UNIVERSITY OF ALBERTA

THE CASE OF THE IMPLEMENTATION OF THE WESTERN CANADA PROTOCOL IN MATHEMATICS IN ALBERTA

BY

KATHLEEN MCCABE ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of MASTER OF EDUCATION.

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THE UNDERSIGNED CERTIFY THAT THEY HAVE READ, AND RECOMMEND TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH FOR ACCEPTANCE, A THESIS ENTITLED THE CASE OF THE IMPLEMENTATION OF THE WESTERN CANADA PROTOCOL IN MATHEMATICS IN ALBERTA SUBMITTED KATHLEEN MCCABE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION.

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ABSTRACT

The purpose of the research was to document the case of the initial implementation of the Western Canada Protocol in Mathematics in Alberta in Pure Mathematics 10 and Applied Mathematics 10.

Two mathematics teachers were the main research subjects and their experiences were documented throughout the initial semester of implementation. The evolution of The Case of the Implementation of the Western Canada Protocol in Mathematics in Alberta was much like the resolution of a complicated play. For this reason the researcher chose to present the case as a drama, with the two teachers being the main characters.

The implementation of the new programs was problematic; therefore the research did not finish when the teachers' involvement did. The research continued, but with a much broader focus—the problems encountered by many stakeholders throughout the province of Alberta, the response of Alberta Learning to these issues, and four of the most contentious issues in the implementation: the mandated use of the graphing calculator, the near demise of the Applied Program, the poor results of students in the new programs and the need for teacher inservice.

The research related the experiences of people involved, the trials of attempting to make changes in what and how mathematics was taught, and what can happen when teachers feel their concerns are not being answered. This case of implementation has implications for anyone involved in curriculum change, most notably for the agencies responsible for determining what the changes are and how they will be implemented.

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ATA	Alberta Teachers' Association
CCF	The Common Curriculum Framework
CMASTE	Centre for Mathematics, Science and Technology Education
EMH	Educable Mentally Handicapped
ESL	English as a Second Language
IOP	Integrated Occupational Program
MCATA	Mathematics Council of the Alberta Teachers' Association
NAIT	Northern Alberta Institute of Technology
NCTM	National Council of Teachers of Mathematics
SAIT	Southern Alberta Institute of Technology
TERM	The Edmonton Regional Mathematics Group
TIMSS	Third International Mathematics and Science Study
WCP	Western Canada Protocol

The Playwright

How I got here

My entire teaching career has been teaching mathematics in high school. In many ways this is very lucky, and in other ways it is very limiting. I have, however, been fortunate enough to teach to all levels of students. On some days, I would go straight from teaching the Advanced Placement Calculus students to teaching, and often learning, with the EMH (educable mentally handicapped) students. This variety, not only kept me on my toes, it allowed me to think about what is mathematics and how do students learn it? Is the same mathematics important for all students? It also led me to ask what mathematics is important for which students? I had students in my integrated occupational program who could not add numbers, without the aid of a calculator. Was it important for them to learn this, or should I just teach them how to use a calculator properly? Was the mathematics I taught appropriate for all students? How might mathematics be taught so that all students are included? It appears that I was not alone in my struggle to answer these questions. With the implementation of a new mathematics program in Alberta high schools soon to occur the personnel of the curriculum standards branch of Alberta Education were also trying to answer these questions. As the new programs were announced teachers and parents of Alberta high school students would be asking these same questions and finding their search for answers quite daunting.

My love of mathematics and teaching, and my involvement with curriculum development, led to a secondment to Alberta Education to write teacher resource material

for IOP (Integrated Occupational Program). The year away from youth taught me many things: I love to think about students' learning and how teachers can foster it;
I enjoy demonstrating how instructional materials can help teachers make the curriculum come alive for students; and I really hated a desk job. I was reminded why I taught in the first place, I love adolescents and interacting with them. I also really missed my colleagues. I wonder in how many other occupations do staff grow as close as they do in schools? Teaching is such a demanding profession that I believe we come to rely on our colleagues to help us keep our focus and to validate what it is we do. I was lucky to be associated with a very dynamic and challenging teaching staff. As a mathematics department, we were always ready to try something new and to share the workload. I feel truly privileged to have worked with such a great group of people.

It was with great anticipation and some trepidation that, after having returned to the classroom for seven years, I accepted a second secondment to the University of Alberta to act as a Field Experience Associate. I believe I was selected for the position, in part because Alberta was about to implement a new mathematics program and I had been involved with it from its conception. I was one of the Alberta representatives on the Western Canada Protocol (WCP) mathematics committee, a group struck with the purpose of making decisions about the mathematics that was important for all high school students to learn and the mathematics that was no longer necessary due to advances in technology. The committee was mandated to look forward as the new mathematics programs would be in place in the new millennium.

The position with the university allowed me to combine the many facets of education that I loved. I was able to work with preservice teachers, helping them understand not only the content of the curriculum, but also how it should be delivered. I was also able to work with teachers, in the field, inservicing them on the new program and its pedagogical underpinnings. In the curriculum and instruction classes my students and I strove to find answers to some of the very questions that led me to be involved in questioning curriculum change and analyzing what mathematics was important for students to learn.

One of the liveliest discussions we had in this curriculum and instruction class was on the use of calculators, an obvious foreshadow for what was to come. As I recall, many of the students were very reluctant to allow students to use calculators prior to senior high, and many were truly appalled to learn that Alberta Education allowed the use of calculators on the grade three-mathematics achievement test. Several of the students had never seen or used a graphing calculator and were surprised to learn that the use of them was mandated in the new program. It became obvious that these preservice teachers were going to have to reevaluate some of their beliefs, if they were to teach the new mathematics programs. This led to lively discussions as to what a mathematics classroom in the twenty first century should look like. We agreed that it should probably differ from current classrooms but how classrooms should change and why they should change were issues left to be resolved. We discussed what the philosophy of the new program meant and on which theoretical ground it was based. It was working with the preservice teachers that influenced my decision to do some more graduate work, and hence I enrolled in the masters program in secondary education.

Exploring Topics for the Play

It seemed only natural that I would write my thesis about the implementation of the new mathematics program, after all I had been intimately involved with it since its conception. What focus would my research take? I have always been interested in how teachers teach, so it seemed logical that the role of the teacher in the implementation would be my focus. I wanted to know how teachers would interpret the curriculum, and how they would make it work in their classrooms. I wondered if the political climate would affect teachers' acceptance of the program change; there had been many budget cuts which were directly felt in the classrooms and teachers were beginning to become vocal about their roles in education. Some teachers were asking, would there be enough money for schools to implement the programs in the way in which they were intended?

Who would be my research subjects? This was a difficult question, as literally hundreds of teachers throughout the province would be involved in the implementation of the new mathematics programs. I decided to have one teacher who was involved in the applied program and one who was involved in the pure mathematics program. Most importantly, I wanted teachers who believed in the new program and would give it a fair trial, teachers who would look upon the change in curriculum as a challenge not a burden. Two teachers agreed to participate in the research, one in her first year of teaching, and the other an experienced teacher. They were both excited about teaching the new programs and were enthusiastic about being part of the research.

This is the story of how I came to this research. Of course this was just the beginning. As happens to many graduate students when it comes time to do the research one's focus often changes. My role, in the implementation of the new program, had expanded greatly and I realized that I had knowledge and a relationship with the new program that would be significant to any study I conducted of the implementation of the Western Canada Protocol (WCP). Although, I originally intended to tell the stories of two teachers, this thesis has become my story of the implementation of the new mathematics program. I am now also one of the research subjects in my thesis. As noted earlier, I was involved in the initial meetings about the new Western Canada Protocol and have been involved ever since in many ways. Currently, I am the program manager for the Mathematics 30 and the Pure Mathematics 30 diploma exams, so my association with the new programs of study remains intimate. Further, my position allows me to be in close contact with many mathematics teachers throughout the province. Because I meet with teachers frequently, their experiences of the implementation have been shared with me. This has allowed me to have a "panoramic" view of the implementation and the associated issues. I began with an interest in the experience of implementation, and now find myself documenting the drama of "The Case of the Implementation of the Western Canada Protocol in Mathematics." So now, there are more actors in a much more complicated play.

The Development of Applied and Pure Mathematics

Though there have been many shifts in the beliefs of what and how mathematics should be taught, it seems the paradigm of the late 1980s is still prevalent today. "Students of all ages construct meaning about themselves and their world out of personal experiences, including the influences of culture" (Caine and Caine in Cook, 1995). The new perspectives of how mathematics should be taught are grounded in psychological research about the nature and learning of mathematics. These led the National Council of Teachers of Mathematics (NCTM) to write the *Standards* documents; *Curriculum and Evaluation Standards for School Mathematics (1989), Professional Standards for Teaching Mathematics (1991), and Assessment Standards for School Mathematics (1995).* The *Standards* documents are political in nature and include the vision of mathematics available for all students. In their belief statements, the authors of the *Standards* emphasized that mathematics should be inclusive rather than exclusive and all students should have full access to mathematics. This "mathematics for all" has not been my experience. In Alberta, students are streamed in high school mathematics into either the non-academic 14, 24 stream; the general 13, 23, 33 stream; or the academic 10, 20, 30 stream. Students' choices of which stream of mathematics they study may have a great impact on their future studies. Though the mathematics they need may not require the skills and knowledge obtained in Mathematics 30, it is often used as a gatekeeper to further education. Often students are denied access to post-secondary studies because they have not been successful in mathematics; an example of this is the admission requirements at the University of Alberta. Mathematics 30 is listed as a group C course but Mathematics 33 is not listed in this category. This essentially means that, although not all faculties require Mathematics 30, they do not credit students who have taken Mathematics 33. What mathematics is necessary for these students in various university programs, and is the same mathematics required for all students?

The *Standards* documents are likely the most influential change forces in mathematics teaching in many years. The *Standards* documents were designed to provide a broad framework for reform in school mathematics. The documents offered suggestions for what mathematics should be taught, how it should be taught and how it should be evaluated. Though the NCTM is an American organization, it is affiliated with other mathematics organizations in many other countries; the influence of the *Standards* documents in North America has been far-reaching. The impact of the *Standards* on the WCP for mathematics from kindergarten to grade 12 in Alberta, is evidence for this. The new Alberta program of studies reflects the impact of the *Standards* in both the recommended content for school mathematics and the epistemological underpinnings of the *Standards*.

My Introduction to the *Standards*

My first introduction to the *Standards* occurred in a graduate course with Tom Kieren in 1988. The *Standards* were available in draft form at this time and the National Council of Teachers of Mathematics welcomed responses to them. As a class assignment, we were required to respond to these draft documents. I recall thinking that this was an American political document, and that it would have little impact on what occurred in classrooms in Alberta. At the time, I believed we had a good mathematics program in our schools; it served the needs of our students, and it was unlikely that we would see drastic changes in content or pedagogy. I also remember members of the class discussing the NCTM's belief in mathematics for all children. If we were to embrace mathematics for all, we had to ask ourselves some questions: did we believe that all children could learn all mathematics; could all students learn mathematics in the same way? To answer these questions we had to examine the structure of our mathematics classrooms. At this time, I believed most high school mathematics classrooms in Alberta looked very much the same, and were conducted in very much the same way. The mathematics lesson often followed the same routine; the previous day's homework was taken up, the new lesson was taught by the teacher on the blackboard, and then the day's assignment was given. Students worked quietly at their desks until the end of the period. The classroom being advocated by the NCTM was very different from this. I do not believe that many of us, at the time, thought that we would do things very differently in the near future.

My second encounter with the *Standards* occurred when I was asked to be one of the Alberta representatives on the writing of the WCP for mathematics. The four western provinces and two western (at this time) territories had agreed to a common curriculum framework for school mathematics from kindergarten to grade twelve. My initial involvement was to travel to Saskatoon, Saskatchewan for a week and meet with representatives from all ministries involved. Our task was to decide what mathematics students would need in the new millennium. We were told that the new programs would involve three clusters of outcomes: common, pure and applied. The labels, pure and applied, had not been fixed and were just working titles. The curriculum developers differentiated the clusters based on the observed needs of the students they were to serve and the mathematics topics to be studied. The outcomes in the common clusters were to represent the mathematics, we perceived, were necessary for all students to learn. The outcomes in the applied cluster were to represent both the type of mathematics we considered had direct and immediate application as well as the mathematics available to the "average" student. The pure cluster outcomes represented the mathematics which would allow students to pursue further studies in university level mathematics. Specifically, these outcomes were intended for students who would go on to study calculus. We were to identify the mathematics we believed should be taught in high school and to identify the cluster in which these outcomes belonged. We did not have to identify a grade or course level, as this would be the responsibility of each province's or territory's ministry. At the end of the week, the representatives of the ministries would take the outcomes identified by all the working groups back to their jurisdictions for review.

The next phase was the responsibility of Alberta Education, as the lead province for the mathematics program. All outcomes and clusters were reviewed and shared with the other ministries representing the protocol partners. From this, *The Common Curricular Framework for K-12 Mathematics* document was produced. Each member of the protocol partnership would now determine how to arrange the outcomes into courses for the jurisdiction they represented. Alberta Education, in this role, decided to arrange the outcomes into six courses, two at each grade level, and one for each of Pure and Applied. The courses in the Applied 10, 20, 30 program were designed for students who learned by having the mathematics emerge from within contexts and who would not go on to pursue studies in calculus. The Applied Program had a numeric and geometric focus whereas the Pure Program courses had an algebraic and graphical focus. Pure Mathematics 10, 20 and 30 were designed for students who would pursue calculus and/or who preferred to learn mathematics for its own sake prior to learning its applications. Members of the Curriculum and Standards Branch of Alberta Education maintained that the two programs were of equal rigor and only varied in approach. Therefore, a student should select the program according to learning style and future educational plans.

Becoming Familiar with the New Mathematics Program

My next involvement with the WCP was as a teacher who would be teaching the new program. I, like many of my colleagues in June of 1995, read sections of the WCP document but did not read it in depth, as it would not be implemented for three years. We were aware that a change was coming but, because it was not imminent, many of us gave the documents only a cursory reading. However, I was seconded to the University of Alberta in September 1996 as a field experience associate and one of my responsibilities was to teach the curriculum and instruction course to the fourth year mathematics majors. I believed that it was my responsibility to become very familiar with the curriculum document, as my students would be teaching this program in the very near future.

While on secondment to the University of Alberta I became quite involved with teacher inservice of the new program. The elementary and junior high programs were being implemented and teachers were struggling as they faced changes to what and how they taught mathematics. My university colleagues and I recognized that there was a need for teacher inservice on the new program and in June of 1997 we offered the first of several inservices on the mathematics program. These inservices attracted teachers primarily from the Edmonton area, but teachers from other areas of Alberta also attended. We also were asked to offer the inservices in other areas of the province. The attendance at these inservices, and the feedback we received from the teachers, indicated that they successfully addressed some of the needs of teachers involved in the implementation of the WCP in mathematics.

In the first year of these inservices, we focussed on the elementary and junior high programs because this was where the immediate demand lay. The senior high programs were still a year away from implementation, so the senior high teachers did not yet request inservice opportunities. High school teachers knew that the program was changing, but few realized the magnitude of that change. As the implementation date for the high school programs drew nearer, there was a growing demand for information about the new programs. I facilitated information sessions at professional development days and at teacher conventions. Once again, the University of Alberta offered successful June inservice sessions on the new program but in 1998 and 1999 these workshops were focussed at the senior high school level.

The Theme of the Play

Teachers of mathematics in Alberta high schools are currently being asked to implement the *Western Canada Protocol Mathematics 10-12 Program*. There have been few far-reaching curriculum changes in high school mathematics in the past twenty years in Alberta. "I haven't seen a major overhaul like this, I think, since the New Math of the 1960s" said Ed Rossol, mathematics department head at Ross Sheppard high school in Edmonton (Unland, 1999, p. B3). The changes mandated by the new high school program began with the grade 10 courses in September 1998 and were truly profound in terms of new topics and new pedagogy. How these changes were implemented, what issues arose and how the problems were addressed is the focus of this study.

Curriculum as planned and curriculum as lived often differ greatly. What causes these differences? Teachers are the main change agents in the classrooms. How they interpret new curriculum will influence not only what they teach but also how it is taught. "History has shown that the parade of innovative materials in education does not significantly change school practice. This has been due, in part, to the fact that the influence of teachers on their curriculum had been overlooked too often by curriculum researchers and designers" (Manouchehri & Goodman, 1998, p. 27). Teachers, by law, must teach the mandated curriculum but this does not mean that they do not make decisions with respect to which learning opportunities are presented to students. The teacher can affect curriculum-as-lived in many ways including, emphasis placed on concepts, skills, units or chapters, methods of assessment, types of learning opportunities, etc.

Seldom is there an opportunity to document teachers' experience of a major curriculum change. The purpose of this research is to examine and describe the implementation of the new high school mathematics programs from a variety of perspectives. The research will focus on the experiences of two classroom teachers teaching the new programs and the experience of the researcher in the development and implementation of the programs.

The experiences of classroom teachers in the interpretation of new curricula are distinct from the experiences of the policy makers, researchers, curriculum and assessment developers. Teachers in classrooms must implement the new programs under very real constraints, whereas, the curriculum developer has often envisioned the implementation in an ideal setting. In this research, both perspectives are offered. The teachers, in a sense, represent the grass roots implementation, and I present the perspective of a curriculum developer and an assessment developer. Having both perspectives in the research helps provide the opportunity to study curriculum implementation in its complexity. Feedback, from other teachers, and parents I encountered in the course of my position with Alberta Learning, also helped inform the study.

Research Questions

The new mathematics program consists of two separate programs, Pure Mathematics and Applied Mathematics. These programs are distinguished on the basis of learning approaches, as opposed to the way the former courses were distinguished on the basis of difficulty. One of the teachers, in the study, relates her experiences of teaching the Pure Mathematics 10 course, while the other teacher relates her experiences pertaining to the implementation of the Applied Mathematics 10 course. The experience of the researcher focuses on the professional development of teachers as they prepared to teach the new program, the issues that arose during implementation, the response of the ministry to these issues and the reaction of the stakeholders.

The research will consider the implementation issues from both the specific experiences of the two teachers, as well as some general implementation questions from a variety of sources. The research will discuss how the informants made the new curriculum become the lived curriculum in their classrooms. In that discussion, insights into the question, "What is the experience of senior high teachers in the case of the implementation of the new Western Canada Protocol in Mathematics" will be offered.

The primary research questions in this study are:

- What is the experience of two teachers as they implement the new programs of study for high school mathematics?

- What are the problems that arise for teachers during the implementation of the new courses?
- What are the constraints and the possibilities that arise with the implementation of Pure and Applied Mathematics 10?
- Other than teachers, who are the other people who play a role in the implementation? What role did they play?

The Thesis Script

The research for the thesis began in the fall of 1998 and continued through the fall of 1999. The original research was to centre on the experiences of two teachers as they taught a new mathematics program. However, due to the many issues that emerged in the implementation, the research expanded so to involve many others in the Alberta mathematics education community.

As I have learned, implementation of a new program affects many people, not just teachers. The students are certainly impacted by any changes; parents have a voice in the changes; and there are many other stakeholders who have a part in the success or failure of the implementation of a new program. To portray an accurate story of the implementation of the mathematics programs in Alberta, these other voices need to be heard since they were certainly part of the drama as it unfolded.

I will divide the cast in the drama into three primary characters:

- the first character will be that of a novice teacher, I will call her Sherry
- the second character is a veteran teacher, I will call her Mary

• the third character is a compilation based on the experiences of several people involved in the implementation.

This third character portrays the story of the implementation on a provincial level and the effect of the implementation on the mathematics community.

The three characters represent different interpretations of the script, but, acting together, should provide the scene for the drama of "The Case of the Implementation of the Western Canada Protocol in Mathematics in Alberta."

Organization of the Play

The play will unfold in the six chapters. The next three chapters focus on developing the setting for the teachers' experiences in the implementation. Specifically, the second chapter, Setting the Stage, is a review of literature on change in mathematics curriculum and pedagogy. The third chapter, Building the Set and Dressing the Set, discusses the research methodology used in the study. Chapter four is entitled Script Preparation, and is a history of the Western Canada Protocol for Mathematics.

The story of the actual implementation unfolds in the final three chapters. The fifth chapter, The Play Itself, is the story of the implementation told through the experiences of Sherry and Mary. Following this is chapter 6, The Reviews, which relates the issues that arose during implementation from a broader perspective. The final chapter, The Denouement, examines why problems arose during implementation and explores some possible solutions to these problems.

There were many teachers however, who did not feel ready to teach the new courses. The *Edmonton Journal* ran a story on June 6, 1998 outlining the changes in the mathematics program. The article contained interviews with various stakeholders including Drew Kurie, a mathematics teacher at Salisbury Composite in Sherwood Park. Kurie said, "The big concern is we are not ready to implement. Alberta Education is not ready and we're not ready" (Holubitsky, 1998, p. 66). Though the curriculum had been available for about two years the lack of resources left many teachers feeling ill prepared.

Setting the Stage

Reform in Mathematics Education

Sputnik

There have been three major shifts in mathematics curriculum in the past century which have permeated most of North America. The first major shift took place around 1960. In 1957, the Soviets shocked the world by launching the Sputnik. This incident caused the Americans to determine that they had fallen behind in mathematics and science and this condition needed an immediate quick fix. One of the results of this quick fix mentality was the development of what was to become the "new" math (Knuth and Jones, 1991). This new math was highly abstract and had a strict conceptual focus. Bruner (1971) and others (Tyler, 1993, for example) believed the structure of the subject was what was important. The changes brought about by the new math were, however, temporary. New math was not fully embraced, and did not bring about any significant pedagogical change in the classrooms (Cook, 1995). The death knell for the new math had been sounded and there was a call to bring back the three R's. The study of reading, writing and arithmetic were seen as the most important for students in the schools at this time. This brought about the "back-to-basics" curricular shift that lasted until the late 1970s.

The 1970s

The late 1970s saw a theoretical shift from behaviorism to cognitive science in educational psychology (see for example NCTM, 1989). The focus for mathematics educators switched from number and operations on numbers to problem solving. The educational psychologists of this time focused on problem-solving in specific content areas, rather than on problem-solving and critical thinking as independent principles of learning which crossed content area boundaries. The shift from a behavioral science approach to that of a cognitive psychological approach resulted in changes to the way educators viewed the learner. The learner was no longer thought of as a passive sponge absorbing information provided by the teacher but was an active learner who was expected to connect new formal knowledge to past knowledge and intuition. With this shift came changes to the way the teacher was viewed. The teacher was no longer seen as the imparter of knowledge but s/he too was a problem-solver, involved in the decision making process.

The 1980s

In the 1980s, these new perspectives of the learner as an active participant and the teacher as a problem solver converged to create a drastically revised version of what should be taking place in the classroom. Teaching mathematics was reconceived as the provision of activities designed to encourage and facilitate the constructive process.

> In the traditional mathematics instruction, every day is the same; the teacher shows the students several examples of how to solve a certain type of problem and then has them practice this method in class and in homework. In the classroom environment envisioned by the NCTM, teachers provide students with numerous opportunities to solve complex and interesting problems; to read, write, and discuss mathematics; and to formulate and test the validity of personally constructed mathematical ideas so that they can draw their own conclusions (Battisata, 1999, pp. 426-427).

