ACCESSING SENIOR SCIENCE AND MATHEMATICS COURSE OFFERINGS IN SMALL RURAL BC HIGH SCHOOLS

by

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ABSTRACT

Access to an equitable educational environment for all students is one of the key goals of the public education system in the Province of British Columbia. The attainment of this goal is problematic, particularly for students in small rural high schools around the province. Compared to provincial averages, students in small rural schools participate at lower rates in provincial examinations for senior science and mathematics courses. This in part could be an issue of access for these students. In an attempt to make sense of this situation, the current study was undertaken. Through a mixed-method interpretive approach, the perspectives of principals, teachers and students from selected small rural schools were sought through questionnaires and follow-up interviews on the issues that impact student access to senior science and mathematics courses.

From the study emerged a number of key factors that impact student access to senior science and mathematics courses, among which include students' access to specialist teachers, distribution of qualified and experienced teachers, student attitudes and aspirations and organizational support for course delivery at the school. The study shows that specialist teachers are unevenly distributed among the participating small rural schools. Additionally, teachers likely teach the majority of their courses outside of their subject specialty areas. Because the schools are small, there are few students who choose to take advanced courses in science and mathematics, which challenges the school's organizational ability to offer these low-enroling courses.

TABLE OF CONTENTS

List of Tables

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CHAPTER 1

Introduction

Small rural schools in BC are as diverse as the landscape that surrounds them. From remote coastal fishing villages, to mining or logging camps in the mountains, to grasslands and the open ranges of the province's interior, schools that serve the student populations in these communities are unique too. As such, they are closely tied to the local culture, and in a sense are microcosms of the local environment. Barker and Gump (1964) in speaking of the ecological context of knowledge development suggested this in saying, "the *course* of the life space can only be known within the ecological environment in which it is embedded" (p. 8). This study attempts to gain a better understanding of the conditions of this life space for students in small rural schools.

Many different criteria could be used to judge whether a school is small enough to be called *small*. But, as we will see, the definition chosen depends on one's point of view. *Rural*, also is a relative term, which has differential meaning depending on context. In the prairie regions of Canada and the US, the distinction mostly means that farming and agriculture form the local economic base. But, in BC, a wider view of what constitutes 'rural' makes sense for BC, since *rural* seems to take in almost any sort of area where people live close to the land, and work in resource extractive activities, such as logging, mining or fishing. Rural communities, then, are found scattered all over the Province of British Columbia (BC), perhaps accessible by floatplane, ferry, paved highway or gravel road.

The local community may have a population of 7000 or fewer than 100. School sizes vary according to the size of the town and the number of students in the surrounding countryside

who can access the physical plant of the school. Many students take long bus rides to get to school. Some commute by boat. Others walk down the street.

The school in the local town may have its own configuration of grade levels. For example, it could serve grades K to 12. Or the town may have one elementary school for grades K to 7 and one high school, serving grades 8 to 12. Other configurations can also be found. Some small towns have an extension or adult learning center, which may be attached to a regional university college or the local school district. Many communities also have some form of private school, whether it is for pre-school, elementary or secondary students. In any case, students from the surrounding area attend school at the facility to which they have access.

Teachers, also, must access the school to do their work. Most of those who work in small rural schools live in the same community. In many small towns, the distance to the next town is great, across difficult terrain, and so, commuting to work is not an option. As a result, most teachers in small rural schools live their lives with a lack of anonymity unimagined by their colleagues and other professionals in urban centers.

1.1 Situating the Researcher and the Study

My own educational history has led me to the current point of my life: a 'liberal arts' college with a direct connection to the Lutheran church granted my bachelor's degree. I agree with the philosophy of this college that intentional and broad exposure to the big ideas in history, philosophy, religion, literature, sciences, arts, among others, provides students with the foundations whereby human existence can be understood in the context of the larger whole.

Viewing our present place in the history of human society, from the variety of perspectives offered through the subject disciplines, enables us to learn from the past, form reasonable judgments and responses to the present, and make plans to guide us into the future. It is from this background that I view teaching as a calling and a passion.

Save one, the schools listed on my resume are mostly small, and mostly rural. One of them involved commuting by boat across the Inside Passage to work each day. As a teacher, my workload has always been diverse, including a variety of courses in a number of disciplines. While my original teaching qualification is in biology, I was hired to teach chemistry and physics for my most recent posting. In the second year at that school, mathematics was added. The schools in the district have been dealing with declining enrolments for a number of years. Fewer teachers are needed each year, resulting in shifting workloads. After a total of four years in the district, my future employment was growing less certain each year.

Seniority issues dominated conversations at the end of each school year, as every teacher in the district wondered which formula would be used this year to implement lay offs, and how many years of seniority a given teacher would need in order to avoid the layoff notices at his or her school. Some of the schools in the district had teachers with 25 or more years of seniority as the least senior members of the staff, who were periodically subjected to layoff notices.

The issue of job uncertainty was a familiar refrain heard in many of the other schools and districts where I have worked. So, it could be said that my move to university was in a way opportunistic. Even as a 'specialist' teacher, I was gradually being pushed out of the district, and my principal supported the notion to return to university to take up graduate studies.

My own experience as a teacher in several small rural schools in BC has made me curious about the conditions under which other small schools in BC operate. I wondered whether my experience of being hired to teach subjects outside of my area of specialization was unique,

or if this was a common pattern around the rural areas of BC. If in fact my experience was not unique, what sort of impact does this particular issue have on the students in these schools? I also wondered how a teacher's background prepares him or her to work in a small rural community. Are there certain elements that enable a person to be a more effective teacher in the setting of a small rural school? I had hoped to find out what these elements might be, but this is a far more complex issue to investigate. Does this mean students experience school differently by virtue of attending a small rural school? What issues of access do students face in small rural schools? A number of these questions have provided a baseline for the inquiry during coursework and research throughout my Masters' program.

This study has been framed to look specifically at issues of access for students in small rural schools to the school subjects of science and mathematics at the senior level, specifically, Biology, Chemistry, Physics and Principles of Mathematics. These are grade 11 and 12 courses that explicitly or implicitly are entrance requirements for post-secondary programs, and ultimately, technical and professional careers. Over the years of my teaching career, I have had opportunity to teach all of these courses, and it is my view that these are important subjects and courses for all students to engage with during and after their high school years. I have seen my role as one in which the subjects I teach provide a starting place for looking at the larger picture of human society, and man's place in the universe. So it is with my graduate work: The subject areas provide a starting place. A broad base of knowledge across a range of subject areas and disciplines, in my view, provides foundational knowledge that can be called upon as needed throughout our lives. An important goal of education, then, is for students to gain exposure to the big ideas and build background knowledge in the various subject areas thus providing a framework for information processing and decision-making, ultimately leading to becoming thoughtful, informed and responsible citizens.

We live in a world where political and economic forces dictate many aspects of our lives. A critical mind, developed through the subject disciplines (and not just sciences and mathematics) allows contemplation and assessment of competing viewpoints, which have often been set up as adversarial and serve to obfuscate underlying power issues and struggles. The science disciplines (including mathematics) provide a view of the world that offers tools for assessing reliability of claims, mechanisms whereby competing viewpoints can be challenged, discussed and examined and a framework for how the greater forces operating in the universe can be understood and utilized to practical advantage (Kuhn, 1962/1996). These are important areas of study for all.

While the scientific disciplines, along with mathematics, are the areas chosen for this particular investigation, the disciplinary areas of Technology Education, Computer Studies and Information Technology are likewise considered by many as prerequisite knowledge for life in our modern information age. These growing areas, in terms of applications to our everyday lives, are also foundational for our understanding of emerging policy issues, recent technical innovations and their potential impacts, lifestyles and many other facets of modern life, provided that they are taught with an eye toward social consciousness and an ecological perspective (Petrina & Dalley, 2003). This has not been the case, nor is it likely to be, according to Petrina and Dalley, as shop teachers are apparently among the most conservative of teachers. It is further argued that this conservatism sustains the wide gender imbalance in technology courses and programs. While the issue of gender is only peripheral to this study, it is important to acknowledge the existence of this type of disparity where access issues are being considered.

