Volume 2

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The MERN Journal is produced by the Manitoba Educational Research Network. Its purpose is to disseminate research by educational researchers in Manitoba and thereby improve the effectiveness of the public education system in the province. It is distributed free of charge through hard copy and the MERN Website (www.mern.ca).

The primary source of content are the MERN Research Fora which are held periodically throughout the year and provide researchers the opportunity to share their findings with all educational stakeholders. *The MERN Journal* publishes submissions from presentations at these fora. From time to time, MERN may also publish research monographs.

Educators who present their research at the MERN Fora will normally be asked to submit their work for publication in the journal, with volumes based on the themes of the fora. The editorial team prefers that manuscripts be submitted electronically, typed and double-spaced. Author(s) name, position, and affiliation should be included on the first page of the manuscript. Submissions should conform to the APA Stylesheet and include an abstract of no more than 120 words. Receipt of submissions will be acknowledged via e-mail within a week. Further, in the event that an article is not accepted for publication, the author will be informed within three weeks of receipt.

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FORUM PRESENTATION LISTS

ACKNOWLEDGEMENT

MERN acknowledges the support of the
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Thank you.

IN THIS ISSUE

Welcome to the second Volume of the *MERN Journal*. We believe that you will find a number of the articles of interest no matter what your position in the Manitoba education system.

In the first article, the Early Years Literacy Partnership Committee of the Brandon School Division details the results of their efforts to improve the literacy skills of grades 2 and 3 reading-delayed students through a guided reading program. The study also implemented smaller class sizes, professional development for the teachers involved, community partnerships, and school partnerships.

The second article presents an interim report on a Middle Years Initiative of the Brandon School Division. The purpose of the initiative was threefold: to improve students' reading comprehension and writing proficiency; to move the assessment practices toward a more descriptive format involving students; and to implement a grading and reporting system that reflected outcomes-based learning.

The third article discusses a strategy for development of higher level thinking skills in adolescent readers through the use of fairy tales and picture books.

The next article examines the beliefs and understanding of pre-service intermediate mathematics teachers and reports on the findings.

High school and introductory level Physics textbooks are examined in the next article. The focus is on the relationship between Mathematics and Physics, and the presentation of concepts, connections, explanations, illustrations, etc.

The following two articles discuss aspects of the teaching of Science. The first study comprises the reporting of the initial qualitative phase of a much larger study. This phase discusses the issues in delivering Science education in a francophone-minority setting.

The second inquiry is a case study that explores teacher attributes and environmental factors that influence Science curriculum delivery at the early and middle years level. Psychsocial factors at the classroom, school, and school division level are also explored.

And finally, the last article discusses the connection between language and conflict resolution as manifested by children with mild intellectual disabilities.

As we deliver this volume into your hands, we would like to take the opportunity to solicit your submission of articles for Volume 3. We are requesting articles outlining research presented at previous forums, especially those from Forum 8 onward.

We thank the contributors to the present volume for their willingness to share their work in *The MERN Journal*.

T. MacNeill, Managing editor

Ensuring Reading Success: Early Literacy Partnership Project

Early Years Literacy Partnership Project committee
Brandon School Division

In 2003, a committee[1] within the Brandon School Division submitted a proposal to Manitoba Education, Citizenship and Youth (MECY) to develop an Early Years Literacy Project through the Class Size and Composition Grant structure[2]. The selection criteria for the Grant required that the selected schools have high concentrations of single parent and low-income families, a high number of students with special needs, a high number of ESL (*sic* EAL) students, and high student transience rates. Three schools formed a partnership[3] to support the increase in the literacy achievement levels for identified Grades Two and Three students. At each of the three schools, one literacy teacher was hired on a 0.5 FTE basis to facilitate a Guided Reading program for students who had been identified as having significant reading delay as measured by the PM Benchmark's recommended level-for-grade. The Committee hypothesized that students with significant reading delays encounter extraordinary difficulty bridging the gap between themselves and their peers without explicit and focused instruction and support. After three years of project implementation and research, sufficient data has emerged to investigate this claim.

This summary presents the results of ongoing evidence-based outcome research that examines the benefits of reducing class size and of small group instruction specifically. Small groups of students were instructed by the literacy teachers on a daily basis throughout the school year, with a targeted focus on the development of reading skills and comprehension strategies.

Students not participating in the project also benefited from class size reduction when their peers were working with the literacy teacher. Key objectives of the Project were to improve both student reading skills and self-perception as a learner. The Project also focused on increasing classroom teacher understanding of instructional strategies in the teaching of reading. Critical to the project was developing and sustaining partnerships between the three project schools as well as linking with classroom, community partners, and future literacy projects at other schools in the Brandon School Division.

Project Evaluation Design

To allow for the statistical analysis of program success and the tracking of target students, a comprehensive database was developed in collaboration with Brandon School Division *Research and Evaluation Services*. The evaluation tools consisted of a comprehensive selection of annual pre/post criterion and norm-referenced assessments and included student, parent, and classroom teacher surveying and interviewing. The formal assessments included: Peabody Picture Vocabulary Test (Third Edition), Lindamood Auditory Conceptualization Test, PM Benchmarks, selected subtests of the Woodcock Johnson Achievement Test (3rd Edition), and Conner's Teacher Rating Scale.

At the end of each school year, the committee investigated the progress of the project, addressing the following evaluation queries:

- Does a reduction in class size improve achievement in Literacy?
- Does change in class composition affect

1 Members of the initial committee that developed the Literacy Project proposal: Kathy Brigden, Nancy Dane, John Minshull.

2 The Early Years Literacy Partnership Project committee wishes to acknowledge Cathy Watt, literacy teacher, and Adrian Kuryliw, coordinator of Research and Evaluation, for completing this submission.

3 Brandon School Division professionals who have been members of the Literacy Project since 2003 include the following principals; Kathy Brigden, Nancy Dane, Mathew Gustafson, Craig Laluk, John Minshull, and the following literacy teachers; Arlene Ash, Diane Bauman, Marianne Bensen, Maureen McDuffe, Wanda Nichol, Cathy Watt with Nadine Fort (Speech Language consultant) and Adrian Kuryliw (research coordinator).

achievement in Literacy?

- Does the classroom teacher experience more success with a reduced class size and change in composition?
- Do students with low achievement levels show an increase in achievement in a smaller class size/with a change in composition?
- Can partnerships with schools support the improvement of Literacy levels?

This action research project utilized mixed method data collection (quantitative and qualitative) within an intra-group, comparative design. Evaluation included annual pre and post testing in the fall and spring of each school year. Continual evaluation was also maintained using running record analysis throughout each year. Control groups were not utilized. While this option was considered, the feasibility of excluding students from this service to form a control group was judged to be unethical in this case. Descriptive statistics and two-tailed *t-test* analysis of variables (ANOVA) were employed to measure the significance of the differences between means.

Project Evaluation Results

Skill level changes for the whole student group are noted in Table 1, documenting the aggregation of the first three years of program results.

The PM Benchmark book level ($p<.05$), Woodcock-Johnson 3rd Edition Broad Reading ($p<.01$), Word Recognition, Reading Fluency ($p<.01$), Reading Comprehension ($p<.01$), and Lindamood Auditory Comprehension ($p<.01$), all demonstrated significant mean annual improvement over what would be expected given the pace of student learning at the pre-test marker. Results approaching significance were noted in behavioral improvement ($p<.10$) for the group, according to the pre and post measurement of the Connor's Rating Scale.

The program results were then disaggregated by gender, Aboriginal status, receptive vocabulary ability, and age/grade placement to further investigate subgroup benefits. The following were noted:

1. Boys made the same *academic gains* as girls; and both genders benefited from the program equally.
2. Boys made the same positive classroom *behavioral gains* as girls; and both genders benefited from the program equally.
3. Grade 2 students made greater *academic gains* than grade 3 students, although both groups benefited from the program ($p<.05$).
4. Aboriginal students made the same *academic gains* as non-Aboriginal students.
5. Aboriginal students made more positive classroom *behavioral gains* than non-Aboriginal students ($p<.05$).
6. Significant decreases in *inattentive and hyperactive behaviors* were demonstrated in the classroom for the group ($p<.05$).
7. Students with average language skills

TABLE 1

Annual Pre/Post Assessment	Score Type	*n*	Annual Mean Change	SD	*t-test*	*p*
PM Benchmarks	Book Level	121	+7.9	3.6	8.25	<.05
WJ Word Recognition (WJ-III)	Std. Score	119	+6.9	2.1	32.20	<.01
WJ-Fluency (WJ-III)	Std. Score	108	+5.0	2.2	23.62	<.01
WJ-Comprehension (WJ-III)	Std. Score	114	+7.6	2.1	38.64	<.01
Auditory Comprehension (LAC)[4]	Raw Score	121	+22.9	6.3	22.52	<.01
Connor's Scale (Teacher)[5]	Std. Score	44	+3.2	4.2	0.62	<.10

[4] A raw score increase of "+10" on auditory comprehension (LAC) indicates expected growth given student age, grade placement and previous achievement.

[5] The Connor's Scale was used as an assessment instrument during the 2005-2006 school year, alone.

tend to make more *academic gains* than students with below average language skills ($p<.05$)

8. Results of both student and parent pre/ post survey data demonstrated significant positive changes to student *reading behaviors* at school and at home ($p<.05$).

Project Implementation

At the beginning of each school year, classroom teachers identify students in their classroom with significant reading delays. From the group of students recommended by the classroom teachers, the students with the largest reading delays are chosen for the program, accounting for 15-18 students per school, per year. Once the students are identified, the literacy teachers in each of the three project schools, collect assessment information utilizing a variety of criterion and norm-referenced, as well as observational and interview, instruments. This data is used to form Guided Reading groups and to develop the instructional program. A total of 121 students have successfully completed this project over the past 3 school years.

Project Materials

Guided Reading resources, consisting of multiple copies of leveled text, were drawn from existing Guided Reading materials available within each of the three schools. By the third year of the project, increased opportunities for students to read informational text became an identified need and increases to these resources were delivered to each project school. This focus resulted from two professional development sessions attended by the literacy teachers on comprehension and informational text (Duke, 2006; Stead, 2005). In addition to this, approaches were developed to supplement project materials to encourage literacy within the students' homes. The Brandon Rotary Club, through their *Literacy Initiative*, donated books to the project, three books for each child in the Literacy Project to keep as their own.

Project Resources

The following teacher resources were used to meet the needs of the students in the program. The resources were pooled by the literacy teachers and shared with classroom teachers. The following list contains the resources most relevant to the project.

- Guided Reading, Good First Teaching for All (Fountas & Pinnell, 2000)
- PM Benchmarks Kit 1 and 2 (Smith & Randall, 2003)
- Comprehension Strategies, Bureau of Education and Resource
- Balanced Literacy Program (Brown, 2005)
- Using Guided Reading to Help Your Students Become Better Readers (Haack, 2002)
- Comprehension Strategies for the Struggling Reader (Forsyth, 2005)
- ELA Curriculum and Blackline Masters
- Guided Reading Coaching Tool
- Time for Non-fiction (Stead, 2006)
- Strategy Instruction in Action (Harvey & Goudvis, 2002)
- Revisit, Reflect, Retell - Strategies for Success with Informational Texts (Hoyt, 2002)
- Making It Real – Strategies for Success with Informational Texts (Hoyt, 1998)
- Reality Checks, Teaching Reading Comprehension with Non-Fiction K-5 (Stead, 2006)
- Success For All Learners, Manitoba Education
- Other resource material compiled by the Literacy Teachers

Typical Lesson Format

Each lesson begins with a short chat about the plan for the lesson, and students are given the opportunity to share information about their day. This has become an important part of building community within the group, encouraging the development of a safe environment where each child feels valued. The students then choose one book to read during *familiar reading time* for a time period of five minutes. An introduction to a new book is then completed and students' prior knowledge is activated. Students are then taken through a highly supported book walk and new words are introduced at this time. Students are encouraged to make predictions about the story

using the information that the teacher and the pictures provide. After everyone has had the opportunity to read the story to the literacy teacher, discussions about the story's elements take place. It is also at this time that the students are encouraged to make *text-to-text*, *text-to-life*, and *text-to-world* connections. On a day when no new book is introduced, the lesson would begin with familiar reading and the second read of the previous day's book. During these times, more focus can be devoted to lessons that meet the students' needs.

Reasons for Success

Once assessed and selected for the program, students remain targeted for support for one full school year. The reasons they may have experienced delays are varied, but time and explicit, individualized teaching has been central to the success of the program. Daily attendance is required for a minimum of 30 minutes per lesson. The literacy teachers are informed by the assessment results prior to the development of the groupings and use this information to develop a program that meets the needs of the students.

The literacy teachers scaffold the students' learning, progressing at the speed necessary for the students to develop strong decoding skills and become familiar with reading strategies that help them become successful readers. Having no time pressure, allows the students to move at their pace and never backslide as a result of being pushed to move along.

The groupings are homogeneous, based upon similar academic needs, and are comprised of no more than 5 students. Small groups allow the literacy teachers to address the needs of each of the students as they work through new text. Guided Reading groups allow for flexibility, and this becomes important as the reading skill of the students improve and change. The project was also successful in giving those students with negative learning experiences a more optimistic and healthy view of reading. Very quickly, as they are supported and given the tools they need to read, the students become more confident and are often seen bouncing down the hall eager to be challenged. Students begin to boast about going to read every day and can often be heard saying "This is easy for me!" Their confidence increases because they are able to feel successful every day. Gaining this confidence allows the students to take more risks in the classroom and to spend more time working independently.

A quiet, safe atmosphere was provided for every Guided Reading lesson. The students who attend are often the students who, inside the classroom, are less willing to offer an answer and more reticent to participate in classroom activities. These students require more wait time in comparison to their classmates who have better developed academic skills. Being pulled out of the classroom allows these students to experience a safe learning environment, where risk-taking is encouraged. An increase in reading levels for many students means an increase in self-esteem and leads to more independence in the classroom. It has been reported many times that students, after their lessons, are often willing to share what they learn with their classmates.

Professional Development

The literacy teachers received a significant amount of training through a variety of professional development seminars. They then, through local workshops, shared this learning with the classroom teachers associated with the project. The Literacy team made use of Brandon School Division resources such as literacy specialists and clinicians, and attended sessions outside the Division presented by such experts as Tony Stead, Nell Duke, and Pamela Haack. Methods that were most effective for struggling readers were implemented and shared with classroom teachers in workshops over the current course of the project.

The literacy teachers planned professional development sessions for the classroom teachers in the project as well as professional development sessions for other teachers in the Brandon School Division. During these sessions, the literacy teachers shared instructional strategies they had incorporated and adapted into their programming, focusing on the topics: *Comprehension Strategies* and the *Use of Informational Text, Comprehension Strategies for The Struggling Reader, and Strategies for Comprehension:Assisting Struggling Readers.* Literacy teachers

demonstrated how strategies can be adapted for struggling readers, and modeled common language between literacy teachers and classroom teachers.

The strategies discussed during the workshops were used with success for struggling readers but were also strategies that could be used with students who were not identified as having reading difficulties. Teachers reported that the workshop caused them to rethink and adjust their programming to better meet the needs of their struggling readers.

A further benefit of the model was the regular meetings held by the three literacy teachers. During these sessions the teachers reviewed and analyzed their practice, problem solved and discussed future directions. They looked carefully at what they learned from the professional development sessions and discussed how these were implemented in their program. Because all three schools are categorized as *inner city,* the teachers were able to support each other in their problem solving and could relate to the issues faced at other schools such as transience, student absence, and lack of parental support. This project has been an effective model especially in providing mentoring and support for teachers working with at-risk students. Classroom teachers felt that having this program in their schools gave them more opportunity to learn new ways to transition and assist struggling readers.

This project gives teachers the opportunity to learn new ways to assist struggling readers in the classroom. Annual pre/post evidence demonstrates that the project students achieve success in ways that would not have occurred if they did not receive specialized attention. The collaborative partnership between the three *inner city* schools has been of tremendous value to our staff and students. Teachers appreciated the opportunity to share common issues and understandings as it relates to the needs of schools. The reduction of class size, along with an ability to address composition issues, has increased the reading achievement of our students a significant amount. After 3 years of project implementation, both the measurable assessment and anecdotal evidence demonstrates the positive results.

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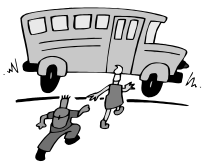

Brandon School Division's Middle Years Initiative: A Chronology of Change

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Summary

This is a summary of a presentation by Donna Forsyth and Betty Howell at the MERN Conference held at Brandon University on November 17, 2006. The presentation documented the development and implementation of two facets of the Initiative – literacy and assessment – from 2004 to 2007.

