals below.

**Contacts**

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Myrna Ingalls  
Education Officer  
Ministry of Education  
(416) 325-2858  
myrna\_ingalls@edu.gov.on.ca

I have read and understood my role as a participant in this PRISM project.

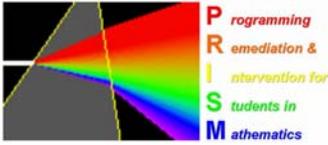
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Signature

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Date

# TRI-BOARD PRISM PROJECT



## RELEASE AND CONSENT (Educator)

In consideration for the video recordings/photographs of me being selected for inclusion in the Internet based video on demand professional learning sessions (the “Professional Learning Sessions”) to be housed on the *Leading Math Success* website (the “Website”) created for teachers, school leaders, educators and interested members of the public and developed, operated and maintained by Curriculum Services Canada, on behalf of the Ministry of Education, and for other good and valuable consideration, I hereby grant the Ministry of Education (the “Ministry”) and Curriculum Services Canada (“CSC”):

THE RIGHT to photograph, record on film, videotape, audiotape, or record on any other audiovisual medium, at \_\_\_\_\_ School on January 16, 2006, my voice, likeness and person, and grant also the non-exclusive and perpetual and worldwide right, licence and privilege under copyright or any other right or licence enjoyed by me to use, broadcast, cablecast, reproduce and distribute the above in the Professional Learning Sessions on the Website. I agree that I will not at any time make any claim for additional compensation in respect of such use, and waive any right to inspect or approve the finished video recordings/photographs.

I FURTHER GRANT CONSENT under the *Freedom of Information and Protection of Privacy Act* to the Ministry and CSC, acting as agent for the Ministry, and grant consent under the *Personal Information Protection and Electronic Documents Act* to CSC to use and disclose my image, voice, likeness and name in the video recordings/photographs to be used in the Professional Learning Sessions housed on the Website, which can be accessed by Website users, and this for a number of years.

I have read this Release and Consent and the attached notice of the collection of the personal information under both the *Freedom of Information and Protection of Privacy Act* and the *Personal Information Protection and Electronic Documents Act* before signing below, and I understand the contents. I understand that by giving this Consent, I am permitting personal information about me to be used in the Professional Learning Sessions on the Website which will be developed, operated, and maintained by CSC on behalf of the Ministry and which can be used by anyone who accesses the Website. I also understand that if consent were withheld this use would not occur. I also understand that neither the Ministry nor CSC have control over or are responsible for the use or misuse of the video recordings/photographs by third parties who access the Website.

I have given this consent voluntarily.

Name: \_\_\_\_\_  
(please print)

Signature: \_\_\_\_\_

DATED at \_\_\_\_\_ [city] this \_\_\_\_\_ day of \_\_\_\_\_, 2005.

## Notice of Collection of Personal Information

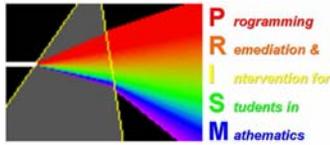
The personal information collected by the Ministry and CSC will be used to develop and deliver the Internet based video on demand professional learning sessions to be housed on the *Leading Math Success* website <http://www.curriculum.org/lms/> that is developed, operated and maintained by CSC <http://www.curriculum.org/csc/legal.shtml> on behalf of the Ministry.

The Ministry is collecting this personal information under the authority of s.8 (1) of the *Education Act*, R.S.O. 1990, c. E.2, as amended.

If you have any questions about the collection of this personal information, please do not hesitate to contact Myrna Ingalls, Education Officer, Curriculum and Assessment Policy Branch, 16<sup>th</sup> Floor, Mowat Block, 900 Bay Street, Toronto, Ontario, M7A 1L2 Phone: 416 325 2458.

## Appendix D: Workshop Evaluation Form

### TRI-BOARD PRISM PROJECT



#### **Workshop # and Topic:**

1. What specific knowledge, or ideas did you learn from this workshop?
  
  
  
  
  
  
  
  
  
  
2. List 2 ways you will apply this information in your math class.
  
  
  
  
  
  
  
  
  
  
3. What would you like to see happen as a follow up to this workshop to help implement your new learning?
  
  
  
  
  
  
  
  
  
  
4. Comments

Thank you for taking the time to complete this evaluation form. Your evaluation and comments are appreciated. Please return this evaluation form to your workshop leader prior to leaving.

## Appendix E: Focus Group Questions

1. What role has participating in PRIME/LL training played in helping you develop mathematics practices that meet the needs of your students?

Probe: And what about your at-risk students?

2. How has participation in PRIME/LL affected your confidence in teaching and learning mathematics?

Probe: In what ways has it changed? Provide examples of the change. In which area or topic was there change?

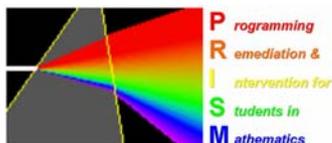
3. What are the strengths and challenges of the program you participated in?