Students choose courses for their graduation programs, and it is often for the utility of the mark they can achieve. The courses provide opportunity to consider options for the future, but

students also see high school courses as prerequisites for further study and career paths. It is also important, in this modern era of technological dependence, innovation and opportunity that students develop knowledge, skills, problem solving ability and habits of mind in order to participate meaningfully in society and have a range of future choices open to them. These are lofty goals and high schools are the last place where a mandatory curriculum is in place. It is here that student interest and options need to be encouraged, explored and codified. Chalmers (1999) has said, "The courses of action open to them...will be determined by the access that they have in practice to the resources necessary for various courses of action" (p. 158). Chalmers' view seems to support a liberal arts perspective on the importance of a broad general education. From the perspectives of the study participants, this access depends on the conditions present in the learning environment at the local school.

This study seeks to gather the perspectives of those who work in small rural schools in British Columbia in science and mathematics around the issues of access faced by students in these schools. It is an interpretive study (Gallagher & Tobin, 1991), which makes no claim to being representative of all small rural schools, yet, certainly presents the stories of those principals, teachers and students on the issues which they believe impact student access to senior science and mathematics in their schools. From a multiple-worlds perspective, participants' views arise from the context of the places where they live and work. These include language and customs, local values, both religious and political, and heritage. The study has collected a diversity of perspectives and worldviews from many regions of the province. Each participant had the opportunity to consider the questions asked and the responses generated as representing the unique situation of his or her life experience. From these stories emerged themes, which through the weight and diversity of perspectives constitute a case study of small rural schools in BC examining the factors that impact student access to senior science and mathematics courses.

1.2 Science and Mathematics as Subject Areas

At the turn of the 20th century, society placed great value on the instrumentality of science through a logical-positivist view (Chalmers, 1999; DeBoer, 2000; Layton, Jenkins, Macgill & Davey, 1993; Matthews, 1994). Education was seen as a social cause, empowering the individual (Dewey, 1910/1991). Being educated meant reason could be used to protect against the excesses of arbitrary authority and help society move toward a democratic ideal. Secondary education, according to Dewey (1915/1961), should give students the opportunity to discover facts, verify principles, study the relationship between means and ends and in general, develop greater independence and individuality. Course offerings in school in the various subject areas offer these opportunities. Relevance was a critical value: that which makes the individual a better person was a personal as well as social goal.

Science and scientific knowledge were valued for what they lent to our understanding of the universe. The potential of great material benefit was seen, as was science for science' sake. At the time, and through much of the 20th century, muscle power was the force for economic output (D. Marshall, 1993) only to be supplanted more recently by information technology and brainpower.

At the turn of the 21st century, in our so-called "information age," the production of scientific and technologically literate citizens has become a concern for national security, economic and political, as well as individual interests. To contribute to discussion of important societal issues, familiarity with the underlying scientific concepts is necessary, as well as a sense of how systems of power and control serve to propagate and sustain themselves. Thus, foundational knowledge in science and mathematics is important. However, the nature of this

knowledge is contentious and evolving. In my view, along with many others, this justifies attention to socio-cultural, political and economic forces operating in society in the teaching of school subjects, as well as those that shape the curriculum (Aikenhead, 1994; DeBoer, 2000; Hodson, 1998). Such an emphasis is advocated in a Science-Technology-Society (STS) approach to science and mathematics education, and while the actual implementation of the approach has been challenging, the goals remain valid.

There are additional goals in the pursuit of science, mathematics and technology knowledge, such as intrinsic interest in the subjects or as a basis for economic development. These are societal goals, which are taken up as individual goals as students move through their school years. These will be discussed in a later section, but in order for students to gain access to scientific knowledge, they need to have access to conditions and coursework in school, which will ultimately enable satisfactory achievement of the personal and societal goals.

Students who live in remote communities set lower expectations for their own educational goals (Andres & Looker, 2001; Looker, 2001). The extent to which this is a consequence of student access to courses and subsequent course-taking behavior among students in BC's small rural schools is unknown. What perceptions do students have on their access to science and mathematics courses? What are the factors that impact access for these students? It is in this context that the need for this study becomes apparent. A case study (Merriam, 1988, 1998; Stake, 1995, 1998, 2000; Yin, 2003) to examine the factors that impact students' access to senior science and mathematics courses in the small rural schools of British Columbia is presented.

1.3 Organization of the Thesis

The thesis is organized into five chapters. The current chapter introduces the researcher and area of interest being addressed by the study. The framework and background for the study is developed in Chapter Two, where literature is reviewed and the problem statement identified. Chapter Three describes the methodology utilized in the conduct of the study, while Chapter Four presents results and discussion. Here, the voices of the participants are heard, and the overall themes emergent from the study are presented. The themes are discussed as they relate to the larger issue of student access to senior science and mathematics courses in the small rural schools of BC. The last chapter, Chapter Five, draws conclusions and proffers suggestions that might be useful in alleviating the challenge of access to senior science and mathematics courses for students in small rural BC high schools. The chapter ends by examining the implications of the study outcomes for appreciation of the status of "access" to appropriate courses by students and suggests questions for further research.

CHAPTER 2

Theoretical Framework

This study considers access to education, and in particular, senior science and mathematics courses, an equity issue. Equity and equitable opportunity are concepts that need operationalizing in order to consider what constitutes access (Ennis, 1976). Where students live and go to school either facilitates or inhibits their access. Student access to science and mathematics in high school means availability of courses in the local schools. Course offerings in high school in part dictate a student's potential to pursue a particular career or educational pathway. Increasingly, the business community, for instance, in British Columbia is encouraging students to pursue technical and professional occupations, many of which require solid foundations in science and mathematics and access to which seems to vary from district to district (BC Ministry of Education, 2003b). In other words, depending on where a student lives, there is a question of access to these courses.

2.1 Equity and Educational Opportunity

During the 1970s, there seemed to be wide general agreement on the ideal of "equality of educational opportunity" as a desirable goal for educational policy (Ennis, 1976). However, the agreement must be questioned when one begins to examine contextual application of this rather ambiguous concept. To call something *equal*, there must be some sort of comparative framework: *Equal* to what?

Controversy abounds over what constitutes *equality of educational opportunity* (Ennis, 1976). What comprises an opportunity? According to Ennis, *education* determines whether student interests are served through the programs offered at the school, and hence, opportunities made available. A number of factors indicate whether or not students will take these opportunities. The factors may be, for instance, environmental, based on personal differences or policy-related. Opportunities, at the school level, are presented in terms of course offerings and programs available to students. If access to these courses and programs is evenly distributed so that every student has the same experience when seeking access to them, then ideally it can be said that access is equitably distributed or experienced. But, if some students can access these courses and programs more than others, then there obviously becomes an issue of inequitable distribution of the opportunity to access the courses and programs.

Two Views of Equity

Equity in education, therefore, becomes a question of equal opportunities to access courses, programs and all other activities constituting education. This study focuses on the senior science and mathematics courses. To ensure equitable access to education and by implication, equal opportunity to access senior science and mathematics courses, one would easily be tempted to adopt a simplistic view of 'one size fits all.' A 'one-size-fits-all' education can be seen as appropriate for everyone, because then the same conditions are present for everyone and it can be called equality of educational opportunity. But, in practice, this is not possible for a number of reasons. Students' backgrounds, interests and individual differences are confounding factors when considering a question of equity or equitable distribution of opportunities. Therefore, true equality of access is not just simple division of opportunities by the number of centers offering the opportunities. Rather, it is a complex distribution of opportunities based on factors such as

regional geography, individual characteristics and environmental differences, such as having a stimulating home environment, parental encouragement and financial support (Ennis, 1976). Furlong and Cartmel (1997) have argued that these factors remain most influential for which possible futures young adults can realistically envision for themselves and how educational opportunity is accessed. In other words, this reduces to what Ennis considers to be the goals held for each child and for education. It then becomes a question of value judgment, hence the question of what an education is supposed to do.

Burbules, Lord and Sherman (1982), see a "Fairness Principle" applied as a matter of social justice. In a nod to Aristotle's Equality Principle, Burbules et al. justify an appropriately unequal distribution of resources in the name of equal opportunity as appropriate because individuals have different strengths and weaknesses, as well as interests and aspirations. This differential distribution is then expected to equalize educational outcomes. This presupposes an understanding of which aspects are considered to be equal or unequal and why the difference is relevant. Value judgments creep in again, as relevance can only be determined by examining the means and the ends to achieving the desired outcomes. Which ends are considered worthy?