The Middle Years Initiative began in 2004 as part of a five-year strategic plan focusing on the learning and achievement of Middle Years students in Brandon School Division. At its inception, the Initiative focused on connecting best practices in teaching, learning, and assessment in a continuous instructional cycle. As the Initiative evolved, three specific goals emerged:

1. To improve the reading comprehension and writing proficiency of all Middle Years students;
2. To develop and refine assessment practices that provide more descriptive feedback and allow for greater student involvement in assessment processes; and
3. To implement a new Middle Years grading and reporting system that reflects outcomes-based learning and communicates evidence of learning effectively.

The Groundwork

Because the advancement of best practices in teaching and learning was central in Brandon School Division's Strategic Plans, the alignment of best practices in instruction with best practices in assessment within the Division's Instructional Cycle became a priority. As the implementation of the Instructional Cycle proceeded, and the Division began a revision of its Assessment Policy, the vital role of assessment in the learning process came to the forefront. In November of 2003, Brandon School Division submitted a proposal to Manitoba Education, Citizenship & Youth (MECY) outlining a plan to re-conceptualize, develop, and implement new formative and summative assessment processes and protocols for Middle Years students. The proposal also included a request for MECY to suspend the provincial regulation directing the reporting of students' progress in percentages in order to allow the Division to develop alternative progress/ performance descriptors for assessment and reporting purposes. This request was approved, with the requirement that the Division provide regular reports to the Deputy Minister's office.

The Organizational Structure of the Initiative

The Middle Years Initiative was co-chaired by Betty Howell, Principal of St. Augustine School, and Donna Forsyth, Staff Development Consultant, who worked with two main organizational groups in providing guidance and direction for the Initiative:

- The Middle Years Access Committee comprised of all Middle Years school principals (18), and
- The Middle Years Steering Committee comprised of two teacher representatives from each school (approximately 35 teachers).

Throughout 2004-05 and 2005-06, the Steering Committee members served as divisional representatives for their schools and participated in ongoing professional learning sessions. As a result, many members of the Steering Committee became literacy leaders for their school teams as they facilitated the sharing, implementation and ongoing study of new literacy and assessment strategies.

By 2006-07, the structure of the Steering Committee had branched off into a number of smaller subcommittees and teams that addressed the literacy and assessment aspects

of the Middle Years Initiative.

2004-05: Focus on Literacy

In September 2003, Brandon School Division implemented the administration of locally developed formative assessments in English Language Arts and Numeracy for all students entering grades five, seven and nine. The central marking contexts created by the assessments allowed teachers and administrators to come together to examine student work and achievement on a division-wide basis. In response to information about student achievement that the assessments generated, the first phase of the Middle Years Initiative began with a focus on literacy in the fall of 2004, specifically targeting nonfiction reading comprehension.

In this phase of the Initiative, all Middle Years teachers participated in a series of three "Reading Comprehension across the Curriculum" workshops. As well, Steering Committee members met regularly for a series of six additional, ongoing literacy workshops throughout the year. The initial focus on strategies in the content areas led us to a deeper examination of best practices in literacy to explore the critical components of a balanced literacy program for Middle Years students. Further study centered on the following eight components of an effective balanced literacy program for Middle Years:

1. Core reading and writing processes
2. Personalized reading
3. Student engagement
4. Managing environments for literacy learning
5. Comprehension
6. Writing competencies
7. Instructional contexts for active teaching and learning
8. Assessment *fo*r learning.

Exploration of the first component, core processes of reading and writing, naturally opened discussions with teachers about the other components. Traditionally, the widespread notion that students in Early Years "learn to read" while students in Middle Years "read to learn" de-emphasized the role of Middle Years teachers as teachers of *reading*. A balanced literacy model for Middle Years highlighted the continued need for teachers to provide demonstration, explicit instruction, guided practice and independent practice in order to develop students' reading and writing competencies at more and more complex levels. We recognized that many students in Middle Years need strategies that teach them how to sustain attention to longer, more difficult text structures as they develop skills that go beyond basic decoding and comprehension skills. In Middle Years, students must be able to extract important ideas from text and carry them forward as tools for thinking, reflect on their own reactions to author's viewpoints and ideologies, and express ideas in a wide variety of writing forms.

A key concern expressed by the teachers on the Steering Committee was meeting the needs of students who still struggle with basic reading and writing in grades five to eight. What could be done when the reading/writing processes broke down for these students? While past practices focused on program adaptations to help students who struggled with literacy function at least at a basic level, we needed to learn about effective interventions and strategies that would accelerate literacy development for these students.

Tempting as it was to look back at past remedial reading programs and practices as a panacea for struggling students, Middle Years teachers soon recognized that the remedial, pull-out programs of the past were not a viable option to address the wide range of students' literacy skills that constituted the reality of today's classrooms. The rationale for traditional remedial approaches was that low-achieving students lacked the skills for meaningful interactions with literary texts or for producing meaningful ideas in written text. The reasoning was that basic students needed basic skills, usually phonics programs and structured basic comprehension programs. These approaches tended to focus on the mechanics of decoding and on low-level recall questions about short, isolated pieces of text at the expense of reading and responding to authentic text. Such approaches essentially underestimated what students were capable of doing, postponed more challenging and interesting work for too long and deprived students of a meaningful or motivating context for continuing to develop literacy skills.

As teachers examined effective literacy practices, they also began to evaluate the reading materials that were commonly available in classrooms. They recognized that a key factor in engaging students in reading is allowing them to make choices in their selection of reading material. The challenge was not only to know students' interests as readers but also their strengths and their instructional needs in order to provide a wide enough variety of texts at appropriate difficulty levels. The realization that material read at less than a 90% accuracy level and a 75% comprehension level constitutes a frustration level in reading created a heightened awareness of the sometimes limited range of texts available for classroom use, and the need for creating multi-level text sets for classrooms. The need to incorporate extensive use of multiple-level texts led to exploring strategies for incorporating and managing a variety of instructional contexts such as small flexible groupings.

As a result of the Steering Committee explorations, plans were developed to create a Literacy Intervention Action Research Group in 2005-06 to study effective Middle Years classroom strategies and group intervention structures for struggling readers and writers. Another team was formed to develop a set of criteria or performance indicators in a continuum for student writing expectations from grade five to grade eight. A third team of Middle Years teachers came together to form a classroom-based assessment study group for the following school year.

2005-06: Focus on Assessment *for* Learning

In the spring of 2005, Brandon School Division conducted a major review of the Strategic Plan that culminated in an update and revision of the goals. Three of the four goals contained in the Strategic Plan focused either directly or indirectly on the Middle Years Initiative. In conjunction with the literacy focus, the foundation for the next phase of the Initiative, centering on assessment *for* learning, had been laid in the fall of 2004 through a regional assessment conference featuring Anne Davies, attended by the 35-member divisional Middle Years Steering Committee.

In 2005-06, the literacy work from the previous year continued within school-based teams, but the divisional scope of the Initiative centered around a focus on "assessment <u>for</u> learning". Early in the fall of 2005, all Middle Years teachers participated in a divisional workshop on classroom-based assessment facilitated by Anne Davies, who also presented a special session for principals.

The two key concepts of "Assessment *for* Learning" that directed our divisional inquiry were:

1) Involving students in all aspects of assessment, and
2) Providing students with descriptive feedback versus evaluative feedback

First, a group of nine Middle Years teachers, representing seven schools, formed a study group to examine current research, to use "Assessment *for* Learning" practices in their classrooms, and share their experiences and insights. Through a special Manitoba Education, Citizenship and Youth (MECY) dispensation granted to Brandon School Division, three teachers from this group agreed to pilot the use of alternate reporting formats that eliminated percentage marks and replaced them with criterion-referenced descriptors of student achievement.

The research of Black & Wiliam, Anne Davies, Jay McTighe, Ken O'Connor, Richard Stiggins, and Thomas Guskey provided the direction not only for the study group and pilot teachers, but also for the steering committee and the principals' group. As these groups interacted, and shared their observations, insights, and questions, the powerful potential of "Assessment ***for*** Learning" was becoming more evident. Traditional practices and beliefs were being questioned; assessment was no longer merely a process of testing and tabulating, but a tool for enhancing learning.

The release of MECY's new support document, *Rethinking Classroom Assessment with Purpose in Mind* in 2006 validated our work, and added the deeper dimension of "Assessment *as* Learning" to our understanding of assessment.

Work on the literacy component of the Initiative continued with four main groups: the Writing Performance Indicators Development Team, the Literacy Intervention Action Research Team, and the Grade Five and Grade Seven ELA Formative Assessment Development

Teams. By the end of the school year, the Writing Team had developed a writing assessment tool that identified six main categories of writing elements (following Cullen's 6-traits model) that could be applied to expository as well as narrative writing forms, and that were cross-referenced with the Manitoba ELA Curriculum. The *Grade 5-8 Writing Performance Indicators* set out grade-specific criteria and descriptors under each of the six main elements or categories, along with a performance-level rating scale. In presenting writing criteria for Brandon School Division students at grades five, six, seven, and eight, *the Performance Indicators* provided a clear basis for descriptive feedback, student self-assessment, and goal setting.

The Literacy Intervention Action Research group devised innovative new ways for classroom teachers to work together as instructional teams and to reconfigure student groupings as they implemented new strategies focused on reading comprehension across the curriculum. At the same time, they worked on building up their collections of multi-level materials and resources, especially in content areas.

2006-07: Assessment *for, as* and *of* Learning

In the fall of 2006, a draft of the *Grade 5-8 Writing Performance Indicators* was distributed to Middle Years teachers over the course of two professional learning sessions. Members of the *Writing Performance Indicators* development team presented an overview of this assessment tool, and led teachers through the six categories of writing descriptors, the grade-specific criteria descriptors under each category, and the performance level rating scale. The *Grade 5-8 Writing Performance Indicators* also served as a resource in the identification of ELA "Critical Competencies" for the Divisional Report Card development teams.

The *Writing Performance Indicators* Development Team continued to work throughout the year collecting samples of student writing to accompany each grade level of the Performance Indictors. All together, samples of nine forms of writing were included with each grade level. The forms of writing included: reports, reflections, procedural writing, explanations, letters, persuasive writing, recounts, narratives, and poetry.

The Performance Indicators and the student samples from each grade, along with other resources, such as suggestions for improving students' daily spelling through "No-excuses" words, was compiled into a complete Divisional Grade *5-8 Writing Resource* published in the fall of 2007.

Another focus for the Middle Years Initiative was experiential learning and differentiation. To this end, Middle Years teachers took part in a professional learning series that engaged them in unit-planning processes focused explicitly on experiential learning and differentiation. As well, teachers explored multi-level, multi-interest student resources to incorporate into their classrooms.

In 2006-07, at least one Middle Years class in every school participated in a pilot project to report student progress and achievement in terms of criterion-based descriptors instead of traditional percentage grades. In total, approximately 60 Middle Years teachers worked together, in various teams and committees, to develop alternatives to percentage marks as a means of communicating students' progress towards specific learning goals or outcomes. The teams planned to use the following framework to guide the development of the new report card format:

1. Identifying three to four levels of performance that describe student work and achievement;
2. Identifying the major learning goals or critical competencies that students were expected to achieve in each curricular area at each grade level; and
3. Establishing clear criteria for the learning goals/critical competencies.

A draft format of the report card was piloted in November 2006, and feedback from parents, teachers, and students was considered for revisions to be made in 2007-08. Finalized drafts identifying the English Language Arts and mathematics critical competencies for the new Middle Years report cards were completed by May 2007, and the critical competencies for science, social studies, physical-education/ health and basic French were to be completed during the 2007-08 school year.

To support teachers in this work, a network of study groups was created, wherein teachers continued to work through and refine "Assessment *for* and *as* Learning" strategies and classroom organizational structures that promoted learning success for all students.

2007-08: The Implementation Journey Continued

The "Assessment *for, as* and *of* Learning" piloting process continued through 2007-08. The target date for full implementation of a new criteria-based report card throughout the Division was set for September 2008. The report card, of course, is only one piece of the assessment picture. Changing classroom assessment practices in schools is "big work"; it requires a fundamental shift in thinking about the relationship between instruction and assessment, and a fundamental shift in beliefs about student engagement and learning. The true power of assessment *for* and *as* learning lies in how it can support daily student learning in the classroom. For assessment to be an effective tool for student learning, our assessment must continue to go beyond merely measuring and judging, to include providing rich descriptions of student performance. If assessments are to improve student learning, then we must use them to inform students about how they can do better next time. This process also requires reporting protocols that provide enough detail to guide learners and inform their parents in a way that a single percentage grade cannot.

As we continue working together to tap the tremendous potential of assessment *for* and *as* learning, our greatest challenge still lies in redefining the traditional judging/categorizing culture of assessment into a culture that fosters student learning and engagement. At the same time, the synergy that is generated from working together on common goals has tremendous potential to propel us forward, overcoming the challenges and achieving a new vision of excellence in instruction and assessment.

(Note: Currently, Brandon School Division's Middle Years Initiative is co-chaired by Betty Howell, principal of St. Augustine School, and Cory Nevill, Staff Development Consultant. This article is respectfully submitted by Donna Forsyth, former Staff Development Consultant for Brandon School Division, and currently Assistant Professor in the Department of Teacher Education at Brandon University.)

Embracing Critical Literacy: Developing Higher Level Thinking Skills for all Adolescent Readers

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Abstract

Being literate in the 21st century means more than just being able to "read and write". With the burgeoning and varied sources of information at our disposal, it is essential that readers be able to read critically. One aspect of critical literacy is to become a "text analyst", that is, one who understands that authors have specific purposes for writing a text. Through classroom instruction, students can learn to identify and question the attitudes, values, and beliefs that lie below the surface of the text. As educators we need to prepare students to think and reflect in thoughtful and informed ways. This paper provides one approach to help students develop the notion of author intent through the genres of fairy tales and picture books.

Being literate in the 21st century can no longer be defined in terms of "being able to read and write" when one considers the information sources available to us through the proliferation of electronic text, global communication via the World Wide Web, and multiliteracies in the form

of print, visual, graphic, and aural formats. With the amount of information continually expanding from a growing number of sources, it is essential that a reader is able to critique and navigate through these texts. This requires reading and thinking skills previously unparalleled.(Moore, Bean, Birdyshaw, & Rycik, 1999). Through a critical literacy curriculum, students can be guided towards questioning assumptions as well as reflecting on, and critiquing an author's writing, and through this, understand how an author can shape our thinking. Critical literacy also presents a natural opportunity to connect our curricular content with the interests of adolescents. It is incumbent upon educators to adapt instruction in response to changes in our culture and to meet the challenge of motivating adolescent readers and writers to become active negotiators and analysts of text.

The term *critical literacy* emanated from the work of Paulo Friere (1970) who believed that literacy empowers people when they are provided opportunities to actively engage in questioning the circumstances within our social world (Moje, Young, Readence, & Moore, 2000). Critical literacy practices are based on the assumption that the language of books, our personal views and the wider society are influenced by certain ideologies that require uncovering to understand who is being privileged and who is being disadvantaged. Critical literacy then is about multiple viewpoints. In classrooms of today, with students of differing learning abilities as well as the ethnic, cultural, social and economic variability, a fertile ground is readily available for deep and engaged discussion. Although critical literacy transcends a set curriculum per s*e* (Comber, 2001; Luke, 2000; McLaughlin & De Voogd, 2004) a creative and thoughtful teacher will build a classroom context that allows every student to begin to investigate the varied nature of their own and their classmates' lives.

A critical literacy approach is a natural fit with the characteristics of effective literacy instruction as identified by research. The qualities of instruction that support literacy development include: promoting higher-level thinking through opportunities for students to engage in rich discussions and written responses about their reading; providing instruction that motivates and draws students into meaningful reading and writing events; and developing high expectations for student achievement, progress, and behaviour. Guided by social constructivist practices, a classroom involved in critical literacy engages students in talk by having them share their varied viewpoints, examining and clarifying their views as well as discussing issues revolving around bias, fairness, and social justice.

Assessment of current literacy programming

Research by the National Assessment of Educational Progress (NAEP, 1998) reveals that the literacy challenges facing both middle and senior years students across different academic domains are not being met by the instructional programs that are currently offered. Subject area instruction in the middle and senior years typically focuses on content rather than on the learning process. NAEP found that while approximately 60% of American adolescents were able to comprehend textual information that was factual, few of the students in their assessment had advanced to more complex reading and writing achievement levels. Less then 5% of the students in their assessment could extend or elaborate their thinking beyond the printed text.