The mathematics classroom was intended to be a community of inquiry, a problem-posing and problem-solving environment in which developing an approach to thinking about mathematical issues would be valued more highly than memorizing algorithms and using them to get the right answers. In the new mathematics classrooms, students would learn how to construct a mathematical argument and assess its mathematical validity (Shifter, 1996).

The *Standards* of the 1990s

The beliefs of the late 1980s are still the prevalent beliefs in mathematics education. "Current visions for teaching mathematics include acknowledging the teacher as one who facilitates knowledge and who orchestrates conducive learning environments" (Manouchehri and Goodman, 1988, p. 27). Such beliefs about the nature and learning of mathematics led the National Council of Teachers of Mathematics (NCTM) to write the *Standards* documents. These documents are probably the most influential change forces in mathematics teaching in many years. The positions asserted in the *Standards* were based on current psychological theories of mathematical learning.

Learning Theories of Mathematics

"How does a student come to think about, to retrieve, just this piece of knowledge and to neglect others? Have these ways of identifying, relating, of giving relevance, constructing, and connecting perhaps been learned also?" (Bauersfeld, 1995, p. 139). This question is being carefully considered in the study of mathematics education. Researchers, in mathematics education, are asking themselves not only how a student learns new mathematics material but also how what is learned becomes a part of the student's repertoire.

Constructivism

"In terms of theory development, we are presently living in an extremely interesting and challenging period. The development of constructivist perspectives, including the recognition of Piaget as a constructivist and the recent rediscovery and acceptance of Vygotsky's writings, has engendered a rich flow of contributions" (Bauersfeld, 1995, p. 140). Constructivism in mathematics takes many forms, and the boundaries among the many theories of constructivism are somewhat unclear. However, Bauersfeld (1995) does make distinctions among realist learning, constructivism and discovery learning. The realist believes the structure lies in the materials themselves. You only have to work with the materials to gain the mathematical knowledge. The realist, according to Bauersfeld, does not have to be socially involved, nor a reflective practitioner in order to gain knowledge. The learner will discover the knowledge inherent in the materials. Constructivists, on the other hand, would argue that there is no such thing as discovery learning; the learning must be built upon that which was previously understood. Discovery learning implies there is an objective reality, it does not recognize the social negotiation for the discovery of truth.

Other researchers advocate that learning is also a social activity not a solo activity (Bauersfeld, 1995). Even Bruner (1990) has come to believe that children do learn in social settings and that reality is a shared, negotiated state. "Students arrive at what they know about mathematics mainly through participating in the social practice in the classroom, rather than through discovering external structures existing independent of the students" (Bauersfeld, 1995, p. 151). This social constructivist view has a great impact on what the mathematics classroom must look like. As noted by Bauersfeld (1995), "The fundamentally constructive nature of human cognition and the processual emergence of themes, regularities, and norms for mathematizing across social interaction, to bring the psychical [sic] and the social together, make it impossible to end up with a simple prescriptive summary for teaching"(p. 156). This view demands that we make changes to the traditional mathematics classroom. As von Glaserfeld (1995) notes, "We all start out with the idea that there is a simple way to give students a piece of knowledge: to tell them. After some experience, however, we have come to realize that telling alone rarely does the trick. In short, understanding is something all of us have to build up for ourselves" (p. 370).

Enactivism

Another current theory of learning and teaching mathematics is that of the enactivists. According to Davis (1995), "Much of the recent activity in the field of mathematics education has consisted in efforts to negotiate a series of impassable dichotomies—dichotomies that seem to be the direct and inevitable consequences of a collision between traditional objectivist perspectives and more recent subjectivist proposals" (p. 2). Davis says educators are breaking away from the rational thought model of the modernists, as represented by Descartes, and are beginning to endorse the postmodernist view of the interdependence of the individual and the environment. This view of knowing is known as pragmatism, social ecology, or enactivism. The enactivists believe that learning and knowing is dynamic, intersubjective, and consensual. "Put differently, one does not pick up information from the environment; rather, one's structure specifies which environmental patterns will trigger action. Furthermore, these environmental patterns do not cause the person's actions. Rather, they present an occasion for the person to act according to his or her structure" (Davis, p. 10).

This embodied view of knowledge acquisition is also shared by Kieren (1998) who feels students need to be engaged in their learning. "In mathematics, learning is a reciprocal activity in which the students and the teacher learn from one another and the situation in which they exist" (p. 2). Kieren further states that "Mathematics cognition is seen as an activity fully determined by a person's structure in which he or she brings forth a world of mathematical significance with others within a sphere of behavioural possibilities" (p. 7). Such views of mathematics learning and teaching demand that changes be made to the content and pedagogy of current classroom practices.

Changes Encouraged by the National Council of Teachers of Mathematics *"Standards"*

> This [constructivist] orientation is currently the target of wide-spread critique, and important recent initiatives such as NCTM's *Standards* project are explicitly directed toward offering curricular and instructional alternatives that are more process-oriented and learner-centered in effect, embracing a more subjective orientation to mathematics. As well, supported by the epistemological framework of constructivism, research in the area has overwhelmingly moved toward a greater awareness of the subjectivity of learning. (Davis, 1995, p. 3)

In 1989, the National Council of Teachers of Mathematics (NCTM) published its document *Curriculum and Evaluation Standards for School Mathematics.* This document advocated vast changes in what and how we teach school mathematics. The NCTM developed these *Standards* to meet three objectives: to ensure quality math programs in schools; to indicate goals and to promote changes in systems and in schools.

One of the profound changes, as promoted by the *Standards*, is that mathematics should be, and must be, made available for all students. The NCTM and others (eg. Apple, 1992) realized that mathematics was often used as a source of social stratification. The NCTM asserts that all students should be mathematically literate. The NCTM further asserted that the literacy would be evidenced by the students' ability to use mathematical power in exploring, conjecturing, and reasoning logically. Ensuring that students of all abilities become mathematically literate is a challenge for teachers who are used to streaming students according to their ability and teaching only the mathematics the teachers felt was significant and accessible to the particular students they were teaching. The *Standards* not only promoted mathematics for all students but also proposed new mathematics should be taught. The NCTM advocated that school mathematics should include such topics as statistics, discrete math, and probabilities. Though some of these topics were touched upon in some school programs, they were not handled in all programs or in any depth in the programs in which they did appear.

The NCTM, in the *Standards* document, also suggested new pedagogical strategies. The *Standards* promoted greater communication in the mathematics classroom and suggested this could be encouraged by the increased use of group work. The *Standards* also encouraged teachers to use a variety of teaching strategies not just whole group lectures. Emphasis on problem solving, procedural facility, and conceptual understanding was suggested. Another key aspect of the *Standards* was that they encouraged authentic assessment of all aspects of the educational system, not just students. Assessment was not to be seen as an add-on but as a key component in the learning environment.

The *Standards* document was intended to provide people in the educational field with a vision for school mathematics; it was not intended as a prescription for instruction. Naturally, various stakeholders interpreted the *Standards* in a variety of ways. As with any standard, the fidelity of the application is open to criticism. There was an enormous range of policies and procedures which fell under the umbrella of the *Standards*. Education in Alberta was not immune to the influence of the *Standards*. Given that the mathematics curriculum had not undergone any major changes since the 1980s, it is not surprising that once it became apparent that the curriculum needed revision the impact of the *Standards* was bound to be felt.

Pedagogical Implications of Using a Constructivist Approach

> Paralleling this [change from behaviorism to constructivism] divergence in epistemological assumptions is a fundamental difference in how the nature of mathematics and the doing of mathematics are understood. The drill and practice approach to math instruction has an affinity for a static and timeless conception of mathematical truth (all the mathematics there is has always already been out there). The constructivists, on the other hand, argue that mathematics is a human invention with a long history, culturally embedded schools of thought compete, fashions change, and some questions may be irresolvable. (Shifter, 1996, p. 494)

As Shifter notes, if we are to change our fundamental beliefs about mathematics and mathematics learning, a reform of teaching practices is necessary. The traditional mathematics classroom where the teacher served as the imparter of truth does not fit either of constructivist or enactivist perspectives of learning. Communication in many mathematics classrooms was a one way activity. True discourse seldom occurred in the classroom, answers were either right or wrong and the teacher would distinguish the difference. A lecture style of teaching is still very predominant and it has its supporters.

Kieren (1998) notes, "There is considerable current literature extolling the virtues of direct teaching" (p. 8). However, this view of the teacher is changing. The new role of the teacher, as being advocated by many, is no longer that of expert but rather as a facilitator of learning both on the part of the students and on the part of the teacher. One advocate is Skemp (1995) who likens the different views of the role of the teacher to what he believes are two definitions of understanding mathematics. Skemp (1995) suggests that mathematics can be understood instrumentally or relationally and the form one prefers will impact the teaching process. Kieren (1998) believes that the teacher must place herself in the middle. This view offers one the possibility of being a fully aware participant in the learning process. "Thus the learning and the teaching are not clearly distinct but are better thought of as reciprocal in nature" (p. 10). If the teacher is no longer the bearer of truth, what can they be expected to do? Kieren asserts the teachers' role is to occasion student learning by creating a mathematical community through interaction with students. The classroom community, then, is connected with other communities which share an interest in our students' education. Teachers are seen as agents who foster learning in their students. Von Glaserfeld (1995) says,

> For anyone who wants to foster understanding - in my view the only learning that is ultimately worthwhile- two rules of thumb can be derived from this discussion. There is no understanding without reflection, and reflection is an activity students have to carry out themselves. Although reflective abstraction always begins on the basis of some form of sensorimotor experience, it is not caused by it.
> (p. 383)

What will these new classrooms or learning environments look like? Clearly, changes have to be made if we are to embrace enactivist or constructivist perspectives of learning. Classrooms needs to reflect the new understanding that knowledge is not attained in isolation, that mathematics knowledge is negotiated, agreed upon by participants in the learning process. This shift in perspective must bring about other changes. "What is done in the classroom, both by teachers and students, in its totality, constitutes (or realizes or brings forth, as other might like to say) the specific culture of this mathematics class: specific with this teacher and with these students, and specific in the emerging mathematizing" (Bauersfeld, 1995, p. 157).

Many researchers emphasize the importance of a mathematical community. In reviewing an encounter in a class, Davis (1995) observed, "As the events of the lesson are re-traced, it becomes apparent that it was not so much the possibility for individual action as it was the opportunity for interaction that contributed to the flow of the mathematics" (p. 4). Pimm (1996) would agree with Davis. Pimm believes that diverse mathematical activity and discourse can be achieved within one classroom. "I argue for the importance of maintaining a rich diversity of styles and sources of classroom discourse within any individual teacher's repertoire" (p. 11). The importance of mathematical discourse is emphasized by many such as Silver and Smith (1996). They state, "Thus, the new role envisioned for mathematics teachers is one intimately tied to issues of communication" (p. 20).

Beliefs about Students and Mathematics Learning

Students are curious, active learners who have individual interests, abilities, and needs. They come to classrooms with different knowledge, life experience, and backgrounds that generate a range of attitudes about mathematics and life. Students learn by attaching meaning to what they do; and they must be able to construct their own meaning of mathematics. This meaning is best developed when learners encounter mathematical experiences that proceed from the simple to the complex and from the concrete to the abstract. The use of manipulatives can address the diversity of learning styles and developmental stages of students and can enhance the formation of sound, transferable, mathematical concepts. At all levels, students benefit from working with appropriate materials, tools, and contexts when constructing personal meaning about new mathematical ideas. The learning environment should value and respect each student's way of thinking, so that the learner feels comfortable in taking intellectual risks, asking questions, and posing conjectures.

> Mathematics is a common human activity, increasing in importance in a rapidly advancing, technological society. A greater proficiency in using mathematics increases the opportunities available to individuals. Students need to become mathematically literate in order to explore problem-solving situations, accommodate changing conditions, and actively create new knowledge in striving for self-fulfillment (Alberta Education, 1996, p. 6).

The emphasis in the *Standards* document and in the *WCP* is on students constructing their own meaning of mathematics. Students are no longer passive recipients of knowledge but active constructors of their own knowledge. "Research findings from psychology indicate that learning does not occur by passive absorption alone. Instead, in many situations individuals approach a new task with prior knowledge, assimilate new information, and construct their own meanings" (NCTM, 1989). This constructivist point of view is new for many mathematics educators but it appears that this is the way students learn mathematics. The structure of the *WCP* documents, though not necessarily user friendly, also reflects a constructivist belief. "Problem solving provides an opportunity for students to be active in constructing mathematical meaning, to learn problem-solving strategies, to practice a variety of concepts and skills in a meaningful context, and to communicate mathematical ideas" (Alberta Education, 1996, p. 8).

Constructivist Classrooms

Evidence from many sources indicates that the least effective mode for mathematics learning is the one that prevails in most of our classrooms: lecturing and listening. Students simply do not retain, for long periods of time, what they learn by imitation from lectures, worksheets, or routine homework. Research on learning shows that students construct their own understanding based on new experiences. Mathematics becomes useful to a student only when it has been developed through a personal intellectual engagement that creates new understanding. The National Research Council (1989) asserts that much of the failure in school mathematics is due to instruction which is inappropriate to the way most students learn.

What will these new mathematics classrooms look like and how will they differ from current classrooms? What will the new roles of students and teachers be? Brooks and Brooks offer the following comparison (Table 2.1).

Traditional Classrooms versus Constructivist Classrooms

Table 2.1

Traditional Classroom	Constructivist Classroom
• Curriculum is presented from individual skills to a synthesis of mathematical ideas. Basic skills are a priority.	• Curriculum is presented as a large problem to solve and is informed by specific skills.
• The curriculum is strictly followed. Emphasis is on covering the curriculum.	• The direction of the lesson is influenced, and often dictated by student questions.
• Instructional activities rely heavily on textbooks and worksheets.	• Curricular activities rely heavily on real sources of data and manipulative materials.
• Students are viewed as "blank slates" onto which information is etched by the teacher.	• Students are viewed as thinkers with emerging theories about the world.
• Teachers generally behave as the "sage on the stage", disseminating information to students.	• Teachers generally behave in an interactive manner, mediating the environment for students.
• Students and teacher seek the "correct" solution to the problem. There is only one correct answer but different methods of solution may be tolerated.	• Teachers analyze students' solutions in order to understand students' present conceptions for use in subsequent lessons.
• Assessment of students is achieved primarily through paper and pencil tests and is seen as the culminating activity of the learning.	• Student learning is assessed in a variety of ways and is viewed as a learning opportunity.
• Students work individually	• Students work primarily in groups.

(Adapted from Brooks and Brooks, 1993)

The Role of the Teacher

Given that the role of the teacher in the constructivist classroom is very different from that of a teacher in a traditional classroom, it is necessary to ask what types of support and training teachers will need to enable them to make the changes required by the reform movement in mathematics. Research has shown that the teacher is the main influence on how a curriculum will be delivered. "No other intervention can make the difference that a knowledgeable, skillful teacher can make in the learning process," as noted in *Doing What Matters Most: Investing in Quality Teaching*, the latest report from the National Commission on Teaching and America's Future (NCTM News Bulletin, 1998).

There has been a wealth of research conducted on teacher change; however, much of it is somewhat contradictory and may not be easy to implement (Smith, 1996, Cook, 1995, Knuth and Jones, 1991). The NCTM seems to contradict itself on the view of the teacher. In the *Standards* documents they advocate the math classroom as a place where students learn together with other students and with the teacher. However, in their document *Professional Standards for Teaching Mathematics* they state that "...mathematical experiences for all teachers should foster the confidence to learn mathematics independently" (NCTM, 1991). In another section of the document, we read, "Teachers need to focus on creating learning environments that encourage students' questions and deliberations -- environments in which the student and teacher are engaged with one another's thinking and function as members of a mathematical community" (NCTM, 1991). If teachers are to encourage a mathematical community in their classrooms, shouldn't they, too, participate in a community?

> When students work with adults who continue to view themselves as learners, who ask questions with which they themselves still grapple, who practice in the pursuit of meaning, and who treat students and their endeavors as works in progress, not finished products, students are more likely to demonstrate these characteristics themselves (Brooks and Brooks, 1993, p. 203).

Teachers need to model mathematical community for their students. Many students associate their math classes with sitting back and letting the teacher teach them. This is very different from the new view of a mathematics classroom where students are highly involved in meaningful mathematical discourse. Davis (1996) states that, "The argument being mounted is that mathematics and mathematical understanding are collective phenomena, not individual ones. Even when an individual is working independently and in apparent isolation on a mathematical task, as continues to be the case in many mathematics classrooms, the action is social, for it is framed in language and procedures that have arisen in social activity" (p. 10).

Does the WCP demonstrate this enactivist view of mathematics? Davis (1995) states "It is important to note that, in terms of current discussions, the enactivist framework does not deny the insights of constructivism, although it does offer a challenge to, for example, the narrowness of its scope" (p. 8).

Communication as Mathematics Learning

The importance of a mathematical discourse community seems to be hidden if not ignored in the *WCP* curriculum document. In referencing the NCTM *Standards* the WCP does state that:

> It is not enough to arrive at an answer. Students must be able to communicate effectively how the answer was obtained. In other words, students need opportunities to read, to explore, to investigate, to write, to listen to, to discuss, and to explain ideas in their own language of mathematics. Thus, students can crate their own links "between their informal, intuitive notions and the abstract language and symbolism of mathematics" (NCTM, 1989) (Alberta Education, 1996, pg. 6).

What is meant by the students' own language of mathematics? It seems that the *Standards* document recognizes the importance of discourse and the role of a mathematical learning community, but the only reference to this in the *WCP* is a reference to the standards for communication as quoted from the NCTM *Standards*. Only occasionally does the *WCP* offer illustrative examples which involve true communication. In many instances when the specific outcome indicates that communication is to be addressed, the illustrative example often does not reflect this. For example, specific outcome A1-2 states "Analyze the limitation of measuring instrument and measurement strategies, using the concepts of precision and accuracy" [C, R] (Alberta Education, 1996, p. 19). The "C" and "R" notation indicates that reasoning and communication processes are to also be addressed in the attainment of this outcome. However, the two illustrative examples provided with this outcome are both multiple choice and ask, in one case, which ruler is more precise and in the second case the example provides four diagrams and asks which demonstrates greater accuracy and precision (Alberta Education, 1996).

To promote communication in and with mathematics, teachers need to employ alternative forms of instruction which permit students to build their repertoire of mathematical knowledge and their abilities for posing, constructing, exploring, solving, and justifying mathematical problems and concepts. Promising models for such instruction are highly interactive. In such models, teachers both model and elicit mathematical discourse by asking questions, following leads, and conjecturing rather than presenting faultless products.

Along with the importance of a discourse community many mathematics educators also note the necessity for an open non-threatening problem-solving atmosphere. The teacher needs to provide rich problems for the students that will encourage them to find more than one solution. Students should be encouraged to try a variety of problem-solving strategies in a number of instructional settings. "Through group and classroom discussions, students can examine a variety of approaches and learn to evaluate appropriate strategies for a given situation." (NCTM, 1989, p. 77).

Changing Roles

A teacher, like his or her students, may not be willing to change, if they feel what they are currently doing is working. Teachers need to be able to see the "big picture" of what is being changed. All four of the elements in the act of teaching, identified by Weeks (1995), are being changed in the *WCP* document, the what, the how, the role of the teacher and the role of the student(s). Of the four elements the "what" may be the most familiar to teachers and this may lead them to continue to teach in the same manner as they had previously, after all it has worked for years. One of the new emphases in the WCP is the connection between mathematical topics as well as between subject areas. Again, the *Standards* are referenced in this area. However, in the *Standards* document there appears to be an inconsistency, in encouraging teachers to expand their methodology they state:

> Based on the assumption that information can be presented by telling and that understanding will result from being told, such an approach does not work because it frequently overlooks two crucial developmental components: the process of assimilation and the issue of readiness.
> Essentially, in this approach, students are "ready" intellectually when the teacher is ready for them to receive the information. Learning through such an approach often fails [sic] to promote a lack of transfer of mathematical information to new situations (NCTM, 1989, p. 10).

Not promoting a lack of transfer would seem to be a good thing if we are trying to build connections among old and new topics.

Will the WCP result in a truly new mathematics classroom? The "what" is slightly different, there are large changes in the "how" and the combination of the two should result in significant changes in the two main roles, that of teacher and that of student. Though there are some small inconsistencies for the most part the vision is both constructivist and enactivist. Support of all stakeholders will determine the success of the new program.

> Teachers at all levels are held accountable for the mathematical growth of students. Therefore, to be effective, policy makers in all arenas -- state, provincial, local, national, business, and industry -- must confer with and support teachers and other mathematics education professionals on issues that affect what and how a teacher of mathematics can teach (NCTM, 1991, p. 152).

The Change Process

The role of the teacher in the process of curriculum change cannot and should not be underestimated. "History has shown that the parade of innovative materials in education does not significantly change school practice. This has been due, in part, to the fact that the influence of teachers on their curriculum had been overlooked too often by curriculum researchers and designers" (Manouchehri & Goodman, 1998, p. 27). For curriculum-as-written to become curriculum-as-lived, the teacher must endorse the changes and implement these in his/her classroom. Change is never easy, and asking teachers to change too much too soon has the potential for disaster. "Recent research on teaching and the teacher has provided evidence that how the mathematics curriculum is implemented depends on teachers' perceptions and images of the mathematics they teach"(Manouchehri, & Goodman, 1998, p. 27). Manouchehri and Goodman conducted an ethnographic study on the implementation of a standards based curriculum in middle school mathematics. Their findings showed that the teachers' personal experiences and beliefs had a profound impact on their pedagogical choices in the implementation of the new curriculum. "The paramount issue in this study was that although the new programs brought about numerous exciting and enriching activities, they did not provide the teachers with detailed methods of how to address the content development" (Manouchehri, & Goodman, 1998, p. 36). How, then, do teachers change their teaching practices? As Prevost (1993) says, "Any attempt to reform one's teaching must begin with reflection" (p. 2). Upon reflection if one finds oneself in a state of disequilibration, then you are ready to act. The change process is not an easy one and is not without risk. Teachers face questions of personal efficacy when going through the change process. Smith (1996) researched teachers' feelings of efficacy.

> The core argument is that a mismatch exists between the pedagogy of current reform and the basis on which mathematics teachers have traditionally felt efficacious in directing student learning. New sources of efficacy consistent with the reform are needed to fill that gap and the failure to explore, identity, and build new foundations of efficacy in teaching mathematics may seriously limit the impact of the reform." (p. 387)

There are many issues that teachers must face and solve for the reform movement to be authentically embraced.

Conclusion

Curriculum changes can be exciting and challenging for the teacher. The change can be seen as a renewal or an inconvenience. Teacher attitude has a profound impact on the implementation process. A teacher who feels overworked and under-supported may not be able to fully endorse the changes. Research (Manouchehri and Goodman, 1998) indicates that the introduction of new curriculum and pedagogy forces teachers to enter an uncertain world, then teachers must be supported and encouraged while engaged in the change process. As Connelly, Clandinin, and He (1997) note "teacher knowledge and knowing affects every aspect of the teaching act" (p. 66). Also, teachers need to construct new knowledge and insight into the ways that students learn. As van Manen (1995) suggests, teachers must become reflective practitioners to be able to act in a way that provides the best education for students. Dewey's (1964) early definition of reflection continues to be useful to educators. He said reflection "enables us to know what we are about when we act. It converts action that is merely appetitive, blind, and impulsive into intelligent action" (p. 211). To provide the opportunity for teachers to become reflective practitioners, implies that teacher education must also change. Teachers need to experience the new pedagogy for themselves. If a teacher experiences the new methods first hand, they are more likely to add these to their teaching repertoire.