Probe: How did it make a difference for your at-risk students? How does this compare to other teacher professional development you have attended? Did you have an “AHA” moment?

4. What recommendations would you offer to the PRISM Steering Committee?

Probe: What would you keep/change? What would you like to see for next steps (at a personal level and a board level)? What type of support do you still require? Where do we go from here?

## Appendix F: Parent Information Letter, Release and Consent



### **Leading Math Success: Professional Development Project: PRISM**

#### **INFORMATION LETTER**

September 2005

Dear Parent/ Guardian:

We would like to inform you about an exciting project that will be taking place in your child's classroom between September and January of this school year. The Ministry of Education recently released a document prepared by an expert panel that details a comprehensive strategy for improving the performance of all students in mathematics. The document, *Leading Math Success*, recommended that "... school boards work with the Ministry of Education to develop regional networks of expertise to support the professional learning of teachers of mathematics- including special education teachers" (p. 59). In addition, the Ministry is particularly concerned about students who do not do well in mathematics. To address the needs of struggling learners, the expert panel recommended that the Ministry work with partners to "...deliver research-based intervention programs for students at risk in mathematics" (p.34).

The Ministry of Education in partnership with the Brant Haldimand Norfolk District School Board, the Halton Catholic District School Board and the Hamilton Wentworth Catholic District School Board, has prepared a series of workshops to aid in the delivery of the mathematics curriculum for students in grades 7, 8, 9 and 10. Teachers who are participating in this project may be asked to use specific teaching strategies and/or assessment tools in their classroom. Information will be collected from both teachers and students in order to help us determine the effectiveness of the professional development provided to teachers.

We want to measure how well students are doing in the area of number sense and numeration. With the exception of a short attitudinal survey about mathematics, all information generated is part of regular classroom practice. Information may be gathered from the report card as well as how well students did on particular in-class assessments. It should be noted that no student, school or Board would be identified by name. We will contact you again with a request for consent should we require any other detailed information from or about your child.

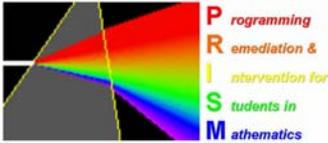
If you have any questions about this project please contact either of the people listed below. We thank you in advance for your support in helping to improve the education of our children.

#### **Contacts**

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Education Officer  
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(416) 325-2858  
myrna\_ingalls@edu.gov.on.ca

# TRI-BOARD PRISM PROJECT



## RELEASE AND CONSENT (Parent or Legal Guardian)

In consideration for the video recordings/photographs of my child being selected for inclusion in the Internet based video on demand professional learning sessions (the "Professional Learning Sessions") to be housed on the *Leading Math Success* website (the "Website") created for teachers, school leaders, educators and interested members of the public and developed, operated and maintained by Curriculum Services Canada, on behalf of the Ministry of Education, and for other good and valuable consideration, I hereby grant the Ministry of Education (the "Ministry") and Curriculum Services Canada ("CSC"):

THE RIGHT to photograph, record on film, videotape, audiotape, or record on any other audiovisual medium, at St. Bernadette School on January 16, 2006, my child's voice, likeness and person, and grant also the non-exclusive and perpetual and worldwide right, licence and privilege under copyright or any other right or licence my child or I may have to use, broadcast, cablecast, reproduce and distribute the above in Professional Learning Sessions on the Website. I agree that neither my child nor I will at any time make any claim for additional compensation in respect of such use, and we waive any right to inspect or approve the finished video recordings/photographs.

I FURTHER GRANT CONSENT under the *Freedom of Information and Protection of Privacy Act* to the Ministry and CSC, acting as agent for the Ministry, and grant consent under the *Personal Information Protection and Electronic Documents Act* to CSC to use and disclose my child's image, voice, likeness and *first name only* ("Personal Information") in the video recordings to be used in the Professional Learning Sessions housed on the Website which can be accessed by Website users, and this for a number of years.

I have read this Release and Consent and the letter giving notice of the collection of this personal information under both the *Freedom of Information and Protection of Privacy Act* and the *Personal Information Protection and Electronic Documents Act* before signing below, and I understand the contents. I understand that by giving this Consent, I am permitting personal information about my child to be used in the Professional Learning Sessions on the Website which will be developed, operated and maintained by CSC on behalf of the Ministry and which can be used by anyone who accesses the Website. I understand that if consent were withheld this use would not occur. I also understand that neither the Ministry nor CSC have control over or are responsible for the use or misuse of the video recordings/photographs by third parties who access the Website.

I have given this consent voluntarily.

