

Running Head: THE LITERACY/NUMERACY CONNECTION

AN EXAMINATION OF LITERACY STRATEGIES THAT  
CAN ASSIST IN THE DEVELOPMENT OF NUMERACY

by

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**An Examination of Literacy Strategies That  
Can Assist in the Development of Numeracy**

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**Dedication**

This work is dedicated to Terry, who loves, encourages, and strengthens me every day; to my children for their patience, humour, and tormenting; to my friends Collette, Sherry, and Laurel, for their unwavering encouragement and support; and last but not least, to my mother, for always being my champion, for giving me unconditional love, and for showing me what it means to be strong, compassionate, and gracious.

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### **Abstract**

Literacy and numeracy are two of the most essential skills taught in school. Ensuring that all young people acquire these skills is one of the greatest responsibilities of educational systems. In Alberta, one mandate of the Ministerial Order on Student Learning (Government of Alberta, 2013) was to enable all students to employ literacy and numeracy to construct and communicate meaning. Literacy and numeracy are more alike than different. This study has examined ways to create a mathematically literate environment by using the knowledge, skills, and strategies acquired through the literacy focus; specifically, how young children's literature and literacy strategies assist them with the development of numeracy. Integrating best practices from literacy into the mathematics classroom might be a first step in addressing the shortfall in mathematical numeracy in Alberta. The author proposes a plan to enhance numeracy in young children by integrating their literature with proven, research-based literacy strategies into the mathematics classroom. The recommendations include increased professional learning through embedded professional development, instructional rounds, and the development of numeracy coaches within the instructional leadership framework to help to reform current instructional practices in numeracy.

*Keywords:* numeracy, literacy strategies, numeracy coaches, children's literature

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## **An Examination of Literacy Strategies That Can Assist in the Development of Numeracy**

### **Chapter 1: Introduction**

Both numeracy and literacy, which are key domains of learning, are essential for student success at school (Victoria Department of Education & Early Childhood Development, 2009). Literacy has been the primary focus of education (Government of Alberta, 2010), and, as a result, there is an abundance of research on best practices in literacy. Researchers and organizations have examined what makes a good reader and how to provide instruction in developmentally appropriate ways and at developmentally appropriate times (Minton, 2007). Based on this research, teachers have effective, proven strategies available to use to teach reading. Pearse and Walton (2011) understood that knowledge acquired through the literacy focus and the use of literacy strategies can now be transferred to the development of mathematical numeracy, particularly in young children.

#### **Background to the Problem**

According to the Organization for Economic Cooperation and Development ([OECD] 2012), the Programme for International Student Assessment (PISA) defined numeracy as the capacity of an individual to identify and understand the role of mathematics in the world, to make well-founded judgments, and to use and engage with mathematics in a variety of contexts. Acquiring numeracy necessitates thinking through the mathematics by making sense and giving meaning to mathematical knowledge (Pearse & Walton, 2011). Pedagogical approaches to teaching literacy can be replicated to enhance the teaching of mathematics by mirroring classroom organization, print-rich environments, and daily practice in reading and writing and by integrating mathematics activities into classroom routines (Siena, 2009).

Although literacy is a fundamental tool to navigate the endless maze of daily communication in modern society (Minton, 2007), numeracy is also an essential skill associated with better opportunities for lifelong learning and success in the workplace (Dingwall, 2000). A workforce with high levels of numeracy enhances the ability of a country to meet the increasing skill demands of the global economy (Employment and Social Development Canada, 2015). With a strengthened focus on numeracy and literacy in the early grades, a solid foundation of knowledge, competence, and confidence will enhance future learning in the practical world.

### **Statement of the Problem**

Numeracy is a key outcome of how teachers teach mathematics and students learn it; it bridges the gap between the mathematics that they learn at school and the variety of contexts in which it is essential in everyday life (Victoria Department of Education & Early Childhood Development, 2009). The OECD (2012) PISA study, which focussed specifically on mathematics, showed that Canadian students' achievement is declining in reading, mathematics, and science. The participants in the research study included 21,000 students from 900 schools throughout all 10 provinces. Alberta has traditionally placed near the top of the international scales. The results, released in December 2013 (Government of Canada, 2013), demonstrate both a provincial and a national decline. Canada ranked 7<sup>th</sup> overall in mathematics in both 2003 and 2006, 10<sup>th</sup> in 2009, and 13<sup>th</sup> in 2012. Although Canada's education system remains among the best in the world, the observable weaknesses need to be addressed.

The OECD (2012) PISA study results followed the Programme for the International Assessment of Adult Competencies (PIAAC) results, ranking Canadians below average in numeracy skills compared to 23 other countries (OECD, 2013). With Canada's modern, knowledge-based economy, these numeracy outcomes "should act as a red flag for our education

system from primary school all the way to post secondary education” (Alexander, 2014, p.8).

TD Economics (2014) concluded in its special report that it is imperative that the Canadian workforce has the literacy and numeracy skills for Canada to remain competitive in the global economy.

### **Purpose of the Study**

The purpose of this study was to examine literacy strategies such as reading, writing, conferencing, guided instruction, and hands-on activities that can assist the development of numeracy in young children. With an abundance of best-practice strategies, literacy teaching methods are well established, well researched, and readily accessible to educators. To create a learning environment in which students’ mathematical understanding grows, Sammons (2010) suggested the use of such strategies as modeling and think-alouds, combined with ample opportunities for guided and independent problem solving and purposeful conversations. Reading literature is a means for children to encounter both ideas and vocabulary through the familiar context of story; therefore, the use of carefully selected children’s literature in mathematics class will offer opportunities for concept introduction and exposure to mathematical vocabulary (Fogelberg et al., 2008). Schiro (1997) considered mathematical literature as mathematical communication and believed that children need to experience a story as literature first before they search for and examine the mathematics within. Hunsader (2004) stated “engagement with literature provides a natural way for students to connect the abstract language of mathematics to their personal world” (p. 618).

According to Zemelman and Daniels (2005), we have a better understanding than ever before of human cognition and how to help students to understand mathematics. For students to become numerate, they must have opportunities to practice and apply the mathematics that they

have learned. The use of children's literature in mathematics class is an effective way not only to launch and foster mathematical concepts (Thiessen, 2004), but also to develop numeracy in young children.

### **Research Questions**

The most important and relevant research questions for this study are as follows:

1. Can the use of children's literature assist in the development of mathematical literacy (numeracy) in young children?
2. Can the use of proven literacy strategies be used effectively in the teaching of mathematical literacy (numeracy) to young children?

### **Importance of the Study**

Numeracy is a fundamental area of learning that ensures that children will be well prepared for future economic and social prosperity (Victoria Department of Education & Early Childhood Development, 2009). Numeracy encompasses more than the computation of numbers; as Pearse and Walton (2011) asserted, it requires deep thinking, meaning making, and sense building. Pearse argued that numeracy promotes independent thinking. Worldwide assessment such as that conducted by the OECD (2012) suggests that a numerate individual has the ability to use mathematics in everyday life and to understand and appreciate information presented in mathematical terms. The OECD further clarified that numeracy looks less at the mathematics that students know and more at what they can do with their acquired mathematical knowledge. Children often do not notice that mathematics is all around them; however, the adults in their lives, specifically their teachers, can introduce them to the important role of mathematical literacy in their lives and help them to make sense of their world (Janes & Strong, 2014).