In this regard, Ennis (1976) and Burbules et al. (1982) appear to link opportunity to personal choice. This also assumes that human agents are knowledgeable and enabled (Sewell, 1992) to put their individual capabilities to the service of personal action. According to Burbules et al., the choice to undertake an effortful act can only be called an *opportunity* if an individual's decision to carry out the act is not constrained in some way. For example, the conditions for access to the opportunity may include criteria for access, such as traits or abilities the individual must possess in order to gain access to the opportunity. These constitute constraints and justify supports in order to allow the individual to gain access to the opportunity. Only after constraints to access have been alleviated does it become a real choice, whereupon it is the individual's

prerogative to take advantage of the opportunity or not.

Formalist and Actualist Views

There are two perspectives to consider on what constitutes *equitable opportunity*. These are much like the two perspectives offered by Ennis (1976), but labeled formalist and actualist by Burbules et al. (1982). The formalist sees choice as a personal freedom, from which advantage can be gained through individual effort. Herein, any disadvantage held by an individual is also the result of personal responsibility. Opportunities are equal because it is individual effort that dictates gaining advantage through the taking of the opportunity. This, in a way, is the modern extension of laissez-faire economics, harkening back to Adam Smith (1776/1904) and his writings on how society would progress: Through individual effort in a competitive struggle, the best and most capable would gain advantage and thrive, while those less well-endowed would not. Arguably, society as a whole would improve in this struggle. Darwin (1859/1985) later extended this argument to the natural world, in his arguments for "survival of the fittest." Struggle for survival as it applies to educational policy represents yet another value judgment when discussing equity of opportunity.

From an actualist perspective, a fairness component is important. Criteria of access may mean that an individual faces barriers to accessing the opportunity, and so the provision of means to overcome the barrier means that access to the opportunity becomes equitable. Burbules et al. (1982) suggest an allied view, which holds that there may be many different routes to attaining the different goals of education, and so personal choice comes into the decision over which route to take. In a way, this enables differently-abled people to achieve the same relative goals or educational outcomes.

Yet another perspective on equality is offered in the *Opportunity To Learn* (OTL)

standards, which arose out of accountability reform efforts in the US in the 1980s (Guiton & Oakes, 1995). These standards represent an effort to import a fairness component into another area of educational policy, that of student achievement. Many of the factors that relate to student achievement are not in direct control of the school, such as teacher quality, availability of materials and equipment and curricular tracking of students. An assumption is made that if all of these factors were equal, then schools and students would achieve at the same level. The reality is that all schools are not equal, so the OTL standards are an effort to identify the distributional inequities found across schools and school systems so that differences can be seen more clearly, and remedies developed. And, despite years of promoting student achievement as a goal, the strongest predictor for academic achievement remains the student's socioeconomic background (Furlong & Cartmel, 1997).

Equity and Course Selections

To study sciences or mathematics at the post-secondary level, and hence gain access to scientific occupations and careers, prerequisite preparation at the senior high school level is necessary, since these courses are foundational for many professional and technical programs (BC Ministry of Education, 2002b, 2003b). Thus, access to these prerequisite courses, becomes an issue of equity as well as agency, since students who attend the larger, mostly urban, schools in BC have a variety of courses from which to choose, while students in the small rural schools of BC have a limited set of choices. For example, courses which serve a scientific literacy purpose or as prerequisites for post-secondary entrance should be available and "equally good," (BC Ministry of Education, 2003b) in all schools. Addressing issues of equity in terms of course selections is very important. Eisner (1998) says,

> Educational equity is provided to the young not simply by giving them access to our schools, but by providing programs that enable them to become what they have the potential to be once they pass through the schoolhouse door. (p. 18)

Equity should therefore be viewed as a goal of education, the same way that student achievement is. In terms of student achievement, a disparity exists between rural and urban areas (BC Ministry of Education, 2003a; BC Progress Board, 2002; Council of Ministers of Education Canada [CMEC], 2002). Addressing this disparity can be seen as a function of education as well as economic policy, since the students of today will become the workers of tomorrow. A Late Modern epistemology challenges the traditionalist view of labor market forces as collective social processes, and rather, suggests that these are now more individualistic since there exists a much greater diversity of possible future paths for young people. Hence, earning additional credentials through advanced schooling has become a point of access for young people in the transition to adulthood (Furlong & Cartmel, 1997).

Thus, the issue of educational equity should be of concern, especially when British Columbia's "prospects for prosperity" are linked to the capacity of its citizens to engage in continual learning and innovations (BC Progress Board, 2002), which as already pointed out depend on science and mathematics knowledge. Access to this knowledge appears to depend on where a student goes to school.

As the viability of many small schools is questioned (BC Ministry of Education, 2003a), the issue of equitable access, not only to science and mathematics courses, but also to education as a whole becomes important. The 1988 Curriculum Framework--Report of the Royal Commission (BC Ministry of Education, 1988) underscored the importance of equity of access to educational resources by students. From an actualist perspective, this study views access to educational opportunity as requiring differential supports, in order that students, wherever they

live, gain this important criteria of access. It is expected that students receive differential opportunities due to individual and environmental differences. However, it is through their experience of access to the school subjects of science and mathematics that the issue of equitable access can be probed. From the students' perspectives, the experience of schooling is mediated through the curriculum.

2.2 Curriculum

Eisner's (1998) notion of educational equity underscores the importance and relevance of what is taught in the school, and reflects the value messages carried in the courses offered and the time allotted in their scheduling. Intentionally or unintentionally, status is accorded subjects and courses through these messages. This section of the thesis provides a framework to view schooling and curriculum. It begins with a brief history of curriculum development and then moves to the purposes of curriculum and schooling. School culture is also an important factor in an analysis of curriculum—both intended and delivered, and so the section concludes with a discussion of school culture in relation to the subjects of science and mathematics. Science and mathematics are said to have cultures too.

Curriculum as a field of study has evolved over the last 150 years or so (Pinar, Reynolds, Slattery & Taubman, 2002). Emphases within the school curriculum have always been shaped by the political, social, moral and economic interests of the time. An analysis, therefore, of the purposes of curriculum and the shape it takes is presupposed on the ideology and philosophy of the political economy of the day.

Early Purposes of Curriculum

In the early 1900s, waves of immigrants arrived on North American shores, and schools needed to provide language training and enculturation to the society. These are functional, yet broad goals, which Dewey argued didn't go far enough. According to Dewey (1897/1978), education is a process of living, and that therefore, the role of the school is to facilitate the students' participation in the process: language training and enculturation would be only part of the larger goal. Because there were hundreds of thousands of new people, a social efficiency model of schooling came to be, which in many ways, reflected the society at the time as it sought to exploit knowledge for capital gain in the most efficient manner possible. This industrial model of education was widely criticized as dehumanizing, particularly for children, who are by nature curious and social (Dewey, 1915/1961). Capitalizing on the nature of children's curiosity, Dewey's philosophy of education can be seen at the core of many curricula today, where learning is to be celebrated for learning's sake, and not just for the utility of industrial production of goods and services. While supporting the notion of education *through* occupations as an organizing theme for curriculum, Dewey was critical of limiting schooling to education *for* occupations, where workers were to be trained with the skills needed for the workplace.

Along with the utility of skill development, student interest in the process of learning was promoted through such curricular designs as the "Project Method" (Kilpatrick, 1918). A *project* was "a wholehearted purposeful activity proceeding in a social environment" (p. 320). Teachers were not to dictate what these projects should be, but rather students were to choose them in order to gain practice in purposing, planning, executing and judging (Pinar et al, 2002), so that the students' "native capacities" were not wasted. Through schooling then, students should learn not *what* to think, but rather, *how* to think. Kilpatrick believed that the content of the subject

matter was less important than the development of appropriate attitudes among students. Teachers served as guides in the process.