While the NAEP report indicates that literacy instruction has failed to develop deeper processing of text, the demands on students' reading abilities continue to escalate. In their policy statement on literacy development, The International Reading Association Commission on Adolescent Literacy (1999) outlined how reading and writing instruction will need to adapt to the literacy demands of the 21st century. For instance, the availability of electronic text has increased not only the amount of text but also access to worldwide sources (Moore, Bean, Birdyshaw, & Rycik, 1999). Students will encounter more text from more people around the globe with differing agendas and purposes. A curriculum in critical literacy will assist students in developing the higher-order thinking skills to competently handle this task. As educators we need to prepare students to think and reflect in thoughtful and informed ways and to consider issues and problems previously unparalleled in history.

Setting the context for critical literacy

In simplistic terms, our understanding of reading has progressed from viewing reading as a word identification activity to recognizing it as a process of connecting text to personal experience (Rosenblatt, 1978). A critical literacy stance extends these previous notions of reading by placing the reader in the role of "text critic" (Freebody & Luke, 1990). In its broadest sense, critical literacy is about becoming aware of the "various agendas, purposes, and interests represented in texts" (Stevens & Bean, 2007, p. 4) Underlying a critical literacy approach is the understanding that texts are written to represent particular viewpoints with the ulterior purpose of influencing the readers' thinking. This knowledge directs the critical reader to identify and question the attitudes, values, and beliefs that lie below the surface of the text.

The ability to consider the viewpoint of the author requires readers to take a perspective that is different from their own. The processes of creativity and problem solving (Treffinger, Isaksen, & Stead-Dorval, 2006) most often associated in the past with gifted and talented education are two essential aspects of reading critically. The reader needs to be able to consider a viewpoint that differs from his or her own, a form of creativity, as well as "problematize" a situation to envision other solutions.

Innovative thinking is also called into action when adopting another person's point of view. This requires the restructuring of previous insights when encountering new information while at the same time developing a greater understanding of another person's life (de Bono, 1976). As educators it is our role to prepare all students to be proficient readers in negotiating and critically examining texts in a variety of formats and from various sources (Stevens & Bean, 2007).

Critical literacy instruction

Where does a teacher begin in implementing a critical literacy curriculum? Since we know that a single "best practice" for raising literacy achievement does not exist, it is best for teachers to be equipped with a range of instructional practices. Critical literacy is one of the essential components in raising literacy achievement in the classrooms of today (Stevens & Bean, 2007). Proficient reading requires the use of numerous strategies that are often applied in a concurrent fashion as the reader negotiates text (Stevens & Bean, 2007; Freebody & Luke, 1999). This includes the ability to decode text, read fluently, and apply strategies for comprehension. Sophisticated readers also realizes that the text is written with the author's agenda in mind and bring this awareness as well as their knowledge and experience to bear on the text.

Teachers who are in the beginning stages of introducing critical literacy need to build students' understanding of "author intent" or how the author uses writing to communicate a particular purpose or viewpoint. As a result, students will begin to realize that the "true" meaning of text is not an absolute but is rendered by the author (McLaughlin & DeVoogd, 2004). Through this instruction, students will begin to realize how the author directs or shapes our view, that the reader needs to consciously decide whether or not to accept an author's particular perspective.

One way to assist students in developing the notion of different perspectives is to read different versions of the same story. This will be demonstrated here through the use of the fairy tale genre and picture book format. By accessing different versions of the traditional tale, *The Three Little Pigs,* students will begin to understand how the author is able to direct the reader to see the main characters in very different ways. The stories will be presented in a way that should engage, humor, and motivate adolescent readers while teaching critical literacy strategies. The genres of picture book and fairy tales will make this text accessible to struggling and advanced readers while both are engaged in high level critical thinking and dialogue. Struggling readers will benefit from the picture support and familiarity with this fairy tale while more competent readers will appreciate the juxtaposition of this genre with critical literacy.

Four versions of the fairy tale *The Three Little Pigs* will be the focus of this paper. Although not intended to be lesson plans *per se,* the following discussion outlines how the teacher can engage students in a critical analysis of each text to determine the intent of the author and how this message is conveyed to

the reader. Each version of the story presents a particular perspective referred to as a dominant perspective, an oppositional perspective, and a marginalized or alternative view.

Before delving into the stories, a brief overview will be presented. The citation for each book will be provided followed by a brief description identifying the perspective represented in each book. This brief description of each story version will highlight the features that distinguish it from the other versions. Then the particular perspective will be discussed to illustrate how the author is able to present the reader with a different viewpoint from which to view the story.

- Galdone, P. (1984). *The three little pigs*. New York: Clarion Books.

This version of the story introduces students to the idea of a *dominant reading perspective* that reinforces the knowledge that our society in general holds, and consequently perpetuates, as true. The dominant perspective refers to the reputation of the main characters in this story; the wolf is viewed as "bad" while the pig is regarded as "good". This story will form the basis on which the other stories are compared and contrasted.

- Scieszka, J., (1989). *The true story of the 3 little pigs*. New York: Puffin Books.

This version puts a twist on the original story. Readers are exposed to an *oppositional reading perspective* requiring a complete shift in thinking. The wolf in this story is portrayed as good and the author even has the reader empathizing with his state of affairs.

- Travias, E. & Oxenbury, H. (1993). *The three little wolves and the big bad pig*. New York, NY: Aladdin paperbacks.

This version adds another perspective to the *oppositional view* with the added twist of role reversal of the main characters. To clarify, the role of the "good pig" and the "bad wolf" are reversed, challenging the status quo. The reader is presented with three good wolves and a very nasty pig … at least in the beginning of the story.

- Celsi, T. (1992). *The fourth little pig*. Metropolitan Teaching and Learning. CO: Longmont.

This version provides yet another perspective, introducing students to a *marginalized or alternative reading*. Sister pig is telling the story from the view of an outsider or a third person perspective while the wolf is again the big bad version found in Galdone's story.

Each book will now be presented with a more elaborated description of the story version and the particular perspective that is represented by the author's writing.

The Three Little Pigs by Paul Galdone is most similar to the original version of this tale. In this story, the first little pig constructs his house of straw, while the second little pig uses sticks as his building material. The third and smartest pig builds his house of bricks. The wolf is politely denied entrance when he visits the homes of the first two little pigs. The wolf responds by blowing down their houses, and afterwards, makes a meal of each of the pigs. The third little pig proves to be much more of a challenge, forcing the wolf to make numerous efforts to trick him out of his brick house. After several thwarted attempts, the wolf meets his own demise when he decides to enter the house via the chimney. The wolf falls into the pot of boiling water cleverly placed by the quick-thinking third little pig and subsequently becomes this pig's dinner.

This version of the story introduces students to the idea of a *dominant reading perspective* that reinforces the knowledge that our society in general holds and consequently perpetuates as true. In this story, the dominant perspective refers to the reputation of the main characters in this story; the wolf is viewed as "bad" while the pig is regarded as "good". After reading this version, the teacher would have students generalize about the characters of wolves and pigs from others sources that they know. Through this expanded conversation, students will begin to realize that wolves in our culture are considered "big, scary animals" as in *Little Red Riding Hood* while pigs on the other hand are viewed as "cute, cuddly animals" such as Wilbur in E.B. White's *Charlotte's Web.* Through closer analysis of the language of the text and the illustrations, students will begin to realize that the author intends for the reader to empathize with the three little pigs as the "good

guys" while the wolf on the other hand, is to be viewed as "big, bad, and scary", eliciting from the reader not a pang of remorse, yet his only crime might have been hunger.

In Jon Scieszka's, *The True Story of the 3 Little Pigs,* the story is told from the perspective of Alexander T. Wolf, who states through humour and a refined gentlemanly character that he is obliged to set the story straight from his jail cell where he is being incarcerated for his alleged crimes. He explains that he has "been framed" by a complete misinterpretation of the true events of the incident involving him and the three little pigs. The truth, he explains, is that he was in the process of baking a birthday cake for his granny, in spite of having a horrible cold. A trip to his neighbour pigs' homes was necessitated by his running out of sugar. Unfortunately, an ensuing sneeze at the straw house and the stick house resulted in his knocking down both houses and killing the resident pigs. While pork is a major component of the wolf diet, he felt compelled to feed on the remains of this natural disaster. Still out of sugar, he advanced to the house of the third little pig. This pig's disrespectful remarks toward the wolf's granny enraged him so much that the police were called to the scene. The end result was that the wolf was sentenced to time in jail.

This version puts a twist on the original story. Readers are exposed to an *oppositional reading perspective* requiring a complete shift in thinking from viewing the wolf as bad to empathizing with him. Essentially, oppositional readings are the opposite of established cultural views. The main idea of the original story, that is, the wolf is bad and the pigs are good, begins to bend with this second version of the story. The tale that students had been introduced to in early childhood was now being challenged. In this version, students are exposed to the idea that the three little pigs may have been mistaken about the wolf's intentions. In fact, the loss of their homes may not have occurred had the three pigs taken a moment to listen to the wolf's neighbourly request for sugar. In this version, students are asked to perceive the big, bad wolf in a not so big and bad way.

As indicated by the title, Eugene Travizas and Helen Oxenbury's version entitled *The Three Little Wolves And The Big Bad Pig* offers another perspective on the *oppositional view* challenging the status quo with the added twist of role reversal of the main characters. As you might expect from the title, the role of the "good guy pig" and the "bad guy wolf" are reversed. In this story, the three wolves are busy building houses for themselves. The first wolf's house is constructed of bricks, where, as you remember, the original story ended in success. But bricks are no match for the big, bad pig aided by modern technology. With the assistance of no less than a sledgehammer he is able to knock down the house. So much for "a huff and a puff". As a side note, teacher discretion is advised regarding students' ability to recognize the more violent nature of these aggressive tactics. All three wolves survive this episode, but wisely decide to build their second house of a stronger material. However, even concrete is no match for the menacing big, bad pig who pulls out his pneumatic drill and smashes the house down. With their chinny-chin-chins trembling, the three determined wolves now opt for yet a stronger building material, iron. Somewhat irritated with the wolves at this point, the big, bad pig settles on dynamite to blow the house up. Needless to say, the house does not withstand the explosion. But luck is on the side of the three wolves who manage to escape with only their "fluffy tails scorched". A second twist in this story has the wolves using a rather unusual building material that stops the big, bad pig from knocking down their final home. If you can imagine, this story ties into popular culture with reference to the aroma therapy trend. A surprise ending concludes this story with both the wolves and the pig, now referred to as the big good pig, living together happily ever after.

While the original tale is recognizable in this version of the story, the traditional roles of the characters are reversed. The teacher may direct students to once again tap into their prior knowledge of the pig and wolf characters in other stories and draw their attention to the role reversal that takes place with the "big, scary wolf" and the "cute, cuddly pig(s)" wherein they become the opposite of what we, as readers, usually expect them to be. Students will also be directed to note the fact that, although in the previous story the wolf was portrayed as good, the pigs have never been portrayed as bad. There is another unique perspective offered in this version that needs to be drawn out. That is

that the reader can actually witness the big bad pig become a big good pig. This concept can be expanded into discussions about bullying and the idea that a peaceful solution is possible to even the most daunting of problems.

The Fourth Little Pig by Teresa Celsi puts a feminist twist on the original fairy tale. In this version of the story told by the three little pigs' sister, the three brother pigs are characterized as weak and vulnerable, while sister pig is seen as the strong leading character. After a long absence while traveling around the world, sister pig makes a visit to her brothers. She is concerned that her brothers spend their days in deadly fear of the wolf. Her mission is to convince her cowardly brothers that they should follow in her footsteps and explore the world. The three brother pigs dismiss their sister's talk. It is not until *she* blows their house down that they begin to acknowledge that she was right all along.

This version provides yet another perspective on this fairy tale by introducing students to a *marginalized or alternative reading*. The sister who is telling the story represents the view of an outsider or a third person perspective. Unlike the Travizas-Oxenbury and Scieszka versions, where the wolf was portrayed as a good fellow, here he is again the big bad version in Galdone's story and literally paralyzes the brother pigs into living a lifestyle focused on protecting themselves from him. The message conveyed in this story is that the three brother pigs could have lived more fulfilling lives had they considered their sister's insights. This story suggests that listening to the viewpoints of others might offer new insights that are worth considering. The ultimate decision, whether to act upon it or not, is always yours.

Summary

A critical literacy curriculum engages students and connects with their interests by creating a place in the curriculum for all students to share their views, opinions, and experiences through conversation. The purpose of this article is to assist teachers in introducing critical literacy into their classroom instruction. The approach described here was intended to provide the reader with a sense of how different versions of *The Three Little Pigs* could be used as a beginning step to introduce the notion of author intent in writing. Through the use of the fairy tale genre, teachers will be able to help students see that the author's words are not neutral, that messages are implicit within the text. The challenge for classroom teachers is to raise the achievement level for both the struggling and the advanced learners in their classrooms. This is accomplished through the approach presented in this paper. Picture books provide a way to engage both struggling and advanced readers; struggling readers will benefit from the picture support to the text, while more competent readers will appreciate the juxtaposition of this genre with critical literacy.

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Supporting Intermediate Mathematics Teacher Development: Assessing Change in Understanding and Beliefs

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Abstract

Elementary teachers typically do not enter teacher preparation programs with specific backgrounds in mathematics, yet demands of reform-based teaching require developing a deep and profound understanding of elementary mathematics. This study examined the mathematical understandings and beliefs held by pre-service elementary teachers in a mathematics methods course taken as part of a one year teacher certification program, and re-examined these characteristics at the end of the course. Teacher beliefs about what is important in mathematics learning, and therefore the teaching of it, were examined along with mathematics understanding at both procedural and conceptual levels. Preliminary results are also reported related to the capacity of a small sample of in-service intermediate teachers.

Teacher knowledge of mathematics is becoming acknowledged as an important factor for student success (Adler & Davis, 2006; Ball, 2000; Ball, Hill & Bass, 2005; Hill, Rowan & Ball, 2005). Differing beliefs about what aspects of mathematics are most important may also play a role in influencing classroom-based decisions (Kajander, 2004; McDougall, Lawson, Ross, MacLellan, Kajander & Scane, 2000). Teachers' attitudes, in turn, impact students (Bishop, Clarke, Corrigan & Gunstone, 2006; Schommer-Aikins & Hutter, 2005; Ruffell, Mason & Allen, 1998). Hence, both teacher knowledge and beliefs will potentially influence the quality of teaching and ultimately impact students in classrooms.

Teachers are naturally influenced by their own learning experiences which may have been traditional in nature (Ambrose, 2004) and thus may find it a challenge to overcome earlier notions of how mathematics should be taught (Raymond, 1997; Ambrose, 2004). The study described in this article examined the mathematical understandings and beliefs which pre-service elementary teachers might typically bring to a mathematics methods course taken as part of a one year teacher certification program, and attempted to measure their mathematical growth during the course as well as examine changes in beliefs. A preliminary study of in-service intermediate teachers took place at the same time, and results are examined in parallel with the pre-service sample.

BACKGROUND

Reform-based classrooms require teachers to understand mathematics more deeply and broadly than previously (Adler & Davis, 2006; Ball, 1990, 1991, 1996, 2000 & 2003; Ball et al, 2005; Hill & Ball, 2004; Greenwald, Hedges & Laine, 1996). However, elementary teachers are not generally mathematics specialists and often have not had opportunities to develop such deep understandings.

The notion of the need for the development of 'mathematics for teaching' is based on substantial work, such as Ma (1999), Ball & Bass (2000) and Ball, Hill & Bass (2005), and this work argues that teachers of mathematics need specialised knowledge that differs from topics typically addressed in secondary and post-secondary mathematics courses. Deep mathematical understanding of the type needed by teachers of mathematics is *not* developed by taking a larger number of undergraduate courses in mathematics (Foss, 2000), and may be challenging for teachers to develop; clearly, teachers themselves must be motivated to pursue such learning. Thus this study is grounded in adult learning principles such as the need to consider participants' self-concerns (Loucks-Horsley, 1996) and underlying values and beliefs (Kiely, Sandmann & Truluck, 2004) which include making available the reasons for

learning (Schmitt & Safford-Ramus, 2001), encouraging active participation in learning (Kiely et al, 2004), and encouraging self-reflection (Gusky, 2000; 2003).

Recent research provides evidence that teachers can learn mathematics for teaching in specially designed courses, but success varies from course to course (Hill & Ball, 2004). It is unclear which features of such courses are most effective. This study begins to lay a framework for how such growth might be examined, described and supported.