Does a new teacher experience less difficulty in implementing a new curriculum? Common sense says, "yes, that the new teacher would not have preconceived notions about what works for them and for this particular group of students." New teachers would also probably not have a previous history with the students and their learning styles. A teacher at the beginning of her career would still be searching for a style that would suit her beliefs about learning and teaching.

In contrast to the beginning teacher, does a veteran teacher have any more trouble implementing a new program than her novice colleague does? The veteran teacher probably does not have to concern herself with classroom management issues; this may allow her more latitude in the types of activities she is willing to try to incorporate in her classroom. The teacher who is not concerned with routine issues may have time to be more of a reflective practitioner, than her neophyte colleague may. Does having time to reflect on one's practice facilitate change? This implementation question should become clearer when the research is complete on the implementation of the new mathematics program in Alberta.

Building the Set and Dressing the Stage

Envisioning the Set

When I initially decided to study the implementation of the new mathematics program, I envisioned a thesis in which I told the stories of teachers implementing the WCP in senior high schools. I planned to compare the experiences of the two teachers in my research, based on the programs they were teaching, the support within their schools and their previous experiences. I believed that the experience of the implementation would differ between the two teachers because one of the research subjects was a new teacher, while the other had many years of experience. I originally believed the main purpose of the research was to tell a story. I did not anticipate that the research would serve any purposes greater than to allow those not involved in the implementation of the new mathematics program to view the intricacies of introducing a radically different curriculum. My intention was to present the views of the two teachers involved in the implementation, not an evaluation of the program.

As my research progressed, the case of two teachers' experiences of the implementation as my main focus started to lessen. The case no longer was simply the tale of two teachers; it had become the tale of the implementation in the province. The evaluation of the program was still not the focus of the research, however, it did provide the liner notes. The teachers were still the main informants of the study but their voices were only two of the many I heard as I explored the implementation of the WCP in mathematics. For my study, they were the actors around which I saw the drama unfold.

I believe the purpose of my study also changed. It expanded from a simple "relating" to an "interpreting" of events. The purpose evolved into more than just a story, it had become a drama with a message. As the case of the implementation of the WCP unfolded, I saw my role change from simply producing the play to directing the play. I could not simply report the experience of the two main characters, I had to add more characters and choose which parts of the drama would be performed. I hoped the study would serve as an informative example for those involved in planning curriculum implementation. I also hoped, that ultimately, the lessons learned by those involved in the implementation of the WCP for Mathematics would help others involved in introducing new curriculum into schools.

Choosing the Settings: Case Study Research

Qualitative Research

Originally I thought the research would represent a form of narrative inquiry, but as the research progressed, I determined that the method I was using was actually case study. The use of case study research is becoming more common in educational research.

> More recently, education has recognized the advantage of using a case study approach for better understanding the process or dynamics of certain aspects of practice. All levels of education - preschool through adult - contain many questions that might best be dealt with by the case study approach (Merriam, 1988, p. 204).

I knew that I could not quantify the experience of the implementation. Because I wanted to relate experiences and interpret these experiences, a form of qualitative research had to be employed, and case study research is a form of qualitative research. Case study research satisfies the three main principles of qualitative research (Tellis, 1997):

describing, understanding and explaining. It was important that I be able to not only report the experiences of the stakeholders in the implementation, but also interpret and explain the significance of some of their experiences. Even by what I chose to report, I was interpreting the significance of some events.

A clear definition of case study is not agreed upon by educational researchers (Yin, 1984, Wilson and Gudmundsdottir, 1987, Stake, 1995), however, most researchers agree that case study research takes place in a natural setting and strives to provide a holistic interpretation of the phenomenon that is being studied. I could not manipulate the experiences of the teachers in my study; I could only report their actions and interpret their experiences. As Stake (1995) reflects, "It is not unusual for the choice of case to be no choice at all" (p. 3). This was certainly my experience as the case of the implementation of the WCP unfolded.

Previous Experience

One of my reasons for choosing to present the data as a case study was because I had prior involvement with case study research. When I was on secondment to the University of Alberta I was involved with several other researchers in gathering data on case studies for Alberta Education. Alberta Education had contracted the University of Alberta to investigate pedagogical practices in teaching grade nine mathematics. Each of the researchers visited a teacher who had been identified as being a successful teacher. The researchers were to present the case of the successful teaching practice after classroom observations and interviews with the teachers. One of the facets of the research that appealed most to me was the wide scope of the type and depth of the data that was collected, and also how the data was presented. Each researcher presented his/her case in a slightly different way. This allowed the personality of the researcher to emerge in the report. Case study research, by its very nature, endorses differences in presentation.

> However, to provide some sense of the parameters within which we are working, we can say that case study may be marked by the following: data are qualitative; data are not manipulated; studies focus on single cases; ambiguity in observation and report is tolerated; multiple perspectives are solicited; holism is advocated; humanism is encouraged; and common and/or non-technical language is used (Kenny and Grotelueschen, 1984, p. 37).

The Use of Metaphor

The use of qualitative research allows the reader to become empathetic with the characters through thick description (Stake, 1995). By providing the set and scene, the reader is able to experience the implementation through the eyes of the main characters, the reader is able to see these teachers as the protagonists in the implementation play. The research is not to discover a cause and effect, rather it is to understand the human experience. "In addition to its orientation away from cause and effect explanation and toward personal interpretation, qualitative inquiry is distinguished by its emphasis on holistic treatment of phenomena" (Schwandt, 1994, in Stake, 1995, p. 43). The experiences of Mary and Sherry reflected the experiences of many teachers involved in the implementation play.

Moreover, the use of case study allows the researcher to use metaphor. I was able to use the metaphor of building a set, setting a stage and writing a play. Through the use of case study, and the narrative of the teachers, I was able to represent the world of the teachers in the way in which they were experiencing it. "Narrative is the primary way through which humans organize their experiences into temporally meaningful episodes" (Polkinghorne, 1998, p. 1).

I also knew that, by the nature of the study, much interpretation was required. The teachers were interpreting their experiences and I was further interpreting their experiences as well as the experiences from a variety of other sources. Case study research recognizes and encourages this type of interpretation. "According to one highly respected writer on qualitative studies, Fred Erickson, the most distinctive characteristic of qualitative inquiry is its emphasis on interpretation" (Stake, 1995, p. 9). Whenever we ask people to speak of their experiences our data is open to interpretation. Whenever we write about what other have said or done, we interpret. Though the researcher may have been in very similar circumstances, we are never in the identical place. Experiences are always time and place bound and dependent on the person who explains them. When relating the experience of others we are forced to interpret the circumstances surrounding the events. Finally, experience does not occur in isolation. One has to interpret how the setting affects the play and how the play influences the set.

Case study research also allows the researcher to make space for new questions to arise and old ones are refined as the study evolves. Though good research questions often foreshadow problems that arise, there are instances where the issues could not have been predicted. The use of case study research allowed me to change my focus as unforeseen issues arose. Upon reflection, I realized I could have foreseen several of the issues that arose, however, I could not have predicted the public reaction to them. I also accepted a new position during the course of the research and this, perhaps, caused me to have a different, and perhaps more intimate relationship with the entire case. The playwright's experiences cannot be separated from the play she writes.

Case study research also appealed to me because I wanted only to present the case of the implementation in Alberta high schools. Through a case study I believed I would reveal the uniqueness of this situation. As Stake (1995) notes, "Case study research is not sampling research. We do not study a case primarily to understand other cases. Our first obligation is to understand this one" (p. 4). This is not to say that this research can only be applied to the one case. Through triangulation some generalization can occur (Stake). By using anecdotal records, interviews, journals and my personal experiences the implementation, I believed the tenets of triangulation were observed and therefore some generalization is justified. I hoped that the lessons learned in this case could provide insight for those involved in other implementation cases.

Building the Props: Data Collection

Once again, the researchers do not agree on what methods should be used for collection of data in case study research. Deciding on a method of data collection can be influenced by the definition of the case. Defining the case may seem to be easy task but this is not always true. As Wilson and Gudmundsdottir (1987) muse,

> It has been our experience that a considerable portion of the researcher's interpretative energies throughout the stages of research design, data collection and analysis, and case writing are directed at answering the question: "What is this a case of?" (p. 44).

The data for my study was collected several different sources. The primary sources were the two teachers, Sherry and Mary. The main research was of their experiences, their teacher stories. The data was both empirical and interpretive. The empirical data was obtained through anecdotal records and archival material. Though empirical in classification, anecdotal records, by their very nature, invite and indeed insist upon interpretation. The participants and the researcher shared in the interpretation of the events and their significance.

The Teachers' Data

The teachers were asked to keep a journal of their day to day experiences as well as provide the researcher with any materials they used in their classrooms. Sherry, as a beginning teacher, had experience in keeping a reflective journal, as this was one of the requirements in her student teaching program. For Mary, keeping a journal was foreign. For this reason, much of my data for Mary was collected through personal interviews.

Sherry's journal entries were extensive and done on a regular basis. Sherry also e-mailed me frequently and these e-mails were used in the data collection. I also had two personal interviews with Sherry, but these were not audio recorded. My frequent contact with Sherry allowed me to have a rich picture of what she was experiencing. Sherry was also involved in resource review for the textbook publisher and provided me with the reviews she submitted to the publisher.

Mary and I met on four occasions. These interviews were usually an hour in length and in some cases were recorded. If I was not recording the interview I took field notes as Mary and I talked. Mary did keep a partial journal but, as this was new to her, she was not as diligent as Sherry. My interviews and my telephone conversations with Mary provided me with an understanding of her experience in the implementation of the new programs.

Both teachers provided their lesson plans, course outlines, exams and other archival material. Analyzing this material allowed me to interpret the experiences of the teachers and students in their classrooms. I also had access to the textbooks the teachers were using and could analyze the text as well as the assignments.

Other Sources of Data

The data for this study was not only collected from the two teachers. As the case of the implementation expanded, I found I was gathering data from many sources. Because I had frequent contact with mathematics teachers throughout Alberta in the course of my job, our conversations also became sources of data. I also had access to all correspondence to superintendents and principals from Alberta Education. The media also became a source of data. As the implementation unfolded, the media presented the case from the view of parents and other stakeholders. I believe the data collected from these sources provide the "thick" description (Yin, 1993) case study requires.

Research data was collected in three stages. The initial data was collected as the teachers were preparing for the new courses, the actors prepare. The second stage of data collection occurred when the new courses were being taught, the plot thickens. The third stage, the final act, asked the teachers to reflect upon their experiences of teaching the new courses. This third stage led into the issues, the denouement.

The implementation of the new mathematics program was province wide and therefore, the data also included newspaper articles and government documents pertaining to the implementation. When appropriate, experiences of the researcher in the implementation process were also documented.

Arranging the Rooms: Research Sites

The implementation of the Pure and Applied Mathematics programs occurred throughout the province of Alberta beginning in September 1998. Because of my position with Alberta Learning I had the opportunity to interact with many teachers and they related their varied experiences which helped inform the study. Also, due to the media scrutiny, teachers were not my only research informants; parents, students and provincial government personnel also provided insight into the character of the implementation. The two main research subjects did, however, remain Mary and Sherry. Due to the reliance on Mary and Sherry's personal experiences to relate the teachers' view of implementation, the make up of their schools plays an important role in providing a backdrop for the case.

Mary's school was located in a middle class neighborhood in an urban setting. Mary had been teaching at this school for many years and was the mathematics department head. The atmosphere at Mary's school was supportive of both students and teachers. If Mary needed help from the administration to provide service to students she was supported. This support came in the form of both money and recognition. The administration knew that new programs could not be implemented without a cost being attached. Though the school did not purchase everything Mary may have wanted for the new programs, she did not have to have students share resources as occurred in some schools. Most of the students in Mary's school were from families where school was viewed as important. The parents provided the students with the tools necessary for their school program. The students at Mary's school came well fed and well rested. If they chose not to have particular items for class it was generally a personal choice not one determined by the lack of funds. Mary's school had a reputation of being successful academically and this reputation ensured that the school would draw students who viewed academics as the priority for their school lives.

Sherry's school was well equipped with technology which reflects its emphasis on technology and the sciences. Academic success by students was related to how well students did in the core subjects and in the options that were available to them. It was assumed that most of the students in Sherry's school would go on to post-secondary schools. The emphasis on academics influenced school policy in such areas as attitude and attendance. The school placed high expectations on the students and, in most cases, the students complied.

Delimitations

The study focused on the experiences of two high school teachers. The teachers were both from large urban high schools. However, because they did not implement the program in isolation, experiences of others involved in the program have been included in this study. This research focused only on the experiences of the teachers; it did not involve formal classroom observation. Activities that occurred in the classrooms were reported by teachers and were subject to their interpretation. Though the researcher recognized that ultimately the most important voice in any curriculum implementation is that of the student, the research was only focussed on students when their teachers or parents brought student issues forth. The teachers involved in the study had the right to submit anecdotal material of their own choosing as well as any classroom artifacts. The researcher did ask for some specific material but the teachers could ultimately choose not to supply it.

The data was collected from the teachers in the first semester of implementation, that is, from September 1998 to January 1999. However, documentation of the province wide experience of the implementation was continued until January 2000. The time frame for the data collection allowed for only the teachers' experiences of implementing at the grade 10 level. By restricting the teachers' experiences to only the one grade level, the case could not represent all the issues of full implementation. I believe, though, that the issues that arose were not atypical of the experience of the implementation of the new mathematics programs.

Limitations

Often when teaching a course for the first time the teacher is more concerned with covering the material than trying to deliver the material in a new or different way. The study will be limited to the experiences of the teachers for one semester only. The researcher had hoped to extend the research for two semesters to compare how the course was taught in the first semester with the second semester. A two-semester study would have allowed the researcher to determine the changes the teachers felt compelled to make when reviewing their experiences from the first semester. However, last minute timetable changes meant neither teacher taught the course in the second semester. By including the experiences and reactions of others in the province the data reflects some of the changes that were taking place after the first semester of implementation.

The experiences of the two teachers and the researcher all represent the female voices. Whether, or not, the experiences of male educators in the implementation would differ from females cannot be determined. Though some general implementation concerns will be shared, the existence of a gender bias will not be detected, if it exits.

The textbook assigned to a course often has a profound influence on what is taught and it may also influence how a topic is taught. There had been only one text approved for the Applied Mathematics 10 course so the experience of this teacher in the application of the text should be representative of the experiences of her colleagues throughout the province. In the case of the teacher teaching the Pure Mathematics 10 course, there were two texts approved for use. The text this teacher used is, in my opinion, very traditional in both material and approach. The other approved resource appeared to be more innovative in its approach to the mathematical topics. Whether the experience of the teacher would have differed if the other resource were used cannot be determined.

Assumptions

Assuming that textbook choice and course stream matter, I am assuming that the teacher implementing the Pure Mathematics 10 program will experience little difficulty. The Pure Math 10 program is not radically different from the current Math 10 program so this should ease implementation. I also assume that the delivery of the Pure Mathematics 10 course will differ little from what is currently being done. I do not think the tenets of constructivism will see their way into the pure program particularly not in the beginning. By its very title many believe that the way the Pure Mathematics 10 course should be taught is in a traditional didactic model.

The experience of the teacher implementing the Applied Mathematics 10 program will differ from her pure math colleague, I believe. The Applied Program is very different from anything we have done before and I think its implementation will face far greater challenges. Often the textual resource available will drive not only what is taught, but also how it is taught. The textual resource for the Applied Mathematics 10 course is very different in its structure from any text previously authorized for use in mathematics classrooms in Alberta. The resource constrains teachers into a certain pedagogical mode. They cannot, at the same time, deliver the program in a lecture style and make good use of the texts.

Researcher Bias

Although there is a concern that my intimate involvement in the WCP biases the study, I am claiming that this research study is possible because I was intimately involved. I was interested to see how the work I was involved with as early as 1995 would evolve. This study, then, exploits my involvement. I am able to bring for the details that an outsider may or may not reveal. At the same time, my intimate involvement may mean there are things I do not see and cannot hear. It is, after all, my play, but I cannot change the characters and cannot adjust the set.

Script Preparation

The *WCP* Agreement

In December, 1993, the ministries of education from Manitoba, Saskatchewan, Alberta, British Columbia, Yukon Territory, and the Northwest Territories signed a document entitled *The Western Canada Protocol (WCP) for Collaboration in Basic Education Kindergarten to Grade 12*. By signing the document, the four provinces and two territories agreed to collaborate in basic education. The partners agreed to have common educational goals and high standards of education. Also, it was believed that by collaborating on common outcomes the transfer from province to province would be easier and there was the possibility for the better use of educational resources. Though the provinces agreed to collaborate on the basic education, it was decided that the partners would take lead roles in certain subject/topic areas. The first curriculum area to see changes was the mathematics program from kindergarten to grade nine. This was to be followed a year later by a grade 10 mathematics to grade 12 mathematics phase of implementation. Alberta was chosen as the lead province for the WCP in mathematics. The proposed changes in the mathematics program reflected current thinking about the role of mathematics in society and the beliefs about students as learners. The WCP also suggested changes in how mathematics should be taught. The WCP followed the lead of the NCTM *Standards* in advocating a classroom built on constructivist beliefs (Alberta Education, 1996, p. 2).

> The redefinition of school mathematics curricula and instruction has occurred at the same time as - and, indeed, has been influenced by- the abandonment of the

> outdated and simplistic behaviorist learning theory that has dictated the course of mathematics teaching for more than 40 years. (Battista, 1999, p. 428)

The *WCP* document changed the lives of many teachers of mathematics in the western provinces and the two territories. The curriculum arising from this document not only changed what was taught but also how it was to be taught.

In this chapter I explore the underlying assumptions of the 10-12 mathematics document and the theories of pedagogy and learning which it embraced. In my view, teachers need not only to understand what outcomes are to be achieved but also they need to understand the spirit of the curriculum. Teachers need to be aware of the implicit roles played by both students and teachers, and how these roles differ from what has occurred in the past.

> Put more simply, the act of teaching can be thought of to include four elements, the teachers, the student(s), the "what", and the "how". It follows then that if teachers are to have a clear understanding of their role, they need to understand the characteristics of each of the elements of teaching and how they interact (Weeks, 1995, p. 31).

Clarifying the Questions

How are these four elements articulated in the new program and how will they influence what is happening in the math classrooms of Western Canada? As with the most curricular documents, finding the "what" is fairly easy but the other three elements are not so obviously laid out. One must study the preamble and belief statements to flush out the role of teachers and students. By understanding the intended role of the teacher and of the student, we will better understand the "how" of teaching. *The Common Curriculum Framework for K-12 Mathematics* (CCF) is strongly influenced by the *Standards* document from the National Council of Teachers of Mathematics for many of its belief statements. The CCF articulates the beliefs about mathematics and mathematics instruction that underpin the intended curriculum.

The framework articulates the general and specific student outcomes as well as illustrative examples in four curriculum strands: number, patterns and relations, shape and space, and statistics and probability. Also included in the document are expectations for the inclusion of mathematical processes; communication, reasoning, visualization, problem solving, estimation and mental mathematics, technology, and connections. Quoted, throughout the document, were the *Standards* for these processes as identified by the NCTM.

The inclusion of the processes as part of the program of studies was new. In the past, the learning of mathematical processes was implied but was seldom overtly identified. Together, the outcomes and processes provided the "what" of teaching the WCP.

The "how" of teaching the WCP is not as clearly articulated as the "what". The how of teaching, of course, is intricately tied to the role of the teacher and the student. The WCP document reveals some of the "how" in the section entitled "Beliefs About Students and Mathematics Learning."

> The use of manipulatives can address the diversity of learning styles and developmental stages of students and can enhance the formation of sound, transferable, mathematical concepts. At all levels, students benefit from working with appropriate materials, tools and contexts when constructing personal meaning about new mathematical ideas. (Alberta Education, 1996, p. 2)

This seems to imply that students learn mathematics by doing and by seeing. How students learn may be enhanced by the use of manipulatives and other appropriate tools. It is safe, I believe, to infer from these statements that the "how" of teaching includes not only the use of manipulatives but also the use of technology. Teachers were encouraged to allow students to explore the mathematics, to construct the meaning for themselves. This belief is clearly stated in the WCP document.

> Students are curious, active learners who have individual interests, abilities and needs. They come to classrooms with different knowledge, life experiences and backgrounds that generate a range of attitudes about mathematics and life.
>
> Students learn by attaching meaning to what they do; and they must be able to construct their own meaning of mathematics. This meaning is best developed when learners encounter mathematical experiences that proceed from the simple to the complex and from the concrete to the abstract. (Alberta Education, 1996, p. 2)

Portraying students as active learners implies a different role for the teacher. The teacher of the new mathematics program is encouraged to guide and facilitate student learning. If students are to reach the goals of using mathematics to solve problems and display a positive attitude toward mathematics (Alberta Education, 1996), then the teacher must develop strategies to foster these goals.

The new mathematics program documents relied heavily on both the content and pedagogical suggestions from the *Standards*. The *Standards* uphold the belief that students do not learn mathematics in isolation, they must be allowed the time and opportunity to construct their own meaning. This constructivist framework called for teachers whose instructional style was predominantly teaching as telling to let students investigate and explore mathematics as opposed to being told what their mathematical understandings should be.

> To develop powerful mathematical thinking in students, instruction must focus on, guide, and support their personal construction of ideas. Such instruction encourages students to invent, test, and refine their own ideas rather than to blindly follow procedures given to them by others. (Battista, 1999, p. 430)

The Strands

The third section of each document was the same and reflected the conceptual framework that was agreed upon by the partners. Basically, the framework indicated that the mathematics was viewed as a continuum from kindergarten to grade 12. The mathematics students had to master were divided into the same four strands, and interwoven through these topics were the seven mathematical processes. Also embedded into these mathematical topics were the beliefs about the nature of mathematics. The conceptual framework illustrated the beliefs of the partners that the discipline of mathematics was comprised of skills, procedures and concepts woven together.

> Activities that take place in the classroom should stem from a problem-solving approach built on the mathematical processes and lead student to an understanding of the nature of mathematics through specific knowledge, skills and attitudes related to each of the strands. (Alberta Education, 1996, p. 56)

Goals of Mathematics Education

The National Council of Teachers of Mathematics notes that the shift from industrial societies to information societies has necessitated the need to change our goals for mathematics education. The NCTM believes that there are four societal goals needed for mathematics education. These four goals are:

1) Mathematically literate workers
2) Lifelong learning
3) Opportunity for all
4) An informed electorate (NCTM, 1989, pp. 3-4).

The spirit of the NTCM goals is reflected in the *WCP Goals for Students*.

> The main goals of mathematics education are to prepare students to:
> - use mathematics confidently to solve problems
> - communicate and reason mathematically
> - appreciate and value mathematics
> - commit themselves to lifelong learning
> - become mathematically literate adults, using mathematics to contribute to society. (Alberta Education, 1996, p. 3)

These goals seem to reflect the beliefs of most educators about the purpose of education. However, the statements are so broad that they seem to be almost mission statements, constructed as to offend no one. These broad goals may lead the reader to think of them as slogans as noted by Michael Apple (1992), warns in his article, "Do the *Standards* Go Far Enough? Power, Policy and Practice in Mathematics Education" where he states that the *Standards* of the NCTM are close to being what he calls a slogan system.