A subsequent notion of what schools and curriculum should do began to delineate the various functions that schools and communities were to have. Perhaps as a reaction to the public expense of training and enculturating the vast numbers of immigrants, Bobbitt (1924) was more prescriptive as to what is appropriate for a school to do and what should be left to other people, groups and organizations. "All education should proceed on the assumption that nothing should be done by the schools that can be sufficiently well accomplished through the normal processes of living" (p. 35). Curriculum was developed so that the "actual activities of mankind" were taught, for example, skills used in particular occupations. As a result, the needs of society would be filled through the personal development of the individual.

Later, in response to criticisms of the Project Method, Kilpatrick (1931) modified his views to reflect the need for educational change to deal with future uncertainty. He remained critical of the traditional, conservative nature of schooling, which had taught particular skills and facts. He favored a more holistic view, but espoused something of a contradiction on his earlier student-centered and teacher-guided approaches as they appertain to the work of science. Understanding the recurring patterns in nature was necessary in order for humans to have greater control over nature. Teachers, then, would have to direct what the students were studying, and for this, Kilpatrick was criticized. Tenenbaum (1939) accused Kilpatrick of "pedagogical stupidity" which didn't reveal itself until much later, when the students had left school and they couldn't actually think for themselves. Students, according to Tenenbaum, were unaware of their own shortcomings, having been victimized by the social project of the Project Method.

As arguments continued over what schools should do and what should be taught, Ralph Tyler (1949) was formulating a curriculum based on learning objectives. His *Basic Principles of*

Curriculum and Instruction became a most influential guide to curriculum as it itemized subject specific objectives while emphasizing the need to attend to learners' needs and the context of the larger society. For example, to produce objectives, Tyler asked scientists and science committees what the major functions of science are. From these functions he drew up overarching goals of science education, such as "contribute to individual and public health practices, attitudes and knowledge" or using and conserving natural resources (p. 30). Objectives could then be chosen that are small in number, highly consistent, follow the school's philosophy and emphasize democratic values. In this way, curriculum is acknowledged as value-laden and objectives become value judgments about what ought to be taught in school. These then form the organizing principles around which learning experiences are chosen. Continuity and sequencing must be ensured so that student knowledge continues to broaden and deepen as the student progresses through the school system.

Tyler's views on the nature of learning objectives, their importance and how to sequence them are visible in many curriculum guides that one could pick up today. Social and political forces have continued to operate to draw curricular emphases in different directions, yet the underlying structure of the curriculum remains as Tyler modeled it in 1949. Today, schools are seen as organic systems (Fullan, 1999), where teaching and learning are emotional practices typified by complex social interactions (Hargreaves, 2001). There are cultural and social factors of the school, community and home that link in complicated ways to the needs of the larger society (Fullan, Watson & Leithwood, 2003). Despite the newer language of some of the social and cultural objectives of learning, Larry Cuban has been critical of school reforms over the past century that "have ruffled the surface of the educational sea, but a fathom deep, in the classroom, practices remain remarkably consistent over time" (Tyack, 1990, p. 188). Reform efforts rarely deal with the issue of school culture, but change cannot happen without it.

School Culture

Culture is seen as a set of beliefs and assumptions that are shared by the members of the community (Evans, 1996; Geertz, 1973), and in this way, schools also have their own cultures. Sarason (1981) says that this represents a barrier to understanding schools, as they are each unique in this regard.

A cultural perspective on the role of schools extends to the social construction of knowledge. Students need to be taught to be critical of their own ideas, and then construct alternate theories (Brickhouse, 1994). Additional "antinomies" also exist in schools, further complicating their missions and operations. Bruner (1996) listed these as important: 1) emphasis on developing human potential or reproducing culture, 2) promote individual ability or the cultural setting in which he or she operates and, 3) views on nature of truth--anti-authoritarian or universality of truth. The larger goals of education and society cannot be separated from the school and what it is supposed to do. Many contemporary curricula reflect this.

Tyler (1949) argued that school curricula must serve the needs of society. In this regard, as society becomes increasingly technological, the need for scientific and mathematical literacy grows (BC Progress Board, 2002; Business Council of BC, 2003a). But the kind of literacy sought by the business community and industry groups to further an economic agenda is different from that advocated by science educators.

Science educators advocate for a broader vision of science education, which includes familiarity with the natural world, an awareness of the ways that science, mathematics and technology contribute to understanding the world, and additionally, the need to understand these as human enterprises, a capacity for scientific ways of thinking and being able to use scientific knowledge and ways of thinking for personal and social purposes (Collins, 1998; DeBoer, 2000). For any of these goals to become actualized, they must first be articulated into a curriculum.

2.3 The Status of Science and Mathematics in School Curricula

A traditional view of the need for a science education holds that people should understand the physical world, in order to explain everyday occurrences (Bateson, Erickson, Gaskell & Wideen, 1991). This view of knowledge in the logico-positivist tradition saw science as a discrete entity, which could be understood and controlled. Those everyday occurrences have grown in complexity as facets of our society have become increasingly technical, and so, now, science and technology are seen to dominate all aspects of modern life. Our notions of the nature of science have changed too (Good & Shymansky, 2001). There exists a tension between modern and post-modern views of what science can (and should) do, and in many ways, these reflect the value attached to different types of knowledge, who it represents and what it ought to do (Harding, 1991). Science knowledge and science education are seen as foundational for engagement in this discussion, as well as for people to be informed citizens and consumers, politically aware and actively participate in society (DeBoer, 2000; Matthews, 1994; Rutherford & Ahlgren, 1990; Science Council of Canada, 1984). Duschl (1988) has argued that science education must broaden beyond the modern view of understanding what is known to include how science and technology have developed. Translated into the curriculum of high school science courses, these concerns should be at the heart of curriculum development.

Science and mathematics are seen as status subjects in school (DeBoer, 2000; Rutherford & Ahlgren, 1990; Matthews, 1994). To students, this means that they must be taken in order to get into university. Indeed, completion of courses in these subjects is prerequisite for entry into a variety of post-secondary programs. These courses have been called "academic capital" (Alexander, Holupka & Pallas, 1987; Andres, 1992; Turrittin, Anisef & MacKinnon, 1983), and

the school has responsibility for providing opportunities for students to develop the potential of their own academic capital (BC Ministry of Education, 2003d; BC Progress Board, 2002). To offer the BC Graduation Program, which currently includes the 11th and 12th grades, high schools must offer course choices so that students may complete the high school graduation requirements and entrance requirements for their desired career paths (BC Ministry of Education, 2003d). The *senior* courses then, serve the purposes of graduation and entry to post-secondary institutions, hence their importance as determinants for high school students' post-secondary career choices.

The Importance of Science, Mathematics and Technology

The current political economy, which has arguably been operating since the turn of the 20th century, continues to use a utilitarian notion of science education as an engine for producing new goods and services. Shifting in the nature of the goods and services produced, since Sputnik, has seen a heightened awareness of the need for developing advanced technologies, which have been perceived as dependent on science, mathematics and technology. The Conference Board of Canada (2003) sees scientific and mathematical literacy as foundational to our national ability to innovate. This argument has been used repeatedly to suggest that the production of more scientists and thus technical innovation can lead to industrial innovation, economic growth and national security. This business view is but one of many that emphasizes science and mathematics education as important.

Other organizations have expressed concern over the problem of finding skilled workers, suggesting that the public education system should train workers for the jobs already out there (BC Progress Board, 2002; Business Council of BC [BCBC], 2003b; CMEC, 2002; Premier's Council on Technology, 2003; Vancouver Board of Trade, 2003). Even researchers in rural education have criticized the capitalist, neo-liberal direction that public-schools-as-skills-

training-centers-for-industry has taken. Haas and Nachtigal (1998) also argue that students need to be trained how to create jobs, not just land them.

Training to work in a particular job is different from learning how to develop new kinds of jobs, or gain prerequisites for post-secondary attendance and subsequent careers based in science and mathematics. If the skills-training agenda is followed, a narrowing of what counts as science and mathematics education (to the specific skills needed in a particular job) may be the end result. Both business and schools have expressed similar concerns and supported this need for skill development, but many of the skills in the so-called "new economy" are in the hospitality and tourism industries, which do not require the advanced courses in science and mathematics. They are notoriously low-paid, low skilled and seasonal (Reid, 1989; Rothman, 1998). By way of contrast, training leading to the technical occupations, which require science and mathematics as prerequisites, can prepare young people for high-paying and high-status careers. Adamuti-Trache (2003) has confirmed this. Herein lies the problem with advancing the service economy as an economic driver.