Existing Instruments

Various instruments to assess teacher mathematics knowledge have been developed (Hill, Schilling & Ball, 2005), but these measures do not address beliefs. Thus, the scarcity of measures may be a difficulty in determining what features of pre-service education and later professional development contribute to teacher learning (Hill & Ball, 2004) and how such opportunities might be used most effectively. Hence, we need measures which examine and *unpack* (Adler & Davis, 2006; Ball & Bass, 2000) different types of mathematical knowledge as well as the relationship of such knowledge to beliefs about the nature of mathematical thinking and beliefs about what kinds of learning should take place in mathematics classrooms (Ambrose, 2004).

Types of Mathematical Knowledge

Mathematical understanding is multi-faceted. In Ma's (1999) landmark study, it was found that many teachers in the United States were in fact able to calculate correct answers to elementary mathematical questions, but were not able to explain why the methods worked, or give an example or problem that showed their understanding of the procedure. However, the needed components for the development of "profound understanding of fundamental mathematics" (Ma, 1999) are not completely clear.

Important challenges related to teacher growth must be faced in methods courses, in order to initiate such mathematical development, and such development should be sustained with further professional development. Teachers' understanding must become more conceptual to allow teachers to probe student understanding, comprehend multiple student solutions and methods, and provide powerful classroom models (Hill & Ball, 2004).

Procedural and Conceptual Knowledge

Unpacking procedural knowledge to support the development of deeper conceptual knowledge is a particular challenge (Adler, 2006). The relationship between procedural knowledge and conceptual knowledge is important in studying knowledge of mathematics for teaching (Ambrose, 2004; Hiebert, 1999; Hill & Ball, 2004; Lloyd & Wilson, 1998; Rittle-Johnson & Kroedinger, 2002). Procedural knowledge as used here refers to computational skills, while conceptual knowledge refers to understanding the underlying mathematical structure (Eisenhart, Borko, Underhill, Brown, Jones & Agard, 1993). Procedural knowledge may be thought of as a sequence of actions while conceptual knowledge is knowledge that is rich in relationships (Hiebert, 1992; McCormick, 1997), for example, the relationship between appropriate physical materials such as classroom manipulatives, and written symbols such as algebraic notation. While teachers may be reasonably proficient in basic mathematical procedures such as, for example, operations with fractions or integers, they may be completely unable to explain, show or justify why such methods work, which are understandings needed for effective teaching (Ma, 1999).

Connections to Beliefs and Values

As well as knowledge, beliefs also appear to play a role in choices teachers make in their teaching (Ambrose, 2004; Foss, 2000) and influencing teachers' beliefs and values may be essential to changing teachers' classroom practices (Stipek, Givvin, Salmon & MacGyvers, 2001; Cooney, Shealy & Arvold, 1998; Ross, McDougall, Hogaboam-Grey & LeSage, 2003).

Probing more carefully into the content of professional development courses to identify variables associated with teachers' learning (Hill & Ball, 2004) and beliefs (Stipek et al, 2001) may be necessary to determine features of successful courses and how such features potentially support later classroom teaching practice. It may be particularly important for pre-service programs to foreground mathematical content (Hill & Ball, 2004) and to include rich

experiences coupled with reflection (Ambrose, 2004; Raymond, 1997; Schmitt & Safford-Ramus, 2001) to enhance resiliency of new beliefs.

PURPOSE OF STUDY

Teacher education in many Canadian provinces suffers from a shortage of time to support teachers' deepening their content knowledge for teaching as well as to address pedagogical issues. Hence, it is crucial that this time be used as effectively as possible, and be based on research specifically about pre-service teachers' needs and learning. The current study focused on investigating the mathematical understandings for teaching held by grade four to ten (referred to in Ontario as "junior-intermediate") teacher candidates, as well as their beliefs about mathematics and how it should be taught. Mathematical understanding was examined under the dual lenses of procedural knowledge and conceptual understanding similar to the framework used in the Ma (1999) interviews. The objectives of the study were to gather information about pre-service teachers' initial mathematical capacity and beliefs, and to examine how these evolved over the duration of a methods course. Initial investigation of a small sample of in-service teachers over the duration of a one-year professional development project was included for comparative purposes.

METHOD

Data was collected in written survey form from about 100 pre-service teachers per year at the beginning and end of their mathematics methods course taken in their certification year. The study is ongoing, but we report here on the first two years, the first of which took the form of a pilot study and allowed an instrument to be developed and revised to obtain acceptable reliability. In the second year of the study (2005-2006), a preliminary sample of 31 in-service intermediate teachers was also examined. These teachers responded to the same survey at the beginning and end of a year of participation in optional monthly half-day professional learning group meetings focused on mathematics.

The instrument probes both beliefs and knowledge about elementary mathematical concepts. The POM (*Perceptions of Math*) survey examines elementary mathematical knowledge and attempts to unpack this knowledge based on ideas of procedural and conceptual knowing (Byrnes & Wasik, 1991; McCormick, 1997). The survey also probes the types of beliefs held by participants about mathematics itself and how it should be taught and learned, based on values associated with procedural and conceptual learning (Rittle-Johnson & Koedinger, 2002).

Participants answer both open-response mathematical questions, and beliefs-related questions which are scored on a four point Likert scale. Four scores are generated by the survey, two related to mathematical understanding, and two related to beliefs about mathematical learning which are referred to here as 'values'. *Procedural knowledge* (PK) is the demonstrated ability of the participant to follow standard mathematical procedures or methods to achieve correct answers. *Conceptual knowledge* (CK) is the term we use to describe the participant's demonstrated ability to explain, model or justify the methods used, based on the premise that conceptual knowledge is a basic prerequisite for developing an understanding of mathematics for teaching. Two beliefs-related variables, termed *procedural values* (PV) and *conceptual values* (CV) respectively, attempt to characterise the importance of each type of mathematical learning to that participant. The beliefs questions are designed to not be mutually exclusive. For example, one might believe that both the procedural values item

> *It is important to be able to recall math facts such as addition facts or times tables quickly and accurately.*

and the conceptual values item

> It enriches student understanding to have to think about different ways to solve the same problem.

are important.

RESULTS AND DISCUSSION

The results reported here are from the 2005-2006 cohort. See Table 1 for a summary of the mean pre-service pretest scores, each shown scaled out of 10, on the four variables

just described.

Table 1. Pretest mean scores on POM survey for pre-service teaches [all scores shown out of 10]

Pre-test Data 2005-2006 Discussion of Pretest Results			
	Mean	**N**	**Std. Deviation**
PV	7.8910	111	1.22701
CV	7.8324	111	1.22216
PK	6.9730	111	2.09527
CK	0.9730	111	1.41073

The pre-test knowledge scores are consistent with findings in other research (eg. Ball, 1990; Ma, 1999), and once again underscore the urgency of the situation. While procedural knowledge scores might be seen to be adequate as an initial position (the survey was administered with no warning), the conceptual knowledge scores had mean scores of about one out of a possible 10 points, or 10%. In fact, the mode score was a startling zero. In other words, these teacher candidates were virtually unable to come up with suitable models or explanations for basic procedures when they arrived at the methods course.

According to the survey, the pre-service teachers studied appear to have believed relatively strongly in the importance of both procedural as well as conceptual learning in their classrooms when they arrived in the program. By the end of the course however, significant change was found in all four variables.

Post-test Results

Table 2 shows the mean post-test results. Conceptual knowledge scores, while still lower than procedural knowledge, are shown to have increased substantially (and significantly, $p<.05$) from the pretest.

Table 2. Post-test mean scores on POM survey for pre-service teachers [all scores shown out of 10]

Post-test Data 2005-2006			
	Mean	N	Std. Deviation
PV	6.1649	111	1.58439
CV	8.4595	111	1.36677
PK	8.4775	111	2.12708
CK	4.7838	111	2.53487

Table 3. T-test between pre and post for each dependent variable (CK, PK,CV, PV) 2005-2006

		Paired Differences	Std. Deviation	Std. Error	95% Confid.		t	df	Sig. (2-tailed)
		Mean		Mean	Lower	Upper			
Pair 1	pre pv - post pv	1.72	1.47	.140	1.44	2.00	12.3	110	.000
Pair 2	pre cv - post cv	-.62	1.50	.143	-.91	-.34	-4.38	110	.000
Pair 3	pre pk - post pk	-1.50	2.32	.22	-1.94	-1.06	-6.82	110	.000
Pair 4	pre ck - post ck	-3.81	2.66	.25	-4.31	-3.30	-15.04	110	.000

In fact, significant change was found in all four variables from the pretest to the posttest, ($p<.05$) using a repeated measures t-test as shown in Table 3. Both knowledge scores increased significantly, as did conceptual values. Also of interest is the drop in procedural values. In other words, by the end of the year, participants generally answered the survey by rating somewhat lower the items related to the importance of focusing on procedural learning, for example requiring that students focus on algorithmic fluency, in their own classrooms.

In-service Teachers

While the sample was small (N=31), preliminary results using the same instrument with in-service teachers also shows development over the year which included their participation in math Professional Learning Groups for a half day a month (see Table 4).

Table 4. Pretest and post-test mean scores on POM survey for in-service teachers [all scores shown out of 10]

	Mean	N	Std. Dev.	Mean	N	Std. Dev.
PV	5.8490	31	1.17801	5.4197	31	1.32955
CV	8.7632	31	1.04115	8.4939	31	1.16584
PK	9.0323	31	1.62242	9.6129	31	0.66720
CK	4.3226	31	2.50848	5.3871	31	2.94027

Note: All score changes are significant ($p<.05$) except the change in CV.

These intermediate teachers showed significant growth ($p<.05$) in both knowledge variables over the treatment period. Interestingly, the mean post-test knowledge scores of the (graduating) pre-service teachers, and the mean pre-test knowledge scores of the in-service teachers were very similar. Also, the conceptual values scores for both groups at the end of their respective professional development experiences were very strongly aligned. The procedural values mean scores, which dropped significantly over the treatment for both groups, remained higher for the pre-service teachers at the post-test.

DISCUSSION

The post-test level of conceptual understanding demonstrated by pre-service participants remained arguably highly inadequate for classroom teaching, and thus this study provides evidence that more time must be allowed for such learning by pre-service teachers if they are to teach effectively. Nevertheless, results provided from the current study appear to support Hill and Ball's (2004) claim that mathematical understanding for teaching can be increased by a single course experience. In-service teachers also showed significant growth based on their Professional Learning Group experiences, although this growth was not quite so dramatic. However, while the post-test mean scores in conceptual knowledge were somewhat higher for the in-service group than the pre-service group, both post-test means remained under six points out of a possible 10 points on the instrument. These results highlight an area of on-going concern.

If one believes that an important aspect of reform-based learning in the classroom might be to support, for example, students' development and justification of multiple solutions or mathematical models, then the results of this study indicate a significant difficulty. Teachers who are not able to effectively describe even one model would certainly be challenged to support such rich classroom activity. Clearly, the mathematics itself is crucially important in the teacher development process, and we must further explore ways to teach both *mathematics* and *teaching* in the same program (Adler, Ball, Krainer, Lin and Novotna , 2005).

Pre-service teachers' beliefs also showed a shift during the year. We conjecture that the values score changes might indicate a shift *toward* the kind of beliefs often associated with reform-based teaching, and *away* from more traditional beliefs; conceptual values rose while procedural values dropped. The deepened interest in conceptual understanding seemed to also be accompanied by a willingness to relax more traditional or procedural goals. However, we have no evidence at this point of the potential resiliency of these evolving beliefs.

While at this point we can not pinpoint the exact reasons for these participant score changes, some consistency of results is observed; as pre-service teachers deepened their understanding, their beliefs about the value of conceptual learning appeared to be enhanced, while their concern with the learning of procedural methods diminished. It makes

sense that as teachers claim to want to focus more on deep understanding in their classrooms as well as being able to demonstrate deeper understanding themselves, they may also rethink some of their previously held goals in mathematics learning, such as privileging procedural learning.

Some parallels were also seen with the in-service teachers; as knowledge deepened, similar beliefs shifts were also observed although the growth in conceptual values did not achieve statistical significance. Further study with a larger sample would be needed to confirm this finding.

In our experience, some teachers tend to have a restricted view of mathematics, typically based on the notion that mathematics is largely about using procedures effectively to generate correct answers. Alternately, we believe they need to see mathematics as a tool for thinking about ways to solve *new* problems which require deep understanding of concepts rather than simply consisting of poorly understood algorithms learned by rote. Such rich learning can be intrinsically enjoyable and motivating for adults (Schmitt & Safford-Ramus, 2001) and needs to be strongly supported in all professional development.

CONCLUSIONS

Pre-service teachers' typically weak conceptual understanding is an area of significant concern. This study adds to other largely American studies that illustrate pre-service elementary teachers' inadequate conceptual understanding of mathematics. Pre-service intermediate teachers in the current study were shown to arrive at their mathematics methods course demonstrating little ability to model, explain, justify or provide an alternate method for mathematical procedures they were able to perform.

After participating in a methods course, which focused directly on conceptual knowledge of mathematics for teaching, substantial improvements were seen for many participants in conceptual understanding, according to a written instrument. However, this understanding was still far from adequate even for fundamental ideas such as basic operations with whole numbers, fractions, decimals, and integers, as well as basic measurement and patterning. Preliminary evidence also indicates that in-service teachers may not be much better off in terms of their conceptual understanding. We believe these results highlight a significant roadblock for teachers attempting reform-based classroom practice.

Beliefs also appeared to be influenced by the treatment, particularly at the pre-service level. By the end of the methods course, pre-service teachers seemed to be less concerned with focusing on teaching traditional procedures and more interested in supporting deep student understanding. Such outcomes might be thought of as desirable goals for a reform-based mathematics teacher education program.

This study attempted to investigate factors which may be important to consider as priorities for pre-service program design, in-service teacher development, and the assessment of teacher growth. Further study is needed to investigate how more enhanced growth can be facilitated for teacher candidates during their teacher training programs and elsewhere in order to more fully prepare teachers for high quality classroom mathematics teaching.

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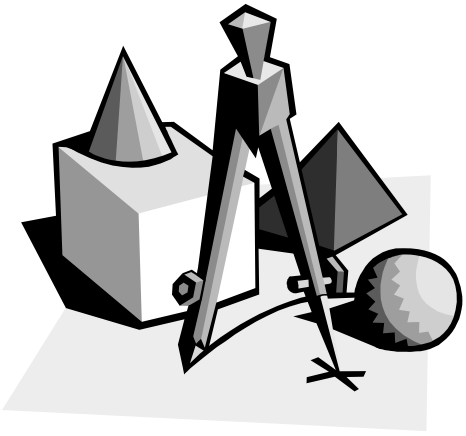

The Mathematical Component of Physics in High School and Introductory Level College Physics Textbooks: Using the Law of Universal Gravitation as an Example

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Abstract

The presentation of the mathematical aspects of physics in the context of the Law of Universal Gravitation is examined by means of an analysis of eight recent physics textbooks used in North American high schools and introductory level college textbooks. The author argues that to achieve conceptual understanding in learning physics, the mathematics presented in textbooks should be used as a tool for maintaining the balance between the qualitative and quantitative aspects of physics. It is argued that mathematics, in the process of balancing the qualitative and quantitative aspects of physics, can be used as a tool for, but not limited to, the following: establishing connections between mathematical and physical symbols; showing the usefulness of different mathematical representations as being effective, productive, and intellectually stimulating for conceptual understanding of physics; displaying data; aiding in explanations, illustrations, derivations; posing questions; making conceptual inferences; making comparisons between different mathematical relationships; and demonstrating the beauty of mathematical relationships.

As research in science education shows, the mathematical complexity of physics has been identified as one of the major factors that prevent students from studying physics (De Lozano & Cardenas, 2002; Hewitt, 1994; Jones, 1992; Lavaly, 1990; Monk, 1994; Rice-Evans, 1992). The presentation of the mathematical aspect of physics in teaching and textbooks is criticized for the lack of connections among concepts, formal representations, and the real world. The lack of these connections in physics textbooks inhibits students' understanding of physics ideas when they learn from texts. My argument is: To ensure understanding when students learn from a text, it is crucial that physics textbooks maintain a balance between quantitative and qualitative aspects of physics. To achieve this goal, the mathematics used in physics textbooks must play an appropriate role in placing and finding ways of presenting physics ideas.

The purpose of this study was to identify, describe and analyze the presentation of the mathematical component of physics in textbooks, to find out if it is used in appropriate sequence in the conveyance of physics concepts, and to examine the modes in which mathematics is expressed in the texts. Ultimately, the purpose of this analysis was to understand what role mathematics plays, or is expected to play, in the development of concepts and ideas in physics.

Conceptual Framework

The following conceptual framework (Table 1) was developed in the light of learning theories, science education researchers' findings, and the requirements of scientific literacy. It has three domains: epistemological, cognitive, and contextual (history and philosophy of science, HPS). Every domain has its sub-domains. These sub-domains were used to categorize the mathematical component found in physics textbooks.