In this study the researcher examined reading strategies that assist in the development of numeracy in young children. An examination of the OECD (2012) PISA study results makes it apparent that Canadian students need improvement in mathematical numeracy. Research has shown a correlation between literacy and numeracy, so it follows that proven literacy strategies can transfer to the teaching of mathematical literacy. Enabling all students to employ literacy and numeracy to construct and communicate meaning is a mandate of the Ministerial Order on Student Learning in Alberta (Government of Alberta, 2013). An exploration of pedagogy that involves the use of literacy strategies to enhance the teaching of mathematics, specifically reading strategies, was the purpose of this study.

### **Definition of Terms**

**Best practice:** Best practice describes solid, reputable, state-of-the-art work in a field. If teachers follow best practice standards, they are aware of current research and consistently offer their students the full benefits of the latest knowledge, technology, and procedures (Zemelman & Daniels, 2005).

**Co-teaching:** Co-teaching is an informal professional learning arrangement in which teachers with different knowledge, skills, and talents agree to share responsibility for designing, implementing, monitoring, and/or assessing a curricular program for a class of students on a regular biweekly, monthly, or term basis.

**Diagnostic assessment:** Diagnostic assessment is a means of gathering information about a student's learning traits and characteristics to plan specific instructional strategies.

**Formative assessment:** Formative assessment is a procedure used to gather information about students' learning throughout the school year to inform instruction.

**Frontloading:** Frontloading is the activation of students' prior knowledge about a concept, building background knowledge or providing additional background, assessing students' strategy needs, increasing their interest in a topic, and setting a purpose for reading.

**Guided mathematics:** Guided mathematics is a teaching structure in which a teacher supports each child's development of mathematical proficiency at increasing levels of difficulty within the context of a small group.

**Guided reading:** Guided reading is small-group reading instruction designed for differentiated teaching that supports students' development of reading proficiency. The small-group model allows children to be taught in a way that is focused on their specific needs, thus accelerating their progress.

**Instruction:** Instruction is school-based activities systematically designed to help children with their learning and to encourage their interest.

**Instructional rounds:** An instructional round is an instruction-improvement practice that combines three common elements of improvement: classroom observation, an improvement strategy, and a network of educators.

**Literacy:** Literacy is the ability to read and write, to handle information, to express ideas and opinions, to make decisions, and to solve problems as lifelong learners.

**Mathematics conferences:** Mathematics conferences are one-on-one conversations with students about their mathematics work as one mathematician talking with another (Sammons, 2014).

**Mathematics literature:** Mathematics literature consists of concept books that are written specifically for teaching mathematical ideas using mathematics concepts as the driving force of the plot line, mathematics-related books that are used to introduce and explore concepts

because the story has a plot of its own, and nonmathematical books that teachers can use to enrich or review mathematical concepts because mathematics can be created from the text.

**Mathematics work stations:** Mathematics work stations are areas within the classroom in which the students work with a partner and use instructional materials to explore and expand their mathematical thinking.

**Mathematical literacy:** Mathematical literacy, also referred to as numeracy, is the second key step for all students, beyond language literacy.

**Mini lesson:** A mini lesson is teacher-led instruction, usually at the beginning of a class, that is brief in time and narrow in focus (Siena, 2009).

**Ministerial Order on Student Learning:** The Ministerial Order on Student Learning establishes the goals and standards applicable to the provision of kindergarten to Grade 12 (K-12) education in Alberta (Government of Alberta, 2013).

**Numeracy:** Numeracy, also referred to as mathematics literacy, is the capacity of an individual to identify and understand the role of mathematics in the world, to make well-founded judgements, and to use and engage with mathematics in ways that meet the needs of individuals' lives as constructive, concerned, and reflective citizens.

**Numerate:** Numerate is the ability to problem-solve, reason, and analyze information. It is the ability to use numbers to help solve real-world problems.

**Organization for Economic Cooperation and Development (OECD):** The OECD is a unique forum where the governments of 34 democracies with market economies work with each other as well as with more than 70 nonmember economies to promote economic growth, prosperity, and sustainable development (OECD, 2012).

**Program for the International Assessment of Adult Competencies (PIAAC):** PIAAC is a household study conducted under the auspices of the OECD to assess the key cognitive and workplace skills required for successful participation in 21<sup>st</sup>-century society and the global economy (OECD, 2013).

**Programme for International Student Assessment (PISA):** PISA is a testing instrument that OECD uses every three years to test 15-year-old school children in different subjects (OECD, 2015).

**PISA 2012: Mathematics study:** The PISA mathematics literacy test asks students to apply their mathematical knowledge to solve problems set in real-world contexts. To solve the problems, students must activate a number of mathematical competencies as well as a broad range of mathematical content knowledge. In 2012, 510,000 students from 65 countries participated (OECD, 2012).

**Summative assessment:** Summative assessment is a means of determining how well a student has achieved the expected grade level outcomes at the end of a grade, unit, or reporting period.

**Think-alouds:** Using a think-aloud strategy, teachers verbalize aloud while reading a selection orally. Their verbalizations include describing things that they are doing as they read to monitor their students' comprehension. The purpose of the think-aloud strategy is to model for students how skilled readers construct meaning from a text (Sammons, 2011).

### **Scope of the Study**

This study focussed on the use of best-practice literacy strategies to assist the development of numeracy in young children, specifically those in the primary grades. By investigating the similarities between reading and mathematics, the researcher discovered that

the characteristics of good readers are also found in good mathematicians. Logic dictates that strategies used to develop comprehension in literacy would be equally as effective in the development of comprehension in numeracy. The researcher also examined the results of the OECD (2012) PISA survey, which is specific to Canada and Alberta, to demonstrate the need for improved numeracy skills; she did not explore the effectiveness of literacy strategies in middle school and high school.

### **Summary**

Numeracy is an essential life skill. Upon reflection on Canada's declining numeracy scores, the researcher notes that it is incumbent upon the teaching profession to explore different ways of teaching mathematics and mathematical literacy. Estrada (2015) remarked that if a child isn't learning the way we teach, maybe we should teach the way they learn. The researcher explored ways to better educate early learners by using research-based best practices in literacy to assist in the development of numeracy in young children.

### **Outline of the Remainder of the Paper**

This paper has four chapters. Chapter 1 presents the background, importance, purpose of the study, research questions, and definitions of terms. Chapter 2 details an exploration and comprehensive review of the relevant scholarly work on best practices for the teaching of numeracy. Chapter 3 describes the selected research methodology involved in the investigation of the enhancement of numeracy development in young children. Chapter 4 interprets, summarizes, and evaluates the research in this study on the use of research-based literacy strategies to assist the development of numeracy in young children.

## Chapter 2: Review of Literature

In chapter 2 the researcher discussed research from a variety of sources that have advocated the use of children's literature and proven literacy strategies in the development of mathematical literacy (numeracy) in young children. She organized the studies in this review into the following categories: historical background of numeracy and literacy, current research, the literacy/numeracy connection, and best practices.

### Historical Background

Mathematics education and the corresponding curriculum have been a source of discussion for decades (Ball, 1993; Davison & Mitchell, 2008; Klein, 2003; Schoenfeld, 2004). Since the inclusion of mathematics in the schoolroom in the 1890s, challenges to mathematics reform have persisted. The dissension in mathematics education can be "best understood as a protracted struggle between content and pedagogy" (Klein, 2003, p. 2). Key aspects of the controversy began with the mathematics that should be taught and who should teach it, followed by how it should be taught. "If content decisions come first, then the choices of pedagogy may be limited . . . in the same way [that] the choice of a pedagogy can naturally limit the amount of content that can be presented to students" (p. 3).