> The *Standards* volumes come close to being a kind of educational literature that is called a slogan system. By calling them by this name, I do not mean to denigrate them. After all, some of the most powerful literature in curriculum, from Ralph Tyler's classic little text, Basic Principles of Curriculum and Instruction (Tyler, 1949) to Jerome Bruner's almost poetic arguments for discipline-centred education, The Process of Education (Bruner, 1960) have been of the same genre Rather, what I want to do is direct our attention to some of these specific characteristics, because slogan systems have peculiar properties and perform a variety of functions.
>
> Slogan systems need to have three attributes if they are to be effective (p. 413).

Apple says that the *Standards* meet the three attributes of a slogan system. That is: "They are vague enough that powerful groups or individuals who might usually have differing opinions can support them, they are specific enough to offer something to the practitioners and they have the ability to charm" (p. 414). That is, they provide us with a positive vision that we can believe is attainable.

The Western Canada Protocol for Collaboration in Basic Education can fall under the same critique. Consider this statement which is found in the introduction.

> Students should:
> exhibit a positive attitude toward mathematics
> engage and persevere in mathematical tasks and projects
> contribute to mathematics discussions
> take risks in performing mathematical tasks
> exhibit curiosity
> show some enjoyment of mathematical experiences. (Alberta Education, 1996, p. 3)

These goals for students fit the slogan system, in that they have a positive view of the student of mathematics and are definitely vague enough that anyone involved in math education should be able to endorse them. Their lack of specificity for practitioners, however, does not fit Apple's slogan system. Taken on their own, the statements give teachers very little direction in the "how" of delivering the program. Further reading and interpretation of the document is necessary to discover the pedagogical implication of these goals.

The NCTM *Standards*, and therefore the Western Canada Protocol by its endorsement of the *Standards*, support the position of the cognitive psychologists in the emphasis on problem-solving and critical thinking.

> Problem-solving -- which includes the ways in which problems are represented, the meanings of the language of mathematics, and the ways in which one conjectures and reasons -- must be central to schooling so the students can explore, create, accommodate to changed conditions, and actively create new knowledge over the course of their lives (NCTM, 1989, p. 4).

A growing research base supports the idea that students learn mathematical concepts best when the concepts are presented gradually over time (Battista, 1999, Skemp, 1987, Shifter, 1996). Educators must be sure to provide students with enough time to discover the solutions to problems they themselves construct.

> Understanding mathematics, however, requires more than abstraction. It requires reflection, which is the conscious process of mentally replaying experiences, actions, or mental processes and considering their results or how they are composed. (Battista, 1999, p. 429)

Reflection takes time and it cannot be a hurried process. Teachers cannot be consumed with covering many topics, if they are to take the time needed to help their students become reflective learners.

Planning the Script

Structuring curriculum around primary concepts is a critical dimension of constructivist pedagogy. When designing curriculum, constructivist teachers organize information around conceptual clusters of problems, questions, and discrepant situations because students are most engaged when problems and ideas are presented holistically rather than in separate, isolated parts (Brooks and Brooks, 1996). The WCP document is organized in such a manner. There are four main strands from kindergarten to grade 12. These strands are; number, patterns and relations, shape and space and statistics and probability. As noted in the *Standards* (NCTM, 1989), "At all levels, teachers need to see the big picture of mathematics across the elementary, middle, and high school years" (p. 5). By dividing the mathematics in the Protocol document the WCP partners have attempted to provide this big picture for teachers. These four main strands were further divided into substrands that were more appropriate for various grade levels. In each of the four strands general outcomes have been identified and these have been further broken down into specific outcomes (figure 1).

General and Specific Outcomes	Illustrative Examples [Discretionary]
General Outcome Generate and analyze number patterns. **Specific Outcomes**	
P2–2. Generate number patterns exhibiting arithmetic growth. [E, R]	2.1 The first modern Olympiad was held in 1896. Every four years after this date the summer Olympics were held. Given such a framework, reveal what should have been the next five summer Olympic years after 1896. Explain why this pattern was never achieved. 2.2 The output of a northern gold mine has remained constant at 2200 ounces per year. If, at the end of last year, the total output of the mine was 122 600 ounces of gold, what will be the total output at the end of this year? At the end of next year? 2.3 A salesperson receives a base salary of $12 000 per year, plus $100 for every unit sold. What is the salary, if 50 units are sold? 51 units? 52 units? 2.4 For the arithmetic sequence 16, 23, 30, 37, . . . , find the next three terms. 2.5 A pile of bricks is arranged in rows. The numbers of bricks in the rows form an arithmetic sequence. There are 45 bricks in the 5th row and 33 bricks in the 11th row. a) How many bricks are in the first row? b) Write the general term for the sequence. c) What is the maximum number of rows of bricks possible?
P2–3. Use expressions to represent general terms and sums for arithmetic growth, and apply these expressions to solve problems. [CN, PS, R, T]	3.1 For the arithmetic sequence 7, 11, 15, 19, . . . , find the 29th term. 3.2 Find the sum of the arithmetic series 3 + 7 + 11 + . . . + 483. 3.3 Mary's annual salary is on a range from $26 785 in the first year to $34 825 in the seventh year. a) If the salary range is an arithmetic sequence with seven terms, determine the raise Mary can expect each year. b) What is her salary in the fifth year? c) What is the first salary in this range that is greater than $30 000? d) What is the total amount that Mary earned in the seven years?

Figure 1. General and Specific Outcomes

The danger in providing the specific outcomes lies in the narrowing of the focus. In analyzing the TIMSS (Third International Mathematics and Science Study, 1995) results, it may be noted that in the United States mathematics curriculum is generally broken into smaller objectives than those used by most of the other countries in the study. There is speculation that this narrowing of focus may be part of the cause of America's poor performance in the study. If presented with too many topics, teachers may just try to cover the material at the expense of spending more time on fewer but deeper problems.

The outcomes of the *WCP* have been organized into clusters which the individual provinces and territories may put together to form courses. *The Common Curriculum Framework* (CCF) for the grade 10 to 12 courses divides these clusters into three types. The three types are common (C), applied (A) and pure (P). The outcomes in the common clusters are expected to be achieved by all students who complete a grade 10-12 mathematics program. The outcomes in the applied (A) cluster are applications of mathematics and represent an approach to learning of mathematics primarily as numeric or geometric. Finally, the outcomes in the pure (P) cluster represent the mathematics to be learned by students who require precise mathematical theory. Here the approaches to learning mathematics are algebraic and graphical. The difference between the mathematics and approaches in the pure and applied clusters was explained, by the curriculum developers, as the mathematics which is needed by students who would pursue calculus in the future (Pure Mathematics); whereas, the mathematics in the applied clusters was for students who would not be pursuing calculus courses in their future studies. Though the outcomes in the common section were to be achieved by all students, it was recognized that how students learned the knowledge in each outcome may differ according to the course they were taking. It was still the right of each partner in the *WCP* agreement to construct specific courses from the outcomes for their province or territory.

Teachers experienced difficulty using the document at first, as it differed from past documents in that it did not provide as much detail as before. Teachers looking for a scope and sequence chart were disappointed because it was left up to them to develop a scope and sequence for their own classes. However, to be a truly constructivist classroom the direction of any lesson would be up to the students. Though the *WCP* did openly endorse the idea of an open time frame it did recognize that this was a very different structure from what had been occurring in classrooms. To this end, the document did provide some guidance in that it stated that each cluster of topics was intended to take 20 to 25 hours of instructional time.

The student outcomes sections of the documents were organized into a three-column format (figure 2). The first column stated the general outcomes for the strand, the second column provided more detail in the specific outcomes and the third column provided illustrative examples. The first two columns represented the legal document; that is, the program of studies that the teachers are mandated to teach by legislation. The third column is for the teachers' information and can be used to help clarify the outcomes. In Alberta, the first two columns are shaded to indicate that this is the mandated part of the course. The third column, the examples, is not shaded. This indicates that the use is optional.

General Outcomes	Specific Outcomes	Illustrative Examples
Generate and analyze number patterns.	P2-2. (PR1) Generate number patterns exhibiting arithmetic growth. [E, R]	2.1 The first modern Olympiad was held in 1896. Every four years after this date the summer Olympics were held. Given such a framework, reveal what should have been the next five summer Olympic years after 1896. Explain why this pattern was never achieved.
		2.2 The output of a northern gold mine has remained constant at 2200 ounces per year. If, at the end of last year, the total output of the mine was 122 600 ounces of gold, what will be the total output at the end of this year? At the end of next year?
		2.3 A salesperson receives a base salary of $12 000 per year, plus $100 for every unit sold. What is the salary, if 50 units are sold? 51 units? 52 units?
		2.4 For the arithmetic sequence 16, 23, 30, 37, ... find the next three terms.
		2.5 A pile of bricks is arranged in rows. The numbers of bricks in the rows form an arithmetic sequence. There are 45 bricks in the 5th row and 33 bricks in the 11th row. a) How many bricks are in the first row? b) Write the general term for the sequence. c) What is the maximum number of rows of bricks possible?
	P2-3. (PR2) Use expressions to represent general terms and sums for arithmetic growth, and apply these expressions to solve problems. [CN, PS, R, T]	3.1 For the arithmetic sequence 7, 11, 15, 19, ... find the 29th term.
		3.2 Find the sum of the arithmetic series 3 + 7 + 11 + . . . + 403.
		3.3 Mary's annual salary is on a range from $26 785 in the first year to $34 825 in the seventh year. a) If the salary range is an arithmetic sequence with seven terms, determine the salary Mary can expect each year. b) What is her salary in the fifth year? c) What is the first salary in this range that is greater than $30 000? d) What is the total amount that Mary earned in the seven years?
(continued)		

Figure 2. Three Column Format

When the WCP was in its initial phase in Saskatoon, we were asked to focus our work on the general and specific outcomes and provide illustrative examples only if we had time. Because of this, many of the illustrative examples were authored after the outcomes had been determined and were written by individuals hired by Alberta Education. This caused some problems. The purpose of the illustrative examples was to help teachers interpret the outcomes and to illustrate the limits of what should be taught. There was much discussion in the Saskatoon meetings about whether or not these examples should be included in the document. It was feared that the illustrative examples may be misinterpreted, and perceived as indicating exactly what was to be taught and that if there was not an example of a certain type that meant it did not have to be covered. In the end, the committee felt that the examples would be useful for teachers and they were retained. By having people write the illustrative examples who were not part of the discussion of the outcomes, the very reason for the examples was jeopardized. The illustrative example writers had to interpret the outcomes, so they could provide examples to help the teachers interpret the outcomes. This circularity lead to some examples being inappropriate for the outcome. For example, one of the illustrative examples for outcome P2-2 generate number patterns exhibiting arithmetic growth, states:

> A pile of bricks is arranged in rows. The numbers of bricks in the rows form an arithmetic sequence. There are 45 bricks in the 5^{th} row and 33 bricks in the 11^{th} row.
> a) How many bricks are in the first row?
> b) Write the general term for the sequence.
> c) What is the maximum number of rows of bricks possible?
> (Alberta Education, 1998, p. 9)

This example clearly seems to be beyond the scope of the outcome. The outcome states that students should be able to generate number patterns exhibiting arithmetic growth but they are not expected to memorize expressions for the general term or the series sum. They also do not study a system of equations until Pure Mathematics 20.

It was hoped that the inclusion of the illustrative examples would help teachers look at the mathematics in other ways. To truly achieve the vision of the *NCTM Standards* and the *WCP* the problems studied would be determined by the students. The curriculum and teaching of mathematics should reflect more closely the real world of the student. "A mathematics curriculum and pedagogy that is largely problem-centred and more focused on integrating mathematics into students' daily lives is pedagogically wise. Yet, the question of whose problems still remains to be answered" (Apple, 1992, p. 424).

After the Signing: The Province Takes Over

After the *WCP* document was signed by the representatives of the ministries, it was left to each province to design its own courses. Provinces were guaranteed control over education in section 93 of the British North America Act and historically have maintained this control. Though each province held responsibility for designing their own courses it was felt that they would have greater influence on the publishers if they could offer them a larger market by having a resource that could be used for all the western provinces. Hence, there was a desire, by the ministries, to align the programs so that a grade 10 text could be used in all of the western provinces and two territories. It was at this time that Saskatchewan opted out of the program. Saskatchewan had very recently implemented a new mathematics program in their senior high schools and they were not ready to implement another new curriculum. The document entitled *Courses Derived from The Common Curricular Framework for K-12 Mathematics* was released in June of

1996. It was created for a call for resources from publishers and for provinces who chose to use the courses. Because Saskatchewan opted out, the document does not bear the provincial emblems. (See Appendix 1 for the timeline of the Alberta implementation of the WCP).

Developing a Textbook Resource

The publishers were to supply resources that would be a 100% fit in both breadth and depth for the new courses. This was new for Alberta Education. In the past, program outcomes were written, a few existing resources were field tested, and then some were approved. Often, it was considered to be a good resource if there was about an 80% fit to the curriculum. Because the resources for the WCP were being written directly for the courses, it was felt that a pilot year was unnecessary. It was also felt that, particularly in the pure program, very few of the outcomes were new, they were just placed at different grade levels. Because the resources were to fit the program so well it was believed that the implementation process would be smoother than in the past and easier for teachers because they would not have to find supplemental material to fulfill the mandate of the program.

The response to the "all call" for text resources for the Pure Mathematics Program was successful and in Alberta two resources were approved, Addison Wesley's *Mathematics 10* and McGraw-Hill's *Math Power 10*. Both resources consisted of student texts, teacher resource materials and assessment material. There was much competition between the two publishers and eventually they virtually split the market. Though both publishers had made assurances that all materials would be ready for the fall of 1998 some of the teacher resource materials and assessment materials were not ready on time. However, again perhaps because the Pure Math 10 course was not perceived as being radically different from anything done in the past, teachers were not overly concerned about this. They had resources from previous programs that they could draw on until the new resources were available.

The "all call" for resources for the Applied Mathematics Program was not so successful. Not a single publisher was prepared to submit a resource for review. Why did no one respond? There are several theories. One theory is that, unlike the Pure Program which was fairly familiar and previous material could be adapted for use, the applied program consisted of many new outcomes. New material would have to be written, as there was little available that was at the right level and included the focus on technology. A second theory is that the Applied Mathematics Program was an unknown market. The acceptance of the Pure Mathematics Program seemed clear, but would the Applied Program be accepted across the provinces and territories enough to generate a sufficient market to warrant the expense of creating brand new resources? The publishers were worried and none would take the risk. This was very problematic for Alberta Education as both the Pure and Applied Programs were scheduled for mandatory implementation at the grade ten level for September of 1998. At this time, Alberta Education, on behalf of the WCP partners, had to ensure that no publisher intended to submit resources for the Applied Program, and a second call for proposals was issued.

The request for proposals was announced to publishers in December 1997. To make the submission of proposals more palatable to the publishers, the WCP partners decided that only one resource would be approved, and the publishing company would have the exclusive "approved" status for the Applied program for three years. The practice of authorizing only one text for a course had been the usual practice prior to 1950 but since then, with the abolishment of provincial exams several resources were usually authorized. It seemed mathematics education had come full circle. Provincial exams were back in place and a single resource was going to be authorized for a course. This unique situation resulted in ramifications that no one foresaw.

Four publishing companies submitted proposals. Addison-Wesley was chosen to produce the text resources for the Applied Mathematics Program. Their mandate was to produce a resource that would be a 100% match in breadth and depth for the Applied courses, and they were also to provide inservice to teachers on the new program. This was a very unique occurrence, occasionally publishers would provide inservice on the use of the resources, but in the past it had not been part of the contract. This was a new situation for Addison-Wesley. They had to provide inservice, write a new resource and have that resource ready for the following September. Due to this time pressure, Addison-Wesley stated that they could not have the resources in final form for September therefore teachers would have to work with pre-print resources for the first semester. This announcement was met with trepidation on the part of the teachers and the opposition to the implementation of the Applied Program in the fall of 1998 had begun.

Opposition

Long before the WCP, there were concerns expressed by Alberta teachers that resources must be in place before new programs could be implemented. The secondary program review in 1985 supported the teachers' concern about resources and in March of

1990, Jim Dinning, then Minister of Education, announced that resources must be in place by June 1 for any new curriculum implementation for September 1 of the following school year. Although the Alberta Teachers' Association (ATA) wanted resources in place eight months prior to implementation, a compromise of June 1st was agreed to. No sooner had the Minister made the promise and it was broken when, in 1991, the quadratic relations unit of the Mathematics 30 course was revised without resources available in advance. Alberta Education did not see this as a breach of the agreement since it only involved one unit of instruction. However, many teachers were not happy with this situation, as the resources in place did not support the new approach to the quadratic relations. Teachers were left to construct or find their own resources over the summer months as they revised their courses at the last minute. This experience was still fresh in the minds of many teachers, and teachers were determined to not let it happen again. They argued that the implementation of the new Applied program should be delayed until appropriate resources were in place. They did not accept the government's argument that pre-print resources would be in place. The teachers also noted that Addison-Wesley only guaranteed that the student resources would be available, the rest of the resource package would not be available until much later. This was more of a concern in Applied Mathematics than in the Pure Mathematics Program. Many teachers were faced with drastically changing how they taught mathematics and some were not familiar with the mathematics topics they were required to teach in the new Applied Program.

Mounting pressure from teachers and the public resulted in the Minister of Alberta Education announcing, in the spring of 1998, that the mandatory implementation of the Applied Mathematics Program would be delayed by one year. Pure Mathematics 10 would still be mandatory for the fall of 1998 but the implementation of the Applied Program would be on an optional basis.

By delaying the implementation of the Applied Program school jurisdictions were able to offer the existing Mathematics 13, 23, 33 stream for one more year. Teachers, administrators and school boards were split on whether or not to take advantage of the optional implementation. Even within school boards, decisions on the implementation varied. Very few schools in the Edmonton area decided to implement the program and there was one very vocal group lobbying against the implementation. In Calgary, many more schools decided to go ahead with the implementation in both the public and separate boards. The implementation in the rest of the province was divided and there appeared to be no significant geographical split in areas where implementation was or was not going ahead. Some teachers also called for the delay in the implementation of the Pure program until such time as both programs were ready. Alberta Education did not delay the implementation of the Pure Mathematics Program as the resources were available and the program was ready to go ahead. Approximately 10 000 *Applied Mathematics 10* books were sold so we can assume that approximately that many students began Applied Mathematics 10 in the fall of 1998, whereas approximately 23 000 students began the Pure Mathematics 10 course in September of 1998.

My Involvement in Inservice

I was not teaching in a classroom, hence my exposure to the implementation of the new programs varied from those of the teachers in the classrooms. I did not struggle with how much instructional time to devote to the various units or how I was going to assess the new courses. My focus, at this time, was more on how I could help teachers in their implementation; how I could provide inservice; and what materials could be produced that would help teachers in teaching the new courses and make their jobs easier.

In 1998, through CMASTE (Centre for Mathematics, Science and Technology Education) at the University of Alberta, we provided inservice to over 100 teachers in Edmonton, and another 50 in Calgary. They all seemed to have the same concerns: what was the content of the programs, how far should they explore each topic, and what were the standards to be reached. Our inservices provided teachers with sample lessons as well as an in-depth look at the curriculum

We believed the morning topics focussed on the main concerns of teachers. We wanted the teachers to focus on the curriculum as a whole, and on the major new topics. Teachers were given an opportunity to select the afternoon workshops according to individual interest. The last part of the day was dedicated to thinking about teaching and learning.

From interaction with the inservice participants, it seemed to the workshop facilitators that the teachers who were going to teach Pure Mathematics 10 did not seem nearly as apprehensive as the teachers who were going to teach Applied Mathematics 10 (see figure 3 for schedule of sessions).

Morning Common Session
9:00 – 11.45

MONDAY	TUESDAY	WEDNESDAY
Group A – 934 Measurement in Applied Mathematics	Group A – 934a Understanding the Pure and Applied Mathematics Curriculum	Group A – 122 Algebra, Functions, and Spreadsheets Pure and Applied
Group B – 934a Understanding the Pure and Applied Mathematics Curriculum	Group B – 122 Algebra, Functions, and Spreadsheets Pure and Applied	Group B – 934 Measurement in Applied Mathematics
Group C – 122 Algebra, Functions, and Spreadsheets Pure and Applied	Group C – 934a Measurement in Applied Mathematics	Group C – 934a Algebra, Functions, and Spreadsheets Pure and Applied

11:45 – 12:45

Lunch	Pizza Lunch, $5	Lunch

Afternoon Conference Sessions
12:45 – 2:15

Statistics 10 Pure & Applied Graphing Calculators TI-83 Rm 934a	Investigating Linear Functions with the TI-83 Rm 934a	Shape and Space 10 Pure & Applied – Linear Scale Factors Rm 122
More Spreadsheets Rm 155	Geometry of a Sphere Pure and Applied 10 Rm 122	Inequalities and Linear Programming, Applied 11 Rm 934
Sequences and Series Pure 10 Rm 934	Matrices Applied 12 Rm 934	Expected Value Gains and Losses, Pure 10 Rm 338
Geometer's Sketchpad Computer Rm 155	Geometer's Sketchpad Computer Rm 155	Investigating Algebra with the TI-92 Rm 934a
Using Investigations in Applied Math Rm 382	Using Projects in Applied Math Rm 382	Unit Plan for Relations and Functions Rm 382

2:15 – 2:30

Coffee

Implications
2:30 – 3:00

How do children learn? Meet back with morning group	How do you learn? Meet back with morning group	Teaching and Learning Meet back with morning group

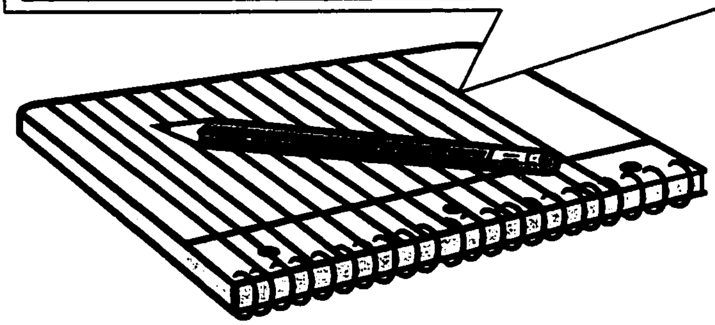


Figure 3. Agenda

There were many teachers however, who did not feel ready to teach the new courses. The *Edmonton Journal* ran a story on June 6, 1998 outlining the changes in the mathematics program. The article contained interviews with various stakeholders including Drew Kurie, a mathematics teacher at Salisbury Composite in Sherwood Park.

Kurie said, "The big concern is we are not ready to implement. Alberta Education is not ready and we're not ready" (Holubitsky, 1998, p. 66). Though the curriculum had been available for about two years the lack of resources left many teachers feeling ill prepared.

The Play Itself

Ready or not, in September 1998 the new high school mathematics program was introduced into classrooms in Alberta. The introduction of the new programs had a profound effect on the school lives of thousands of students and hundreds of teachers. How the program impacted the teachers is the focus of this chapter. It is time for us to meet the principal characters in this play, the teachers.

The Cast

Meet Sherry

Sherry dreamed of being a teacher for as long as she can remember. She spent the summer preparing for her first year of teaching. Though she was well prepared she was still overwhelmed by her first day of school.