Table 1. Conceptual Framework

1.	**Epistemological Domain**	Concepts in physics textbooks should be presented in different modes: • Numerical • Verbal • Graphical • Pictorial • Symbolic

and in appropriate pedagogical sequence

- Simple Complex
- Qualitative Quantitative
- Verbal Algebraic

to enrich the presentation of physics knowledge (fundamental concepts, laws, principles and facts); facilitate conceptual understanding; appreciate the variety of scientific methodologies and appropriately utilize them; and develop connections between symbols and physical reality.

2. **Cognitive** Textbooks could help develop the connections of physics concepts to facilitate conceptual understanding, effective problem solving and the realization of the unity of different variables in different contexts in certain mathematical relationships (direct proportion, inverse proportion, power relationship) when the presentation of material involves:
   - Moving between modes of representation
   - Stating the purpose of using a particular mode
   - Comparing and contrasting concepts by using analogies
   - Constructing conceptual models
   - Critical thinking
3. **Contextual (HPS) Domain** Textbooks should provide real historical examples of mathematics being used by scientists by presenting concepts in physics in historical context to get exposure to the nature and methods of science I n order to:
   - Understand conceptual models of scientists. These models would serve as examples for creating students' own conceptual models.
   - See the plausibility and limitations of different historical models and students' own models to facilitate the process of conceptual change.
   - Appreciate the variety of scientific methodologies.

Methodology

The qualitative content analysis methodology was used for the research of textual material to understand what role mathematics plays in physics textbooks. I examined five recent high school and introductory level physics textbooks used in North America (Table 2).

Table 2. Sample Textbook Overview

Title of Book	Author(s)	Year	Publisher	Code
Glencoe Physics: Principles and Problems	**Zitzewitz & Davids**	**2002**	**Glencoe/ McGraw-Hill**	**GP-ZD**
Conceptual Physics: the High School Physics Program	**Hewitt**	**2002**	**Prentice-Hall**	**CP-H**
Physics: Concepts And Connections	**Nowicow & Heimbecker**	**2002**	**Irwin Publishing Ltd**	**P-NH**
Physics	**Edwards**	**2003**	**McGraw-Hill Ryerson**	**P-E**
Physics: Principles With Applications, **6th ed.**	**Giancoli**	**2005**	**Pearson/ Prentice Hall**	**P-G**
Contemporary College Physics, **2nd ed.**	**Jones & Childers**	**1993**	**Addison-Wesley**	**CCP-JC**
College Physics **5th ed.**	***S*erway & Faughn**	**1999**	**Harcourt Brace & Company**	**CP-SF**
Physics Matters: An Introduction to Conceptual Physics	**Trefil & Hazen**	**2004**	**John Wiley & Sons, Inc.**	**PM-TH**

The analysis of the mathematical component in high school physics textbooks was informed by learning theory and the idea of scientific literacy. Table 3 represents the instrument that was developed for the content analysis of physics textbooks.

Table 3. Instrument for Textbooks Analysis

Categories	Descriptors	Inferences	Analytical Tools
Modes of Representation of Mathematical Concepts in the Law of Universal Gravitation • Numerical • Verbal • Graphical • Pictorial • Symbolic	Mathematical concepts are presented by • Numbers (in tables, charts) • Words • Graphs • Pictures • Algebraic symbols	Multiple representations help develop • Conceptual understanding • Enrich the presentation of physics knowledge • Establish connections between symbols and physical reality Limited representations cause lack of understanding of mathematical concepts.	Constructing a presence/ absence of a particular mode matrix, and making judgments about use of different modes according to the following analytic rubric: • Limited use -only one or two modes are present • Moderate use – three or four modes are present • Extensive use - all five modes are present
Nature of Emergence of Mathematical Concepts in the Law of Universal Gravitation	Mathematical formulas, graphs, tables, and verbal formulations appear and are used		Identifying nature of emergence of a particular mode (based on *static/dynamic* descriptors)
• *Static*	• without explanation, or discussion	• Mathematics, in the case of static emergence, is mostly used for memorization of formulas, tables, graphs, pictures • Verbal formulations do not complement each other • Connections between concepts could not be established	
• *Dynamic*	• with information about background, experimental details, how mathematical relationship expressed in a particular mode is determined, and accuracy of the relationship	• Presentation of the mathematical relationship in the dynamic way could help change students' conceptions • Connections between concepts could be established	

Table 3. (continued)			
Emergent Press (purpose) for a Particular Mode	Stating purpose of using a particular mode	• The replacement of concepts could be seen by students as useful and plausible • Mindless manipulations of mathematical equations occur in a context where the expressed need for such equations is missing	Identifying purpose of using a particular mode if there is one stated
Connections of Mathematical Concepts	• Moving between modes of representation	Students will likely make connections between concepts.	Constructing maps of tracking movements between modes of representation of concepts and evaluating variability of moves according to the following analytic rubric: • Limited –movements are mostly linear, from one mode to another in a single direction with 1-2 back and forth movements between limited kinds of modes • Moderate – movements are mostly not linear, from one mode to another in back and forth directions, and mostly between same kinds of modes • Extensive- movements are not linear, from one mode to another, in back and forth directions between, mostly between different kinds of modes
	• Using analogies	Students would likely use relevant features and ignore irrelevant ones when comparing and contrasting concepts what would help in the interrelationship of knowledge.	Constructing a presence/ absence of analogies matrix, and in case of presence, providing examples of analogies
Sequencing Mathematical Content: Simple → complex • Qualitative→quantitative • Verbal→algebraic	• From describing qualities (features) of observations, experiences, inferences to describing measurable quantities involved; • From describing mathematical relationships in words to giving symbolic equations	This way of presentation is in agreement with learning theory; therefore, meaningful presentation of the mathematical component of physics is likely to happen.	Using maps of tracking movements. The following rubric is applied: • Appropriate – the simple→complex sequence is used

Table 3. (continued)			
Complex→simple • Quantitative→ qualitative	• From presenting measurable quantities to describing features	This approach is not recommended by educational researchers since cognitive gaps could be formed if such approach is used; therefore, learning of mathematical concepts will be complicated.	• Not appropriate – the complex→simple sequence is used
• Algebraic→verbal	• From describing mathematical relationships in symbols and algebraic equations to describing mathematical relationships in words		
Balancing Qualitative and Quantitative aspects of Physics in Presentation of Example Problems Problem Solving Approach: Appendix A.			Analyzing the content of example problems and the approach taken to solve them. The following analytic rubric will be used to determine the extent of balancing:
• qualitative	The approach, where verbal explanations are engaged (conceptual problems)	• Lack of problems engaging qualitative approach would impede students' learning • Engaging students in solving only quantitative problems would signify engagement of primitive levels of thinking which are not suitable for generating conceptual models • Qualitative reasoning combined with quantitative mechanism to communicate thinking strategies would help generate these models and make mathematics meaningful to students	• Limited – mostly quantitative approach is used with almost no qualitative reasoning • Moderate – algebraic equations, calculations a backed up by some qualitative explanations • Extensive – algebraic equations, calculations are backed up by detailed qualitative explanations
• quantitative	The approach, where calculations, symbolic equations are engaged		
Presentation of Mathematical Concepts through HPS: • Descriptive	Presentation of mathematical concepts referring to HPS with no students' assignments related to the historical context	If HPS is presented descriptively only, students get little exposure to the nature and methods of science and significance of mathematical equations in science could not be understood.	Constructing presence/absence matrix (based on descriptors) featuring descriptive/ instructional presentation of mathematical concepts through HPS, and in case of presence, providing illustrative examples

Table 3. (continued)			
• Instructional	Presentation of mathematical concepts referring to HPS with assignments related to the historical context and requiring from students doing exercises, completing projects, participating in discussions	If HPS is presented in instructional way, students will get exposure to the nature and methods of science by applying presented ideas during construction of conceptual models of their own, gaining experience to evaluate their conceptual models in terms of accuracy, simplicity, plausibility, predictability, and fruitfulness.	
Presentation of Mathematical Concepts Viewing Science as a Way of Thinking	• Illustrating the use of *assumptions*, *models*, and *thought experiments* in the presentation of history of the development of the concept of gravity • Discussing *evidence and proof* • Referring to *Newtonian Style* • Showing fecundity of mathematics • Referring to *Newton's geometry* and *calculus* for the description of gravity	• Mathematics would be used as a conceptual tool in learning about gravity, and would facilitate students' construction of their own conceptual models • Mathematical formulations would get significance and show their usefulness, fruitfulness, plausibility, and limitations, thus facilitating the process of conceptual change • Higher order thinking would be engaged in understanding NOS and help establish connection between mathematics and physics	Constructing presence/ absence matrix (based on descriptors) featuring presentation of science as a way of thinking, and in case of presence, providing illustrative examples

Results and Discussion

The findings of this research show that mathematical concepts in the unit of universal gravitation in the selected textbooks are presented in various modes. However, the graphical mode of presentation which is very instrumental in visualizing functional relationships is not engaged by many of the selected physics textbooks. In one of the books, the numerical mode was not used at all. Engaging numbers in the reasoning process also could be a very helpful tool to come up with brilliant ideas, as was illustrated by the history of science examples, for instance, when Newton demonstrated how he deduced the inverse-square relationship between the force of gravity and the distance separating the Earth and the Moon.

Different approaches were used in exhibiting various modes of representation of the mathematical component in the physics of universal gravitation. The difference could be traced not only in the manner of emergence of a particular mode but, as well, the purpose for which a particular mode is used. There is only one textbook where all modes of representation of the mathematical component appear dynamically where mathematical formulas, graphs, numbers, pictures, tables, or verbal

explanations are placed in context with an explanation of how they came to be and the purpose of their use. Other textbooks used both static and dynamic approaches in the presentation of mathematical components in different modes of representation.

Variability of movements between different modes of representation of mathematical concepts in textbooks was another factor of the analysis. In some textbooks the movements between verbal, numerical, symbolic, graphical, or pictorial modes appear to be nonlinear, from one mode to another the moves are in back and forth directions, and mostly between different kinds of modes. It is likely that students would establish connections between concepts for better learning, and the balancing between mathematical and conceptual aspects of physics would likely happen. The other textbooks exhibited moderate variability of movements between different modes of representation of concepts; the movements between modes of representation are not linear. However, the movements happen mostly between the same kinds of modes, for example, between verbal and symbolic, in back and forth directions. In some textbooks, variability of movements between different modes of representation of mathematical concepts is limited; the movements are mostly linear, from one mode to another in a single direction with one or two back and forth movements between limited kinds of modes.

Many textbooks used analogies in presentation of the material that made them more instrumental in establishing connections between concepts and more helpful in the balancing of mathematical and conceptual aspects of physics in the presentation of the law of universal gravitation.

In all textbooks, verbal descriptions preceded algebraic ones. Numbers, pictures and graphs were also used to support verbal explanations. This sequence, from qualitative to quantitative, verbal to algebraic, is supported by learning theory as educational research reports (Arons, 1984; de Berg, 1993; Hewitt, 1994; Monk, 1994; Mazur, 1996; Stinner, 1994). This appropriate sequence in the presentation of the law of universal gravitation will likely make students' learning better when conceptual understanding accompanies algebraic symbols involved in the presentation of material. Numbers, symbols, and graphs would attain appropriate meaning and serve the tools for balancing the qualitative and the quantitative aspects of physics.

One of the findings from the studies of experts' and novices' problem-solving strategies (Larkin et al., 1980; Chi et al., 1981; Gabel, Sherwood, & Enochs, 1984; Shoenfeld, 1985; Dillon, 1998; Van Heuvelen, 1991) was the experts' use of extensive qualitative reasoning compared to novices' mostly quantitative, often mindless, ways of approaching problems. Indeed, engaging students in solving only quantitative problems enacts primitive levels of thinking which are not suitable for generating conceptual models, and consequently, impedes students' learning. On the other hand, qualitative reasoning combined with quantitative mechanisms to communicate thinking strategies (mathematics is a language of physics) would help generate these models, and make mathematical concepts in physics meaningful to students. If experts' strategies were proven to be successful in problem solving, then they might work for the presentation of the material in physics textbooks. Indeed, the choice of problems shown in textbooks' examples does determine in what thinking activities students will be engaged, given the fact that students and teachers still use textbooks materials.

To maintain the balance between the qualitative and the quantitative aspects of physics in problems used in textbooks, it is important that students be encouraged to do conceptual analysis of the situations described in these problems, whether the problems require only verbal explanation (conceptual problems), or whether algebraic equations and numbers have to be used to solve the problem. Four examined textbooks indicated an extensive degree of balancing of the qualitative and the quantitative aspects of physics in the example problems on the law of universal gravitation. In these examples, algebraic equations and calculations were supported by detailed qualitative discussions and explanations. Significant space was devoted to discussing limitations and assumptions which had to be taken into account to develop solutions for these problems. In three textbooks, the extent of balancing was found moderate because only

some qualitative explanations accompanied symbolic equations and calculations used in the solutions of the example problems in these textbooks. The discussions and explanations were very brief and did not cover many conceptual understanding issues. Only one textbook was found to give limited attention to qualitative reasoning in the presentation of example problems on the law of universal gravitation. This textbook used mostly the quantitative approach when students were encouraged to select a useful mathematical equation, rearrange it, and solve for the unknown variable. No qualitative discussions or explanations were involved; no limitations or assumptions were considered. It would be hard to expect that this approach would be helpful in developing students' understanding of concepts involved in the law of universal gravitation.

There is a strong research support (de Berg, 1989, 1992; Chiappetta et al., 1991; Lederman & Niess, 1997; Stinner, 1998; Tzanakis, 1999; Wang, 1998) for the inclusion of the history and philosophy of science (HPS) in teaching science. Through historical examples, textbooks can show in the presentation of the material how mathematics was used to describe and develop understanding of concepts in science and how mathematics helped scientists either to change or support their conceptions about the physical world. From the history of science examples, students can see how scientists themselves struggled to strike a balance between their experiences or intuitive thinking and mathematical equations obtained at the end of their journey of discovery .

In the case of the subject of the present study, textbooks could show how the history of gravity developed, what scientists contributed to the development of the theory of universal gravitation, and how mathematics could be used to help understand this theory. Research on introducing the history and philosophy of science in the teaching of science is in an evolving state, but suggestions on how to use HPS in the presentation of material in science textbooks are readily available. For example, de Berg (1989) suggests introducing HPS not just in a descriptive format, when concepts are presented with no student assignments related to the historical context in a certain unit, but more importantly, in an instructional way when presentation of scientific concepts through the history and philosophy of science is given in a more engaging way. Some suggestions are: offering assignments related to the historical context used in the presentation of the material, requiring that students do complete exercises or complete projects, and participation in discussions.

This research showed that in most textbooks, the examples of HPS were used in a descriptive mode, with no tasks offered to students. However, in some textbooks, both descriptive and instructional approaches, were used. Presentation of mathematical concepts through the history and philosophy of science in an instructional sense required students to conduct research, to participate in debates, and to construct and test arguments. This approach would likely benefit students in understanding the nature and methods of science, and the meaning and significance of mathematical equations in the unit on universal gravitation. In the process of researching, discussing and evaluating scientists' conceptual models, students would find motivation for constructing their own conceptual models. The students would also learn how to defend their arguments, to evaluate their models, as well as what steps to take if their models proved to have flaws. In this process of constructing, evaluating and defending arguments, students would always have to perform the balancing act as symbols, numbers, graphs, pictures and words interact with each other to yield understanding of powerful ideas in physics.

Science educators agree that presenting science as a body of knowledge where facts, concepts, principles, laws, hypotheses, theories and models are given as descriptions would not reflect a contemporary, appropriate view of the nature of science (NOS) as shared by scientists, educators, and philosophers of science (Chiappetta et al., 1991; Hestenes, 1992; de Berg, 1989, 1992; Tzanakis, 1999). If science were presented in physics textbooks mainly as a body of knowledge, students would get a false impression, not only of the nature of science but as well, about the role of mathematics in physics. The mathematics utilized in physics, given such an approach, would be perceived by students as a memorizing mechanism to recall information for tests. Viewing science as a way

of thinking reflects the progressive ideas of scientists, educators and philosophers of science. Given this view, students might well look at mathematics in a different way; the mathematics used in physics had the possibility of being used as a conceptual tool, in this study, a conceptual tool in understanding gravity. This understanding could facilitate students' construction of their own conceptual models. Mathematical formulations would gain in significance. Students would see them as useful, fruitful, plausible, as well as having limitations. This approach to presenting science as a way of thinking could facilitate the students' process of conceptual change. In the process of engaging in higher order thinking (like modeling) students would be able to understand the nature of science, and this in turn would help them establish connections between mathematics and physics.