Among the calls for mathematics curriculum reform, two historical moments stand out: The first of these occurred at the turn of the century, when a curriculum of unified and applied mathematics was the focus; the other, during the 1950s and 1960s when modern mathematics was the core of reform efforts. Others who cited these moments (Kilpatrick & Stanic, 2004; Wojciechowska, 1989) suggested that these same two moments recurred when the gap between the mathematics taught in school and mathematics as a scientific discipline seemed particularly large and when the views on how to close the gap seemed to set the terms of debate.

In the past two decades literacy and numeracy have been the focus of reform initiatives in K-12 education. Some of the reforms include the National Numeracy and Literacy Strategies in England (Earl, Watson, & Torrance, 2002), standards-based reform in the US (Dutro, Fisk, Koch, Roop, & Wixon, 2002), and literacy and numeracy strategies in Ontario (Campbell & Fullan, 2006). Alberta reforms, as the “Framework for Student Learning” (Alberta Education, 2011) notes, identified literacy and numeracy as the foundational skills required for successful learning and living.

Governments, business leaders, researchers, and communities in Alberta, Canada, and around the world, investigating the requirements of 21st century learners, have identified the need for competencies to be more central in the education of young people if they are to be active participants in an increasingly knowledge-based and globalized society.

(Alberta Education, 2010, p. 9)

At the centre of a competencies-based, student-focused curriculum are literacy and numeracy skills (Alberta Education, 2010). Mathematics and literacy instruction can easily share strategies for inquiry and comprehension, as well as for classroom organization, routines, and student expectations. “Oddly, even when reading strategies are seen as keys to success for students, they are rarely taught in subjects other than reading” (Sammons, 2010, p. 20). Alberta Education (2013) requires cohesiveness with and between subject areas. According to Fogelberg et al. (2008), connecting with the same thinking strategies throughout the day and across subjects helps students to transfer their thinking.

### **Current Research**

Successful students in mathematics need to demonstrate a variety of literacy skills to develop and convey their knowledge, skills, and understandings of mathematics (Kenney, 2005).

Current research into the effective teaching of young children has focused on the child as an individual rather than on the class as a whole (National Association for the Education of Young Children, 2009). In an ideal world the teacher would have precise and current knowledge of the starting point for each student and the assistance that each student needs to move to the next level (Fullan, 2011b). Effective literacy teaching involves teaching in smaller, guided chunks (Fountas & Pinnell, 2013). These same chunks, which have proven so effective in teaching literacy, can also be applied to the teaching of numeracy, as can the concept of using children's literature to enhance instruction (Minton, 2007). The successful instructional strategies for reading need not be abandoned in teaching numeracy. Just as reading is closely linked to thinking and language, so is mathematics.

### **Numeracy/Literacy Connection**

The "K-3 Numeracy/Literacy Report" (Alberta Education, 2006) indicates that the key to success in learning is early intervention and a strengthened focus on numeracy and literacy in the early grades. Numeracy and literacy skills are crucial to every child because they enable each young person to develop as an individual, to live a satisfying and rewarding life, and to actively participate in society (Government of South Australia. Department for Education and Child Development, 2013). According to Fogelberg et al. (2008), since mathematics is a language on its own, adaptation and incorporation of literacy practices, grounded in theory and research, should help early learners to better relate to, learn from, and understand mathematical numeracy.

The term *braiding* further highlights the numeracy-literacy connection and explains students' connection of thinking, language, and mathematics to engage with and understand new learning (Hyde, 2006). Relying on literacy skills to read, write, talk, and represent mathematical thinking and problem solving creates a mathematically literate environment. The pedagogical

approaches to literacy such as daily practice in reading and writing, the workshop model, small-group work, guided reading, independent practice, and conferencing can also maximize numeracy learning (Siena, 2009).

### **Best Practices**

Ensuring that teaching is good for every child, every day, and in every classroom is the single most important means by which schools and teachers can deliver on their promise to enable all children to learn and achieve at high levels (Peterkin, 2011). The integration of literacy strategies into mathematics can include reading, writing, and teacher-student conferencing.

**Reading strategies.** Combining mathematics and literature activities in the classroom is one way that teachers can invite children into the world of mathematics. Reading books that weave mathematical ideas into engaging stories helps to dispel the myth that mathematics is dry, unimaginative, and inaccessible (Wilburne, Keat, & Napoli, 2011). Books for children not only generate interest in mathematics, but can also provide contexts that help to give meaning to abstract concepts. Burns (2005) promoted storybooks in mathematics class:

For many of us, the storybook shelf isn't the first place we go to when we start to plan a math lesson. But children's books can be a great math teaching tool. They spark students' imaginations in ways that exercises in textbooks or work-books often don't. When I visit classrooms, I find that connecting math to literature can boost the confidence of those who love books but are "math-wary." And students who love the abstraction of math can learn to appreciate stories in a whole new way. (p. 27)

Children's storybooks can help students who love to read, but who think that mathematics is difficult, to experience the wonder of mathematics in the same way that they already enjoy the

wonder of books. Conversely, students whose first love is mathematics will learn to look at books in a new way. “As in reading, comprehension is the ultimate goal of mathematics, as it makes sense to borrow the language of reading comprehension when teaching math” (Siena, 2009, p. 34).

The power of mathematics-literacy integration becomes evident when the underlying similarities in making connections, predicting, questioning, visualizing, inferring, summarizing, and determining importance are revealed. Appendix A is a comparison of mathematics and literacy learning strategies. According to Fogelberg et al. (2008), “students need to learn and use the same set of thinking strategies in reading, writing, or math work” (p. 4). Good mathematicians have many of the characteristics of good readers, as Appendix B shows. Because of the similarities between reading and mathematics, it is logical that strategies to increase comprehension in literacy are just as effective in increasing comprehension in numeracy. Martinez and Martinez (2001, as cited in Metisto, 2005) highlighted the importance of reading to mathematics students:

[Students] . . . learn to use language to focus and work through problems, to communicate ideas coherently and clearly, to organize ideas and structure arguments, to extend their thinking and knowledge to encompass other perspectives and experiences, to understand their own problem-solving and thinking processes as well as those of others, and to develop flexibility in representing and interpreting ideas. At the same time, they begin to see mathematics, not as an isolated school subject, but as a life subject—an integral part of the greater world, with connections to concepts and knowledge encountered across the curriculum. (p. 10)

Adding mathematics content to what students are reading, writing, and talking about during literacy lessons will teach them to engage meaningfully with mathematical numeracy.

Children become engaged in stories. Stories make ordinary situations come alive, and because of this, literature can be very effective as a vehicle for teaching mathematical concepts (Sammons, 2010). Books for children with mathematics problems or concepts related to the stories become relevant mathematical links to real life. According to Sammons:

To encourage students to recognize these math/literature links, teachers can use a think-aloud strategy as they read a story, detailing the mathematical connection and questions that occur to them as they read the story. Over time, the responsibility for finding these mathematical connections can be turned over to the students, who are asked to find the math in stories. (p. 124)

It is evident that a variety of reading strategies are effective in teaching numeracy to young children: read-alouds, think-alouds, independent reading and writing activities, word studies, centres and work stations, and student-teacher conferences (Kenney, 2005; Minton, 2007; Sammons, 2010; Siena, 2009). Placing mathematics in a meaningful context, such as using a storybook, helps young children to relate to and make sense of mathematics. The mathematics-literacy connection is natural in helping children to construct meaning in the world.