Recent changes to the BC high school graduation requirements allow for more locally developed courses, such as Entrepreneurship, Hotel Management and Food Service, to meet graduation requirements (BC Ministry of Education, 2003d). Expansion of such programs may be seen as a way around the science and mathematics requisites and allow more students entry into these industries. But they also have the potential to produce a generation of low-level skilled workers who are scientifically and mathematically illiterate, since the science and mathematics components of these programs are of a 'Minimum Essential' variety, which means that they are far less demanding of students than are the senior science and mathematics courses recognized as prerequisites for post-secondary programs and in many ways are more focused on particular skills. For example, the *Essentials of Mathematics 11* course (BC Ministry of Education, 2000),

which is the minimum graduation requirement for BC students, includes checkbook balancing in one of the units of study. While an important skill, it is hardly demanding a more substantial level of student thinking or problem solving, especially for a knowledge economy. Students who choose the less-demanding paths may be working in opposition to the desire expressed by the BCBC (2003a), among others, that young adults need access to training in higher-skilled, technical fields, such as computer and information technology, medical and engineering services and oil and gas exploration, to name a few.

These are some of the so-called "Third Option" careers (BCBC, 2003b) and have been recommended to parents and students because they do not require university training. In fact, the BC Business Council reports that while 69% of parents want their children to go to university, in reality, only 20% of all high school graduates actually attend university (BCBC, 2003b). In the BCBC survey, done in 2000, 28% of high school seniors applied to university, 21% were admitted and 16% actually attended. Andres (2002) reported a much higher percentage of university attendance among the BC graduating class of 1988, where 34% of women and 44% of men attended university in the year after high school graduation. While these reports appear to be discrepant, the point is that university is not where most students end up, parental expectations notwithstanding, and so it is appropriate to view science and mathematics courses in a wider view that includes non-university career pathways too.

Many of the skilled Third Option careers promoted by the BCBC (2003b) require foundations in science and mathematics. Examples include aviation and aerospace technology, mining and petroleum engineering, information and communication technologies, health care and forestry. These are technical careers, requiring specialized training. Offering students choices that will enable their participation in this technological society, wherever they live, is fundamental for our public school system (BC Ministry of Education, 2003d). Active

participation in a technological society is the basis for underscoring the importance of science and mathematics education.

Science and Science Education

Feminists are critical of the fact that in science certain types of knowledge are presented or offered as privileged, whether intentionally or not. Other forms are marginalized in a struggle for control and power (Harding, 1991), leading to increased status and power for some, while continuing to maintain the status quo, and disenfranchising the majority. Harding argues that the consequences of technological applications cannot be separated or removed from the social, moral and political discourses. The maintenance of status occurs through the decision-making of which questions can be asked, which research studies are funded and how the information is disseminated. When men are overrepresented as teachers in secondary science (73.0% of secondary science teachers in BC are men) and mathematics (70.4% are men) (BCTF, 1998), a particular view of science and science education may be propagated and a gendered perspective on the nature of science and mathematics is likely. A gendered perspective may not be a bad thing if it means that science teaching happens in a gender-fair manner by female-positive teachers (Taylor & Sweetnam, 1999). If science is not taught in such a manner, the entrenched biases will continue, further contributing to the leaky science pipeline. Not all science students will become scientists.

Gender bias is only part of the so-called "leaking science pipeline," a phenomenon which has received much attention (Davis et al, 1996; Hanson, 1996), and is more pronounced among young women (Adamuti-Trache, 2003). Topics in science courses may lack relevance for students and hence, interest and determination to enter fields of work within the scientific

disciplines may be unsustainable through the long and arduous process of graduate and post-doctoral work.

Rop (1997) has argued that more female students would pursue science careers if pedagogical approaches and the learning environment were more supportive of female ways of knowing. Some have criticized the conservative nature of the teaching profession, because teachers go about their practice much as their own teachers had (Lumpe, Haney & Czerniak, 2000).

A wider view of what counts as science education and why it is important is promoted in the ideology of Science-Technology and Society (STS) programs. Aikenhead (1994) and Ziman (1994) have argued that STS approaches stimulate student interest, as well as teach social responsibility. These goals are admirable, but the actualization of effective STS courses has been a problem (Hodson, 2001). One of the most significant problems came in the form of teacher resistance to the introduction of applied science programs in England, Wales and BC and industrial science in BC (Gaskell & Hepburn, 1997). Part of the acknowledged problem was the inability to define what emphasis the underlying science or trades principles should receive, as well as where the course should to be taught, e.g. the science department or the industrial shop. These disciplinary boundaries constitute a problem for re-envisioning any established program, and may in some ways reflect the culture of the subject as maintained by those who operate within it.

The Culture of School Science

Many science educators recognize the existence and influence of a "school culture" (Aikenhead, 1996, 2001; Aikenhead & Jegede, 1999; Cobern, 1993, 1996; Costa, 1995) on students' success in science. Aikenhead's (1996) description of culture seems apt: a culture has

its own attributes, communication strategies, social structures, customs, attitudes, values, beliefs, worldviews, skills, behavior and technologies. Within a culture can exist a variety of subcultures. For example, a small school may have had a chemistry teacher for a number of years, who consistently draws a disproportionately large number of students into Chemistry 11 and Chemistry 12. The subculture of this Chemistry classroom, then, is a part of the school culture, and could be said to have its own customs, structures, attitudes, beliefs, etc. Some teachers seem to draw more students into the subject areas, and could be said to successfully mediate student access to the subject. This is consistent with what Giroux (1992) suggested to be the role of a well-prepared teacher who is a subject specialist. Lave and Wenger (1991) would agree that teacher preparation is key for this type of mediation, as enculturation involves interaction with more experienced others (Chaiklin, 2003; Karpov, 2003).

Cobb (1994) has argued that learning involves both constructivist and socio-cultural processes, and if learning science is indeed enculturation, as Hodson and Hodson (1998) suggest, the borders inhibiting the development of personal relationships between teachers and students must be overcome. It may be according to what Roth, Boutonne, McRobbie and Lucas (1999) have suggested happens when people from different lifeworlds enter into dialogue, whereby differences are made clear and bridging the gap becomes possible. And, according to Duit and Treagust (2003), a new theory of learning will be needed too, which includes situational and cultural factors while attending to individual cognitive development. Teachers' responsibilities for enacting this new theory of learning will ultimately enable students to successfully negotiate access to the subcultures of science and mathematics.

Evidence for the existence of a unique subculture of school science can be found at many different levels of analysis: subject area classrooms, individual teacher's beliefs and attitudes, students' subcultures and community cultures. As a part of the learning environment, each of

these levels impacts what goes on in the school, how the community's values are transmitted and what type of experience each person in the school encounters.

While teachers represent the school's culture, they also represent a science teacher subculture that sometimes distorts the nature of science through science teachers' beliefs in classical empiricist and logical positivist views of the world (Duschl, 1988). A typical science teacher is a "positivist, authoritarian, non-humanist, objective, purely rational and empirical, universal, impersonal, socially sterile, impersonal teacher who is unencumbered by the vulgarity of human imagination, dogma, judgements, or cultural values" (Aikenhead, 1996, p. 39). In fairness, this assessment may not characterize all science teachers, but Aikenhead has further argued that this view is propagated in science classrooms, and for students to be successful in school science, a 'border crossing' must be negotiated (Aikenhead & Jegede, 1999; Giroux, 1992). Success in crossing this border is mediated through the school and its administration, the teachers and the students.

But, even successful students may adopt a Western view of science as the science worldview, and compartmentalize their own cultural belief systems in a form of 'cognitive apartheid' where different knowledge systems are utilized for different types of situations (Cobern, 1993). Jegede (1995) has called this 'collateral learning,' where despite conspicuous efforts to expand students' understandings to include a more scientific worldview, individual knowledge remains walled off and contextualized in different settings, such as school or community. Campbell, Lubben and Dlamini (2000) assert that, for students, the out-of-school domains are more important contexts for student learning than in-school settings. This poses problems for the efforts of the school and science teachers as they seek to help students construct more scientific personal worldviews.