> *I AM a teacher. The day was great-- on the way home I cried for joy because I was overcome by the emotions of the day. I had a great sleep, surprisingly enough. I think it was due to my taking the time to be as prepared as I was. I was at school about an hour early, giving me time to collect myself.*

Fresh out of university, Sherry was hired in a large urban high school to teach mathematics. Part of Sherry's assignment was to teach the new Applied Mathematics 10 course. Sherry's situation was not unique, from talking to teachers in many schools I have come to learn that the new teacher on staff was often the person assigned to teach the applied course. Sherry reflects on assigning teachers to the new courses.

> *It would be smart for schools to hire only brand new teachers to teach the applied. This way they would be ensuring that the program was fully tried. I have*

already heard through the grapevine that many schools are teaching the Applied from the Pure text. At times there is an overlap in common clusters, but when there aren't project and investigations done this doesn't give this a fair shot

Many other teachers, who have been doing this for a while, find this Pure approach more straightforward and less time consuming, therefore they stay away from projects.

The Applied Mathematics 10 course represented a great departure from traditional mathematics and mathematics teaching, so many veteran teachers were uncomfortable with teaching it.

There was very vocal opposition to the new applied course for several reasons, some of them were that the resources were not in final form and that the course would not serve the audience of Mathematics 13 students. Sherry was not concerned with many of these issues. She had spent much of her summer preparing materials and did not have preconceived notions of what the students were capable of. Some teachers felt that the mathematics taught in the new course was not real mathematics and that students taking this new course would be lacking vital mathematics skills such as algebra. Sherry believed the new course would serve the needs of students in different ways. She felt that students could learn mathematics in different ways than they had in the past. She was looking forward to learning along side her students. She was anxious for the curtain to rise on the implementation of the WCP mathematics in Alberta.

Meet Mary

Mary had been teaching for over 15 years and was the mathematics department head at a large high school. Mary's teaching situation was such that she was able to interact with teachers and students from both junior and senior high levels. The new mathematics program had already been implemented in the junior high schools so Mary knew some of the issues that had surfaced during this phase of implementation. She also knew the strength and weaknesses of the students who would be part of the implementation of the grade ten programs. As the department head Mary felt it was her duty to teach one of the new courses. There was only one section of the Applied Mathematics 10 course to teach and one of Mary's colleagues had already expressed an interest in it. Mary decided to teach the new Pure Mathematics 10 course. The schools in Mary's jurisdiction were each given the right to decide on whether they would offer the new Applied program in the fall of 1998, or wait until mandatory implementation. Mary's school chose to implement both courses.

> *We're going to have to teach both courses eventually so I felt that we may as well get a jump on it now. Why wait a year? This isn't going to go away. I'm looking forward to teaching a new course. It's been a while since I've had to prep a new course.*

Though Mary was only teaching the new Pure Mathematics 10 course, her role as department head meant that she also was involved in helping with the implementation of the Applied Mathematics 10 course as well. It meant Mary had to be familiar with both programs and had to answer to parents whose children were involved in either course.

The Actors Prepare

Sherry Becomes a Teacher

Although Sherry was a new teacher she was very familiar with the WCP. The study of these documents was a large component of the methods courses she took in university. Students in those courses were not only required to become familiar with the WCP documents but they also had to do some background reading on the theory behind the curricular and pedagogical change. Further to that exposure, for 2 years Sherry's summer employment was to work with educators who delivered teacher inservice. Sherry and two of her peers did word processing and research for summer workshops. The first summer the focus of the workshops was on the elementary and junior high programs, the second summer the focus was on the high school level with particular emphasis on the grade ten courses in Pure and Applied Mathematics. In the third year of the workshops Sherry was again involved, this time as a participant.

Sherry felt comfortable with her knowledge of both the content and pedagogy. It appeared to be the case, that students right out of university were more familiar with the program than many of their veteran colleagues. As a recent graduate, Sherry had spent many hours studying the content and philosophy of the program. Sherry was also much more familiar with the available technology than many of her veteran colleagues. Again, as part of her studies and her involvement in helping to facilitate inservices, Sherry had been exposed to graphing calculators and was proficient in their use. Though the use of the graphing calculator was mandated in the new programs very few of Sherry's students had purchased one. This did not represent a huge issue for Sherry as there was a computer lab available for the mathematics department, it was seldom used so she could access the lab and have students use such packages as "zap-a-graph" to fulfill the required technology component of the new program.

Sherry, like other teachers throughout the province, spent much of her summer preparing for the teaching of the new course. Of course, for Sherry everything was new. For Sherry, this was exciting.

> *It's now August and I am quickly approaching my first day of school with some uneasy feelings. I have spent much of my summer doing lesson plans and thinking of how I will run my classroom. It was constantly running through my mind. So much so that if I didn't do some kind of preparation in a day I would have teaching nightmares at night. Silly but true.*
>
> *I will be teaching Math 10 Applied because my school is implementing the new math curriculum. This is very exciting for me to be part of. I will also be teaching two Computer classes which does cause me to worry. It's not my area of expertise, but it is an area of frustration. Luckily my school seems to be full of very supportive people.*
>
> *Currently, I am attending a workshop held by my school board. It has been very interesting and is helping me gather more ideas and more thoughts. It runs all week covering things such as year plans, unit plans, management, rubrics, assessment, first day, and professional development. It's also a great way to meet other first year teachers.*
>
> *My journey continues and the closer I get the more my excitement grows.*

Sherry was busy attending workshops.

The workshop is over, which is both good and bad. It's good because now I can spend my days using the great information I gathered to set up my classroom both physically and in my mind. It's bad because I was learning so much.

I'm glad I have time because that's what I must need right now. I need to mull over the ideas. I have to decide what is best for me and my class of students. I look forward to the next 10 days when I can lay out my ideas in a more organized way.

I have so many jumbled thoughts.

As the start of school approached, Sherry reflected on what it meant to be a teacher.

If you touch a rock, you touch the past.

If you touch a flower, you touch the present.

If you touch a child, you touch the future.

Mary Reaffirms her "Teacherism"

Mary was a very conscientious teacher and began to prepare for the new program in the spring of 1998. She reaffirmed what it meant to her to be a teacher. She once again had to interpret the curriculum and to decide how best to present it to her students.

One of the first tasks Mary faced was to choose a new textbook. This was one of the first big decisions that had to be made. Though both resources were written for the program and guaranteed a 100% match with the curriculum, they did differ in format. The Addison-Wesley text did not differ greatly from texts Mary had previously used and was much more traditional in format than the McGraw-Hill text. Many people felt the new Pure Mathematics 10 course did not differ greatly from the previous course and went with the format they were already familiar with. When asked if the Addison-Wesley text supported the program in terms of showing mathematics in real world contexts Mary observed that:

> *They do. Not tons of it. Like it would be really neat if we could have had something with every topic because I find that most of their real life applications are in those extra pages, the mathematical modeling, the technology, that sort of stuff. And guess what happens? Especially in the first year of the implementation, you don't get to that.*

Mary's school had previously been using the Addison-Wesley text for their mathematics program and she wanted to go with the publisher with which she was most familiar. Mary's jurisdiction wanted all schools to agree on one textbook and she felt pressure to select one text in particular. A general meeting of high school department heads was called and they were to choose a book at this meeting.

The department heads at this meeting were split on which text they wanted to use and resisted having the choice forced upon them. Mary and others questioned why it was so important that they all use the same text, they would be teaching the program which ever text they used. It was decided that each school would choose the text they felt was best; Mary's school ended up using the Addison-Wesley text.

The importance of text selection is profound when teachers rely on them to incorporate the curriculum. As Mary noted:

> *You know we still have people who don't crack the curriculum. They rely on the textbook. Now, thank heavens, we've got textbooks that are a 100% curriculum fit but this is still the interpretation of the publisher.*

This was not a new phenomenon. Sigurdson and Kieren note the importance of the textbook in the history of Canadian mathematics education.

> Such heavy reliance on a textbook is a firmly entrenched tradition and results in dictating the course of study.
>
> Euclid's *Elements* has a 2000-year history in mathematics education. Perhaps because of this history of dominance by a single textbook, mathematics teachers came to revere the textbook as a source of knowledge. It is little wonder that provincial authorities seized on this device as a means of controlling mathematics education. Provincial control was easily implemented in the area of mathematics in that the textbook was "the course" (Sigurdson and Kieren, in press).

Mary attended inservices on the new program prior to the fall of 1998 to familiarize herself with the content and the pedagogy of the new course. She, like many of her colleagues, wondered how she would be able to cover all the content and remain true to the constructivist framework of the program. At first look it appeared that the Pure Mathematics 10 course had a lot of new content in addition to all of the old content and it had to be taught in 120 hours. At Mary's school this meant one semester of instruction, everyday for 60 minutes and one day with a double period. It appeared to be a daunting task.

The Plot Thickens: The Beginning of the New Mathematics Programs

September 1998 saw thousands of students and hundreds of teachers in the province of Alberta begin the process of implementing a new program. The initial challenge for teachers, like Mary and Sherry, was to understand for themselves what was in the curriculum, in what order it should be taught and how a course outline should be developed. As Mary noted:

I'm wondering how far to go and how to interpret this new curriculum. The "Illustrative Examples" help but some of them are confusing too. And wow some of them seem awfully hard for a grade ten course.

Mary also noted that, for the first time, the inclusion of the seven mathematical processes, estimation and mental mathematics, problem solving, connections, technology, visualization, communication and reasoning were a mandated part of the course. The ways in which the mathematical processes, in some specific outcomes, can be included is obvious but in others how they can be incorporated is not so apparent. As Mary questioned;

Was there a lot of thought given to how these (the processes) were placed in the outcomes? Some seem a bit of a stretch.

Including the processes as part of the mandated curriculum was new and was not seen as a benefit by all. Some teachers felt that by listing the processes to be addressed in each outcome they were being told how to teach that outcome. Some teachers felt that by the inclusion of these processes and some of the specific outcomes in the legal document the government was mandating not only what should be taught but also how it should be taught. They felt that this was not the right of the government, teachers should be able to teach in the way they feel is best suited for their students. Emery Dosdall, superintendent of Edmonton Public Schools made this point in a presentation to the school board.

> Simply put, Mr. Dosdall believes that the new program goes beyond telling teachers what to teach and tells them how to teach it, something curricula never did so explicitly before. It is an important distinction for trustees, who unanimously endorsed Mr. Dosdall's recommendations, and for teachers, who view the new math program as a direct attack on their professional independence (Steel, 1999, p. 28).

Course Outlines

In most schools in the province, teachers are required to provide students with a detailed course outline within a few weeks of the beginning of the course, This course outline generally covers what the expectations of students are and how they are to be assessed. This practice caused problems for many teachers involved in the implementation because they were not very familiar with the new courses. Though the curriculum had been available as a list of outcomes to teachers since 1996, many did not realize how drastic the changes were and did not feel adequately prepared to teach and assess the new programs. This was particularly true for the small number of teachers who were going ahead and teaching the new Applied Program.

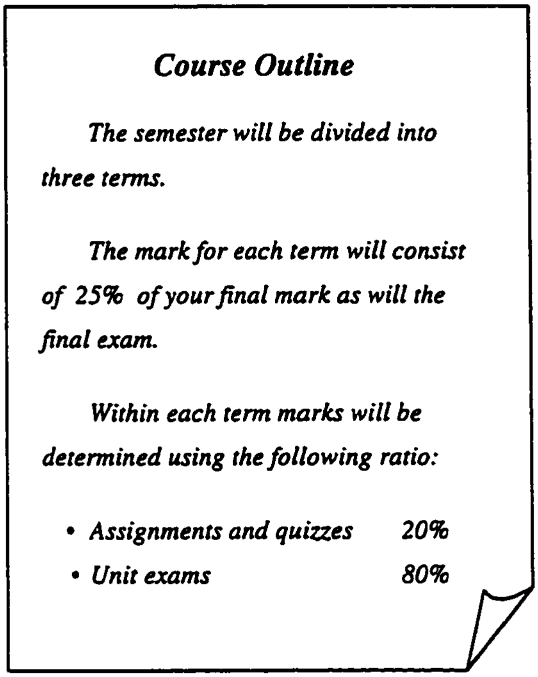
Mary's outline for the students in her Pure Mathematics 10 course offers some insight into her beliefs about the rigor and flavour of the course. Under the heading of homework she stated:

> *Tons of it! Expect a lot of homework in Pure Math 10 as it is an academic course and a great deal of material must be covered.*

The amount of homework became an issue in many schools. Because both texts approved for Pure Math 10 had to guarantee to cover the breadth and depth of the course there was a lot of material presented. Further, some of the outcomes in the program of studies are ambiguous; as a result the publishers often went beyond the intended scope of the course and included unnecessary material. The *MathPower 10* text, especially, included a lot of exercises. Many veteran teachers were engaged in the practice of assigning the whole set of questions for their students. In doing this with the new textbooks they could inadvertently assign 100 or more questions, some with several parts.

Mary was careful to go through the homework questions before she assigned them to her students, even so, many parents complained about their children's workload.

Issues surrounding assessment arose for Mary, like many of her colleagues, she wanted to assess the course in a new way but was not sure how it could be done. Like others, Mary responded to this quandary by leaving the course outline somewhat vague (see figure 4, representation of her outline).



Course Outline

The semester will be divided into three terms.

The mark for each term will consist of 25% of your final mark as will the final exam.

Within each term marks will be determined using the following ratio:

- *Assignments and quizzes* 20%
- *Unit exams* 80%

Figure 4. Mary's Course Outline

Though the above breakdown appeared to be a fairly standard form of assessment and was quite traditional in nature, it gave Mary the flexibility to call such things, as projects, assignments, and communication activities, quizzes. For her situation, this vague approach seemed to be the best idea. This way she could change some of her assessment activities but they would still fall within the broad outlines. Some of the teachers would argue, however, that the heavy emphasis placed on exams did not meet with the intent of the course. This would appear to be true, but Mary knew that ultimately (grade 12) the assessment of her students' mathematical skills would be based largely on a provincial exam. Traditionally, this exam is a paper and pencil test and Mary could not see the provincial assessment of the new Pure Mathematics 30 course being radically different. She felt her students needed to have practice in writing this type of test, so that when they were faced with the writing of the diploma exam in their Pure Mathematics 30 course they would be familiar with the experience. Mary included advice about writing these tests in her course outline.

Writing Tests

Read the instructions carefully. Preview the whole test, determine the easiest questions and do them first. Leave the questions that you are unsure of to the end. Check over your answers. After the test correct all your mistakes and make a summary of basic mistakes to avoid them in the future.

Sherry was much more specific in her Applied Mathematics 10 course outline (represented in figure 5). Sherry had never prepared a course outline so she relied on the experience of her colleagues and prepared the course outline to look much like those of her colleagues. It is one thing to give a detailed course outline in a course you have taught many times but it is quite another thing to do it in a course that is new to everyone. Sherry divided the course into units and provided students with the number of classes on each unit and the percentage weighting of each unit. The breakdown was as follows:

Units	*Percentage Weighting*	
• *Measurement*	*12 classes*	*10%*
• *Number Patterns in Tables*	*9 classes*	*10%*
• *Relations and Functions*	*11 classes*	*20%*
• *Sampling*	*6 classes*	*5%*
• *Coordinate Geometry:*		
• *Line Segments*	*10 classes*	*15%*
• *Linear Functions*	*15 classes*	*20%*
• *Trigonometry*	*13 classes*	*20%*

In addition to these units we will also spend:

• *Computer Lab*	*8 classes*	
• *Review*	*3 classes*	

Figure 5. Sherry's Course Outline

Sherry also clarified how the percentage of each unit would be calculated and how the final course grade would be determined (see representation in figure 6).

Calculation of Final Grade

• *Exams 35%*	*(This includes weekly quizzes and chapter exams from the material covered in the course outline.)*
• *Midterm 15%*	*(Includes material taught up to midterm week.)*
• *Final Exam 30%*	*(Includes the entire year.)*
• *Homework and Test Corrections 15%*	*(Includes work assigned during class and due the next class.)*
• *Projects 5%*	*(Includes all individual and group projects done in class.)*

Figure 6. Calculation of Grades

Sherry's course syllabus was fairly traditional in nature and, as with Mary's outline, the weighting of tests was 80% and other assignments constituted the remaining 20%. Sherry's syllabus did differ slightly from Mary's in that she did include a project mark, which was still a rare form of assessment in mathematics courses. Though the weighting of the project work appeared to be light, over the course of the semester many of the homework assignments involved work from the student project text.

Sherry also believed that homework was important in the mathematics class and addressed the issue in her course outline in the following way (represented in figure 7).

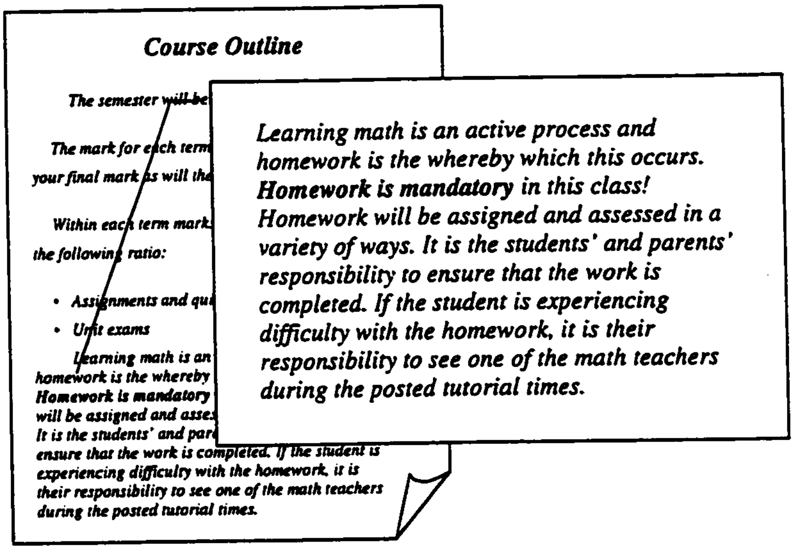


Figure 7. Importance of Homework

The teachers who were going to teach Pure Mathematics 10 did not seem nearly as apprehensive as the teachers who were going to teach Applied Mathematics 10. To quote Mary,

> *I don't think the new math 10 course is really much different, math is math and the only thing different is how it is to be taught and how it is to be evaluated.*

The teachers on the applied side however, were facing a much greater challenge and felt great trepidation about how they were going to manage. Often when I hosted committees of teachers the conversation centered on the problems the teachers were having with the Applied implementation.

In the course of doing my job, I spoke to many teachers from all areas of the province and could verify that the feelings of Sherry and Mary were not unique. I heard from teachers in small jurisdictions and from teachers in schools where the population exceeded 1000. It appeared that no matter the setting, the experience was the same, the start up was difficult and there were many issues that would not disappear.

Stumbling Over Lines: Some Issues Emerge

Technology

In the spring of 1998, Alberta Education issued a new calculator policy that would come into effect in the fall of 2000. The policy reflects the mandate of the new programs that all students should have a graphing calculator whether in the Pure or Applied Mathematics Programs.

> Improvements in technology, and its increased availability in schools, have changed the focus of mathematics education. The time saved by using calculators or computers to perform complex calculations can be used to help student better understand mathematical concepts. Students can them understand the relationships among concepts and use these relationships to solve problems (Alberta Education, 1996, p. 5).

Hugh Sanders, Assistant Director of Mathematics and Science in the Curriculum and Standards Branch for Alberta Learning said, "I guess we're openly saying there is an awful lot of mathematics that people do by using technology, so why not use that technology in the classroom" (Holubitsky, 1998, p. G6). This, in effect, meant that the approximately 33 000 students who were involved in the implementation of the new program would need to purchase a calculator that was valued at more than $100.00. Students could purchase some calculators that would have cost less than $100 but in many cases the students chose to purchase the calculators that were modeled in their textbooks. The need for the graphing calculator and the dominance of one company led to great controversy on many fronts.

The mandated use of a graphing calculator for both of the new programs was an issue for Mary and others. It raised issues for all stakeholders. It seemed that most people could see the benefit of the use of these calculators but there were many problems associated with their mandated use. Mary's jurisdiction did not require that students purchase these calculators, it was left up to each school to handle the situation as the staff saw fit. At Mary's school the teachers decided calculator purchase would be the responsibility of the students. Mary's students were told they would need the new calculator and approximately two thirds of them purchased a graphing calculator. As the mathematics department head, Mary had to answer questions from many frustrated parents who could not understand why they were being asked to spend more than $100 on a calculator when they themselves had done just fine in mathematics without one. In addition to this problem, however, there were some students who could not afford the calculator, and they would manage with a scientific calculator without graphing capabilities. Mary was caught in the quandary of how to be true to the spirit of the new course, and yet, validate the concerns of parents who could not afford the calculators. Mary's school did have a computer lab but mathematics classes had very little access to this overbooked facility.

Very few of Sherry's students had graphing calculators. In her school, the teachers did not see this as an issue and did not push students to purchase the calculators. In Sherry's Applied Mathematics 10 course, only three of her students had graphing calculators. She told them they would be an important part of the course and demonstrated their capabilities but her students did not see them as a priority. However, because Sherry had access to a computer lab, she felt the technology component of the course could be addressed through the use of graphing software and spreadsheets. For Sherry, the calculator issue was not at the forefront of her implementation concerns.

Lack of background knowledge

Many teachers, teaching the programs for the first time, questioned the mathematical background of their students. The WCP had already been implemented in the junior high grades but many teachers felt that their students were ill prepared for the grade 10 courses. Students in Mary's Pure Math 10 course were required to fill out a questionnaire on their first day of class. The questionnaire consisted of two parts. The first part asked the students to rank their abilities in certain math topics. They were to rate their knowledge in calculating percentages, using properties of exponents, solving equations, properties of polynomials, factoring, using trigonometric ratios and identifying key elements of a problem. They could rank their knowledge in one of three categories; "never studied before", "don't remember well" or "I'm fine with it". The second part of the questionnaire consisted of typical exam questions from the previous categories. Many students claimed they did not study some of the topics whereas their peers, from the same class, would say that they were fine with this topic. This discrepancy caused Mary to question the validity of the students' responses to the first section of the questionnaire. The second part of the questionnaire was more telling in that it exhibited common weaknesses in the students' backgrounds. Mary felt that many of her students did have the knowledge necessary for them to continue their studies but in some cases she felt that they did not have the intuitive understanding of the patterns in mathematics. Mary summarizes the early results when she was asked how her students were doing.

> *The students actually aren't doing too badly. I'm finding though that it is really separating the math students from the ...like the true math student from the one who has worked really hard to maintain their marks throughout Junior High. And now they're running into a little bit of a roadblock and it's all the abstract stuff.*

Sherry was also experiencing some disappointment with the ability and effort her students were displaying.

> *My heart goes out to some of the students in my class. It appears that they want to understand math so they decide to make an effort, but then they get frustrated because they are missing some of the vital stepping stones. This effort here and now may be good, but they simply cannot succeed as they want to because of past experiences and the lack of it.*

Many schools maintained their same recommendation policies for placing students in Pure Math 10 and Applied Math 10 as they had for the former Math 10 and Math 13 programs. For many schools, including both Sherry's and Mary's the recommendation was that students wishing to take Pure Math 10 have at least a 65% in grade 9, math and if they wanted to go to Applied Math 10 they should have at least a 50% in grade 9 math. This policy seemed to work against the premise that the new courses were of equal rigor, and students should choose the program they enroll in according to learning style and future education plans.