**Writing strategies.** Writing is a universal thread that can unite all content areas. Mathematical writing is a tool that provides teachers with a way to understand student learning and look at individual student strategies while encouraging students to reflect and revise their thinking (Fogelberg et al., 2008). Journals, prompts, and problem solving can facilitate writing assessments. Teachers can use writing assignments as either informal or formal mathematics assessment tools. Writing often reveals misconceptions and gaps in learning, which can direct

instructional planning and intervention strategies. Student writing can also offer valuable insight into the mastery of mathematics concepts. Burns (2004) explained writing in mathematics class:

Writing in math class has two major benefits. It supports students' learning because in order to get their ideas on paper, children must organize, clarify, and reflect on their thinking. Writing also benefits teachers because students' papers are invaluable assessment resources. Their writing is a window into what they understand, how they approach ideas, what misconceptions they harbour, and how they feel about what they are discovering. (p. 30)

Writing in mathematics class helps students to revisit their thinking and reflect on their ideas.

Writing in mathematics class differs from writing in other subjects in that it should be technical rather than creative (Minton, 2007). Writing gives students a way to reflect on their own learning and to explore, extend, and cement their ideas about the mathematics that they are studying (Burns, 2004). The process of writing about a mathematics problem often leads to a solution. Written explanations in mathematics involve what is being done and why it does or does not work. Writing about mathematics requires deep thinking. The type of thinking involved in justifying a strategy or explaining an answer is different from that needed to solve an equation. Samples of student writing from mathematics class have the added benefit of focusing teacher-student mathematics conferences. Writing about mathematics work and mathematics processes helps students to make sense of mathematics and improves teachers' understanding of what students are learning.

In literacy classes students write about what they have read, about what they are studying, and about their own feelings and attitudes: "These notebooks support self-assessment by providing students with an avenue to articulate their thinking" (Siena, 2009, p. 115). In this type

of writing students have an active role in their learning. Writing-to-learn strategies include journal keeping, the creation of problems similar to the one being solved, and directed expository writing. It follows that in mathematics classes, students write about mathematics processes. Teachers should use writing to engage students in mathematics thinking at the outset of a lesson and continue to ask them to refine their thinking throughout the lesson by putting their thoughts into writing.

**Conferencing.** Literacy teachers are familiar with student-teacher conferences, and conferencing in reading (Fountas & Pinnell, 2012) is a proven and effective strategy for student assessment. Conferences are one-on-one conversations with students about their work. This literacy strategy can also be used effectively in mathematics class. Mathematics conferencing can help to monitor individual students' ability to apply mathematical strategies: "Not only do teachers discover much more about their students' capabilities and next steps in learning, but close bonds between students and teachers are formed" (Sammons, 2014, p. 14). According to Sammons (2010), one-on-one conferences help teachers to assess their students' understanding of mathematical skills, clarify or correct misunderstandings and errors, extend or refine their understanding, and ensure success in mathematics. Conferencing provides ongoing feedback between student and teacher.

Mathematics conferences are times for students to share their mathematical thinking. These thoughtful conversations go to the core of student understanding and prompt them to think more deeply about the how and the why. According to the Saskatchewan Ministry of Education (2009, as cited in Sammons, 2014):

These conversations between students and teachers serve to increase the capacity of young mathematicians to effectively engage in mathematical thinking and problem

solving, critically consider the mathematical data and the reasoning of others, and clearly communicate their own mathematical thinking, so that they will be able to successfully apply the knowledge, skills, and strategies they have acquired to new situations and problems they encounter throughout their lives. (p. 17)

An important part of teaching mathematics to children in the early grades is teaching them to see themselves as mathematicians. As they grow, they begin to understand not only new mathematics concepts, but also how they, as unique problem solvers, approach these mathematical concepts.

Many teachers routinely hold individual conferences with students during literacy blocks. Conferencing takes place in the classroom with the goal of meeting with each child at least once over the course of the week. This strategy also applies to mathematics: “Asking students to orally explain what they are doing is a good way of getting them to articulate their thinking” (Minton, 2007, p. 53). It is of particular importance to conference with students who struggle with mathematics to remediate misconceptions or partial understandings before they become part of the students’ belief systems (Fogelberg et al., 2008). The questioning and listening that occurs during conferencing is twofold: It improves student learning and drives classroom instruction. For conferencing to be an effective numeracy learning strategy, Siena (2009) stated that it requires good questions, good listening, and a solid understanding of mathematical processes. Listening and responding to the mathematical thinking and ideas of individual students drive instruction, facilitate formative assessment, and help students to see themselves as mathematicians.

**Summary**

The pedagogical approaches to teaching literacy can be reproduced to augment the teaching of mathematics by emulating classroom organization and print-rich environments, practicing daily reading and writing, and integrating mathematics activities into classroom routines (Siena, 2009). Teachers have access to effective, proven strategies to teach reading, strategies that transfer to the purposeful teaching of mathematical numeracy. Pearse and Walton (2011) asserted that the knowledge acquired through a focus on literacy and the use of literacy strategies can be transferred to the development of mathematical numeracy, particularly in young children. Minton (2007) wrote:

Remember that the positive results in literacy are a direct result of dedicating resources (that is, time and money) to discovering how children learn to read and providing teachers with frameworks and materials that support teaching and learning. Clearly, achieving similar results in mathematics will take time, but if we are able to draw from our understanding of literacy, we may sooner be able to positively impact mathematics education. (p. 26)

This chapter has presented ways to better educate young children by using research-based best practices in literacy to assist in the development of numeracy.

### Chapter 3: Method

The use of children's literature to enhance the development of mathematical literacy in young children is not a new consideration. For more than 40 years, Marilyn Burns, founder of Math Solutions Professional Development, has been dedicated to the improvement of mathematics instruction in Grades K–8 and an advocate for the inclusion of storybooks in the teaching of mathematics since the 1980s. Burns' (2012) *Math Reads* is a mathematics and literature program for Grades K–5. Through Common Core lessons inspired by engaging children's literature, *Math Reads* develops students' mathematical thinking, reasoning, and problem-solving skills. With the impetus of proven, research-based literacy teaching and the promotion of cross-curricular competencies, as the Alberta Ministerial Order on Student Learning (Government of Alberta, 2013) directs, the power of the mathematics-literacy integration is evident. Using exemplary children's literature with both deliberate and incidental mathematical content is an effective way to enhance numeracy in young children. Using quality literature and incorporating proven, researched-based literacy strategies into the teaching of mathematics develops a deep conceptual understanding (Hyde, 2006; Kenney, 2005; Minton, 2007; Pearse & Walton, 2011; Siena, 2009). Sharing literacy best practices in teaching numeracy provides students with the same set of routines and thinking strategies throughout the day.