Students' commonsense views may very well conflict with their teachers' (Cobern,

1993). Costa (1995) has observed that students negotiate the borders between home, family, peers and school and school science in one of several ways depending on how the subcultures of the student and school align. Many of BC's small rural schools are predominantly populated by First Nations students (BC Ministry of Education, 2003a). And, the majority of science teachers are typically white, male, middle class, authoritarian, and as mentioned previously, hold logical positivistic and classical empirical views on the nature of science (Duschl, 1988). While no grouping of people is homogenous, whether community, school or science teachers, there is a societal assumption that cultural knowledge is shared. But Krugly-Smolska (1995) sees this not to be the case. It may be that teachers hold an unexamined assumption that students have the responsibility to adapt their own understandings to the teachers' and the culture so represented. This could be one facet of the border between students and teachers, the negotiating of which is key to accessing school science.

Scientific Literacy

Scientific literacy is a widely stated goal for education, yet continues to defy definition (DeBoer, 2000). Its characterization has shifted over time, and now includes a little bit of everything:

> Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. (National Science Education Standards, quoted in DeBoer, 2000, p. 590)

These lofty goals end up being rather nebulous when a teacher must consider how to implement these notions into classroom practice.

There are also different forms of scientific knowledge. According to Latour (1987), "ready-made-science" is that body of knowledge that is taken for granted as truth. It is viewed as uncontroversial and presented as such. Another type is "science-in-the-making" where scientific knowledge is seen as a claim, which is subject to contestation and revision. It is this type of knowledge that has caused so much trouble in the current social context, since uninformed consideration of such claims may mistake these two types of knowledge for each other. It also depends on how *truth* is viewed.

Scientists and non-scientists view truth and scientific knowledge differently (Harding & Hare, 2000). To scientists, *truth* deals with individual theories, which are supported by a body of evidence. As this body of evidence grows, the understanding becomes less tentative. In other words, truth comes to be more certain as time goes on. To a non-scientist, including non-scientist teachers, *truth* deals with propositional knowledge, which is static. This is a narrow view of the nature of science, which can then be misrepresented to students. The importance of science teachers having a scientific conception of the nature of science is therefore very important.

Included in the concept of science literacy, then, is an individual's ability to assess truth claims according to a scientific worldview. Understanding the basis for claims of truth is quite different than understanding scientific principles in order to apply them in the production of goods and services. In a way, this reflects Dewey's (1915/1961) distinction between education *through* occupations as opposed to education *for* occupations. Perhaps 'science literacy' has become a rhetorical device, used to argue for whichever point of view is being espoused. Any discussion of what it means, how it is to be applied and what students should be able to do is at the same time, political, social and moral.

According to the *Integrated Learning Theory* (ILT), learning must be on-going as our society shifts from an industrial base to a learning one (Claxton, 1996). This will involve a wider view of scientific literacy, which takes in global, political, economic, psychological, spiritual and sociological perspectives. The social context of the learning is vital for both the teacher and the student, as knowledge is constructed in the collaborative environment of a classroom. Duit and Treagust (1998) argue that there is a strong connection between students learning science and the science knowledge of the teacher. My own experience learning and teaching science attests to this claim.

2.4 Teacher Expertise

Teachers make a critical difference for the learning environment of the classroom (Laczko & Berliner, 2001; Shulman, 1987; Stigler & Hiebert, 1999; Wenglinsky, 2002). Darling-Hammond (1997) has said

> Teacher expertise-what teachers know and can do-affects the entire core tasks of teaching. What teachers understand about content and students shapes how judiciously they select from texts and other materials and how effectively they present material in class. (p. 8)

Possession of expertise about pedagogy (or *pedagogical content knowledge* [PCK]) and curriculum (or *general content knowledge* [GCK]), as well as specific content knowledge (*subject matter knowledge* [SMK]), and strategies to employ this knowledge are prerequisite for teachers to be effective in their classrooms. These types of knowledges are particularly difficult to quantify, reflecting the complex interplay of the many facets of expert teaching. *Teacher knowledge* has been described as "a variety of cognitions from conscious and well-balanced to

unconscious and unreflected intuitions" (Henze, VanDriel & Verloop, 2004), having its origin within the content areas, the materials and settings of the institution, research on schooling, development and social organizations, as well as wisdom developed through practice. And, training to become a teacher during a teacher education program is only one of the places where this type of knowledge develops.

Pedagogical content knowledge [PCK] (Shulman, 1986) underlies teacher practice and has a variety of origins, including the teacher's life experiences, teacher training and subsequent practical development. It has been defined as "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own form of professional understanding" (Shulman, 1987, p. 8). PCK has 5 components for teachers and science teaching: 1) orientation toward teaching, 2) knowledge and beliefs about science curriculum, 3) knowledge and beliefs about student understanding of particular science topics, 4) knowledge and beliefs about assessment in science, and 5) knowledge and beliefs about instructional strategies (Magnusson, Krajcik & Borko, 1999). While components #3 and #5 have been emphasized as vital for classroom practice, Henze et al. (2004) acknowledge that the components interact in complex ways to inform a teacher's practice. But, PCK in all its complexity is just one dimension of teacher knowledge.

Expert teachers then, can be said to possess this complexity of knowledges, as well as knowledge of the learners and their characteristics, educational contexts and means, purposes and values of education (Shulman, 1987). How one can come to understand, and then develop these types of knowledge has become the focus of much research. Darling-Hammond (2000) has documented the importance of well-qualified teachers, in terms of content area expertise and knowledge of teaching and learning. She has subsequently supported the need for professional development that teachers choose for themselves, in order to further develop areas of subject

expertise, as well as practical knowledge. Other research has sought to identify tools for teachers to use in developing PCK. Henze et al. (2004) found the use of scientific models and modeling by teachers as effective in improving PCK. This work also suggests that students who work with expert teachers will develop subject interest, deeper understandings and achieve at higher levels, so the importance of teacher knowledge cannot be overstated.

Teacher expertise comprises a framework through which to view student access to senior science and mathematics. Brickhouse (1994) has characterized science subject matter knowledge according to three sets of views teachers hold on: 1) the nature of science theories; 2) the nature of scientific processes; and 3) the progression and change of scientific knowledge. The views that teachers hold in these three areas form the backdrop against which teaching is approached, and may, in many ways, be tacit (Polanyi, 1967). For instance, if a teacher holds the view that scientific theories are tools that scientists use to understand how things work, the emphasis in teaching will be on the utility of the theory. Conversely, if the teacher believes scientific theories represent immutable truth, instruction may emphasize identification and memorization of this truth. Hawk, Coble and Swanson (1985) have warned that in classrooms where teachers lack sufficient subject content knowledge, deficiencies can be expected in their representation of scientific theory.

Teachers who gain SMK through earning an undergraduate degree in a particular subject, and GPK and PCK through completion of a teacher education program, can be seen to have at least entry level competency for teaching the subject specialty courses in high schools. Certification to teach in British Columbia, at the secondary level, involves completion of an undergraduate degree and completion of a teacher training program through one of the universities or university colleges (BC Teacher Qualification Service, 2004). Experience is a most significant mode of teacher development (Shulman, 1987), and

> From the teacher's own accounts, but also from more detached research studies, it is clear that the teachers' previous *life experience and background* help shape their view of teaching and essential elements of their practice. (Goodson, 1992, p. 243)

Goodson goes on to speak of the teacher's lifestyle both in and out of school, his or her identities and cultures, and life cycle stage as places where understanding of teachers' practice can be gained. Study of how teachers do their work, combined with relevant professional development activities (Darling-Hammond, 1997, 2000), offer opportunity to study how teachers become expert. Just as PCK is inadequate by itself, so too SMK (Wilson, Floden & Ferrini-Mundy, 2002). Through a lack of these types of knowledge, teachers may limit their students' access to science and mathematics.