The data collected in this research showed that the mathematical component of physics in the unit of universal gravitation is presented not as a static collection of formulas and facts but as an important component of understanding gravity through the dynamic presentation of science as a way of thinking. Illustrating the use of assumptions was the feature which was present in all but one of the textbooks analyzed. Illustrating assumptions is very important in students' understanding that any model has limitations, and whatever they conclude as a result of creating the model, they have to be mindful of when a particular model is applicable and when it is not.

Unfortunately, thought experiments did not appear frequently in the researched textbooks. In only three high school textbooks were thought experiments used in the presentation of material on gravity. It is unfortunate because the value of thought experiments can not be overestimated. As reported in science education research (Brown, 1986; Helm, 1985a; Helm, 1985b; Kuhn, 1977; Matthews, 1989; Stinner, 1990; Winchester, 1991), thought experiments played an important role in the history of science, and, therefore, should not be neglected in teaching and presenting science.

The textbooks analyzed were not found to contain enough material illustrating the use of models in science; nor was there sufficient presentation of material on universal gravitation. Four textbooks made some use of models to help students visualize described properties and see similarities and differences between them. These models could be very instrumental in developing conceptual understanding of universal gravitation. Indeed, illustrating the use of models is important not only to show how they were used by scientists but also to provide examples which could be helpful in the development of the students' own conceptual models.

All analyzed textbooks presented some evidence for stated facts and, where possible, proof for arguments, mathematical statements, or ideas. The proofs were often given both in qualitative and quantitative form, and were grounded in examples from the history of science. Presenting proofs in the form of arguments, discussions, and mathematical derivations engages, I believe, higher order thinking skills, such as critical thinking. Critical thinking enables students to make connections between facts, their own experiences, and the mathematical tools used to develop the chain of reasoning. Consequently, learning material would make sense to them.

In most textbooks, some reference to the mathematical tools used by Newton was found in the presentation of material on universal gravitation. However, no applications of Newton's geometry have been found in the textbooks' example problems. This is unfortunate given the fact that geometry assisted in the conceptualization of gravity due to its visual quality and ability to represent physical phenomena; it was often used by ancient scientists to provide proofs. It is not practical to reproduce all Newton's steps from the *Principia* because many of Newton's geometric proofs are very lengthy, and sometimes, beyond the students' knowledge of geometry. However, if students were exposed to Newton's geometric proofs (the basics of Newton's geometric method) they could use them as a mode of thinking in solving other physics problems.

Conclusion

The findings from the qualitative content analysis of the unit on universal gravitation in physics textbooks revealed that textbooks

present the role of mathematics in many dimensions, serving many purposes. To achieve conceptual understanding in learning physics, mathematics presented in textbooks should be used as a tool for maintaining the balance between the qualitative and quantitative aspects of physics. Mathematics, in the process of balancing the qualitative and quantitative aspects of physics, can be used as a tool for, but not limited to, the following: establishing connections between mathematical and physical symbols; showing the usefulness of different mathematical representations as being effective, productive, and intellectually stimulating for conceptual understanding of physics; displaying data**;** aiding in explanations, illustrations, and derivations; posing questions; making conceptual inferences; making comparisons between different mathematical relationships; and demonstrating the beauty of mathematical relationships.

The usefulness of mathematics in derivations cannot be overestimated. Derivations of mathematical formulas and calculations serve the important purpose of establishing connections between ideas. As a result, new information can be provided by obtaining new relationships that would demonstrate the fecundity of mathematics. Conceptual inferences would also be impossible to make without using ratios of numbers, establishing and analyzing proportionalities, and performing dimensional analysis. In showing the usefulness of mathematics, textbooks demonstrate an important role for mathematics, a calculating tool for problem solving. In problem solving, one cannot underestimate the role of mathematics in generating conceptual models in the process of presenting evidence and proof, or in the process of thought experiments. To succeed in this process, and enable students to learn from textbooks, mathematics has to be used and taught quantitatively and qualitatively in a balanced way.

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Factors Influencing Science Delivery in Francophone-Minority Settings

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Abstract

The study described in this paper is the initial qualitative phase of a multi-phase study focusing on improving science education delivery in francophone-minority settings in central Canada. This phase of the study elucidates the broad and complex factors influencing Kindergarten to Grade 9 science curriculum delivery in these settings. The study begins by exploring the themes generated from several qualitative studies pertaining to the phenomenon of science delivery in selected francophone-minority settings in Saskatchewan and Manitoba. Using Urie Bronfenbrenner's bio-ecological model, the study, furthermore, systematically conceptualizes the origin of, and interplay among, these factors. Finally, a description of current science education development activities within Manitoba francophone-minority settings is provided.

Although science is acknowledged as an important part of every child's education, there is much evidence to suggest that science education, in environments where the teaching of science is the responsibility of generalist teachers (i.e., normally Kindergarten to Grade 8), is in a perilous state in many settings both nationally and internationally, (Goodrum, Rennie, & Hackling, 2002, Lewthwaite 2005, Mulholland & Wallace, 1996). This situation arises from the fact that, as Fullan (1993)

affirms, the success of curriculum implementation and improvement efforts is influenced by several system elements, and no one single factor can be targeted to effect change in curriculum delivery. These system elements are typically identified as being specific to teachers or the environment in which they work. While science education, in general, is the cause of much apprehension in Canada, the concerns associated with science education delivery are considerably higher for francophone-minority settings. Francophone-minority settings are francophone settings situated, primarily, outside the province of Quebec, where French is not the dominant spoken language. Within the provinces of Manitoba and Saskatchewan, where this research inquiry in situated, there are communities with a significant francophone population, but these communities are largely in a minority relative to the larger English-speaking provincial population. In the francophone-minority setting, the language of instruction is not necessarily the language spoken in the home, village or city in which the student lives. While the student receives instruction in French at school, his or her activities outside the school setting may be conducted in English, the language of the majority setting. The results of national assessments (Council of Ministers, Canada, 2004) have revealed that Canadian francophone students, who study science in the minority language, score lower than their anglophone counterparts. These students also tend to have a more negative attitude towards science (Pruneau & Langis, 2000). These data would suggest that although the implementation and delivery of science programs is influenced by a broad and complex amalgam of factors, this amalgam seems to be even more complex in francophone-minority settings.

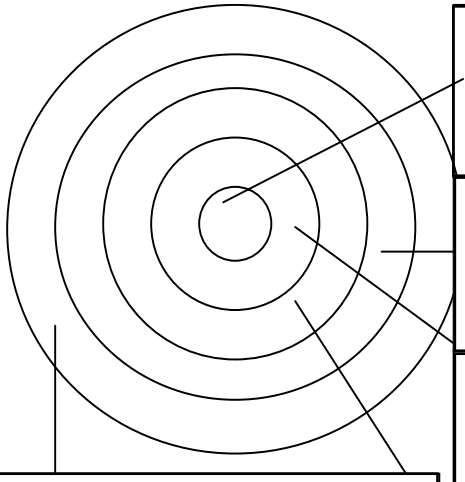
Purpose of the Study

In response to the complexity of factors influencing science delivery, this first phase of a multi-phase study endeavors to first identify the teachers' personal attributes and environmental factors influencing science education delivery in Kindergarten to Grade 9 francophone-minority school communities. Second, further components of this research and development project will endeavor to develop a Learning Environment evaluation instrument that incorporates the factors identified in this study, to assist schools in identifying factors influencing their science delivery (Lewthwaite, Stoeber & Renaud (in progress)); and third, by so doing, respond to these factors by implementing mechanisms for achieving science education curriculum aspirations within francophone-minority settings; and finally, evaluate the effectiveness of such mechanisms.

Methodology

This research inquiry uses a variety of data collection methods to identify the teacher personal attribute and environmental factors influencing science education delivery in Kindergarten to Grade 9 francophone-minority school communities. The data collection methods included: (1) two Kindergarten to Grade 12 school case studies to identify constraints and contributors to science delivery (one in rural Saskatchewan and one in rural Manitoba); these involved interviews with teachers, principals and school board representatives; (2) a questionnaire/survey eliciting ten Grade 9 teachers' perceptions of factors influencing science delivery in the francophone minority schools in Manitoba; (3) follow-up interviews with most of the Grade 9 teachers; (4) interviews with the parents of twelve students in one francophone-minority school identifying their aspirations for their children's education and specifically the place of science education in their overall aspiration for education; (5) a review of the literature pertaining to factors influencing science education delivery, especially within francophone-minority settings and, finally, (6) a focus group consultation with four key stakeholders (i.e., francophone-minority teacher; science education curriculum consultant; francophone science education professor; school science development specialist) which further identified factors influencing science delivery. Most interviews were conducted in French. All interviews were audio-taped and transcribed. Themes were generated from these data relative to the intent of the inquiry by the three authors and a francophone-minority school consultant. That is, they systematically conceptualized the teacher personal attribute and environmental factors influencing science

Figure 1. Factors perceived to be constraining or contributing to the delivery of science programs in francophone-minority schools



Individual - Personal Attribute Factors:
Teacher interest and motivation to teach science; professional science knowledge including knowledge of learners, strategies for teaching science, content knowledge, contextual knowledge, strategies for teaching science to learners with less-developed French language abilities.

Exosystem Factors:
Community aspirations for the school especially in terms of curriculum priorities. Community support provided for teachers in their teaching of science. Financial decision making at the School Board level and its' influence on funding availability.

Microsystem Factors:
B. Collegial support among staff in contributing to teacher development in science; student interest in science and language development capabilities; physical resource availability and appropriate French language science resource materials .

Macrosystem Factors:
Provincial government curriculum policy decisions; resource material development at provincial level; professional development support within school division.

Macrosystem Factors:
A. School-wide priority placed upon science by the school reflected in timetabling, resource allocation; hiring policies and actions.

education delivery in Kindergarten to Grade 9 francophone-minority school communities. Because the study in its simplest form endeavors to understand a phenomenon (teacher perceptions of factors influencing science education delivery in francophone-minority settings), it is interpretivist in nature. More precisely, this research inquiry employs an action research methodology. In line with action research methodology, this inquiry is the first step of a three-step spiral process (Lewin, 1951). This first, "reconnaissance phase" of this multi-phase project is focused on understanding the processes influencing science program delivery in francophone-minority schools based on the perceptions and reflections of the experiences of those closely associated with the phenomenon. The project, in the subsequent phases, will go on to evaluate the effectiveness of mechanisms, collaboratively decided and implemented by members of the francophone science education community in Manitoba. Consistent with action research methodology, the inquiry in its totality is focused on improving the quality of the science education experience provided for francophone-minority students based on the collaborative design of a methodology and its implementation, followed by an analysis of data and evaluation to improve practice (Lewin, 1951).

Results and Discussion

Eleven major teacher personal attribute and environmental factors or themes influencing science education delivery in Kindergarten to Grade 9 francophone-minority school communities were identified by the research team. In previous studies by the first author, a fewer number of factors have been identified, indicating that the issues influencing science curriculum delivery in francophone-minority settings are broader and potentially more complex. The several themes of factors that research participants (i.e., teachers, parents, principals) perceived as either contributing to or impeding the delivery of science education are listed. As well, these factors are presented systematically according to Bronfenbrenner's bioecological systems in Figure 1.

Teacher Personal Attribute Factors Influencing Science Delivery

Consistent with other studies by the first

author (e.g., Lewthwaite, 2000, 2001) a variety of teacher personal attribute factors were recognized as contributors or impediments to effective science delivery. Two factors commonly cited were: (1) teacher confidence and (2) teacher motivation and interest in teaching science. A third factor also emerged. Teachers identified a need for a complex knowledge base required for teaching science, a knowledge base that has become of particular interest to science educators and policy makers both nationally (Gustafson, Guilbert, and MacDonald, 2002; Lewthwaite, 2005) and internationally (Abell & Roth, 1992; Lewthwaite, 2001). Francophone-minority teachers often identified most of these knowledge bases, but four were identified more frequently. Critically important for the teachers, was the role of pedagogical content knowledge as a unique knowledge base essential for effective science teaching. A further frequent comment was in reference to knowledge of students as learners. Teachers commonly mentioned a need to have a better understanding of students' backgrounds, both in terms of their interests and French-language capabilities. Coupled with this was teacher identification of the need for knowledge of how to teach subjects like science to students whose French-language skills were poorly developed. As identified in previous studies (Lewthwaite, 2001, 2005), teachers identified the need for an improved content knowledge base. In general, teachers were able to identify a variety of teacher attribute factors that contributed to or constrained their effectiveness as science teachers. Although many of these factors are typical of those cited by teachers in mainstream settings, teachers identified some factors specific to minority language settings, in particular, their knowledge base for teaching students with a limited French language base.

Environmental Factors Influencing Science Delivery

Participants in this research study were able to identify a variety of environmental factors influencing science program delivery at the classroom level. A fourth factor influencing science delivery commonly cited by respondents was the priority placed on science at the school level. This priority placed upon science was influenced by a variety of factors at the classroom, school and community level. Most significantly, the priority placed on French language development often compromised the attention given to science as a curriculum area. These findings affirmed those cited by Gilbert et al. (2004), that teachers commonly mentioned the need to compensate for shortcomings in students' language skills and cultural experience and, in so doing, shifted curriculum priorities away from science. Fifth, the availability of professional science support and sixth, opportunities within and external to the school, were commonly cited as factors influencing science delivery. A further seventh significant factor influencing science delivery was time availability. Time constraint is a salient and often-cited feature influencing science curriculum delivery (Lewthwaite, 2001). In the context of this study, many teachers cited the demands of multi-grade and multi-subject classroom teaching requirements and the impact that this had on their efforts for adequate preparation and teaching. As mentioned earlier, broad curriculum demands contributed to a 'squeeze' on curriculum priorities.

As previously mentioned, teachers often stated that the language backgrounds of their students and, thus, the range of student French language competencies were a factor (the eighth) influencing science program delivery. There were some other characteristics of students that influenced the delivery of science. Factors such as student interest in science and behavior were cited as a ninth contributor or impediment to science delivery. A final tenth theme influencing science delivery was associated with the curriculum itself. The curriculum for francophone-minority schools is the same curriculum as that for mainstream Manitoba and Saskatchewan schools, albeit in French. Teachers made mention of the science curriculum requirements, orientation of the curriculum and the 'teacher-friendliness' of the curriculum as influences on science program delivery.

In summary, teachers were able to identify a variety of environmental factors that contributed to or constrained their effectiveness as science teachers. Similar to the personal attribute factors, although many of these factors

are typical of those cited by teachers in mainstream settings, teachers identified some factors specific to minority language settings, in particular, the language characteristics of their students and the priority placed upon science as a curriculum area as influenced by the teacher, school and community curriculum priorities.

Summary

Figure 1 illustrates the multi-system factors perceived by respondents to be influencing science program delivery in the selected francophone-minority settings reported on in this study. The figure illustrates and identifies individual and environmental factors which were identified as contributors or constraints to science delivery. In most cases the factors influencing science program delivery, according to the respondents in the settings investigated, are risk rather than protective factors; that is, the factors are constraining rather than contributing to science program delivery. Although the factors are listed as isolated spheres, it is obvious from this study that there is interplay among these spheres, especially in terms of how environmental factors have influenced (usually negatively) the personal attribute factors. As an example, the priority placed on science as a curriculum area by the school and school community strongly influences teacher decisions and motivation towards the teaching of science. More importantly, student French language abilities impact significantly on teachers in their ability to teach science effectively. As well, the illustration does not suggest that the macrosystem factors most removed from the central individual sphere have the least influence on science program delivery.

The information gathered from this study does suggest that significant factors are influencing science program delivery negatively within francophone-minority settings. These factors are associated with teacher attribute factors such as science teaching interest, confidence, and professional science knowledge. Although these factors are commonly cited in the research literature (Lewthwaite 2000, 2001), they would appear to be significantly more complex in francophone-minority settings where student French language abilities make greater demands on teachers' knowledge base for the teaching of science. This microsystem factor significantly influences the school's (macrosytem) curriculum priorities. As well, this priority would appear to be influenced by the school community's (exosystem) aspirations for school focus to be on language acquisition possibly at the expense of the science experience afforded to students. Student comprehension of science is likely hampered by their limited exposure to scientific concepts and principles in French outside the classroom setting. The language of science becomes even more challenging given the fact that some students may not be as confident in the minority language and may have some deficiencies in their linguistic understandings (Landry & Allard, 1990). This problem may be compounded by the priority placed on certain subjects such as French and mathematics by the school so that science is not perceived as being as important a subject by the student. Clearly, student language capabilities have a significant effect on other systems.