Guided mathematics instruction, mathematics work stations, and the mathematics workshop model are approaches to teaching numeracy. All three approaches to teaching mathematics have roots in literacy. These approaches to teaching reading and writing have been developed, and continue to be refined, to address the complex goals of literacy learning (Fountas & Pinnell, 2013; Hyde, 2006). Using these same models in mathematics (Diller, 2011; Pearse &

Walton, 2011; Sammons, 2010; Siena, 2009) also embraces the diverse nature of numeracy. The specific, targeted focus of reading children's literature in mathematics class has proven to enhance numeracy learning, as has the focus on writing and student-teacher conferences. In chapter 2 the researcher reviewed a variety of sources that support this claim. Guided reading, work station, and workshop approaches to teaching literacy can also be effective in teaching numeracy. Following the examination of the three approaches in detail in chapter 3, the researcher presents a strategy called SOLVE Math, intended to integrate the literacy workshop framework into the mathematics classroom.

The goals of numeracy are similar to the goals of literacy. In literacy, students use the rules of language to acquire, construct, and communicate meaning (Alberta Education, 2015). In numeracy, students interpret, represent, and communicate meaning in situations that involve numeracy (Alberta Education, 2010). To be truly numerate, students need both knowledge of language and knowledge of quantitative information to deeply understand mathematical concepts and to develop an affinity for mathematical thinking. Students must read mathematical situations and understand them to become skilled in mathematics.

### **Guided Mathematics**

Guided mathematics is a structured, practical way of matching mathematics instruction to the diversity of individual learners in the classroom. This approach respects the belief that every child is capable of learning and understanding mathematics and recognizes that students learn at varying rates of development (Sammons, 2010). Guided mathematics is a close replica of guided reading. Using this strategy, teachers assess students both formally and informally to create homogeneous groups according to skill proficiencies. The groupings are subject to revision as students understanding changes. Fountas and Pinnell (2013) used this method of guided reading

to meet the specific needs of individual students. Based on targeted achievement levels and needs, the teachers in their study worked with small groups during guided mathematics instruction and observed their work closely while offering struggling learners strong support and providing proficient learners with extra challenges. Not only the amount of instructional time, but also the content of the material covered and the amount and level of difficulty of the assigned practice work differ (Sammons, 2010). Guided mathematics groups efficiently meet the needs of individual students.

Small-group guided mathematics instruction is efficient and effective and must be uninterrupted. As a result, teachers must also consider the students who are not directly involved with them. Activities that offer scaffolded practice run concurrently with small-group guided mathematics and help students to assume ownership of their learning (Sammons, 2011, p. 34). Both small-group instruction and differentiated activities helps all students to become actively involved during guided mathematics.

### **Mathematics Work Stations**

Mathematics work stations are learning activities that follow direct whole- or small-group instruction. Students work on activities in pairs, for example, to play a game, make something, or solve a problem. Each station has familiar materials from previous lessons. The stations are focused, hands-on tasks that the teacher has pre-taught in teacher-led instruction. Although they allow room for independent thinking, reasoning, and exploration, the strategies are not literacy based. Students need to be trained in the routines and expectations of mathematics workstations. Diller (2011) defined work stations as

areas within the classroom where students work with a partner and use instructional materials to explore and expand their mathematical thinking. During math stations, a

variety of activities reinforces and/or extends prior instruction, allowing children the opportunity to develop their mathematical understanding. Math work stations are a time for children to practice problem solving while reasoning, representing, communicating, and making connections among mathematical topics as the teacher . . . meets with a small group. (p. 7)

Work stations allow choices, make learning relevant, and create engagement. They are similar to mathematics centres in that they give students opportunities to practice and apply the skills and strategies that they learned in the classroom. Engaging students in purposeful work station tasks also gives the teacher an opportunity to work with individual students or small, flexible groups to meet their individual needs.

### **Mathematics Workshops**

The mathematics workshop model is closely linked to the literacy workshop model. This approach includes instruction, practice, and reflection while supporting independence, understanding, and differentiation in mathematics (Siena, 2009). This method of teaching allows differentiation, explicit teaching, and both guided and independent learning. Like guided mathematics and the work-station approach, the workshop model begins with literature and thus reinforces the mathematics-literacy connection. The versatile structure of the workshop concept accommodates a vast array of learning activities (Sammons, 2010), and its flexibility is one of its greatest advantages. Following a teacher-led mini lesson, students can work individually or in pairs or other groupings, depending upon the task to be completed. The independent work might consist of interactive games, paper-and-pencil activities, mathematics-facts practice, exploration activities, problem solving, journal writing, or computer practice. Because children develop both

literacy and numeracy skills through active engagement in genuine opportunities, this model of instruction is particularly effective because of the social and constructive nature of learning.

Mathematics workshop rounds have the additional benefit of emulating their literacy counterpart because they use the same methods, set of strategies, routines, and procedures: “Because in many ways goals in mathematics closely mirror those in literacy, teachers have successfully adopted the workshop model to structure mathematics lessons” (Siena, 2009, p. 74). The workshop model affords students an opportunity to take more responsibility for their learning by including such activities as mini or whole-group lessons, independent mathematics work, exploration and practice, guided small-group support, conferring, group-work structures for collaboration, and mathematics shares (Siena, 2009). From current research on reading and writing instruction, teachers have learned the value of giving students some choice in what they write and what they read (Fogelberg et al., 2008). When students have choices, they take more ownership of their learning experiences. The mathematics workshop concept also allows the exploration of mathematical topics over an extended period of time (Siena, 2009).

### **Synopsis**

In chapter 3 the researcher has examined many facets of literacy-influenced numeracy instruction. The exploration of guided mathematics, mathematics work stations, and the mathematics workshop model has shown that each method of mathematics instruction is valid. Sammons (2011) pointed out that

teachers are forever searching for an overall set of instructional strategies to help them bring out the very best in their students. . . . It is not surprising that this pursuit has often focused on methods for teaching reading. After all, reading and language are so inextricably linked to thinking. (p. 20)

Each of the three methods targets diversity in learning while valuing students as individuals, providing a variety of activities, and giving students voice and choice to become actively engaged early learners. Each method also has its roots in literacy. Sammons' (2011) seven literacy-comprehension strategies of making connections, asking questions, visualizing, making inferences, determining importance, synthesizing, and monitoring meaning transfer easily from reading to mathematics, which strengthens the literacy-numeracy fusion. All of the methods advocate for a literacy-numeracy connection to teach young children.

All three methods begin with a reading component. Teachers use children's literature to introduce or review a concept and/or model skills with a read-aloud mini lesson. The term *mini lesson* describes both the brevity of the lesson and the narrow specificity of the lesson's topic (Siena, 2009). The literacy read-aloud mini lesson has been integrated into numeracy teaching and is incorporated in each of the three methods.

In addition to the similarities, the three methods have some distinct differences. Guided mathematics focuses on small-group instruction with the teacher (Sammons, 2010), mathematics work stations spotlight purposeful partnered activities linked to mathematics teachings (Diller, 2011), and mathematics workshops foster practice, sharing, and reflection (Siena, 2009). The mathematics workshop model integrates ample literacy strategies into numeracy instruction because it uses children's literature to enhance the development of mathematical literacy by including literacy strategies in conjunction with the literature itself.

### **SOLVE Math: A Proposal**

**The beginning.** Teachers can use children's literature effectively with young children to help them to develop mathematical literacy (numeracy). *Math Reads* (Burns, 2012) and *MathStart* (Murphy, 1995) programs are specifically designed to teach mathematics skills and

concepts through children's literature. Teachers can use children's mathematics storybooks from *Math Reads* and *MathStart* as read-alouds to introduce, reinforce, and review mathematics concepts. Student engagement with the stories might lead to meaningful mathematical learning that emanates from the literature (Janes & Strong, 2014).