The reality in many classrooms, particularly in the applied course, was that many students had not even passed grade nine mathematics. I spoke with many teachers across the province who indicated that they estimated that up to one third of their applied students had not passed grade nine mathematics. This situation was not unlike the situation in Math 13 classes. It seems that students who do not have grade nine math do not want to take the recommended Math 14/24 sequence as it is seen as a dead-end program. They usually do not have the option of repeating grade 9 math so attempting Math 13 is seen as the best course of action. In my experience, it is not infrequent to see failure rates of upward of 20% in Math 13. Teachers were beginning to worry that the failure rate in Applied Math 10 might meet or exceed the failure rate for Math 13.

Time

One of the most frequent concerns I heard from teachers was the need for more time in the new programs. Both the Applied and the Pure Mathematics 10 courses appeared to have a lot of material to be covered. Mary was finding that she was pressed for time throughout the semester.

> *I'm finding that there's a ton of material to be covered. Are we going to finish?*

Teachers believed the former Mathematics 10 program involved as much content as they could cover over the number of hours in the course. With the new course, teachers expressed a belief that it involved more content.

> *Very simple sample questions were turned into huge obstacles. I had to include a section in my lesson to show them how to break down what the question*

was asking us. No wonder I don't have time for student projects. I am feeling guilty about not having incorporated the student project back in the last two units so this chapter--sampling, I'm really going to try. Although I can already see that all of them would need some major altering to work in my class. First, I only have time for one class to be used for it. Most of them require a few classes plus times outside of class. It's already a challenge to get them to do homework let alone a huge project--negative thought go away--open-minded. I'll try it to see how it works.

Having to include the seven mathematical processes in the teaching and learning was taking additional time for the teachers and their students. When incorporating technology, many teachers I spoke with noted that eventually the ability to use the graphing capabilities of the calculators would save time, but training the students in their use took time. The other process that teachers saw as a time consumer was communication.

Though communication in mathematics had seen more emphasis for several years, this was the first time it was mandated as part of the program. There were many cases where the students knew the mathematics but they could not communicate it in a clear manner. Also, in many cases, Mary noted, "*Students are just reading to get the gist of the information, like they do in English.*"

Sherry was also getting frustrated by her students poor communication skills and found it was interfering with the students' learning of mathematics.

In math today, I learned that any sheet with lots of reading is a problem. First it is too overwhelming for students and they immediately get turned off. The *other thing is that I may not only be fighting a math barrier, but also an English and comprehension barrier.*

I heard from several teachers throughout the province that had trouble with the communication process mandated by the program. A common lament from students was, "This is math class not English how come we have to read and write?" It should be noted that both Sherry and Mary taught in schools where the students came predominantly from families whose first language is English. I could understand the frustration of our colleagues who were in situations where many of their students were English as a Second Language (ESL) students.

Word of teachers' concerns about the assessment of the new programs reached the people in the Curriculum Standards Branch of Alberta Education. In response to these concerns, Jack Edwards visited many areas in the province and listened to teachers' concerns. One of the overwhelming concerns was that the students were not passing the courses and the teachers were experiencing great pressure from the parents of students who were not doing as well as expected. Alberta Education acknowledged the concerns of the teachers and gathered a group of teachers to write assessment standards for both Pure and Applied Mathematics 10, in November of 1998. The first draft of these standards was published in January of 1999. Teachers welcomed the standards but many felt that they should have been published prior to the course being implemented, and that a group of students had become guinea pigs in the experiment of implementation. As Alberta Education was revising and editing the grade 10 standards plans were already under way to begin the process of writing standards for the Pure and Applied Mathematics 20 level courses.

The Plot Unfolds

Assessment

September turned to October and teachers across the province were struggling with the assessment of the new Mathematics 10 programs. The Program of Studies document was not clear in many of its outcomes. For example teachers of Pure Mathematics 10 had trouble interpreting the following outcomes:

> P2-2. Generate number patterns exhibiting arithmetic growth.
> P2-3. Use expressions to represent general terms and sums for arithmetic growth, and apply these expressions to solve problems.
> P2-4. Relate arithmetic sequences to linear functions defined over the natural numbers.
> P2-5. Generate number patterns exhibiting geometric growth.
> (Alberta Education, 1998, pp. 9-10)

It appears many teachers interpreted these outcomes as the same as the objectives from the old Mathematics 30 program and assessed them in a like manner. As is often the case when teaching a program for the first time, the textbook used in the classroom became the course. Teachers relied heavily on the publishers' interpretation of the program of studies to determine the breadth and depth of what should be taught.

As it turns out, the publishers of the Pure Mathematics 10 texts pushed the envelope in their interpretation of the rigor of the course. When examining questions which are intended to address the outcomes noted above, some interesting trends can be observed. Addison-Wesley published a grade 12 mathematics text in 1991 which was being used as a text for the old Mathematics 30 course in much of the province. When comparing the questions from this text to their text for the Pure Mathematics 10 course, it may be noted, that many questions from the chapter on arithmetic and geometric sequences from the Math 30 text are the same as questions from the number sequences chapter in the Pure Math 10 text. For example, on page 13 of the pure 10 text #1 a-e is the same as #3 a-e in the old text, #43 in the 10 text is #55 in the old math 30 book. This use of old questions at times means it may not be exactly the same but has been updated. For instance, on page 21 of Addison-Wesley *Mathematics 10*, 1999, question #6 states:

> For the summer months (12 weeks), Job A pays $400 per month with a monthly raise of $20. Job B pays $100 per week with a weekly raise of $5. Do the jobs pay the same total amount over the summer, or does one pay more that the other? Explain your answer.

Compare this with #6 from page 396 of Addison-Wesley *Mathematics 12*, 1991;

> For the three summer months (12 weeks), Job A pays $325 per month with a monthly raise of $100. Job B pays $50 per week with a weekly raise of $10. Which is the better paying job?

It appears, in the textbooks, the only concession made to the new program was to include an element of communication by asking students to explain their answers. Questions in the McGraw-Hill Ryerson *MathPower 10* text also seemed to be at the level formerly expected of grade 12 students. Compare question #56 on page 76 with multiple choice #25 from the January 1995 Mathematics 30 diploma exam.

Mathematics Power 10, #56

> On the first day of practice, the soccer team ran eight 40-m wind sprints. On each day after the first, the number of wind sprints was increased by 2 from the day before.
>
> a) What are the values of a and d for this sequence?
> b) Write the general term for the sequence.
> c) How many wind sprints did the team run on the 22^{nd} day of practice? How many metres was this?

January 1995 Mathematics 30 diploma exam, multiple choice number 25:

> Fifteen members of a relay team compete in a race. Each member runs to a marker and then back to the starting line. The first marker is 10 m from the starting line, and each successive marker is 5 m further away. If the fist member runs to the first marker and back, the second member runs to the second marker and back, and so on, what fraction of the total possible distance is completed by the first nine members?
>
> **A.** 2/5
> **B.** 3/5
> **C.** 2/3
> **D.** 3/4

It appears that not only are we expecting grade 10 students to understand and apply the same outcomes as their Math 30 counterparts we were also requiring it much earlier. Many teachers, especially when teaching a course for the first time, follow the order of the text. It appears then, that students in Mathematics 30 were encountering sequences and series much later in the course than the students in Pure Mathematics 10. Mary gave her number sequences test on September 15, the first unit in the course. Several of the questions on Mary's test were very like previous diploma exam questions. She, like other teachers, found that her students did not do well and parents were phoning with concerns. Mary noted:

> *Much emphasis is placed on assuming students have mastered previous learning- the reality is that they haven't. This is definitely separating the men from the boys.*

The Pure Mathematics 10 teachers were not alone, the teachers in the Applied Program were experiencing equal difficulty in assessing their students. Sherry expresses her frustration in an e-mail:

This unit has been very frustrating for all of us. I think today I am going over the test they wrote-by the way the average was a whopping 28%. We did mark summaries for today. The class average over all is okay, 54%. Obviously could be higher.

She continues in another e-mail:

So I gave my first midterm on Monday. The average was 45%. Better than the other Math 10 applied class where only 5 passed. I'm getting very frustrated with my class. I really want them to do well, but they are really having trouble. I can't help but wonder what I am doing wrong.

Mary, the experienced teacher, was also starting to question her teaching ability. She was finding it difficult to incorporate the technology, as well as the real world applications, into her mathematics classes.

There's actually a little bit of interest, like we'll talk about application things and why we need to know this stuff and whom this affects. They listen and there's a little bit of dialogue going on but I'm sure I'm not touching every kid in there.

Though there were many concerns with the grades in the new program many teachers reported that the students were enjoying the new courses and the new approach to learning mathematics.

It was an extra busy week because I did projects Monday to Thursday with the 10 Applied class. They really enjoyed it and it served as a GREAT review. The week was great but like I said doing stuff like this tires me out more than instruction classes.

The students were not alone in learning new material. Many teachers in the province found they had to learn some new mathematics. Keeping up with the technology was also a challenge for many, as Mary experienced.

I tried to do the spreadsheet work with the kids but they all said they had done it before in other classes. Then, when they did get stuck I couldn't help them, I just don't have the background. It's also really frustrating when you have machine problems and nobody around who knows how to fix it.

Parent Concerns

By the beginning of November report cards had gone out and Sherry was about to face her first round of parent teacher interviews. She was apprehensive. Students in both the Pure and Applied programs were struggling and parents were asking why.

Next week we have parent teacher interviews. I'm a bit nervous, but am looking forward to it at the same time. I don't know what to tell parents about what course their child takes next. I wish we'd decide if we're going to teach applied again next term.

So in three weeks I will be sitting across from parents in parent teacher interviews telling them that their kids won't be able to get into university with the math applied stream. THIS IS CRAZY. WHAT THE HECK IS GOING ON HERE?

It appears that many parents were not sure what the new mathematics curriculum was about and certainly did not understand the difference between the pure and the applied programs. By this time in the term, word was also reaching some parents that some schools were opting out of the applied program. This was causing great confusion. Mary experienced this in her parent teacher interviews.

We had interviews last week and the parents were saying, that is the ones who knew enough were asking, what is the difference in the new programs? Why are the marks so much lower for a lot of kids?

Mary explained to these frustrated parents that,

This curriculum demands that the kids have all of their ideas and knowledge at their fingertips. It's not that, we re-teach, they re-learn more. It's not my responsibility to review for them. I have to tell them what they need to know but they have to do the review. And that's tough because that's putting a ton of responsibility on the student.

Many parents were very frustrated by their students' lack of success in the new programs and questioned the teachers on why the marks were so low. Although, most parents understood that the teachers were teaching a new program, some felt that the teachers were to blame. This led to some unfortunate finger pointing; Sherry experienced some of it.

Yesterday was not a great day in the parent teaching area. I was actually having a GREAT day until I went to call a parent who had sent a note in with his son. Right away I knew I was in trouble. This father was in a nasty mood and took everything out on me. He told me that his son's average was garbage and that the class average was also garbage. He told me that I must be teaching it too fast, or not clear enough and then suggested that I reteach the trig unit.

Such accusations were a concern for Mary as well. She wondered where the question of accountability should lie.

There's also an accountability issue that has been perpetuated into the accountability of the teacher for the learning. The accountability of the students and parents has to be improved as well. We have to say the responsibility for learning is from the student and that has to be stated loud and clear.

Midterm was a frustrating time for teachers. Many were working harder than they had in years, and they were beginning to question whether it was worthwhile. Mary said that she spent every evening working on Pure Mathematics 10 and she worried that it was to the detriment of her other courses.

Intermission: Christmas Break Arrives

Mary and Sherry welcomed this Christmas break like no other. They were exhausted and somewhat frustrated like their colleagues on both the Pure and Applied sides of the program, they had dealt with interpreting a new curriculum, incorporating new technology, preparing new assessment materials, dealing with irate parents and defending a program they were not sure they fully supported. Sherry, and other teachers on the Applied side, had some unique frustrations. In many schools, decisions were being made to return to the Math 13 program. In Mary's school, Applied 10 was taught until about mid-October when the teacher involved decided that the students were not succeeding in the program and returned to teaching Math 13. Mary was disappointed but supported the teacher's decision that they abandon the program.

I think people have to get on line with this new applied program. There is some wonderful mathematics in it. There's some very rigorous math in it.

Sherry was also very frustrated with the lack of support of the Applied Program. She believed in the program and was sad to see its validity questioned. Returning to the old Math 13 course would also mean a lot of new preparation for Sherry. She met with colleagues and administrators from other schools to decide what to do about the Applied Program.

> *Things are screwed up. Math 10 Applied is not acceptable to the university so it is basically a dead-end course. All schools are experiencing low averages which was a good thing for me to see. They are also frustrated with the students and their poor habits.*
>
> *I'm hesitant to voice my opinions because of my lack of experience. So next term we are looking at not continuing 10 Applied. Crap! I've put a ton of work into this course. Plus my teaching assignment might change hugely! Yikes.*

It is no wonder that Sherry's last entry in her journal before Christmas reflects a teacher in need of some time off.

> *Here I sit in the very best of moods. It is 8:35 and 10 people are in my class. Everyone is in great spirits! What an incredible feeling. Who cares about spreadsheets? Not me, or my students right now.*
>
> *Yahoo- it's Christmas Break.*
>
> *I made it through to Christmas.*

Mary, too, looked forward to the break but was worried that she was already 2 or 3 days behind where she had anticipated she would be. She wondered how she was going to make up the time between January 4^{th} and the final class day of January 23^{rd}. This was a common situation for teachers in the new courses. When I spoke to teachers it appeared several spent much of their Christmas break preparing for the last part of the first semester.

The Final Act: The End of the First Semester

After the Christmas break Sherry returned to class with renewed optimism that her students would do well for the rest of the semester. She had time to finish up the last unit and prepare for the final exam.

> *We are reviewing for the last five days. Unfortunately, I've heard students "shut down" when they hear review. I wonder if these students will really study. They had a hard time remembering over Christmas, let alone since September. As of now, I have seven out of 27 failing. I hope that only five will fail. That is my goal, but after the review it goes out of my hands. It is up to them and I'm not sure how much they realize about a final exam being worth 30% of their mark. I wish them lots of luck. Next term I plan to scare my classes with this term's results to show them it is not an easy class and they are going to have to work hard. (it might help -- it might not.) Anything might help. I'm going to have lots of help sessions during exams -- I hope they take advantage of my help.*

Mary found her time after Christmas spent struggling to get her students through the probability and statistics unit and still have some review time. She felt pressured to have a lengthy review for the students because she did not feel that they had retained much from the start of the course. She tested her final unit on January 14th and used the remaining class days for course review.

Both Mary and Sherry found that their students did not do as well as they had hoped. Mary found her failure rate just slightly higher than she normally had in Math 10. The students who did not pass the course were ones Mary had identified early in the term as students who did not have the background for the course. She was disappointed but not devastated. Sherry, on the other hand, had not taught before so she could not compare how her students did with how others had done in the past. Her only comparison was with the other Applied 10 class in her school and in this comparison her students had done well. One more student than she expected had failed but others did better than she expected, so she was not disappointed. She expresses her joy in being finished in an e-mail.

> *I just wanted to let you know that I have officially finished my first term in my first year of teaching!!!!!!!!! It feels pretty good. I've learned a lot and I'm anxious to apply it to my second term classes. I'll be making some new rules and ditching some old ones as well as starting some new routines. YAHOO!!!!!!!*

At the end of the first semester I spoke with a number of teachers from across the province about their results. The results throughout the province, after the first term, seemed to indicate that yes, the students were finding the Pure Mathematics 10 course slightly harder than the old Mathematics 10 course but not significantly. People who were concerned about the results in Applied Mathematics 10 appeared to have justification. The students' results were not good, and the failure rate was high. It is worth remembering that a failure rate of 30% or more was also not unheard of in Mathematics 13. Once again though, the media reported the concerns of parents whose children were in the applied program. "A parent ..., said the course set his child back severely. He hopes the boy can succeed in Math 23 so he can go on to an apprenticeship program at NAIT" (Unland, 1999, p. B1).

The experiences of Mary and Sherry were not unique. I believe their stories reflect the stories of the hundreds of teachers involved in the program implementation. The concerns of the teachers involved in the implementation were real and valid; though at times, the teachers felt their concerns were not being heard.

> *It seems we don't know when to speak up in terms of letting our superiors know or our departments of education know what's happening in the classroom. I get this, I get this funny feeling that curriculum is set, it's sent out there and then all of a sudden it's not the department's problem anymore.*

Mary's words would prove to be prophetic. It certainly was the department's problem. The case of the implementation had raised so many issues the government had to respond to many of them very quickly. The issues, and Alberta Learning's[1] response to them, is the topic of the next chapter.

[1] On May, 1999 the ministries of Alberta Education and Advanced Education were combined and were now known as Alberta Learning.

The Reviews

Unlike the reviews for most dramas, the reviews for The Case of the Implementation of the WCP in Alberta came out long before the curtain was closed. Shortly after the implementation began problems started to arise. The issues that had the greatest impact on what was happening, and what would happen, in the classrooms are the topics of this chapter.

The Calculator Issue

The Cost

The issues around the requirement of a graphing calculator were province wide and were being addressed in many different ways. The new programs did not mandate that each student must *own* a graphing calculator but, instead, each student should have access to the use of the graphing calculator or equivalent technology. Many teachers felt this was placing an unfair burden on the schools and their resources. Each school jurisdiction handled the issue in its own manner. Some schools had class sets of calculators that could be used, others established rental programs and still others had calculators donated for needy students by local businesses and service clubs.

The month of September 1998 saw a large number of phone calls to Alberta Education from irate parents. There were days, I would have as many as ten phone calls complaining about the cost of calculators and questioning the need for them, and I was not the primary contact person to call. The Curriculum Branch staff and the assistant director of mathematics and science - Student Evaluation fielded most of the calls. Even the deputy ministers and minister were not immune to the wrath of parents. These calls were difficult, many parents did not see how they could possibly spend any more money in September. School fees had been climbing the last several years, they had to pay for clothing, the dues for sports teams had to be paid and now they had to find money for a graphing calculator. Answering these calls was very difficult. Often parents told me stories about having recently gotten off welfare and now they would have to ask for help again. Many felt that their children would be left behind if they did not find a way to purchase these calculators. In one case, I spoke to a mother who told me that the teachers at the school her son attended told her that he would have to take Math 23, if she could not provide the calculator he needed for Pure Math 20. These situations were difficult for all concerned. Parents were assured that though the initial cost of the calculator was high their children could use the same calculator throughout their high school mathematics and science career. This did little to appease those parents who could not afford the initial outlay of the $120. This $120 was the cost usually advertised but, in reality, some of the graphing calculators were $20-$40 less than this. Schools were encouraged to find ways of providing calculators for students who could not afford them, and many schools found creative ways to do this. The parents' ire found support in the media in the form of articles in magazines and newspapers and letters to the editor. The calculator issue refused to go away and is being argued yet today.

> The provincial government may have miscalculated its recommended use of the graphing calculator in the new high school math courses.
>
> Concerns from parents and teachers over the calculators' cost -- not to mention the advantage given to some students and the difficulty in assessing learning -- have reached the office of Alberta Learning Minister Lyle Oberg.
>
> "We're taking a look at the issue of the graphing calculators," said Learning Department spokesperson Ed Greenberg. "He (Oberg) wants to discuss it with departmental people very quickly" (Turchansky, 1999, p. B4).

The Necessity for the Calculator

For many parents, the issue of the graphing calculator was more than just the cost. Their children's teachers were questioning the pedagogical validity of using such a tool in a mathematics class and voiced these opinions publicly. This further encouraged the parents to question why the government was insisting their children purchase the calculators.

> Terry Melnyk, the head of mathematics at Queen Elizabeth, tries to get his students to use computers for math but knows it's not the same as having the latest personal calculator.
>
> "I think it's very difficult for students struggling with a lot of financial demands to afford the calculator," says Melnyk. "I hear it constantly. And a real problem provincially, students from more affluent areas—whose parents are engineers and doctors—100 per cent have calculators. Well that's not happening here" (Turchansky ,1999, p. B4) .

Parents not only had a voice in teachers, such as Mr. Melnyk, they also had a voice in other parents in professional roles. One letter to the editor in the *Edmonton Journal* was from a parent of three high school children who questioned the necessity of high technology access for his children. This parent notes that he is employed as an aeronautical engineer, and he has never had the need for anything more sophisticated than a scientific calculator. There were many letters to the editor from parents complaining that these calculators were too expensive and that the students were becoming far too dependent on these devises. The parents found support in this attitude at the university level as well. In a letter from three university professors, Andy Liu, Robert Moody and Akbar Rhemtulla, to the Minister of Education, partially reprinted in the *Alberta Report News Magazine*, they voiced their concerns about the mathematics program in general and the use of calculators in particular.

> "Please note, calculators are not permitted on university exams," they write. "As university mathematics instructors, we are astounded that calculators are introduced so early in your mathematical curriculum. One can only compare this to the use of cars to teach children to walk. Technology is truly an integral part of society, but technology does not create students who will be able to think better." (Steel, 1999, p. 28).

Though the opinion of these professors was one which seemed to be widely held, it was not supported in the research (such as Carl, 1993, Dunham, 1996).

> Calculators do only the low-level tasks of computation— they do not "think." Calculators can speed up the learning process. Student understanding the appropriated use of calculators experience more time to explore challenging and interesting mathematics (Pomerantz, 1997, p. 12)

The comments of Andy Liu, Robert Moody and Akbar Rhemtulla, may be a little misleading. Though calculators are not allowed in many first year university calculus classes at the University of Alberta, their use is mandatory in other courses and in some other institutions. One of the complaints teachers and Alberta Education staff frequently heard from parents and students was that Alberta Learning would not allow a particular calculator on the diploma exam, yet this calculator was the one the faculty of engineering was recommending their students purchase. It appeared that the universities were very divided on their stance for calculator use. However, the voices being heard, for the most part, were those of the opponents.

The Calculators' Capabilities

Another problem for teachers was the geometric growth of the calculators' capabilities. When the new programs were introduced both approved texts for the Pure Mathematics 10 course and the approved resource for the Applied Mathematics 10 course, based their calculator instructions and diagrams on the Texas Instruments TI-83 calculator. Because of this, many teachers purchased these calculators for their schools and this was certainly the calculator most students purchased. This was a good situation as teachers did not need to learn how to use a number of different calculators and students could follow the keystroke instructions in their textbooks. Unfortunately, about six months into the new mathematics programs the Texas Instruments company ceased retail production of the TI-83 and replaced it with the TI-83+. Many teachers saw this as somewhat of a betrayal, already the calculators they were using were out of date. This added to the teachers disgruntlement. They had learned to use one calculator, and six months later they were going to have to learn another one. They also wondered if this new calculator would become out of date in another six months. Also, Alberta Education announced that the TI-89 and the TI-92 calculators were approved for use on the diploma exams. These two calculators had algebraic manipulation capabilities. Teachers did not see how they could fairly assess when some students had these powerful calculators in their hands. So, not only were they being asked to implement a new program, they also had to find new ways of assessing many mathematical skills. Teachers also questioned the fairness of the calculator policy. The calculator policy for the diploma exams for the new courses called for the clearing of all calculators prior to the exam. This meant that a student who had down loaded programs which would upgrade his calculator to the capacity of the TI-89 or the TI-92 would have his programs cleared prior to the examination whereas a student who had the more powerful calculator would still have access to all the programs.

Perhaps the calmest voice to be heard in this drama was that of the student. In classrooms throughout Alberta, mathematics students were getting down to work and looking at the graphs of functions and how they could be interpreted.