Within the context of science education both nationally and internationally the spotlight for the improvement of science delivery in mainstream settings has traditionally fallen on the individual teacher usually with an emphasis on his or her shortcomings. This study situated within francophone-minority enlarges that focus to the microsystem and exosystem level illuminating the influence of language background of students on teachers and their ability to teach a curriculum area such as science. Although teachers openly identify limitations in the personal attribute factors that detract from effective science teaching, they equally identify how the context in which they work challenges and makes even more difficult their role as teachers of science.

This study began by acknowledging the results of national assessments and international tests that reveal that Canadian francophone students who study science in the minority language score lower than their anglophone counterparts (Council of Ministers, Canada, 2004). As well, these assessments indicate that these students also tend to have a more negative attitude toward science (Pruneau & Langis, 2000). The results of this study suggest that these attitudinal and achievement outcomes are likely to be caused by a variety of identifiable teacher personal attribute and

environmental characteristics. The ongoing phases of this multi-phase research and development project will respond to this diagnostic phase by establishing mechanisms that can make improved science teaching and learning for francophone-minority settings in Manitoba a reality. Improvement in science delivery at the francophone-minority settings in Canada must be seen within the larger social context of the school and, in particular school community, in which teachers and their classrooms are located. Focusing on the limitations and inadequacies of teachers only restricts the potential impact of strategies enacted to foster continued improvement in science education.

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Exploring the Influence of a Superintendent on Science Curriculum Delivery: A Case Study

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Abstract

This research inquiry explored the factors influencing successful science program delivery among early- and middle-years schools within a rural school division in central Canada. The study is framed by the author's personal inquiry into how psychosocial factors at the classroom, school, and school division level influence science program delivery. In line with case study methodology, the inquiry uses a variety of qualitative and quantitative methods and data sources to identify the contributors to science delivery at the classroom, school and divisional level. A validated science program delivery evaluation tool, the Science Curriculum Implementation Questionnaire (SCIQ), is used as the foundation for the quantitative data collection and ensuing teacher, administration and science education community discussions. Bronfenbrenner's bio-ecological model and Rutter's views on resiliency are used as a framework for interpreting the data collected and understanding the factors supporting successful science delivery. Participants identify a variety of personal attribute and environmental factors, and the interplay between these factors, as supportive factors contributing to effective science delivery at the classroom, school and divisional level. Implications of this inquiry are discussed, especially within the context of the role of the superintendent in influencing curriculum delivery.

This research inquiry explores the teachers' personal attributes and environmental factors influencing successful science program delivery among early- and middle-years schools within a rural school division in central Canada. The study is framed by the authors' personal inquiry into how psychosocial factors at the classroom, school, and school division level influence science program delivery. In keeping with case study methodology, the inquiry uses a variety of qualitative and quantitative methods and data sources to identify the contributors to science delivery at the classroom, school and divisional levels.

As well, the study endeavors to determine whether a validated science program delivery Learning Environment instrument, the Science Curriculum Implementation Questionnaire (SCIQ), can be used to accurately identify and support teacher, administration and school community discussions pertaining to the contributors to science delivery at the classroom, school and divisional level. Finally, the study endeavors to determine whether Bronfenbrenner's bio-ecological model and Rutter's views on resiliency can be used as a framework for interpreting the data collected and understanding the factors supporting successful science delivery across a school division as an educational environment.

Understanding how teacher personal attribute factors and multi-system environmental factors influence successful delivery over time in a school division is likely to be best understood by considering cultural-contextual theories of development. One such theory appropriate for the context of this inquiry is posited by the work of Urie Bronfenbrenner, a colleague of Learning Environment pioneer Kurt Lewin.

Bronfenbrenner's (1979) bio-ecological theory of development posits that development is a joint function of the person and all levels of their environment. The former includes personal attribute factors that are both biological and psychological (e.g., genetic heritage). As suggested by other studies (for example, Lewthwaite, 2001), teacher personal attribute factors such as professional science knowledge and science teaching efficacy are likely to be important determinants in influencing science delivery. The latter encompasses the physical, social, and cultural features of immediate settings in which human beings live (e.g., schools). Bronfenbrenner sees the ecological environment as a system of five nested structures.

The first structure represents the individual. The remaining four structures range from the immediate face-to-face setting to the more remote setting of the larger culture. The innermost structure consisting of a teacher's colleagues, the microsytem, is the immediate proximal setting with which the person directly interacts that invite, permit or inhibit activity (Bronfenbrenner, 2005). The developmental processes that occur within a microsystem are in good part defined and limited by the beliefs and practices of the individual's immediate setting, the mesosystem, society's blueprint for a particular culture or subculture. Thus, the school's belief systems and values may strongly influence the expectations endorsed by members of a microsytem. As an example, within the school context the belief systems held by senior teachers, the principal and school administration concerning the importance of a curriculum area are known to strongly influence the school's ethos for a curriculum area (Lewthwaite, 2004a).

The third structure, the exosystem, refers to environmental influences that do not involve directly the developing person but still influence the setting in an indirect manner. As an example, the community's or school division's aspirations for science as a curriculum are likely to impinge on school-based policy decision making and implementation.

Finally, the most removed structure, the macrosystem, refers to societal and cultural ideologies and laws that impinge on the individual. In the context of this inquiry, provincial curriculum agendas are likely to influence the school's response to science as a curriculum area. Of importance to this inquiry is the acknowledgement that, as Bronfenbrenner suggests, supporting processes within these overlapping environments are 'engines' for development. These suggestions are endorsed by research in other areas of development. For example, Rutter's research in resiliency extends this understanding of how bio-ecological attributes can influence development. He suggests that both 'risk' and 'protective' factors contribute to an individual's development and resiliency (Rutter, 1987). Risk factors are personal attribute factors or processes in the individual's environment (e.g. low science-teaching interest) that contribute to negative trajectories in development. Aligning his work with Bronfenbrenner's, Rutter suggests that protective factors are the 'engine' processes possessed by an individual (e.g., positive self-concept) or in an individual's environment (e.g., a committed principal) that contribute to positive outcomes. As might be expected, development is likely to occur where risk factors are minimized and protective factors are maximized.

Methodology

The case study method was used in this research inquiry. Using multiple sources of qualitative and quantitative data, the study endeavors to understand and explain the processes influencing effective science delivery from Kindergarten to Grade 8 at the classroom, school and divisional level. The study strives towards a holistic understanding of cultural systems of action within a social system, the school division (Sjoberg, Williams, Vaughan, & Sjoberg, 1991). The unit of analysis in this case study is the dominant players in science program delivery across the division: the superintendent, principals, and teachers. Drawing upon multiple sources of information, the case study includes a multi-perspective analysis drawing themes from the relevant players and the interaction among them. The themes generated are, in turn, compared to those commonly cited in educational leadership literature (Cuban, 1988; Fullan, 1992, 1993).

A comprehensive, validated instrument, the *Science Curriculum Implementation Questionnaire* (SCIQ) (Lewthwaite, 2001), was used in the evaluation of factors influencing science program delivery at these schools. The instrument has been applied in over 300 schools in New Zealand, Canada and Australia and has been the foundation for data collection in numerous research publications (for example Lewthwaite 2004, 2005 a, b, Lewthwaite & Fisher, 2004, 2005). This is the first time it has been used to evaluate science delivery across a school division. The SCIQ is a 7-scale, forty-nine -item questionnaire that provides information concerning the factors influencing science program delivery at the classroom and school level in schools where the teaching of science is a regular part of a teacher's teaching duties. The scales have been developed with the intent of

gauging teachers' perceptions on a 1 (Strongly Disagree) to 5 (Strongly Agree) scale in areas that are identified as major impediments to science program delivery (Lewthwaite, 2001). Four of the scales pertain to the school environment. These environmental or extrinsic scales include Resource Adequacy, Time, School Ethos, and Professional Support. The remaining three scales relate to teacher personal attributes. These intrinsic factors include Professional Science Knowledge, Professional Adequacy, and Professional Interest and Motivation.

Results

The SCIQ was completed by all teachers teaching science in all Early and Middle Years schools within the school division. This included a total of eight schools with a total number of 54 respondents. Over a two month period, mean and standard deviation results for each of the scales and descriptive profiles for each scale were presented to a meeting of all of the science teaching staff at each school within two weeks after they had completed the SCIQ. The first author presented and facilitated the one hour discussion, first determining the accuracy of the data and descriptive comments through teaching staff feedback. Second, this information became the foundation from which discussion, reflection and deliberate focused change could begin (Stewart & Prebble, 1993). The staff discussion ensuing from the data presentation, facilitated by the author, were audiotaped, transcribed and authenticated as a literal transcription by the principal and science teaching staff. Follow-up interviews with the superintendent, six principals, eighteen teachers and the divisional curriculum consultant endeavored to ascertain the factors that were contributing to the recognized exceptionally positive SCIQ results across the division. The authors noted in their data analysis that in the approximately 300 previous applications of the SCIQ, no school profiles had scored such positive results.

It was particularly notable that the mean scores for the personal attribute scales (teacher professional science adequacy, professional science knowledge, and professional science interest and motivation) were quite positive and consistent among teachers across grade levels and across schools. The one-hour follow-up discussion with the teaching staff affirmed the accuracy of the personal attribute and the environmental scales. The authors' discussions with the superintendent, principals, teachers, and the divisional consultant gave clear evidence that the influence of the superintendent had contributed significantly to the improvement in science delivery at the classroom level.

Several themes identified as supportive factors influencing science delivery positively were evident from the discussion. These themes included:

1. Possessing and Articulating a Vision. As suggested by Cuban (1988), an organizational leader influences organizational direction and outcomes. The vision for science delivery manifested in the science curriculum was the superintendent's (at that time the curriculum consultant's) desired outcome in the division's classrooms.
2. Establishing a Shared Vision Among Leadership Reflecting Stakeholder Needs and Concerns. The emphasis that the superintendent placed on improved learning through purposeful and engaging teaching, as a consultant, was a characteristic and 'common' or 'shared vision' (Cuban, 1988) of the division's current Leadership Team. He was motivated to diagnose divisional educational needs, especially in the area of curriculum, recommend strategies for improvement, and enable individuals to attain these goals. His perceived role was very similar to that cited by Johnson (1996). She suggests that the 'new superintendency' is charged with the task of diagnosing divisional needs and identifying strategies for addressing needs.

3. Identification of Strategies to Accomplish the Vision. Achieving development goals in science education was largely enabled by a coherent planning strategy based on the superintendent's awareness of factors influencing curriculum change. He had previously been involved in curriculum implementation projects and was aware of some of the challenges associated with fostering change. His role as an organizational leader was not only to influence organizational direction by influencing the motivations and actions of others

to achieve certain goals but also to ensure the mechanisms developed would support teachers in realizing their aspirations.

4. Ongoing Evaluation and Improvement through Informal and Formal Feedback. A common theme among the respondents was the responsiveness of the division to their concerns. Requests or suggestions for improvement in areas such as resourcing, facilities, and professional development were acknowledged and responded to. Teachers identified that principals were sensitive to the school-based needs and concerns. Teachers perceived that this responsiveness came from the fact that the principals knew that, in turn, the division's administration was responsive to concerns. These four themes, evidenced through participant responses, are not dissimilar from what are typically cited as the behaviors and actions associated with educational leaders that foster educational change effectively (Cuban, 1998, p. 194). Although these characteristics were clearly evidenced in the superintendent's intentions in science education, participant responses would suggest that these themes are as much characteristic of the division's Leadership Team in its efforts in achieving educational goals.

5. Contribution to the Teaching & Learning of Science. This study provides evidence that multi-system factors contribute to science program delivery and the role of the superintendent is significant in affecting change across these systems. As well, it provides evidence that the SCIQ, and the follow-up discussions it supports, assist in identifying the personal attribute and environmental factors influencing science delivery across a school division. Clearly, a divisional superintendent as a prominent member of the exosystem can play a significant role in pervasively influencing the motivations and actions of principals and teachers to achieve educational goals at the teacher-student level. As detailed in this study, an effective superintendent as a curriculum leader needs to be able to identify or develop and articulate achievable goals; motivate a leadership team, especially principals, to work towards a common goal; change and enhance existing structures to foster the achievement of goals; invest in human and physical resources; and monitor through evaluation, the success of the interventions. Within the context of science education both nationally and internationally, the spotlight for the improvement of early- and middle-years science delivery has traditionally fallen on the individual teacher, usually with an emphasis on his or her shortcomings. This study enlarges that focus, and the perspectives provided by Bronfenbrenner and Rutter provide a model of how supportive structures established because of the leadership of a superintendent can contribute to individual teacher success at the classroom level.

Implications of this Study

Much of the focus in science education reform is on the teacher. Although teachers are at the centre of classroom reform efforts, this study makes clear that any effort to foster teacher development must take place within the larger sphere of the environment in which teachers work and how this environment can be influenced by a superintendent who focuses on fostering teacher change. For the many Manitoba education researchers working in the context of schools and school divisions, this paper enlarges the focus of their activity to ensure they consider the wider context in which teachers are situated when working to foster curriculum reform.

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The Role of Conflict in Learning

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Abstract

The relationship between language and conflict resolution is examined. The dominant view is that language influences conflict negotiation. The author's research illustrates how students with mild intellectual disabilities manifest differences in their "conflict talk", compared to normal students. Conversely, the position that conflict may impact on language acquisition has only begun to be explored; preliminary arguments for this view are advanced. As conflict is central in many areas of development, it is essential to be open to the hypothesis that conflict may be a catalyst for language development.

Why study conflict? This is a fundamental question. Scholars have suggested that conflict plays a major role in development. For example, conflict has been linked to the development of the child's social behaviour (Bearison, 1982; Bearison, Magzamen, & Filardo, 1986; Miller & Brownell, 1975; Weinstein & Bearison, 1985). Piaget proposed that conflict is an impetus for cognitive growth (1932, 1958). Erikson (1963) likewise implicated conflict in the development of the child's ego. Others have asserted that conflict is instrumental in moral development (Berkowitz & Gibbs, 1985; Kohlberg & Gilligan, 1972).

Educators face increasingly greater

numbers of conflict situations (Malloy & McMurray, 1995). Schools have responded by re-structuring their pedagogy to enable children to deal constructively with conflict (Johnson & Johnson, 1995; Opotow & Deutsch, 1999). Teachers need approaches to conflict resolution that are compatible with effective learning (Spann, 2005). Conflict resolution programs are increasingly popular and include: *Second Step* (Frey, Van Schoiack Edstrom, & Hirschstein, 2005), *Peer Mediation* (Hall, 1999), *Social Circle* (Adams, 2003), *Resolving Conflict Creatively Program* (Brown & Coauthors, 2004), and *Discursive Space for Verbal Interaction* (Long, 1998).

Social interaction is an important catalyst for intellectual development (Cooper, Ayers-Lopez, & Marquis, 1982; Doise & Mackie, 1981; Light, 1983; Mugny & Doise, 1978; Neilson & Dockrell, 1982; Fawcett & Garton, 2005). In this respect, the theories of Piaget (1932) and Vygotsky (1978) have been foundational. Piaget (1932) argued that peer interaction fosters cognitive conflict, essential for restructuring thought. Vygotsky (1978) proposed that social interaction with adults or more capable peers allows the child to solve novel problems with assistance, before solving them independently. The Vygotskian perspective links cognitive change to collaborative interaction; this may involve negotiating which strategies to adopt for solving a learning problem. Social interaction is at the heart of 'cooperative learning', a classroom arrangement advanced by David and Roger Johnson (1986). Teachers have embraced 'cooperative learning' as it "has the most widespread and powerful effects on instructional outcomes" (Johnson & Johnson, 1991, p. 22).

Understanding conflict dynamics in classrooms is essential for success for all learners. In practice, educators recognize that conflict is important for learning (Bearison & coauthors, 1986; Forman & Kraker, 1985; Limon, 2001). They also know that students' conflict resolution skills are linked with peer acceptance (Walker, 2004). Disagreements are a feature of 'cooperative learning' group dynamics (Johnson & Johnson, 1989, 1991; Johnson, Johnson, & Smith, 1995; Tocalli-Beller, 2003; Sorsana, 2003). The question of how students with learning difficulties negotiate and collaborate during learning engagements is especially important (Holmes-Lonergran, 2003). Therefore, the author investigated how students with learning difficulties function in conflict dialogues.

