

Final Report for the Literacy and Numeracy Secretariat:

Niagara Catholic District School Board's Early Learning Math Inquiry Project (2013-2014)



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EXECUTIVE SUMMARY

Background

The program of professional learning that was the focus of this research sought to enhance early childhood educators' practices in mathematics instruction. Problem solving is the main context for mathematics learning and math talk is the vehicle for sharing and developing thinking. Within a math-talk community students engage in questioning, explain their mathematical thinking, describe sources of mathematical ideas, and assume responsibility for their own learning. Engaging with the big ideas in number sense and numeration allows students to explore the concepts in depth and see the connections to other concepts. This may be accomplished through inquiry-based instructional practices that engage students in co-operative, hands-on activities that make connections and applications between mathematics and other contexts. Teachers' use of inquiry-based instruction is influenced by their beliefs in its effectiveness. There is a need to support teachers' professional learning with respect to the role of language in mathematics inquiry-based teaching, while attending to their beliefs and attitudes about mathematics instruction and their content knowledge. A mathematics facilitator should support teachers as they explore pedagogies, mathematics concepts, and work in collaborative groups. Reflection is also an important consideration in teacher professional learning in mathematics. These components were key to the professional learning evaluated here which sought to build on early learning educators' mathematics content and pedagogical knowledge while bearing in mind their beliefs and attitudes about mathematics instruction and how students learn mathematics.

Methodology

The teacher professional learning in these schools focused on supporting students' conceptual understanding of number sense and numeration (e.g., cardinality, identifying symbols, composing/decomposing numbers, place and value) while participating in a collaborative, inquiry-based professional learning community. A Numeracy Facilitator led all professional learning sessions and worked with the Numeracy Consultant and two Math Coaches to offer ongoing support for the teachers throughout the project. There were two plenary sessions that were attended by all teacher participants and five, half day sessions that were guided by the Numeracy Facilitator at each of the school sites.

This research was an evaluative case study with the purpose to inquire into an educational program in order to determine its effectiveness. There were five research questions that related to educators' practices, beliefs, attitudes and students' achievement. Quantitative and qualitative data (surveys, interviews, fieldnotes, learning blogs, assessment scores) were collected from four sets of participants: teachers, early childhood educators, facilitators, and students. There were 16 teachers (ELKP to Grade 2) and 8 Early Childhood Educators (ECE) at three schools that participated in the program and their students (n=245) indirectly participated as recipients of the educators' professional learning. All participants signed informed consent forms to volunteer for the data collection.

Findings

The use of a diagnostic or assessment for learning measure provided teachers and early childhood educators with achievement data in relation to specific numeracy concepts to make instructional decisions accordingly. This moved the educators' orientation away from a deficiency perspective focussed on what the student *does not* know and prioritized student learning around foundational instructional concepts such as the eight principles of counting.

To foster dynamic inquiry-based instruction, educators allowed students to take the lead in their own learning, using students' interests as a catalyst. This supported students' knowledge of multiple ways to solve problems, make meaningful schematic connections, and it kept students engaged in the learning process. As well, teaching through problem solving with manipulatives and visuals was successful at supporting students' conceptual understandings, fostering student engagement and

making abstract concepts more meaningful and relevant. Educators intend to continue to teach number sense using inquiry and multiple strategies to accommodate for students' individual differences.

The importance of focusing on students' learning process, not just the product of their work, was identified as a way to promote students' understanding of concepts. Students were required to explain their thinking and talk about strategies to reinforce the importance of processes and appeal to higher-order thinking. Interactive dialogue with the student was highlighted as an important vehicle for cultivating an accurate picture of students' understanding. Educators became more aware of how they wanted to continue to use language in relation to how they talked about numbers. Math talk needs to be modelled and embedded into the culture of the classroom.

Educators investigated the progression of number sense expectations from primary grades into the junior division and recognized that number sense is pervasive throughout the curriculum. As a result, number sense could be effectively taught by integrating curriculum expectations into lessons rooted in other curricular strands and this appeared to be an efficient way to cover curriculum.

While there appears clear support for implementing evidence-based practices in the classroom, it can be difficult for teachers to know the extent to which they should be using such practices. Despite the consistent pressure of time constraints on classroom activities, teachers began covering material more thoroughly because they gave themselves permission to trust their instructional instincts enough to slow down and cover material comprehensively.

Shifts in educators' beliefs about math instruction occurred. Educators are less likely to hold the belief that mathematics problems are solved by proposing an absolute solution - there are multiple pathways to process mathematics questions. Similarly, these educators are more likely to believe that mathematics is a dynamic of many different ideas and learners interpret and organize this dynamic of information. These educators do not contend that mathematics learning is demonstrated through computations and the ability to memorize facts, procedures or formulae. In a similar vein, these educators do not believe that students should be focused on quickly getting a correct right answer to a mathematics problem - the process of problem solving and understanding why and how one derived at a solution is of great value. The educators regard a mathematics learning context as one that is enhanced by challenging mathematics problems within a supportive environment, and activities which build upon and respect students' experiences. The educators now appreciate their key role in monitoring and being responsive to students' activities in mathematics.

Educators welcomed the opportunity for growth, as they recognized they were at a critical inflection point on their own learning curve and that in order to promote student achievement they needed to invest in building their personal capacity. Accordingly, educators perceived their new instructional strategies and practices discussed at facilitated sessions to be of value to their instructional repertoire. Educators appreciated having access to support, both human support in their classroom to model best practices, and access to tangible resources. Support was a positive influence in their efforts around instructional capacity.

The results of the analyses of students' conceptual understanding and achievement were noted in students' transfer of skills to new settings and a demonstration of their own initiative without prompting. Students appear to be more confident in math, more comfortable with open ended tasks, and willing to take risks. Quantitative results derived from a pre-test and post-test of students' mathematical concepts complement these qualitative findings. There was a significant growth in student performance for all students (ELKP, Grade 1, 2) at all three schools in the majority of assessed concepts.

Implications

Based on the findings, implications for practice and future research are offered. Facilitators should begin with a discussion of how to foster a student-driven classroom culture that supports inquiry-based strategies. On-site instructional modeling and demonstrations of new strategies might set the stage for educators to translate into their own practice. An expansion of the current program of professional learning might include a blend of teachers that have previously participated and teachers new to the initiative. Comprehensive baseline data about students' knowledge in relation to curricular expectations needs to be collected early in the school year.

Authors' Note:

Dr. Tiffany L. Gallagher is an educational researcher and Associate Professor in the Department of Teacher Education at Brock University. Her research expertise is in mixed methods research designs that investigate assessment and teaching strategies and students with exceptional learning needs.

Dr. Marybeth Fortune is an educational researcher and instructor in the Department of Teacher Education at Brock University. Her research expertise includes the investigation of leadership strategies in relation to the implementation of improvement initiatives and the management of organizational change.

A request was made by NCDSB to the Research Officer at Brock University Faculty of Education for researchers to investigate the *Early Learning Math Inquiry Project* and together Drs. Gallagher and Fortune elected to assume this task. Throughout the 2013/2014 school year, Drs. Gallagher and Fortune have remained at arms-length to the design and facilitation of this project. The research of this project was vetted through the Research Ethics Board at Brock University and NCDSB. The researchers independently and confidentially collected and analyzed all of the data contained in this report. Drs. Gallagher and Fortune have never been employed by Niagara Catholic District School Board and were not remunerated for the research or writing of this report; consequently they have remained objective evaluators throughout this process.