Sections 2.1, 2.2, 2.3 2.4 and 2.5 of this chapter have so far discussed how educational opportunity can be defined in terms of providing access for students to conditions for learning. What is considered equitable depends on the philosophical stance and assumptions of the viewer: equal may mean that the same thing is provided to everyone, or equal could mean that provision of opportunity is differential because people have different needs and therefore different criteria of access. The choice of perspective will dictate how educational services are provided.

A brief overview of science and mathematics as curricular areas provides a discussion point for theories in the development of curriculum. Even while these subjects are seen as high status, there are differing views on what type of science knowledge should be valued, and hence, taught in school. Teacher expertise in terms of pedagogical content knowledge and subject matter knowledge are complementary, and it may be that the teacher is the most significant factor in providing educational opportunity for students. Student access to the foundational courses in science and mathematics in small rural schools is the focus of this study. Section 2.6 provides a brief overview of the historical context of small schools both in the US and in Canada.

2.5 *Historical Context of Small Schools*

Small schools, at one time were seen as disadvantaged and deficient (Conant, 1959). Indeed, many still are (BC Ministry of Education, 2003a; DeYoung, 1994; Johnson & Johnson, 2002; Sher, 1983). In the postwar era in the US, small schools dotted the countryside. While population levels were small, small schools served the local population. A wave of population growth and moves to increase efficiencies saw the closing of thousands of small schools, and the consolidation of students into large, comprehensive high schools (Conant, 1967). It was believed that schools had to be large in order to effectively utilize school personnel, give students the chance to learn to get along with different people and allow academically talented students to take senior physics (Conant, 1959, 1967). The view of small schools as deficient is problematic, but has been used to justify school consolidation, arguably for the sake of efficiency in an economic argument.

This wave of consolidations created the mega-schools now common in most urban areas of the US. For instance, in Florida, one of the most populous states in the US, the average high school has 1,565 students, compared to Montana, one of the most sparsely populated, with an average of 277 students in its high schools (National Center for Education Statistics [NCES], 2003). The large schools in many parts of the US, particularly in urban centers, now experience poor performance, violence and social problems (American Broadcasting Corporation, 1999; British Broadcasting Corporation, 1998; NCES, 2002). Whereas large schools may provide benefits in terms of choices available to students, economically disadvantaged students do less well in large schools (Lee & Smith, 1997) and therefore, questions about the effectiveness of schooling are legitimately asked. The larger issue of what determines "effectiveness," and for

whom, is a separate issue from efficiency of school operation.

Conant (1959, 1967) used "economy of scale" concerns to justify increasing the size of schools. Now, the same justification is being used to close schools in BC. In the last two years, 81 of 92 schools that were closed were "rural" (BC Ministry of Education, 2003b; BC Teachers' Federation, 2003). More closures are expected for 2004/05 (Landry, 2004). School consolidation or closure in BC has been justified by asserting that small rural schools are too expensive to operate (among others, School District 57, School District 72, School District No. 61). Perhaps, in BC, we should ask, as did Sher (1983), too expensive "compared to what?" Darnell (1981, p. 227) concluded that "Fairness requires that funds be allocated in a variety of ways and amounts" and that in rural schools, the responsibility for providing equality of opportunity means that a higher cost can be expected and should rightly be borne. This actualist perspective on equality of opportunity can only be realized if the school remains open and services available. In other words, efficiency is a confounding variable in the picture of equality of opportunity. Sher (1995) pointed out that the fight to prevent a local school's closing is not the same as fighting to improve education and the conditions for the learning environment in schools. Where efficiency is concerned with spending less money on educational services, effectiveness means that appropriate services are being delivered. In some ways, these forces are competing, and overemphasis on one may preclude the other. The next section is devoted to examining the delivery of educational services in rural areas.

2.6 Education in Rural Areas

Researchers in rural schooling believe that education in rural areas is and should be distinct from education in suburban or metropolitan areas (Barnhardt & Barnhardt, 1983; Clark, 1992; Howley, 2002; Rural School and Community Trust [RSCT], 2000a, 2002a, 2002c; Sher, 1995). From the curriculum perspective, locally developed or centrally produced documents may present differing emphases. These two emphases are different within the curriculum perspective, as well as where curricular decisions are made. *Rural education* puts its focus on issues of local relevance, and hence, is developed locally, while *education in rural areas* subscribes to a belief in the universality of curriculum. Hence, it is centrally produced and delivered to all students, regardless of where they live. This is the case in BC, although discussion is beginning to happen over how to increase local content (BC Ministry of Education, 2003d).

The issue of who gets to decide the content and focus of the curriculum is widely discussed and highly contestable (Eisner, 1998; Evans, 1996; Fullan, 1999, 2001). The Australian Government policy on rural schooling has been criticized because it fails to honor the significant contributions made by rural areas to the social, economic and cultural fabric of Australia (Sher & Sher, 1994). Those who work in the rural areas of Australia believe that rural education should be conceived and deployed specifically for the students in that rural or remote location (Clark, 1992). This has been called *rural education* and can be viewed as localized, context-specific and environmentally based schooling developed by and for that community. Clark is critical of a universal view of the applicability of curriculum and argues that an imposed curriculum neglects consideration of the uniqueness of the local setting. It is therefore inappropriate to merely import curriculum and methods from an urban area (Clark, 1992). Sher

and Sher (1994) advocate an emphasis on the local community as the focal point for education through a rural education policy that has four E's: Empowerment, Environment, Entrepreneurship and Education. Rural education reform efforts in Australia have been criticized as inadequate when they have failed to take into account the local differences and unique capacities of remote areas of Australia (Sher, 1995). For Sher, producing locally developed and relevant curriculum is not the same as having an overriding governmental policy that includes this curricular view. In other parts of the world, various locally based programs have been developed, which are intended to more effectively address the unique learning and living situations for those in rural and remote communities.

The *Alaska Standards for Culturally Responsible Schools* (Alaska Native Knowledge Network, 2000; RSCT, 2000a) have been developed specifically to ground education in locally based heritage, language and indigenous culture. Like in Australia, recognizing and honoring the importance of cultural heritage has become an important aspect of educational policy in Alaska.

Previous models for education in the remote areas of Alaska saw the use of technology to connect villages for the delivery of educational services through the 'Learn Alaska' network (Barnhardt & Barnhardt, 1983). Similar to this model is Australia's 'School of the Air,' which provides satellite Internet and classroom services to remote areas (Kaplan, 2003). BC is also exploring the use of technology to deliver educational services across the great distances between BC's rural communities, and improved access to technology is seen as having great potential in these areas (BC Ministry of Education, 2003b). Like Alaska and Australia, BC also has a rich and diverse cultural heritage, but curricular attention to cultural education remains limited in BC (BC Ministry of Education, 1998). Emphasizing cultural education and connecting communities through technology could be possible models for focusing local development efforts.

BC's Distance Education Schools have for many years offered traditional print-based courses for students who choose a distance learning delivery mode. However, studies have shown dismal completion and success rates for students taking courses through these traditional distance learning models (Bosetti & Gee, 1993; Moore & Kearsly, 1996). It is hoped that modern technology can better support students (BC Ministry of Education, 2003b), and perhaps with an increased emphasis on local culture and content, more effectively deliver educational programs in remote areas.

Changes to the traditional modes of course delivery in distance education and the nature of the learning materials will be necessary in order to effectively utilize the interactive potential of modern technology (Downer & Downer, 1993; Lesniak & Hodes, 2000; Moore, 1993). Fullan and Miles (1992) recommend careful consideration to structural changes before implementation, since different types of student and teacher behaviors are required for on-line learning (Beaudoin, 1990). Nonetheless, pilot projects are under way in BC to connect students in remote areas of three school districts to a teacher with a class of students via live video over the Internet (BC Ministry of Education, 2003a). In order to facilitate these connections, high speed or satellite-based Internet will enable students to have synchronous interaction with a teacher and a class. This high level of interactivity has been shown to be significant for students' attitudes (Phillips & Peters, 1999) and success (Moore, 1993). In a synchronous environment, the computers and technology tools enable direct, real-time interactions. In many remote areas, students have been unable to take certain face-to-face courses due to the small size of their schools or the small number of students who want to take the course in which they have an interest. Using technology tools to link up students and teachers separated geographically from each other may enable these students to access courses they previously could not access.