> As a grade 11 student I am surprised at the stifled, negative thinking in the adult opinions with regard to "School computers making us dumber," Letters, Sept. 15.
>
> One thing many adults do not understand is you must have a firm understanding of how to input the information into the calculator. Getting an equation that is recognized by the calculator takes many steps on paper to do, therefore you must know what you are doing.
>
> If you think these calculators are overpriced at $120 (and will be used for a minimum of three years in the math pure program) think how much you put out for those "special" shoes or jeans so your child "looks good."
> (Lewchuk , 1999, p. B3)

The issue of the use of calculators in the senior high math program did not disappear. The *ATA News*, January 11, 2000, quoted MLA Sue Olsen in an article entitled "New Curricula Adequately Funded – Government".

> "We have youth in those particular schools that come from homes where it's a struggle just to put food on the table, it's a struggle to clothe kids and it's a struggle to pay the bills every month. Many of my constituents don't have the extra funding…for the $120 calculator that's required by the department of education in order to do the problem-solving in the new math curriculum."
> (Svidal, 2000, p. 7)

The calculator issue rages on. There are still many opponents to the mandated use of the graphing calculator. As the first diploma exams loom near, the inclusion of the calculators with algebraic manipulation capabilities on the approved list is still being met with great opposition. Whenever, in my role as exam manager, I am presenting the proposal about the new diploma exams to teachers, there is much discussion about the calculator policy. A large number of teachers believe that calculators with algebraic manipulation capabilities should be banned from the provincial exam. In these discussions, I have found I had to explain that these calculators were on the approved list and parents were guaranteed that once a calculator appeared on that list it would stay on the list for at least four years. This effectively means that a student could be guaranteed to be able to use the same calculator for his or her entire high school math career. Many teachers are calling for two part exams, one without calculators and one with calculators. At this time it appears Alberta Learning is not entertaining this option.

The Near Demise of the Applied Program

The Early Problems

Though many jurisdictions chose to delay their implementation of the Applied Program, the issues with the implementation were still at the forefront of many discussions and meetings in those jurisdictions. The opposition to the program was widespread and in several areas very vocal. A group of Edmonton area mathematics teachers, TERM, (The Edmonton Regional Mathematics Group) were encouraging their fellow teachers to rally together with parents to write the minister and express their concerns about the program. Two large school boards, who did implement the new program in many of their schools, were questioning their decision to offer the Applied course instead of offering Mathematics 13 based on feedback from teachers, parents and students. Many schools abandoned the program midstream and returned to teaching the Mathematics 13 course.

> *I just got an e-mail... math 10 applied teachers and administrators are going to meet later in November with the superintendent about this course, apparently* (other boards) *aren't going to teach the applied and they are going to*

stick with the 13 and 23 stream. Wow! Can they do that? They must be very unhappy with it. I personally think it's great.

Sherry's e-mail reflects the opinions of many teachers who were struggling through with Applied Mathematics 10. They recognized that there were problems with the program but they felt that these problems could be solved, and the program was worth saving. The debate about the applied program was becoming very political and emotional, often teachers and students were caught in the middle of struggles between school boards and the provincial government. At lease one jurisdiction opposed the Applied Programs. They wanted Alberta Education to reinstate the Mathematics 13, 23, 33 program. They held meetings with teachers and administrators to allow them to voice their opinions about the program. One might speculate that they were trying to pressure the government. Sherry found herself participating in meetings.

> *I went to this meeting at* (a local school) *last night about the 10 applied and how it is going. It was great for me to hear that other people are finding it just as frustrating and that the kids aren't doing very well across the whole area. The guy running the meeting ... is having a BIG MEETING this Friday with BIG IMPORTANT people whoever they are and he wanted to know what to tell them about the new curriculum. We basically decided that we need to put it on hold to get the curriculum figured out. It sounds like the curriculum is good but that it isn't getting the right audience. Most teachers feel it would be good for the math 10 regular stream students not the ones failing in grade 9 math.*
>
> *The scary thing is we have to decide what the heck we are doing next term. Do we offer it again even though it might be postponed? Also, did you guys know*

that the U of A is not going to accept math 30 applied? They don't feel that it prepares kids for the algebra they will meet in university level courses.

The frustration Sherry was feeling was common among the Applied 10 teachers. In many schools, the teachers of the Math 10 Applied course were new teachers and they experienced the additional challenges faced by all beginning teachers. They were concerned with classroom management and their development as teachers as much as they were concerned with implementing a new program. These new teachers were being asked to help make some very important decisions.

Sherry's jurisdiction scheduled a meeting to discuss the future of the Applied Program in their schools. In preparation for this meeting the teachers at Sherry's school met to decide what their position would be. "*So it looks like we'll be teaching 13 next term unfortunately. I really like this curriculum. My ideas didn't stand up. I don't think the meeting tomorrow is going to change my department's decisions.*"

A meeting between Sherry's jurisdiction and Alberta Education occurred shortly after the jurisdiction met with their teachers. The purpose of the meeting was to try to resolve some of the issues surrounding the Applied Mathematics 10 course. Whether this was accomplished or not is open to interpretation. As Sherry said, "*So the meeting yesterday was pretty useless. Alberta Education gave out a sheet that had a response to each of our concerns, but they weren't very good or useful.*"

Non-acceptance by Post-Secondary Institutions

One of the key factors in the reluctance of school boards to accept the Applied Program was the post-secondary schools' position. The perceived lack of acceptance by the provincial universities caused many people to see the Applied Program as courses that would lead nowhere. The universities, particularly the University of Alberta, were vocal with their concerns about the program. The colleges and institutes of technology were more open to accepting the Applied Program, and in one case stated that it would be accepted on the same level as the Pure Program.

> The universities, meanwhile, began to express their opinions about the new regime. The University of Calgary decided to limit its acceptance of Applied Math 30 graduates to fine arts and general studies applicants, though the latter must also have completed a second language course.
> The U of A took a harder line, refusing the Applied course for all its faculties. (Steel, 1999, p. 27)

Alberta Education was so concerned about the acceptance of the Applied Program by the post-secondary institutions they added a link to their web site which would take interested people to a page which listed the current status of acceptance in Alberta's post-secondary schools (http://ednet.edc.gov.ab.ca/studentprograms/math/psupdate.html)

Not everyone held the same views. The institutes of technology, including NAIT and SAIT, were endorsing the Applied course. In a letter to the editor in the *Edmonton Journal*, Feb. 11, 1999, Rob Gossen of Drayton Valley wrote:

> That technology institutes, with a finger on the pulse of the high-tech job market, upon seeing high school students coming their way without the ability to apply math to practice should be the driving force towards change, is not surprising.
> If university engineering and technology departments are not fomenting the same change, why not? Is it because they are too staid, too theoretical, too much steeped in the idea that we will train them when they get here? (Gossen, 1999, p. B6)

The controversy over the implementation of the Applied Program was still being debated in January of 1999. In an *Edmonton Journal* article dated January 27, 1999, Karen Unland writes that, "Alberta Education does not intend to delay introducing Applied Mathematics 10 to all high schools this fall, despite criticism that the course leaves weaker math students behind. " She further quotes Kelley Charlebois, spokesperson for Minister Gary Mar as saying, "Every time new curriculum is introduced, there are bugs in the system. For people to call for a moratorium is not addressing the actual problem" (Unland, 1999, p. B3).

It appeared that Alberta Education was planning to weather the storm of the implementation of the Applied Program. This belief was proven false in a news release from Gary Mar issued on February 1, 1999. "Gary Mar, Minister of Education announced today that schools may participate voluntarily in the new senior high Applied Mathematics curriculum for another year. Full provincial implementation now is scheduled for September 2000." Further, the Minister states, "Teachers, post-secondary educators and the business community helped us design a good curriculum. In the next little while, we will announce steps to strengthen our support for the new program."

The announcement of Minister Mar foreshadowed the provincial response to many of the concerns of teachers throughout the province. The teachers' calls for changes to implementation dates, student readiness and teacher inservice would ultimately be addressed.

Impact of the Media

The impact of the media on the controversy of the implementation of the new programs cannot be ignored. Usually, when a new curriculum is introduced into schools only those directly impacted by the changes are aware of its existence. The implementation of the new mathematics programs however, was under media scrutiny. It seemed that the newspapers were carrying an article each week related to mathematics during the first few months of implementation. Alberta was not alone under this media microscope. It appears that changes in mathematics education were topics of discussion in other places, as well

> What seemed to be overwhelming national consensus on directions for change in mathematics education is now facing passionate resistance from some dissenting mathematicians, teachers, and other citizens. Wide dissemination of the criticisms- through reports in the media, through Internet mailings, and through debates in the meetings and journals of mathematics professional societies- has shaken public confidence in the reform process. (Schoen, James, Fey, Hirsch and Coxford, 1999, p. 445)

Many teachers, and those of us with Alberta Learning, found ourselves being questioned about the program from a wide variety of sources. I found friends and acquaintances not directly involved in education asking me, "What's with that new math program? Is it really that awful?" In speaking with colleagues throughout the province, I determined that my situation was not unique. For example, a fellow teacher in a small jurisdiction told us how the parents of his students felt he was directly responsible for the new program and everything associated with it. These parents even went so far as to suggest that he had shares in the Texas Instruments Company and this was the reason he was insisting all his students buy these new graphing calculators.

As is often the case, the media reports did not capture the whole picture and at times seemed to contradict each other. The following is an excerpt from an article in the *Edmonton Journal* June 6, 1998.

> Dozens of educators, parents' groups, post-secondary institutions and professionals such as engineers went over course material page by page, to ensure that the math students would learn would meet their needs after they left high school.
>
> Peter Hancock, an engineer who taught at NAIT for 30 years, was one of 10 educators and professionals on a committee that took an in-depth look at the proposed math.
>
> The group would meet several times a year to pore over the new math program, page by page, illustrated example by example (Holubitsky, 1998, p. 67).

This article contrasted others that maintained that the post-secondary institutions were not consulted when the programs were being designed.

> The department of mathematical sciences, says Prof. Solomonovich, is particularly upset because Alberta Education neglected to consult with them while developing it. "If they would have consulted," he says, "they would have seen right away that it was inadequate." The main problem with Applied Math, he says, is that even though there is a lot of work, it is mostly calculator driven (Steel, 1999, p. 28).

The programs became the topic for varied journalists, some of whom, it is hoped, wrote with tongue firmly in cheek.

> The new math curriculum, which gets rid of those pesky, confusing designations like "Math 10" and "Math 23" simply divides the program into two general groups: The Quick and The Dead, or more formally, Pure Math and Applied Math. The difference is that Pure math student get to go to university. Applied Math students get to work night driving Pizza Pi around the circumference of the city (Sass, 1999, p. A2).

It was rare for educational issues and in particular for curriculum issues, to be the object of such media scrutiny. In my view, this scrutiny was partly responsible for the announcement of the delay of implementation of the Applied Program by the Minister, Gary Mar.

The Birth of Math 10 Prep

One of the issues addressed at the meeting between Sherry's board and Alberta Education concerned the preparation of students in the new programs. Questions arose about their mathematical background from grade nine. Representatives from Alberta Education stated that the expectation was that students entering the Applied or Pure Mathematics 10 courses would have passed grade nine mathematics. The teachers from the jurisdiction informed the Alberta Education representatives that this was not the reality of what was happening in schools.

One big discussion at this meeting centred around the idea that Applied and Pure were created with the understanding that the students entering them were successful in Math 9 and if they weren't should be entering Math 14. But in reality that isn't happening. They are ending up in our math applied class.

One thing that causes me some thinking is: what do we do with the kids who aren't making it in math 10 applied? To send them to math 14 would be a disaster. It would turn them off of math, create management problems because they would be bored, many of the ones in my class failing are too advanced for 14 but [Alberta Education] *says if they can't make it in applied they belong in 14. It doesn't work though.*

Once again the media championed the controversy of the success of the students in the new mathematics programs. The *Calgary Herald* reported a story of a board meeting where the prerequisites of students entering the Applied and Pure Math courses was discussed.

> Calgary school board administrators are recommending higher prerequisites for Grade 10 math courses.
>
> Brendan Croskery, superintendent for school, student and parent services, told a Calgary Board of Education meeting on Tuesday night there is a "sense of urgency here" in adopting the recommendations because Grade 9 students are now looking at selectioning courses for Grade 10.
>
> Prerequisites for Applied Math 10 and Pure Math 10 are 50 per cent. The recommendations include a 70 per cent or better mark in Grade 9 as a prerequisite for Pure math 10 and a 55 per cent or better mark in Grade 9 for Applied Math. (Toneguzzi, 1999, p. B5)

The ATA also became involved in the controversy. In the early spring of 1999, the ATA called together a group of 22 teachers. The objective of this meeting was to have the teachers share their views about the high school math programs and the "problem-riddled" implementation of the Applied Program. One of the recommendations of this curriculum circle was that a Mathematics 10 preparation course be developed. They did recognize, however, that the introduction of another high school math class would restrict students' options for study in other areas.

As a result of this meeting and others like it throughout the province, Alberta Education released a letter to all high school and junior high principals addressing the concerns. In the letter, Alberta Education identified four major issues: a need for clear and appropriate assessment standards for both of the new courses, a need for a statement about prerequisites, a need for a grade 9 equivalent math course available to high school students and a need for clarification of transferability between the programs. Alberta Education stated that they had addressed these concerns by writing assessment standards for Pure and Applied Mathematics 10 courses and by allowing schools to offer a grade nine equivalent math course to the high school students. It was revealed, in the letter, that Alberta Education would grant as many as five credits to this grade 9 equivalent course. This letter, and its promises, led to the development of a course that would become known as Mathematics 10 Preparation. Superintendents were informed of the new course in a letter dated January 7, 1999 from Jim Dueck, Assistant Deputy Minister. In the letter, Mr. Dueck stated that the interim program of studies for the course would be available to schools in June 1999.

Mathematics 10 Prep was designed for students who did not pass grade 9 math but who did not want to go into the Math 14/24 stream. The course was designed in such a was that it could be offered for three to five credits. The outcomes in the Math 10 prep course consisted of outcomes from the grade 7, 8 and 9 WCP documents. How a teacher put the outcomes together would be determined by student need and the number of credits assigned to the course.

Math 10 Prep was greeted with mixed reviews. Some teachers felt that students should not be given credit for the course, as students who passed grade 9 math when they were in grade 9 did not receive high school credit. Also, some of the CTS (Career and Technology Studies) teachers were worried that the introduction of another high school math course would affect the enrolment in their courses. However, I heard that Grade 9 teachers liked the idea that Math 9 would be a prerequisite to high school math courses because students would be required to take their junior high schooling seriously.

At the time of this writing, very few regular high schools offer Math 10 Prep. Instead the instruction is left to the summer and night schools. Some schools specializing in adult students do offer Math 10 Prep as a five-credit course.

The Need for Inservice

"Where is the support for the teacher? I am spending every evening working on Pure Math 10. It's a good thing I've taught the other courses I have or I'd be doomed."

Many teachers in the field echoed Mary's frustration. They were spending an inordinate amount of time preparing the courses. They had to, interpret the curriculum document, decide how they could teach the topics in a new way, find ways to encourage the use of the graphing calculator and ascertain which of the text questions should be assigned. They did not dare allow students to work on a few questions in class time and then assign the rest for homework because some sections of the textbooks had over a hundred questions for a particular curriculum topic. Teachers were overwhelmed and were looking for help.

Addison-Wesley, in their agreement with Alberta Education, was providing inservice for the teachers of the Applied Mathematics program but there was little support for the teachers of Pure Mathematics. The focus of many local professional development days was the new mathematics programs and how some of the problems could be addressed. Alberta Education was fielding many calls from teacher associations asking for speakers to come out and talk to their teachers. The staff from the Curriculum Standards Branch traveled throughout Alberta answering questions and listening to the stakeholders. Alberta Education's position was that their mandate was not to provide inservice, this was the mandate of the local consortia and individual school boards. This position was not well received, particularly in school divisions where there were no mathematics specialists acting as consultants and the local consortium was not very active.

As Mary lamented:

> *People want to know what the curriculum is and what the intent of it is and what directions it can take. Actually we talked about that last night. We're all working our butts off and we need help. I think every school is reinventing the wheel. We need to get together and share stuff.*

At this time I found myself having to turn down many speaking opportunities. There were too many requests to attend to them all. It seemed that school boards were desperate to provide some inservice for their math teachers. The Mathematics Council of the Alberta Teachers' Association's (MCATA) conference in Calgary in October 1998 was so well attended that many of the sessions were over crowded and many teachers were frustrated. Often if they wished to attend a session they would have to wait at the door for at least an hour. This situation just added to the frustration they felt. Mary and Sherry both attended this conference and were both disappointed in how few sessions they were able to attend because of the large number of delegates.

> *So we went to the conference in Calgary on Friday and Saturday. It was terrible. I had a great time with the people, but he actual conference was a disappointment. The sessions were often full, or cancelled. The exhibitors were nothing exciting. It was a waste of PD money -- but it was a good bonding experience for out math department, which is important.*

The need for province wide inservice was very apparent. This message reached Alberta Education who was receiving feedback about the need from parents, teachers and administrators. The need for teacher inservice was one of the primary concerns raised by the ATA curriculum circle. The ATA felt that teacher inservice should be provided whenever a major curriculum change occurred.

On February 10, 1999, the government announced the provision of funds for the inservice of teachers of mathematics. In the announcement from Premier Ralph Klein the government committed to providing $2.2 million to support teacher inservice in the new mathematics programs. "This curriculum represents a wholesale change in the learning of mathematics, and I want to give teachers the initial help they need to deliver the new programs," said Gary Mar. The inservice money was directed at supplying inservice for junior and senior high mathematics teachers and was to be coordinated through the local consortia. the consortia viewed the money as operating funds and some of it was directed for infrastructure costs.

Both Mary and Sherry were pleased with the announcement of new funding for inservice but they wondered how this inservice would be organized and what form it would take.

> *I really prefer the workshop style inservice. Workshop things where we're actually doing something rather that...Like I...it's good to listen to stuff too but I don't want just the esoteric things. I want things that we can actually do, things that we an actually work with. I want to hear from other teachers about things that work in the classroom and how they worked. Even the problems, I want to know what the problems with it are.*

Mary had seen many other inservice programs come and go and hoped this would not follow in the same manner. Mary, like many of her colleagues, was disappointed that the money could not be used to cover the cost of substitute teachers. *"It looks like this is just one more thing they are putting on the teacher's plate, and it's already awfully full."*

As seemed to be the case with announcements related to the mathematics programs, the funding announcement met with some opposition and was not immune to media scrutiny.

> If I'm reading Mar (education minister) right, he figures the only thing wrong with the new curriculum is that the teachers simply don't know how to teach it.
>
> But having to spend $2.2 million teaching teachers to teach the stuff may indicate some, ah, weaknesses that go beyond the challenge of doing Farmer

> But having to spend $2.2 million teaching teachers to teach the stuff may indicate some, ah, weaknesses that go beyond the challenge of doing Farmer Brown's books. Heck, for $2.2 million even Farmer Brown could learn to teach math. (Sass, 1999, p. A2)

It seemed that Alberta Education was trying to answer the concerns of teachers in most areas of the implementation but each fix resulted in other problems. By the end of the 1999 school year many schools had opted to return to the old Math 13, 23, 33 program until mandatory implementation of the Applied 10 in September of 2000. Few schools were offering the Math 10 Prep course in regular school time but enrolment for the course in summer school was sufficient to run many classes. Many teachers were spending a week or more of their summer involved with inservices or they were planning to give up weekends in the new school year for workshops. In my discussions with teachers, I realized that some teachers felt resentful about having to give up personal time for these workshops. They felt it was unfair that none of the $2.2 million the province had provided for inservice could be used for substitutes. The teachers saw this as yet one more demand on their time.

In late 1999, the calculator issue was starting to come to the forefront again as teachers began to speculate on what form the provincial assessment of the new programs would take. Many felt the inclusion of calculators with algebraic manipulation capabilities on the approved calculator list for diploma exams would mean that very little algebra could be tested.

The implementation of the new mathematics programs in Alberta raised many issues, some of which could not be foreseen. Alberta Education attempted to resolve many issues by providing teachers with more materials than they had in the past. Assessment standards were produced, a new mathematics course was created and funding was provided for inservice. Though many of the issues that arose during implementation have been addressed, many should have been avoided. The issues of where the implementation went wrong and how could it have been improved upon are explored in the next chapter.

The Denouement

The purpose of the research was to examine and describe the implementation of the new high school mathematics programs. The implementation of the Western Canada Protocol for K- 12 Mathematics had begun in 1997 in Alberta in the elementary and junior high schools. At the time the data was collected, the high school implementation was the final phase and it began in September 1998. Unlike in the past, this was to have been full implementation, there was not to be a pilot year. However, due to the lack of available resources the implementation took place in two phases. The mandatory implementation of the Pure Mathematics courses began with the grade 10 level in 1998. At this time the Applied Mathematics program began its first year of optional implementation.

The research for this study was gathered from two primary sources, one teacher implementing the Applied Mathematics 10 course and another teacher implementing the Pure Mathematics 10 course. These teachers kept journals, sent e-mails, were interviewed and supplied the researcher with classroom artifacts such as outlines and tests. In addition to this, there were many secondary sources of data. The researcher had access to a number of teachers throughout the province and these teachers shared their experiences of the implementation process with her. Also, the implementation of the programs was of interest to many stakeholders such as parents, students and government personnel. Their stories have also added to the research of the Case of the Implementation on the WCP in Mathematics in Alberta.

The research attempted to answer four research questions:

- What is the experience of two teachers as they implement the new programs of study for high school mathematics?
- What are the problems that arise for a teacher during the implementation of the new courses?
- What are the constraints and the possibilities that arise with the implementation of Pure and Applied Mathematics 10?
- Other than teachers, who are the other people who play a role in the implementation? What role did they play?

The two teachers, Mary and Sherry had similar yet different experiences. Their experiences were similar in issues pertaining to the use of technology, the lack of time and the challenges of assessment. Their experiences differed because they were teaching different courses and the implementation of the Pure Program was much less drastic than the implementation of the Applied Program. Sherry also faced the particular experiences of a novice teacher whereas Mary had years of experience to help her in implementation decisions. For Mary, as department head of her school's mathematics department, the implementation meant some decisions had to be made on the expenditure of resources and the establishment of school policies related to the new programs. So, though Mary did not teach the Applied Program she did have to make some decisions in relation to staying with the course or returning to the previous Math 13 course. For Sherry, the experience of the implementation contained a lot of frustration. There were occasions where Sherry questioned whether, as a novice teacher, she should speak up and if she did would she be heard. Sherry had a strong belief in the validity of the Applied Program but she was in the minority in both her school and her jurisdiction. When the decision was made by Sherry's jurisdiction to return to the old programs it was very disheartening for her. Her experience of the implementation was not always pleasant and was shared by others trying to implement the Applied Program.

Numerous problems arose during the implementation. Some of the problems could have been foreseen but some could not have been anticipated. One of the first problems that arose was the mandatory use of a graphing calculator. Each jurisdiction, and often each school handled the issue of the calculator in their own way. Some jurisdictions sent out notices to the students stating that they must have a graphing calculator, whereas other jurisdictions left the decision up to the individual schools, some of whom chose to ignore it altogether.

A second problem arose part way through the implementation. This problem was one of assessment. It appeared that students were not doing well and teachers and parents questioned if the courses were too hard for students. Alberta Education had not yet produced the assessment standards; so many teachers were trying to interpret the curriculum and the textual resources for assessment criteria. In many cases the assessment appeared to be at too high a level for the students in the courses.