I CERTIFY THAT I AM THE PARENT / GUARDIAN of \_\_\_\_\_ [name of student], a student at \_\_\_\_\_ [name of school]

Name: \_\_\_\_\_ Signature: \_\_\_\_\_  
(please print)

DATED at \_\_\_\_\_ Oakville this \_\_\_\_\_ day of \_\_\_\_\_, 2005

## NOTICE OF COLLECTION OF PERSONAL INFORMATION

The personal information collected by the Ministry and CSC will be used to develop and deliver the Internet based video on demand professional learning sessions to be housed on the *Leading Math Success* website <http://www.curriculum.org/lms/> that is developed, operated and maintained by CSC <http://www.curriculum.org/csc/legal.shtml> on behalf of the Ministry.

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## Appendix G: Teacher Survey Results

**Table 1:**

Survey Questions by Dimension	Mean Score		Sig.
	Elem N=26	Sec N=18	
<b>Program Scope: D1</b>			
4. I tend to integrate multiple topics of mathematics within a single unit (i.e. geometric and algebraic concepts together).	4.04	<b>4.22</b>	.600
13. In high school it is just as important for students to learn geometry and statistics as it is to learn algebra.	<b>4.96</b>	4.72	.539
16. *I like my students to master basic mathematical procedures before they tackle complex problems.	4.92	<b>4.67</b>	.464
<b>Student Tasks: D2</b>			
1. I like to use math problems that can be solved in many different ways.	4.92	4.94	.950
2. I regularly have my students work through real-life math problems that are of interest to them.	4.62	4.67	.871
11. *When students are working on math problems, I put more emphasis on getting the correct answer rather than on the process followed.	2.12	<b>1.78</b>	.353
<b>Discovery: D3</b>			
14. I don't necessarily answer students' math questions but rather let them puzzle things out for themselves.	<b>4.12</b>	3.61	.135
<b>Teacher's Role: D4</b>			
5. I often learn from my students during math class because my students come up with ingenious ways of solving problems that I have never thought of.	<b>4.23</b>	3.78	.290
17. I teach students how to explain and defend their mathematical ideas.	4.42	<b>4.50</b>	.830
<b>Manipulatives and Tools: D5</b>			
10. I encourage students to use manipulatives or technology to explain their mathematical ideas to other students	<b>4.15</b>	4.06	.803
18. *Using computers to solve math problems distracts students from learning basic algebraic and procedural skills.	<b>2.58</b>	3.06	.470
19. *If students use calculators they won't master the basic algebraic and procedural skills they need to know.	<b>2.58</b>	2.88	.476
<b>Student-Student Interaction: D6</b>			
3. When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with the class.	<b>4.92</b>	4.72	.618
6. *It is not very productive for students to work together during math class.	<b>1.88</b>	2.17	.517
9. In my classes, students learn math best when they can work together to discover mathematical ideas.	<b>4.42</b>	4.06	.349
<b>Student Assessment: D7</b>			
8. I integrate math assessment into most math activities.	4.04	<b>4.33</b>	.336
12. Creating rubrics for math is a worthwhile assessment strategy.	<b>3.88</b>	3.39	.283
<b>Teacher's Conceptions of Math as a Discipline: D8</b>			
15. *A lot of things in math must simply be accepted as true and remembered.	3.31	<b>2.56</b>	.094
<b>Student Confidence: D9</b>			
7. Every student in my class should feel that mathematics is something he/she can do.	<b>5.58</b>	5.22	.302
20. *You have to study math for a long time before you see how useful it is.	1.80	1.82	.945

\* negatively worded item.

Note: Bolded mean score numbers within the table indicate the group (elementary or secondary) with the more positive mean score response. This is the higher score for the positively worded questions, and the lower score for the negatively worded questions. The heading SIG represents the statistically significant value for the question, in this case no significance was found between groups.

**Table 2:**

Survey Questions by Teacher Efficacy	Mean Score		Sig.
	Elem	Sec	
<b>Efficacy in Student Engagement</b>			
22. How much can you do to motivate students who show low interest in mathematics?	3.92	<b>4.06</b>	.591
23. How much can you do to get students to believe they can do well in mathematics?	4.15	<b>4.33</b>	.437
24. How much can you do to help your students value learning mathematics?	4.04	4.06	.939
31. How much can you assist families in helping their children do well in mathematics?	<b>3.52</b>	3.33	.437
<b>Efficacy in Instructional Strategies</b>			
25. To what extent can you craft good questions about mathematics for your students?	3.88	<b>4.11</b>	.271
29. How much can you use a variety of mathematics assessment strategies?	3.69	<b>4.17</b>	.047
30. To what extent can you provide an alternative explanation or example when students are confused about mathematics?	3.81	<b>4.56</b>	.000
32. How well can you implement alternative mathematics strategies in your classroom?	3.48	<b>3.89</b>	.101
<b>Efficacy in Classroom Management</b>			
21. How much can you do to control disruptive behaviour during mathematics?	4.38	<b>4.61</b>	.318
26. How much can you do to get children to follow classroom rules about mathematics?	4.12	4.11	.982
27. How much can you do to calm a student who is disruptive or noisy during mathematics?	<b>4.31</b>	4.22	.678
28. How well can you establish a classroom management system for mathematics with each group of students?	4.15	<b>4.50</b>	.125