Just as literacy and mathematics show a natural integration when stories cross over from reading to mathematics, so can the strategies to teach them. The next step in the mathematics-literacy fusion would therefore be the introduction of a literacy workshop teaching model in mathematics classes. In its simplest form, the workshop model has five basic parts: the purpose and focus mini lesson, work time, sharing time, reflection, and debriefing (Siena, 2009). SOLVE is a feasible framework that uses proven literacy strategies effectively to teach mathematical literacy (numeracy) to young children.

**What is SOLVE Math?** SOLVE Math is a specific format that employs the mathematics workshop model. SOLVE is an acronym for the five rounds included in this workshop model. The word *solve* was an inspiration that resulted from the lifelong goal of solving in mathematics and numeracy. SOLVE encourages and supports children's mathematical learning by giving them carefully scaffolded numeracy opportunities that help them to deepen their understanding, use meaningful and creative solution strategies, and confidently engage in mathematics (Ontario Ministry of Education, 2006).

This framework begins with a mathematics-literature read-aloud and uses literacy strategies to introduce or review the mathematical concept under examination. These literacy strategies can include predicting, inferring, making connections, synthesizing, making meaning, visualizing, and questioning. SOLVE also uses specific terms and mathematical vocabulary to ensure that students become acquainted with the specialized, subject-specific terminology.

Identification of the mathematics in the story is a joint teacher-student effort (Schiro, 1997). Students often see familiar mathematics concepts in storybooks but need help with deeper thinking and understanding deeper meanings (Burns, 2005). Through exposure to and repetition of this process, finding mathematics in literature can become habitual. Students are able to self-regulate by determining whether they have identified the mathematics, they understand it, and can explain it to someone else. After the read-aloud and subsequent discussion, the teacher gives instructions for the five rounds of the SOLVE acronym: the strategies of guided practice, independent practice, hands-on exploration and practice, conferring, and group work. Upon completion of the rounds, students regroup for debrief and mathematical shares.

**S – Small group.** Small-group work gives students opportunities for learning and practice with the teacher. It is an efficient way for teachers to provide differentiated instruction to meet the needs of diverse learners (Sammons, 2010). The amount of time that they spent on teacher-led instruction varies according to the specific needs of the students. Some might grasp a concept quickly and be ready to move on to independent work; others might need additional time for more intensive instruction. Not only can the amount of instructional time differ, but also the content of the material covered and the amount and level of difficulty of the practice work assigned. If all students are at the independent stage during small-group work, the teacher might conference with a student.

Conferencing in mathematics class allows students to share their learning, understanding, and mathematical thinking with the teacher. Sammons (2014) stated, “Students learn not only to organize and express their mathematical ideas cogently, but also continue to reassess the validity of their reasoning” (p. 17). Spending time one-on-one with students during mathematics class

not only extends and deepens their numeracy, but also builds positive, caring student-teacher relationships.

**O – Online.** In the online round students work with technology, specifically Chromebooks or iPads. Teachers choose and assign the tasks and specifically target the concept that they are teaching. Students can work independently or in pairs. According to the Ontario Ministry of Education (2006):

Computer manipulatives can sometimes be more powerful than concrete manipulatives. . . . Technology in primary classes should offer multidimensional mathematical tasks ensuring both student input into the direction of their learning and supporting more varied learning outcomes. Such an approach to technology enables students to use powerful yet familiar media to express and extend their learning. (p. 3)

**L – Literature.** In the SOLVE approach, reading mathematics literature independently, in pairs, or in groups of three is the focus of this round. Children’s storybooks provide a rich context for promoting mathematical connections. A variety of mathematics-related storybooks are available to students, and they can also review teacher read-alouds. Wilburne et al. (2011) noted:

Children are motivated and stimulated to solve mathematical problems when they are presented in the context of a storybook. Their ability to pretend and imagine enables them to become emotionally involved with the storybook and enter the storybook world. In this world, the mathematics appears relevant as opposed to mathematics taught as expository instruction. (p. 21)

In addition to the read-alouds, a variety of topic-specific storybooks will be on hand for the students. Some of the mathematics literature might come from *Math Reads* (Burns, 2012),

some from *MathStart* (Murphy, 1995), and other from the teacher's personal mathematics library. Students' asking to read mathematics literature during available reading time validates reading in mathematics class. Mathematics teachers ultimately strive to help their students to understand mathematics and use it in all aspects of their lives. Mathematics literature can be an effective conduit between mathematics at school and mathematics in the real world.

**V – Vocabulary and journals.** “Writing in math class? Absolutely!” (Burns, 1995, p. 40). In the SOLVE writing round the students give written explanations of their learning that include words, pictures, and numbers. When students are required to write an explanation or explain their problem to someone else, they develop a deeper understanding of the concept. Or, if they have any misconceptions, they will be discovered and can be easily corrected. Student writing is closely connected to student-teacher conferencing because it is the basis for both discussion and assessment. Young learners can work on mathematics journal prompts, problem solution/creation, or interactive mathematics notebooks. Mathematics vocabulary is a critical part of mathematics writing. Fogelberg et al. (2008) noted that mathematics has its own language, specialized vocabulary, and specific terms that students must learn to be able to make sense of mathematical concepts. In SOLVE math, students use interactive mathematics journals for their vocabulary work. Burns (1995) attested to the importance of writing in mathematics class:

The process of writing requires gathering, organizing, and clarifying thoughts. It demands finding out what you know and don't know. It calls for thinking clearly. Similarly, doing mathematics depends on gathering, organizing, and clarifying thoughts, finding out what you know and don't know, and thinking clearly. Although the final representation of a mathematical pursuit looks very different from the final product of a

writing effort, the mental journey is, at its base, the same—making sense of an idea and presenting it effectively. (p. 3)

Mathematics journals and the vocabulary within them then document the students' growth over time, and their writings help them to monitor their own thinking and development to improve their metacognition.

**E – Exploration.** The SOLVE exploration round involves active engagement with manipulatives during hands-on activities. Young learners are expected to demonstrate involvement with the mathematics that they are studying. Game-like activities can create an atmosphere in which children are encouraged to think, discuss, explain, and share their ideas with others. Exploration creates a context for using reasoning, which can motivate students and capture their interest. These activities are engaging replacements for paper-and-pencil practice. Burns (2009) explained that game-like activities “support students’ math learning . . . [and] help to lift math off the textbook pages” (p. 23).

Using manipulatives can generate far more practice with vocabulary and reasoning than students would be expected to do using a conventional textbook exercise. Perhaps the most powerful reason for introducing hands-on activities into the mathematics classroom is children’s enthusiasm, excitement, and total involvement and enjoyment when they engage in game-like activities. When the students become highly motivated and immerse themselves completely in the games, their attitude toward numeracy flourishes.

### **Summary**

Classroom environments in which mathematical opportunities are rich and plentiful are pivotal to young children’s development of a comprehensive understanding of numeracy. Students require ongoing opportunities to apply mathematics to both familiar and unfamiliar

situations to be able to develop a mathematical habit of mind. Students who are actively participating are learning. Giving students choice fosters higher levels of interest and engagement and is one way of differentiating instruction.

A variety of literacy formats have proven to be effective in teaching numeracy, and all of these formats begin with children's literature that contains both explicit and implicit mathematical understandings. Reading storybooks is an authentic way for children to connect with mathematical experiences and integrate content, processes, and skills from literacy. SOLVE Math is an original, well-researched approach which utilizes the workshop model of reading and adapts the strategies, routines, and expectations into a format for use with young learners. Students can benefit from the interconnectedness of learning methods from literacy to numeracy.