The many problems associated with the implementation of the Applied Program, such as the lack of resources and the poor results of students, caused its near demise. Jurisdictions' decisions to stay with the course or return to the former Mathematics 13, 23, 33 program were often made after pressure was placed on them by parents and did not have agreement of all the teachers. In several cases the teachers in jurisdictions and in individual schools were split on the issue of whether or not to offer the Applied courses.

Not all aspects of the implementation were negative, however. Teachers were being given an opportunity to teach new mathematics in a new way. Teachers were rediscovering what it meant to be a teacher. In many cases they were learning along with their students. Teachers were finding that the graphing calculator was allowing them to explore more mathematics. Many teachers were using alternate assessment strategies, such as projects, for the first time in their classrooms. Though the teachers did complain that they did not seem to have enough time to cover the courses, they often seemed to be enjoying teaching them.

Usually when a new curriculum is introduced only the teachers and students involved are aware of it. This was not the case of the implementation of the WCP in mathematics in Alberta. Because of very vocal opposition by teachers, parents and other stakeholders, the implementation case became well known through media coverage. It seemed everyone had an opinion on the new courses. Students, parents, teachers and university personnel wrote letters to editors of newspapers. Members of the Legislative Assembly received letters pertaining to the new programs and they in turn asked for information from the Minister of Education. It seemed that the government had to defend each of its decisions through the media.

Could some of the implementation problems have been avoided? Perhaps, seems to be the obvious answer. Though Alberta Learning has addressed many of the implementation issues, they probably should have addressed some of them prior to implementation. The rest of this chapter offers some suggestions on how curriculum implementation could take place.

Teachers Must be Informed

It appears that Alberta Learning, in their quest to introduce a new mathematics program in Alberta, made many of the same mistakes that were made when the "new math" was introduced in the 1960s. At that time, as is the current situation in Alberta, the curriculum developers did not have the support of the teachers who would be teaching the new math. Change is always difficult and people in the change process need to believe that the change is worthwhile and is not simply change for change sake. Though the Western Canada Protocol document was available to teachers for at least two years prior to the implementation many had not read the document until just prior to implementation. This is neither the fault of Alberta Learning nor the fault of teachers. The demands on teachers' time are such that they are often forced into the situation of reacting to what has happened as opposed to preparing for what is to occur.

The change mandated by the new mathematics program was vast and, for many teachers, frightening. The fear of the unknown caused many teachers to react negatively to the new program without truly understanding its philosophy or its purpose. Many teachers were aware of the Western Canada Protocol initiative but did not really understand the vast curriculum changes it would cause. Alberta Learning, at the beginning of the mathematics changes, did not see its role as a provider of inservice to teachers. The inservice of the new program was left up to the jurisdictions and individual teachers. Most jurisdictions did not have any central office personnel dedicated to the inservice of mathematics and therefore in many regions inservice simply did not exist.

Some inservice opportunities were available, however, and the interest was great. For example, CMASTE, through the University of Alberta, offered very successful inservices in the summers of 1998 and 1999 that were attended by many teachers. However, though inservice was available, some teachers were not able to avail themselves of the opportunities that did exist. When the education funding cuts occurred, the money available for professional development was often one of the first cuts made by schools. Of the teachers who did attend inservices, several were doing so at their own cost. Also, in many cases, inservice opportunities were available only on school time and teachers could not get release time from their school boards. This situation led teachers, through no fault of their own, to the unenviable position of knowing they had to teach a new program they knew very little about. These teachers felt that they were left without support by the government and by their own teachers' organizations. Many, who had loved teaching, were finding it hard to be enthusiastic and keep their spirit.

> *It's the spirit of the teacher that is gone. Not gone, but it certainly is hurting and it can't be left up to just MCATA and the NCTM. It has to be the government that supports us. It has to be our Alberta Education, our education leaders.*

Could the problematic implementation have been avoided? Perhaps not in its entirety, but had Alberta Learning provided more inservice prior to the implementation, some of the fears could have been allayed. When the Alberta Government announced the release of $2.2 million for inservice of the new mathematics programs, it appeared to me that they were admitting they had erred by not making inservice available at the beginning of the implementation. I believe teachers' opposition to the new programs would not have been as great if they had known more about the philosophy and pedagogy and therefore would have been more comfortable with implementing the program. I also believe that a portion of the money should have been allocated to providing release time for teachers.

By not allowing any of the money to be allocated for payment of substitute teachers, it appeared that the government was simply adding to the workload of teachers.

The Support of Key People Must be Sought

> Ironically, despite this pandemic of mathematics miseducation, the only time that Americans pay any attention to mathematics teaching is when educators attempt to improve it. But misconceptions about mathematics and mathematics learning are so deeply ingrained in our society that most people can't truly comprehend the improvements, so they fear and resist them. (Battista, 1999, p. 430)

The situation described by Mr. Battista was also true about the situation in Alberta in 1998. Many people felt that what had been taught in the past had served the students well, so why change it.

> They (Liu, Moody and Akbar) argue for a reinstatement of Euclidean geometry to the province-wide curriculum since it has been the "primary tool for teaching mathematical reasoning for several thousand years and has never been surpassed in this respect" (Steel, 1999, p. 27).

There was speculation among the public that the changes in the mathematics curriculum were not well thought out. There was a belief that the changes were being made simply for change sake.

> One of the reasons Alberta students get to be guinea pigs for new math is because the Alberta Department of Education appears to believe that whatever is newest is best. And we need the best right now because Alberta students have to compete around the globe.
>
> It did not seem to matter that Alberta already had a good high school math curriculum (students transferring here from B.C. and Ontario were considered to be a year behind their Alberta peers). Nor did it matter that Alberta workers have been respected globally for their technical know-how by such corporations as NorTel. (Toneguzzi, 1999, p. B5).

I am not sure if all the negative press and mistrust of Alberta Education could have been avoided, but I believe the situation could have been less severe had Alberta

Education received the support of key people and groups prior to the implementation. I believe that if there had been inservice opportunities for teachers prior to the implementation the teachers would have been more supportive. If the teachers were more supportive of the programs they would have been able to help dispel some of the parental fears about the new courses.

In many cases the public outcry was due to the poor test results of the students in the new courses. Many parents and teachers were claiming that the results were far lower than in the previous courses and that the failure rates were much higher. Alberta Education's response to this was to develop assessment standards for the 10 level courses. However, these standards were not developed until the first semester of implementation was almost over. The assessment standards should have been part of the teacher training prior to the courses being introduced. Normally, there is a pilot year for new courses so this would not have been an issue. Even without a pilot year, teachers would have been able to develop preliminary standards based on their best professional judgement. Teachers using these untested standards would have known that there could be areas that would have to change. This situation would have been far superior to the case of having no standards for the courses set at all. It seems that the standards for the grade 10 courses could have been developed in much the same way as the standards for the 20 and 30 level courses. The standards for the 20 and 30 level courses have been developed prior to anyone having completed the courses. Teachers were asked to use their best judgement and prior experiences to set benchmarks for the standards for the courses. These standards would then be reviewed when the courses had been taught. Teachers were extremely grateful for these standards as they helped inform them for setting course outlines and weighting of units.

There was much confusion among parents, teachers, administrators and school councilors about which program students should enter. This issue became so pronounced that Alberta Education curriculum staff traveled throughout the province in February and March of 1999. The purpose of these meetings was to speak to administrators and school guidance councilors about the new programs and how to determine which courses specific students should take. Unfortunately, by the time these meetings occurred, a whole semester had passed. These informational meetings should have occurred prior to implementation. Alberta Education would have been wise to budget for meetings across the province with administrators, parents and teachers in early spring of 1998. By doing this, students entering the programs in the fall of 1998 would have been able to make informed choices about programs.

Teachers Must be Supported

> *I'm worried that I'm not doing enough at the school. I am SO busy trying to do my best in the classroom, but others seem to do that plus coach teams, run clubs... So far, I really haven't done anything for grad. I have to take some initiative. Get myself busy in school affairs. People say I'm doing a great job in terms of dealing with students with poor attendance and problems, plus dealing with their parents and families. That makes me happy. But if I can just make myself indispensable to the school I'll be set.*

The pressure on teachers at the time of the implementation was incredible. Education budgets had been severely slashed resulting in larger classes and less support for teachers. Not only was Alberta Education not providing inservice at the start of the implementation, budget cuts had resulted in most school boards not having any consultants in their central offices.

> The course content at Alberta Schools is changing too quickly and placing too much stress on teachers, says a provincial council of school principals.
>
> "The amount of program changes is incredible, "Manny Ferreirinha, acting principal at Blessed Damien School in Calgary's Catholic district, said Tuesday. "It's a ton of change happening all at once, and there's not a lot of support for it." (Dawson, 1998, p. B5)

This *Calgary Herald* article also quoted Judy Tilston, chairwoman of Calgary's public school board, about the lack of support for teachers and school involved in curriculum change.

> "When the curriculum changed before, it didn't matter as much because people had the money to provide resources and professional support, and now they don't," Tilston said.
>
> She blamed the lack of funding for teacher support on Alberta Education, and said Calgary's public board has substantially reduced its curriculum support staff since the Alberta government restructuring in the mid-90's to balance the budget (Dawson, 1998, p. B5).

The lack of professional support caused many teachers to re-examine the reasons they joined the profession. Many teachers felt that they could not possibly accomplish all that was being asked of them. The new mathematics curriculum was not the only new item on their job descriptions. They were also now being asked to provide professional development plans to their principals at the start of the year with the understanding that these would be reviewed at the end of school year. In these plans, the teachers had to outline their plans for their own professional development in the school year. In many cases, these professional development opportunities were to be undertaken at the teachers' expense. Also, new in the teachers' job descriptions was the incorporation of the technology outcomes as mandated by Alberta Education. These outcomes described the technology skills students should have achieved at each grade level. The students were to achieve these outcomes as part of their regular school program.

I really don't know when I'll have time to get everything done. I'm already staying at school till about 6 and then doing a few more hours at home. This is crazy.

Further, many teachers found that their schools were not monetarily supportive of the new programs. It seemed that many school principals were used to handing their mathematics teachers a box of chalk in September and saying, "See you in June." The new programs required teachers have access to technology and equipment. To be able to accomplish the outcomes in the new program, the math departments needed larger budgets than they had before. For many teachers, because of school based budgeting, this meant they had to change the existing budget paradigms within their schools.

Alberta Education replied to the funding issue by announcing an incentive program to reward jurisdictions that showed improvement in a variety of ways, including provincial test scores. Many stakeholders felt that by offering an incentive program Alberta Education implied that teachers were not already doing their best. This incentive program met with so much opposition that it was placed on hold very quickly. However, some damage had been done. Joan Cunningham, principal of St. Monica Catholic Primary School, took, then Minister, Gary Mar to task in a letter to the editor.

> You and your caucus make it abundantly clear that you think of us as undeserving of any self-respect. And yet, we are to go into our classrooms each day and get those kids learning -Make you proud. Right, Minister? Let me tell you, sir, you are lucky to be getting the best education possible for our children when you use the power of your position to abuse the very persons who are charged with making your goals a reality.

> Give your head a shake. Do you think Glen Sather goes down into the dressing room before a game to tell the players how undeserving they are and to announce that low wages are all his players should expect? (Cunningham, 1999, p. A11)

Alberta Education replaced the original incentive proposal with one developed in cooperation with many of the stakeholders. The result of the new plan will help put more money into schools and this money can be used in accordance with the jurisdictions' needs. In some cases, this new funding will be used to help alleviate some of the costs involved with the introduction of the new math courses.

Stakeholders Must Have a Voice

One of the most serious concerns teachers had about the new Applied course was that it would not meet the needs of the average student. Teachers worried that, because the new programs were to be equally rigorous, the average math student would have no course to meet his or her needs. Sherry found this to be a confusing situation.

> *It would have helped if they had made the Applied for the middle level students instead of creating two courses of the same difficulty level. We are talking about offering a 10 prep course that will prepare kids for 10 Pure and not having 10 Applied at all. Wow! Now Alberta Education is not really sticking with their original plan. They said you HAD to have a bridging course to move between Math 10 Applied and Pure 10 for example. Well now they say you don't necessarily need it, with a recommendation you can move. Recommendations seem to screw things up and will mean I have students in my 10 Applied who*

should be in Math 14. Very confusing. We spend so much time talking about it, but not much happens or changes. It is so frustrating.

Alberta teachers were used to having two main streams in high school mathematics, the Math 13, 23, 33 stream and the more rigorous Math 10, 20, 30 stream. Students who were not successful in the academic stream could switch into the other stream with very little in a time penalty. For example, in most schools students who failed Math 10 with a 45% or better could switch streams and take Math 23 as their next math course. If the student then passed Math 23 they would be granted retroactive credits for Math 13. This situation meant that the student would have lost no time in the pursuit of their high school math credits. Students also had the option to switch from the Math 13, 23, 33 stream into the 10, 20, 30 stream. A student who had passed Math 13 could then take Math 10 or a student who had passed Math 23 could then take Math 20. Though not recommended by Alberta Education, many schools allowed students who were successful in Math 33 to take Math 30. In effect this meant that students who began in the easier stream were not blocked out of the academic stream, it simply meant that they would take an extra high school math course.

Bridging Courses

When the new high school programs were introduced, they were being touted as equal in rigor but the approach to the mathematics was very different. Because of the vast differences in approach it was felt that students would not be successful in switching from one program to the other. For this reason, Alberta education developed bridging courses which would allow transfer from one program to the other. If students wished to switch at the 10 or 20 level they would have to take a 3-credit bridging course. If they wished to change at the 30 level, they would be required to take a 5-credit bridging course. The introduction of these bridging courses met with a lot of opposition from teachers and administrators. Schools could not imagine that they could possibly timetable all these extra courses. Their resources were already being stretched, and many principals felt that they simply could not staff these extra courses. It seemed then, that because schools would not be able to offer these bridging courses students would have to stay in the program they chose at the onset. This was a situation that students and teachers were not familiar with and did not like. Alberta Education defended their position stating that the bridging courses were one way to satisfy the needs of students who required extra time to accomplish the same learning outcomes. The situation caused much confusion among those involved. For example, I answered phone calls from teachers in the field asking if they had to offer the bridging courses or was there some other way their students could switch from one program to the other.

Alberta Education responded to these concerns in a letter to junior and senior high school principals dated January 7, 1999. In this letter Jim Dueck, Assistant Deputy Minister, says, "Alternative course transfer sequences that do not require students to complete bridging courses are described in Attachment 2. The contents of Attachment 2, in part, state that the bridging courses are no longer necessary.

> Principals have indicated to us that they want the flexibility of being able to put students wishing to change from one course sequence to the other into regularly scheduled classes of Applied or Pure Mathematics, rather than establish specially scheduled sections of bridging courses. In addition, they have asked Alberta Education for guidance in the use of principals' placements and challenge assessments in the new mathematics course structure.
>
> Principals have the right to waive prerequisites so as to allow students **who have passed one course** to take the course in the alternate sequence, whether at the same level or at the next level. In exercising this right, they should consider the following:

- Pure Mathematics 10-20-30 is extremely sequential. Students should be able to show either how they can attain, or that they have attained, the relevant algebra skills from the previous courses in Pure Mathematics. There is far less risk for students transferring to Pure Mathematics at the same level than for students transferring to Pure Mathematics at the next level.
- Success in Applied Mathematics 20-30 requires that students have significant computer skills, and the ability to work independently on novel problems and complex projects. Students should show that they have the relevant skills and abilities before thy are granted the waiver. Again, there is less risk for students transferring to Applied Mathematics at the same level than for students transferring to Applied Mathematics at the next level.
- Favourable teacher recommendations should be sought before granting the waiver. Students should have an excellent chance of success in the desired course before a waiver is given (Letter to Junior and Senior High School Principals from Jim Dueck, Assistant Deputy Minister, January 7, 1999)

Teachers were happy to see the government change their opinion on the bridging courses but it meant that what had been true for students in the first semester was no longer true. Many teachers felt that, because it appeared the rules were changing, parents were questioning the teachers' credibility and with justification. The teachers had told parents that students could only change programs by taking a bridging course but now the students could change if given a waiver. Many stakeholders felt that Alberta Education, in their rush to implement the new programs, had not taken the time necessary to be able to judge the impact of the implementation from several different angles. It was felt that they only addressed the implementation from the view of the government and did not take into account the realities in the schools.

The delays in the implementation of the Applied course also caused timetabling problems for schools and confusion for students entering into grade 10. Students could choose to enter into the Pure Math 10 course or, in some schools, students could choose Math 13. In other schools, students could not choose Math 13 because that school had decided to implement the Applied Math 10 course. This confusion was further enhanced when Minister Mar was quoted in the *Edmonton Journal* (Unland, 1999, p. B3) as saying he was rethinking the position that Math 13 would no longer be available in September 2000. He later changed this position saying that the mandatory implementation of the Applied Program would go ahead as scheduled in September 2000.

Changes Since Implementation

One of the biggest changes since the implementation of the new mathematics programs was the merger of Alberta Education and Advanced Education into the new portfolio, Alberta Learning. Had this change occurred prior to implementation the issue of the acceptance of the Applied Program by post-secondary institutions may have been less intense. I do not think that the issue could have been entirely avoided but I think that if the two levels of education were working together greater acceptance could have occurred. Had assessment standards been available for the institutions to peruse informed decisions could have been made. Even though these were not available, the acceptance of the programs by various institutions occurred throughout 1998 and into 1999. Perhaps, if the two ministries had been working together, the acceptance by institutions could have been released prior to implementation. This would have greatly alleviated some of the problems faced by student councilors in the schools.

Another major change since the introduction of the math programs is reorganization within Alberta Learning. Under the new organization, providing service to stakeholders appears to be a priority. Also, the Minister of Alberta Learning is no longer Mr. Mar but is Dr. Oberg. Dr. Oberg made many decisions early in his ministry which led teachers to believe he was listening to their concerns and reacting to their needs. He placed the School Performance Incentive Program on hold, he fired the Calgary Board of Education, and he announced a one-time grant of $151 million to school boards to alleviate their debts. These actions met with favor among teachers and helped inform their sense of a working partnership with Alberta Learning.

Though there were still some negative feelings among teachers about the new programs and their implementation they knew their voices were being heard. In my assessment, the government would have served its clients better had more preparation work, prior to the implementation, been done. This preparation work could have made the transition from the old programs to the new ones smoother. The ministry did, however, respond to the concerns of the parents, teachers, students and other stakeholders. The mandatory implementation of the Applied Program was delayed by a year twice, assessment standards for the new courses were produced, a Mathematics 10 Preparation course was developed and was offered for credit in high schools, and money was provided for inservice of mathematics teachers. This response proved to teachers that if they rallied together changes would be made.

Learning from Our Mistakes

The next subject to be implemented by the WCP partners is the English Language Arts program. The style of the implementation of the English Program is very different from the one in mathematics. First of all, a discussion draft of the program with a response guide was sent to all superintendents, high school principals, and English department heads. These documents were also sent to the senior academic officer in each of the post-secondary institutes in Alberta. These documents were sent out in April of

1999 and by September of 1999 over 120 responses had been received by Alberta Learning.

The concerns expressed by the respondents focussed on several key areas. Alberta Education responded to these concerns in a letter to the respondents dated Oct. 4, 1999. The main concern of the respondents was related to the equal rigor of the two course sequences. The respondents felt that these courses would not address the needs of the students enrolled in the English 13, 23,33 sequence. In response to this Alberta Education was prepared to develop a common grade ten course but the courses at the 20 and 30 level would be differentiated. A second concern expressed the fear that the focus on communication in the one sequence would diminish the role of literature study. Alberta Education ensured the stakeholders that all aspects of the programs would support the development of a strong literature base in students. The third concern was related to professional development. Once again, Alberta Education addressed the concern and assured teachers that support would be part of the implementation plan. It appeared that the concerns expressed by the English stakeholders were very like the ones expressed by the Mathematics community. The concerns expressed in these submissions were addressed when the "pre-pilot" draft of the program was produced.

There were still some concerns expressed by individual teachers and by organizations such as the ATA about the proposed structure. These concerns led Alberta Education to revise their plan. These revisions were outlined to stakeholders in a letter dated November 18, 1999. In this letter, Alberta Education acknowledges teachers' beliefs that there should be differentiated courses beginning in the grade 10 year. In response, Alberta Education stated that there would be two courses, differentiated by standards, at the grade 10, 11 and 12 levels. It was clearly stated in the letter that the standard for the new English Language Arts 10G, English Language Arts 20G, and the English Language Arts 30 G would be similar to the standards for the current English 13-23-33 course sequence. This was very different from the approach first taken with the math programs. It was not until standards were being set that teachers were told to set the standards for the students who would be in the program.

Another difference between the implementation of the math and English programs was that the new English program would have a "pre-pilot" phase where approximately 12 senior high schools from across the province would pilot a phase of the program in the 1999-2000 school year. A formal pilot phase beginning in grade 10 in September of 2000 would follow this. Grade 11 would occur the following year and grade 12 the year after that. The full implementation would occur one year following each of the pilot years, that is: Grade 10- September 2001, Grade 11- September 2002 and Grade 12 -September 2003. Because Alberta is not the lead province for English Language Arts, they have been able to vary more from the agreements of the Protocol partners. In some cases, they have adjusted outcomes to better suit Alberta students and have not approved some of the resources which were approved by the WCP.

The Case of the Implementation of the Western Canada Protocol in Mathematics in Alberta has caused a revision in the implementation process by Alberta Learning. Other Ministries of Education can learn from the mistakes made in the implementation of the mathematics programs. I believe the time spent on educating the stakeholders prior to implementation cannot be overemphasized. Further, it is imperative to gain the support of influential individuals and organizations. The people involved need to not only have their voices heard but they must also believe that their concerns are important to the people in the Ministry and will be addressed.

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Appendix 1

Time Line for *WCP* in Mathematics

WCP agreement signed	December, 1993
Initial writing of outcomes in Regina	August, 1994
K-9 document signed	June, 1995
Writing senior high outcomes in Saskatoon	August, 1995
10-12 curriculum outcomes published	June, 1996
Request for Proposal for Applied resources issued.	December, 1997
Applied/Pure Program of Studies published	April, 1998
Delay in Applied implementation announced	Spring, 1998
Mandatory Implementation of Pure Mathematics 10	September, 1998
1st Optional Implementation of Applied Mathematics 10	September, 1998
Announcement of Mathematics 10 Prep	January, 1999
Second year of optional implementation for Applied announced	February, 1999
Announcement of $2.2 million in inservice money for Mathematics teachers	February, 1999
Mandatory Implementation of Pure Mathematics 20	September, 1999
2nd Optional Implementation of Applied Mathematics 10	September, 1999
1st Optional Implementation of Applied Mathematics 20	September, 1999
Mandatory Implementation of Pure Mathematics 30	September, 2000
Mandatory Implementation of Applied Mathematics 10	September, 2000
2nd Optional Implementation of Applied Mathematics 20	September, 2000
1st Optional Implementation of Applied Mathematics 30	September, 2000
1st pilot (20%) diploma examinations from Pure & Applied Mathematics 30	January, 2001
Mandatory Implementation of Applied Mathematics 20	September, 2001
2nd Optional Implementation of Applied Mathematics 30	September, 2001
Mandatory Implementation of Applied Mathematics 30	September, 2002