'Conflict Talk': A Study of Adolescents with Mild Intellectual Disabilities

Research into the 'conflict talk' of adolescents with mild intellectual disabilities skills has been conducted (Okrainec, 1997). This interest in "conflict talk" was twofold. First, conflict is a social activity conducted primarily by means of talking (Benson, 1996; Garvey & Shantz, 1992; Garton & Renshaw, 1988; Grimshaw, 1990; Hay & Ross, 1982; O'Keefe & Benoit, 1982). Second, other researchers have explored the skilled and differentiated communicative behaviour of conflicts (e.g., Eisenberg, 1992; Eisenberg & Garvey, 1981; Lindow, Wilkinson, & Peterson, 1985; Renshaw & Garton, 1986). This study was designed to explore the links between these two branches of research.

Study Overview

Participants included 25 dyads, 12 male pairs and 13 female pairs. Dyads were comprised of a normal student paired with a student with a mild intellectual disability. Students were nominated for the study by their teachers. The mean age of students with a mild intellectual disability was 169.64 months (14 years 1 month, SD = 11.39 months); the mean age of the normal-progress students was 159.32 months (13 years 3 months, SD = 8.41 months).

Prior to undertaking the learning task, participants were administered two language measures: (a) a general language measure, the *Test of Adolescent and Adult Language-Third Edition (TOAL-3)* (Hammill, Brown, Larsen, & Wiederholt, 1994); and (b) a measure of social communication, the *Test of Pragmatic Language (TPL)* (Phelps-Terasaki & Phelps-Gunn, 1992). The normal students attained a mean *TOAL-3* Language Quotient of 95.9 (SD = 14.3); the students with a mild intellectual disability attained a mean *TOAL*-3 Language Quotient of 57.6 (SD = 10.2). On the *TPL,* the normal students attained a mean age equivalency of 164.4 months (SD = 20.5); the students with a

mild intellectual disability attained a mean age equivalency of 108.9 months (SD = 23.5).

For each dyad, conversations were taped during a 20-minute social studies task, "Fort Walsh" (CLASS Software, 1987). "Conflict" was defined as "when one person does something to which a second person objects" (Hay, 1984, p.2). Verbal conflicts arising during the learning activity were analyzed using an adaptation of Eisenberg's (1992) coding system. Conflict talk exchanges were noted, including: who initiates the conflict, number of oppositional turns, presence or absence of negative affect, presence or absence of justification, the individual taking the last verbal oppositional turn, the 'speech act' category of the opposed utterance, the topic of the conflict, the outcome of the dispute, and the initial type of opposition. Conflict examples are available in Appendix A.

Findings

In what follows, the main findings of the study are summarized.

Number of Conflicts. Across the 25 dyads, 211 verbal conflicts were identified. On average, there were 8.44 conflicts per dyad (SD = 5.06), with a range of 1 to 15 conflicts per dyad.

Conflict Length. The average length of the conflicts was 2.19 conversational turns (SD = 1.88), with a range 1 to 15 turns. Most conflicts were short. In fact, 85.8% of conflicts were less that four conversational turns in length. 48.3% of the conflicts consisted of a single turn (compliance exchanges), while 51.7% were longer, mutual conflicts.

Conflict Initiator. The normal peer initiated most of the conflicts during the learning engagement. In fact, 64.0% of the conflicts (135 of 211) were initiated by the normal-progress students. Students with a mild intellectual disability initiated 36.0% (76 of 211 conflicts). This difference in conflict initiation was highly significant, as determined by the Wilcoxon Signed Ranks test (Sign Rank = 6, *p*-value = .0005).

Initial Opposition Strategies. There were differences in the conflict initiation strategies used by students with intellectual disabilities and normal students. 'Simple no' and 'indirect no' (low level strategies) were used at relatively higher rates by students with intellectual disabilities and coexisting language difficulties. Higher level strategies such as 'justification', delay/distraction', and 'question/challenge' were used at relatively higher rates by normal students. The results are outlined in Table 1 below.

Table 1. Initial Opposition Strategies for Normal (N) & Intellectually Disabled (ID)

Conflict Initiation Strategy	N (%)	ID (%)
Simple No	8.2	11.9
Indirect No	5.1	14.5
Justification	20.0	15.8
Alternative	31.9	35.5
Delay/Distract	11.8	10.5
Question/Challenge	23.0	11.8

Normal students used the less direct 'question/challenge' conflict mitigating strategy significantly more frequently than their intellectually disabled counterparts. The results of the one-tailed Wilcoxon Signed Ranks test were highly significant (Sign Rank = -105, *p*-value = .0001).

Speech Acts. Disagreements arose in response to a partner's speech acts: 'requests for permission', 'requests for action', 'statements of intent', and 'statements of fact'. No conflicts were initiated in response to a 'request for permission'. 'Requests for action' precipitated most conflicts, 69.2%. Conflicts were initiated in response to 'statements of intent' 15.6% of the time, and in response to 'statements of fact' 17.2% of the time.

Negative Affect. Negative affect seldom occurred in verbal conflicts. It was displayed 15.2% of the time by the normal peers (32 of 211 conflicts), and 14.7% of the time by students

with intellectual disabilities (31 of 211 conflicts). In 'mutual' conflicts consisting of two or more conversational turns, negative affect was demonstrated by the normal peers 22.0% of the time (24 of 109 mutual conflicts), and 23.9% of the time by students with intellectual disabilities (26 of 109 mutual conflicts).

Justification. Students with intellectual disabilities used justification at any point within conflicts 26.1% of the time (55 of 211 conflicts). Normal students used justification 42.7% of the time (90 of 211 conflicts).

Dispute Topic. Dispute topic varied: 80.1% of the time the dispute topic related to the 'lesson content' (169 of 211 disputes), 16.6% of the time to 'lesson process' (35 of 211 disputes), 2.8% of the time to the level of 'assistance' (6 of 211 disputes), and 0.5% of the time to 'other' issues (1 of 211 disputes).

Dispute Outcome. The outcomes of the verbal disagreements were as follows: students with mild intellectual disabilities submitted 41.7% of the time (88 of 211 conflicts); normal students submitted 31.3% of the time (66 of 211 conflicts). Standoff occurred 20.8% of the time (13 of 211 conflicts), and compromises were reached only 6.2% of the time (44 of 211 conflicts).

Summary. The analysis of "conflict talk' episodes provided data regarding how students with mild intellectual disabilities function in conflict dialogues with normal students.

Does Conflict Play a Role in Language Development?

Could conflict be a 'catalyst' for language development? After all, conflict is a catalyst for several other areas of development, so why not for language development as well? Turning to research connecting language and conflict resolution, three bodies of work are noteworthy. First, studies exploring the relationship between language and conflict in normal children are described. Second, research suggesting that conflict resolution deficits and language difficulties co-occur is examined. Third, evidence that language-learning can be enhanced through conflict interventions is presented.

Language and Conflict in Normal Children
Several investigators have examined language and conflict during development. Taken together, these investigations allude to a relationship between conflict and language in normally developing children. In 2005, Ljungberg and coauthors studied post-conflict reconciliation in preschool boys, noting that communicative factors in the pre-conflict period were distinctively correlated with post-conflict behaviour. Toohey (2001) tracked two preschoolers longitudinally, observing that success in peer disputes offered a child occasions to negotiate new meanings, while lack of success reduced opportunities for participation in classroom conversations.

Conflict may have some bearing on the development of literacy. In 1998, Pellegrini and coauthors investigated dyads of kindergarten friends and non friends (63 male dyads, 53 female dyads). Friend versus non friend groupings elicited more conflicts and resolutions, plus more literate language. Besse (1996) examined the processes of written production for 27 French children, aged 5 years 0 months to 6 years 4 months. The children were invited to produce an unfamiliar written form, one not yet presented in class. This task gave rise to cognitive conflict, leading to resolution of a problem not previously encountered. Manning and coauthors (1995) investigated 12 nonreaders in kindergarten over an eight-month period. This study examined the strategies nonreaders use to relate spoken words to segments of printed sentences. Results showed a complex interaction of various strategies leading to conflicts, partial solutions, and final coordination.

Conflict and Children with Language Learning Impairments. The second set of studies concerned children with language-learning impairments. Marton and coauthors (2005) compared children with 'specific language impairment' (SLI) and age-matched peers (seven to 10 years old). The children with SLI used inappropriate negotiation and conflict resolution, demonstrating qualitatively different strategies from typical children. They employed more nonverbal strategies, demonstrating

passive and withdrawn behaviour. Horowitz and coauthors (2005) videotaped 11 boys with language impairment (four to seven years old) and 20 boys with typically developing language (four to six years old). The boys with language impairments reconciled fewer conflicts (47.3 compared to 63.6 for the boys with typically developing language); they also used verbal reconciliatory behaviours in a smaller proportion of conflicts.

Mullet (2001) analyzed the conflict resolution processes of 28 8th grade students with a learning disability in the language area. The experimental procedures involved structured interviews, including adaptations of resolution strategy scales (Thomas & Killman, 1994; Johnson, Johnson, Dudley, & Acikgoz, 1994). Students with language impairments displayed weaknesses in conflict resolution skills, compared to age-matched peers. Donahue (1988) investigated the performance of reading-disabled first and second graders on a group decision-making task. When disputes arose during decision-making, students with reading problems were less likely than typically developing readers to make the winning move. Ring (1996) reported on factors that contributed to children's antisocial or oppositional behaviour. Among the factors were 'language and expression'.

Conflict Interventions to Promote Language Learning. Some studies suggest that conflict interventions may promote language skills. Tocalli-Beller and Swain (2005) suggested that cognitive conflict has a role in second language learning. These investigators looked at 12 students in seventh grade. In their experiment, students' own writing was reformulated and they had an opportunity to notice the changes in the two texts. Presenting students with cognitive conflicts led them to articulate differences between the original writing and the reformulation, which aided learning a second language. In 1986, Dean and Howell outlined an intervention strategy for children with phonological disorders. The strategy aimed to develop the child's awareness of the phonological structure of language. This intervention approach viewed the child as learning through conflict and reflection.

For normal children, a relationship between language and conflict has been intimated. As well, children with language impairments exhibit deficits in their conflict skills. Finally, interventions that employ conflict to promote language learning are beginning to emerge.

Conclusion

In this paper, a rationale for educators' continued interest in the study of conflict is asserted. The author's research into the conflict negotiation skills of students with learning difficulties is summarized. Research initiatives to advance the hypothesis that conflict may be a catalyst for language learning are suggested. Future investigations may reveal that children's 'conflict talk' episodes indeed offer opportunities for language learning.

Appendix A

Conflict Examples

Conflict Coding – Example 1

0 Peer: 'Kay, your turn to read.
1 Intellectually Disabled: No, your turn. Go on.
0 Peer: [Begins to read]

****

Initiator – disabled student.
Number of turns in this conflict – 1.
Negative affect – absent for both students.
Justification – No justification (both).
Last turn – taken by the disabled student.
Speech Act – request for action.
Dispute topic – lesson process.
Dispute Outcome – peer submits.
Initial Opposition Strategy – alternative.
Explicit Negative – present.

Conflict Coding – Example 2

0 Intellectually Disabled: [Let's take] tools and rope.
1 Peer: So?
2 Disabled: So we can make stuff like weapons.
3 Peer: Well, why not just bring weapons?
0 Disabled: Oh

****

Initiator – Peer.
Number of turns in this conflict – 31.
Negative affect – Present for the peer, absent for the disabled student.
Justification – Present for both students.
Last turn – taken by the peer.
Speech Act – request for action.
Dispute topic – lesson content.
Dispute Outcome – standoff.
Initial Opposition Strategy – question/ challenge.
Explicit Negative – absent.

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FORUM PRESENTATION LIST

Forum #8 November 17, 2006

Rural Education

Tim De Ruyck "Identifying and addressing the challenges of the rural principal"

Dawn Wallin "Rural educational priorities and capacity in Manitoba: A summary of research"

Mathew Gustafson, Craig Laluk, John Minshull & Cathy Watt "Brandon school division literacy project 2003-2007"

Marlene Atleo "Rurality a potential advantage?"

Mona Maxwell "A framework for sustainable agriculture in Manitoba curriculum"

Lynn Whidden & Ralph Mason "Changing the scale of professional development"

Betty Howell & Donna Forsyth "Brandon school division middle years initiative"

Paul Cuthbert, Scott Hill & Students "Senior years review in Evergreen school division: Engaging student, teacher and community voices in dialogue toward change for our high schools"

Rodelyn Stoeber & Brahim Ould Baba "Linking communities to enhance learning opportunities in science for both teachers and students in minority language schools"

Marlene Atleo "Aboriginal teacher and EAL (English as an additional language) teachers: Developing a common discourse"

Amjad Malik & K.P. Binda "An examination of educational problems as perceived by rural educators"

Donna Michaels, Marlene Gregory, Doug Milak, Adrian Kuryliw & Barry Gooden "Brandon school division graduation study 2003-2005"

Laine Mosset "Manitoba community schools: New models for community economic development"

Sharon Burns "A voice for parents in rural Manitoba"

Brian Lewthwaite, Robert Renaud & Rodelyn Stoeber "Teacher perceptions of factors influencing science program delivery in rural francophone minority settings in Manitoba & Saskatchewan"

Karen Rempel "Rural education and learning: Past, present perspectives and future possibilities"

Jeanne Gitzel "Student voice: Voices of today and tomorrow"

Don Metz "The whole school approach to education: A case study of an environmental school in rural Costa Rica"

Harold MacDonald "Prevalence of anxiety disorder among intermediate students with reading comprehension problems in northern Manitoba"

Dawn Wallin "Rural educational priorities and capacity in Manitoba: A summary of research"

Brian Lewthwaite & Paul Cuthbert "'I want to enable teachers in their change': Exploring the influence of a superintendent on science delivery"

Carolyn Crippen "Teacher-candidate perceptions of educational leadership: Democratization in Manitoba schools"

Glenn Cockerline "WebCT ;Is it the answer to small enrollment courses in rural Manitoba? What the research says about who is advantaged by the use of WebCT?"

Forum #9 February 23, 2007

Science Teaching and Learning

Barbara McMillan & Brian Lewthwaite "Combining the view of both worlds: Perceived constraints and contributors to achieving aspirations for science education in Qikiqtanii"

Léonard Rivard & Rodelyn Stoeber "Linking communities to enhance the teaching and learning of science in minority language schools: A progress report"

Norman Lee "Developing the workforce of the future".

Florence Glanfield "Experiences of Aboriginal high school students in mathematics and science"

Brian Lewthwaite Student creativity in science investigative planning

Ann Kajander, Carlos Zerpa, & Dave Paddington "Intermediate mathematics teacher capacity and growth: Enhancing knowledge and beliefs"

Craig Blagden & Ralph Mason "Citizenship Mathematics"

Don Metz, Stephen Klassen & Barbara McMillan "Integrating science curriculum in the middle school: Utilizing a historical perspective"

Ken Clark "Comparison of achievement and context in science based on SAIP 2004 assessment results"

Marilyn Mooibroek "Seeds and sparks - evaluation of the hotline program in the

Alberta science networks"

Mona Maxwell "Secondary level learning resources addressing students perceptions of 'uninteresting' and 'complex' science: A CRYSTAL study"

Inessa Rozina "The presentation of the mathematical component of physics in high school and introductory level college physics textbooks: Using the law of universal gravitation as an example"

Amanda Freedman Tetrault "We are all downstream: The risk and protective factors for teaching sustainability education in middle school science"

Tony Bartley, John Friesen & Robert Jerome "Science curriculum development for a northern internet-based high school"

Heather Teller "Using interactive vignettes in the teaching of the mole concept in secondary chemistry"

Brian Lewthwaite "Impediments and contributors to chemistry teacher candidate development"

Forum #10 ***May 4, 2007***

Talent Development

Kevin Chief "Shared vision"

John Tooth and Laura Sokal **"**Partnership research in education: An ethics protocol"

Helen Armstrong "Both Dr. Jekyll and Mr. Hyde had gifts: Constructing 'ideal schools' to nourish the talents of kids coming before the justice system"

Lisa McLean "World Council/University of Winnipeg: A partnership for talent development"

Robin Enns "Quick think: A practical approach"

Mike Bergsgaard, Annette Greene, Suzanne Barrett "The education students' anthology: Process and publication"

Chris McCluskey "Talent Development at Mountain View High"

John Tooth Laura Sokal "Partnership research in education: An ethics protocol"

Neil Dempsey "More than content: Why schools emphasize convergent thought and what you can do to change that"

Donna Copsey Haydey "Critical literacy through alternative texts: Is the wolf a villain or victim? Are the three pigs innocent or at fault? And what does the fourth pig have to do with any of this?"

Kevin Lamoureux and Robert Dixon "Enrichment and inclusion"

Lisa McLean "World Council/University of Winnipeg: A partnership for talent development"

Sylvia Bastable and Bob Bastable "Tapping into the talents of at-risk students: The Regional Support Center experience"