### **Chapter 4: Summary**

The purpose of this research project was to determine whether the use of proven literacy strategies and children's literature would help young children to develop mathematical literacy (numeracy). Enabling all students to employ literacy and numeracy to construct and communicate meaning is a mandate of the Ministerial Order on Student Learning (Government of Alberta, 2013). The acquisition of literacy and numeracy is essential for student success at school and beyond. It follows that the integration of literacy and numeracy enhances student learning and supports the "Inspiring Education" (Alberta Education, 2010) document, which highlights the need for Alberta students to learn with cross-curricular competencies.

The literature review supported the premise that best-practice literature strategies can effectively enhance the teaching of mathematical literacy to young children. Early intervention and a strengthened focus on numeracy and literacy in the early grades are key to success in learning. The skills, tools, and strategies that teachers use to teach reading successfully can also be used to teach mathematical literacy successfully (Alberta Education, 2006). Current research has shown that successful students in mathematics need to demonstrate a variety of literacy skills to be able to develop and convey their knowledge, skills, and understandings of mathematics (Fogelberg et al, 2008; Hyde, 2006; Kenney, 2005; Minton, 2007). The literature review confirmed that reading, writing, speaking, and listening are integral components of both literacy and numeracy. Because many of the characteristics of good readers are also evident in good mathematicians, sharing proven, research-based strategies creates a win-win learning environment for students and teachers.

The examination of specific mathematics instructional models in chapter 3 attests to the effective use of children's literature and literacy strategies in teaching numeracy to young

children. Teachers have adopted the literacy workshop model to structure their mathematics lessons (Fogelberg et al., 2008). In this workshop approach to teaching mathematics, teachers have developed structures similar to those in the literacy workshop. The consistency of the instructional models that the researcher reviewed includes instruction, practice, and reflection; but the instructional models could differ in classroom delivery and procedure (Siena, 2009). One teacher might include a daily mini lesson, time for independent practice with conferring, and a whole-group share or reflection. Another teacher might start a workshop with a mini-lesson two or three times a week and include a combination of independent reading and book clubs or partnerships with daily guided reading groups. The SOLVE model promotes the sharing of thinking strategies such as questioning, predicting, inferring, visualizing, and making connections. Teachers have found the workshop model effective in a number of subjects, from physical education to French, and it is well suited to the teaching and learning of mathematics (Siena, 2009). When teachers carefully teach, model, and establish analogous routines and procedures in the classroom, the children know what is expected of them and how to do certain things on their own. These predictable patterns might allow teachers to spend more time in meaningful instruction. The workshop model uses the same strategies, language, routines, and expectations in literacy and numeracy to streamline learning for young children.

### **Implications**

The research suggested that teachers of young children could use more professional development in the teaching of mathematics and numeracy. Numeracy, like literacy, must permeate the curriculum (Hyde, 2006; Pearse & Walton, 2011; Sammons, 2011). Professional learning communities need to work collaboratively to build the mathematical capacity of teachers. An environment in which teachers and students alike are active learners of

mathematics and all educators are responsible for numeracy development is imperative (Ontario Ministry of Education, 2012). The literacy-numeracy link might benefit teachers who are uncomfortable with mathematics yet feel confident in teaching literacy. Integrating research-based literacy models and strategies that teachers are already using into the instruction of mathematics can improve teachers' efficacy.

In addition to utilizing literacy approaches, teachers might need to be introduced to the world of mathematics through storybooks (Welchman-Tischler, 1992). They require practice in identifying and using the three categories of children's literature for numeracy instruction: mathematics concept books, mathematics-related books, and nonmathematical books. Training teachers who are already using an array of children's literature in the effective incorporation of mathematical literacy into reading and reading into mathematics instruction should be supported (Wilburne et al., 2011). This literature can help students who love to read but find mathematics difficult to experience the wonder of mathematics in the same way that they already appreciate the wonder of books (Burns, 2005). Conversely, students whose first love is mathematics will learn to look at books in a new way.

Inspiring change to create and sustain a schoolwide numeracy culture that recognizes, emphasizes, and reinforces a cross-cultural approach takes ongoing, intentional work (Ontario Ministry of Education, 2012). All members of a school community must be on board with a shared vision of numeracy to ensure student success. Teachers who are not numeracy specialists will need assistance to develop appropriate classroom skills. Professional learning communities are a good place to start to build a numeracy vision, as are embedded professional development times.

## Conclusion

The integration of children's literature into the teaching of mathematics can enhance young children's numeracy, as can the use of research-driven literacy strategies. Research has shown that the characteristics of good readers are similar to those of good mathematicians (Minton, 2007). Children's literature used in the instruction of mathematics can create excitement in ways that surpass textbooks or workbooks (Burns, 2005). Teachers will find effective ways to unleash the potential of literature in the mathematics classroom. Children's literature can foster the learning of important mathematics in a framework that is robust and relevant to the real world (Janes & Strong, 2014). Integrating meaningful mathematics and children's literature can create purposeful mathematical learning experiences.

## Recommendations

Three recommendations are based on the research: an increase in effective, embedded professional development on numeracy for teachers; the implementation of numeracy-focused instructional rounds; and the establishment of numeracy coaches. Each of the recommendations has research support (Barth & Guest, 1990; Fullan, 2011b; Marzano, 2011b).

**Embedded professional development.** Student learning depends on continuous teacher learning (Fullan, 2007). Educators need to have greater knowledge of numeracy more than ever before. Teachers need to understand and establish a collection of numeracy strategies to work effectively with a range of students. Educators require a deep knowledge of mathematical approaches for their instruction to be purposeful. With embedded professional development, teachers are learning all the time. According to Fullan (2011b):

Effective professional learning for today's teachers should include the following features: it must be grounded in inquiry and reflection, be participant-driven, and focus on

improving planning and instruction; it must be collaborative, involving the sharing of knowledge and focusing on communities of practice rather than on individual teachers; it must be ongoing, intensive and supported by modeling, coaching and the collective solving of specific problems so that teachers can implement their new learning and sustain changes in practice; and it must be connected to and derived from teachers' work with students—teaching, assessing, observing and reflecting on the processes of learning and development. (p. 2).

The process of job-embedded professional development is ongoing and comprehensive (Marzano, 2011c). Providing in-house numeracy support for teachers is essential for student growth. Just as each child comes to the classroom with different skills, so do teachers arrive with different skills. Professional development services must be flexible and adaptable. This approach to teacher learning is one way to create a culture of numeracy in a school through a shared vision, collaborative work, and a deeper understanding of pedagogy.

**Instructional rounds.** Instructional rounds enhance numeracy instruction. The purpose of instructional rounds is to improve classroom instruction through classroom observation, a collaborative improvement strategy, and a network of educators (Marzano, 2011b). Teachers observe other teachers to compare their own instructional practices with those of the teachers they observe. Teachers who have become experts in integrating mathematics literacy and numeracy can share their knowledge with others to promote and sustain that culture. The practice, which began with administrators, has become increasingly popular in schools in which teachers are usually the most enthusiastic rounds participants and lead the next evolution of the practice (City, 2011). When teachers understand what they are teaching, they teach for understanding.

Instructional rounds are a disciplined way for educators to work together to improve instruction (City, 2011). They stimulate excitement and energy among staff members and are one of the most valuable tools schools or districts can use to enhance teachers' pedagogical skills and develop a culture of collaboration (Marzano, 2011b). When teachers have an opportunity to observe and interact with their colleagues in a nonevaluative way regarding instruction, everyone wins. Sustained professional learning is a factor in students' success in school (Fullan, 2007). Numeracy enhancement is a potential outcome when numeracy becomes the focus of instructional rounds. Instructional rounds facilitated by a mathematics lead teacher or a numeracy coach focus on learning strategies and positive outcomes in mathematics achievement.

**Numeracy coaches.** Literacy coaches have positive effects on student achievement at both the classroom and the district level (Lynch & Alsop, 2007). Because coaching is an essential component of effective professional development for teachers, with purposeful introduction and support, numeracy coaches can have a similar positive effect on both teacher learning and student achievement. According to Aguilar (2013), coaching can build will, skill, knowledge, and capacity because it can go where no other professional development has gone before: into the intellect, behaviors, practices, beliefs, values, and feelings of educators. Coaching is a collaborative endeavour. Kouzes and Posner (2010) observed that positive collegial relationships in the workplace lead to positive outcomes. Working in teams helps teachers to better meet the needs of their students. Sharing clearly defined numeracy goals and practices helps them to “talk about practice, observe each other, work on curriculum, and teach each other” (Barth & Guest, 1990, p. 31). Put in mathematical terms, the sum is greater than the parts.

Teachers benefit most when they view coaches as collaborators rather than as external trainers or evaluators (Lynch & Alsop, 2007). Principals play an important role in nurturing collaborative relationships and monitoring achievement targets. Because coaches are teachers who have both content and instructional expertise, numeracy coaches promote student learning and raise achievement by building on teachers' skills as knowledgeable practitioners who are already using quality instructional techniques. Coaching creates a relationship in which teachers feel cared for and are therefore able to access and implement new knowledge. Teachers must have opportunities to become connected with numeracy for children to understand and use the tools of mathematics to make sense of their world. Numeracy coaches must make good relationships with teachers a priority, begin by working with teachers who are interested and open to change on a different way to teach mathematics, and work beside teachers as co-teachers to reflect on and improve instructional practices. Coaching builds teacher capacity through reflection on and implementation of effective instructional practices (Fullan, 2002). Coaches encourage teachers to share what they are learning about numeracy with others, and numeracy coaches enhance student learning and engagement. They foster conditions in which deep reflection and learning can take place, a teacher can take risks to change practice, powerful conversations can take place, and growth is recognized and celebrated (Aguilar, 2013). Numeracy coaches can improve student numeracy outcomes by modelling quality teaching. They should coach and guide classroom teachers in the delivery of purposeful, quality numeracy teaching; and they should build leadership capacity by providing teachers with ongoing, in-house professional development.

**Comments**

The development of staff and the building of respectful collegial relationships can create a culture of learning and leading. Barth and Guest (1990) identified the enlistment and empowerment of teachers as a win-win with well-established relationships as the resource that keeps on giving. Literacy coaches affect teacher pedagogy and student learning, and I believe that numeracy coaches should also be integral in enhancing elementary education. Developing a mathematical habit of mind must include teachers as well as students and must reach across the curriculum. Hyde (as cited in Pearse & Walton, 2011) reported that the development of initial numeracy of young children aged 4 to 9 is crucial to later mathematical success (p. x). Using both children's literature and proven, research-based literacy strategies in the mathematics classroom is an effective way to enhance numeracy and create a love of mathematics in young children.

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## Appendix A: Comparison of Math and Literacy Learning

Table A1

### *Comparison of Math and Literacy Learning*

Math	Literacy
<p><b>Make connections</b> I can make connections to this problem by thinking about others like it that I have solved before. I can make connections between this concept and what I know from reading in science or from what I have learned about solving problems in my everyday life.</p>	<p><b>Make connections</b> I can make connections to what I am reading by thinking of other books that I have read like this one. I can make connections to what I am reading based on experiences I have had and with what I know about the world.</p>
<p><b>Make predictions</b> I can make predictions about patterns, data, upcoming learning, problem solving, solutions, etc. I can make estimations. I need to check to see if predictions or estimations were correct or need revision.</p>	<p><b>Make predictions</b> I can predict what the story is about by looking at chapter titles. I can predict what characters will do next or predict motives, plot, or resolution. I can predict themes or predict topics in nonfiction, etc. I need to check to see if predictions were correct or need revision.</p>
<p><b>Ask questions</b> I can ask questions about data or for clarity or to determine what the problem is and to decide if the answers and solutions make sense.</p>	<p><b>Ask questions</b> I can ask questions about story elements, characters' motives, and author's purpose to clarify meaning and understand the text.</p>
<p><b>Self-regulate or be metacognitive</b> Think about the problem: Does it make sense? Do I need to reread or restate the problem? Does the solution make sense? Can I solve the problem another way? Do I understand the math terms? Can I summarize the problem and explain my answer?</p>	<p><b>Self-regulate or be metacognitive</b> Think about the reading: Do I understand what I am reading? Do I need to reread the reading in my own words? Do I have questions? Do I need clarification of the way the author is using certain words? Can I summarize what I am reading? Do I agree or disagree with the author?</p>
<p><b>Infer</b> Much like predicting, I can infer what will come next using the data presented. I can make an informed guess about additional information needed. I can infer or estimate a solution.</p>	<p><b>Infer</b> I can draw conclusions about the character, setting, or solution to the main character's problem. I can infer the meaning of words using context. I can infer the author's intent or biases.</p>

*(table continues)*

Math	Literacy
<p><b>Visualizing</b> I can make pictures in my mind or draw what I think the problem is about. I can represent the different parts of the problem by drawing or diagramming the problem.</p>	<p><b>Visualizing</b> I can create pictures in my mind of the setting and the characters. I can picture the problem the characters are facing and think about how I would act to solve the problems. I can imagine what the characters are feeling and how they look and act.</p>
<p><b>Summarize</b> I can summarize the problem and explain the steps to solve the problem. I can justify the solution using logic and mathematical reasoning.</p>	<p><b>Summarize</b> I can summarize the story, state the theme or author's intent, and justify the interpretation of the text using examples from the text.</p>
<p><b>Determine importance</b> In reading math problems, I can separate the important information from the supporting details. I can determine which details are used to clarify and which are not important.</p>	<p><b>Determine importance</b> In reading, I can separate the main ideas from the supporting details. I can reflect on new information and decide whether this information contributes to an understanding of the main points of the story or article.</p>

(Fogelberg et al., 2008)

**Appendix B: Similarities Between Good Readers and Good Mathematicians**

Table B1

*Similarities Between Good Readers and Good Mathematicians*

Characteristics of good readers	Characteristics of good mathematicians
They call upon their prior knowledge to make meaning from text.	They call upon their prior knowledge to understand concepts and solve problems.
They are fluent readers.	They are procedurally fluent.
They have a mental image of what they are reading.	They create multiple representations of mathematics concepts and problems.
They use multiple strategies to understand and interpret text.	They use multiple strategies to understand concepts and solve problems.
They monitor their understanding as they read.	They monitor their understanding as they solve problems.
They can clearly explain their interpretations of the text to others.	They can clearly explain their mathematical thinking to others.

(Sammons, 2011)