Both face-to-face and distance learning models exist for delivery of educational services in small and remote communities. Some have been developed in response to a recognized need in the local community, while others have been the initiative of governmental policy. Whether *rural education* or *education in rural areas*, these models rely on technology to support students who live in remote communities. A small school with a very small population of high school-aged students is viewed as unable to support the full range of high school courses, hence the increasing interest in distance learning models which utilize the interactive potential of technology for delivery of educational services to students in outlying areas.

2.7 The Context of the Small School in the Local Community

Small schools are closely tied to their local communities (Beckner & O'Neal, 1980; BC Ministry of Education, 2003b). This may be according to a community school model (Human Resources Development Canada, 2002), or by virtue of the students having a strong sense of place, connection, worth, belonging and civic involvement (Haas & Nachtigal, 1998; G. Smith, 2002). Klonsky (2002) suggests that in small schools, everyone knows each other well, and that this enables strong linkages between people. These connections have been shown to positively impact schooling (Osborne, 1999).

Numerous studies have examined education in small, rural and remote communities, including schools in Canada, US, Australia, and around the world. Studies compared schools in urban and rural communities (Dahllof, 1981; Hewson, Kahle, Scantlebury & Davies, 2001; Hite, Randall & Merrill, 1994; Newton, 1993; Sher, 1983). Recently, much attention has been given to

the strengths and weaknesses of small schools (Cotton, 1996; Downer & Downer, 1993; Fowler, 1992; Meier, 1996; Raywid, 1998). Large and small schools have been compared in efforts to show large schools are best (Conant, 1959, 1967), or that small schools are more effective (Howley, 1994; Howley & Eckman, 1997; Irmsher, 1997; Klonsky, 1995). The differences appear to be in point of view: efficiency or effectiveness. These perspectives hold differing priorities for finances or students, and use different operational definitions for equality of educational opportunity.

Since Conant (1959) advocated for small school consolidation, others have examined the impacts (Bosetti & Gee, 1993; Fanning, 1995; D. Marshall, 1993; Nelson, 1985; Sher, 1995). When large schools, particularly in urban areas were demonstrated to be less effective, means to utilize the large buildings more effectively for students have been explored through establishing 'schools within schools' or downsizing (Cotton, 1996; Klonsky, 1995; Meier, 1996; Newton, 1993; Raywid, 1998; Sher, 1995). Reform efforts and new models for education in small schools have also been explored (Haas & Nachtigal, 1998; Knight, 1993; D. Marshall, 1993; Payne, 2001; Weibe & Murphy, 1993).

Studies in the US, usually among urban schools, have shown that compared to large schools, smaller schools are more successful at promoting academic achievement (Howley, 1994; Meier, 1996; Raywid, 1998; Van Ark, 2002), helping students learn better (Lee & Smith, 1997), behave better (Stockard & Mayberry, 1992), participate more in civic life (Parker, 2001) and other school activities (Jacobs, Finken, Griffin & Wright, 1998), dropout less often (Pittman & Haughwout, 1987) and, cost less per graduate (Nathan, 2002; Stiefel, Berne, Iatorola & Fruchter, 2000). Others have argued that, for small communities, the cost of operating a school is a necessary cost, in terms of equality of opportunity and fairness (e.g. Darnell, 1981). The Royal Commission Framework (BC Ministry of Education, 1988) appears to convey the same message

in their definition of equity. But, studies that compare results for large urban schools and smaller urban schools in the US may not be appropriate as referents for small rural schools in BC because of what they each mean by "smallness."

Contrary to Conant's (1959) deficiency view of small schools, Howley (1994) and Arfstrom (2001) have concluded that rural students ranked at or above their urban peers on several points of comparison: achievement levels, involvement in after-school activities, graduation rates, levels of technology in the schools and smaller class sizes. Arfstrom also compared large urban schools with small rural schools using these varied measures of school effectiveness.

Another means of comparing schools can be found in Johnson and Johnson (2002). The researchers spent a year teaching in a small, rural elementary school in an impoverished region of Louisiana. Their book chronicles the lives of students and teachers from a brutally poor region of the US. Instead of focusing attention on the various comparisons showing rural school superiority, Johnson and Johnson draw attention to the inequities present in the structure of the school system, the inadequacy of the resources available to the teachers and the overemphasis on state-mandated testing policies, which expended the annual equivalent of two teachers' salaries on standardized testing protocols to determine what everyone already knew: these kids weren't learning because their basic needs of food, clothing and shelter weren't being met. Instead of directing much-needed funding to classroom resources, building maintenance or lunch programs, the testing program was a waste of money in the Johnson's' view. Confirming that the students were impoverished and still poor learners was redundant. In this case, the smallness of the school enabled the teachers and staff members to know each other well, but due to the crushing poverty of the community and the district, students were not aided by this knowledge.

In her study on small rural schools, Cotton (1996) identified the smallness, and not the

ruralness, of small rural schools, as responsible for positive results on a number of criteria that were attained in small rural settings. With Arfstrom's (2001) report that 70% of the schools in the US are rural, perhaps the issue of equity for these schools and communities is the more fundamental.

An additional complicating factor in reviewing studies that compare school size is that the small schools in the US were compared to large urban schools that house 3000 or more students. Smaller, more intimate settings for schools produce better results on a number of measures compared to the enormous schools to which they were compared. It may likewise be the exceptionally large size of the large urban schools that militates against students having equitable access to an effective learning environment. While numerous factors can be considered as influencing the school environment, there is a growing trend to focus on achievement scores from standardized tests (BC Ministry of Education, 2002d, 2003c; NCES, 2003).

Recent studies (Rural Schools and Community Trust, 2000b, 2002a, 2002b, 2002c) have considered the linkages between school size and student achievement. In the rural areas of Arkansas, a state with many impoverished rural regions, smaller schools in small districts were more effective in mitigating the adverse effects of poverty for their students, both in improving achievement and in narrowing the achievement gap between poor and affluent students. Large schools have a smaller effect on affluent kids, but breaking up large schools had the effect of decreasing the variance in achievement due to poverty (Howley & Bickel, 2000). This is a significant effect for students in impoverished rural regions. Parker (2001) also found positive benefit from small-sized school environments, suggesting that small towns raise better citizens due to strong community and school connections. Small towns in BC are much smaller than the small towns of the US and farther removed from urban centers across immense geographic

diversity, and thus access to services and achievement results in BC and the US may not be comparable.

2.8 Rural and Small

Rural

In general terms, small and rural means the community lies outside the sphere of regular influence of a populous, urban area offering all of the cultural, social and employment opportunities to be found in a big city (Arfstrom, 2001; Bollman, 1999; DeYoung, 1994; Pooley, 1997; Sher, 1983; Storey, 1992). The term *rural* is defined differently depending on context. International organizations, such as the Children's Defense Fund (CDF), the Organization for Economic Cooperation and Development (OECD) and the United Nations (UN) all define *rural* differently. However, in most of the definitions, a key element is the primacy of agricultural production in the local economy. In addition to agriculture, in BC, the presence of other resource-based industries, including ranching, logging, forestry, fishing or mining denotes rural (BC Ministry of Education, 2003a; Hayter, 2000).

Montgomery (1999) developed an *Index of Rurality* for BC communities, which compares service levels for law enforcement, education, social and medical services, and allows for comparison of the extent to which a BC community is rural. While his study examined the working lives of professionals living in the small communities of BC, Montgomery considered the degree of ruralness to be a significant factor, so the index allows for comparisons to be made. The most rural of communities in BC, according to the index of rurality, have none of these services (e.g. police, schools, social services, hospitals) located in the community, are very small

and usually very remote. Less rural communities may have all of these services available locally, as well as a substantial population base. Montgomery defined *service center* as a community that has all of these services available. In the current study, Montgomery's view of service centers is adopted as those communities considered to be less rural, and outside of the context of this study.

Rural School Districts

In speaking of rural communities, as did Montgomery (1999), different criteria can be applied to define ruralness. Likewise, school districts, as a unit of analysis, can be considered rural by several different definitions. A study by Hite, Randall & Merrill (1994) looked at administrators in communities in the US, and defined school districts as rural if they met at least four of these five criteria: 1) less than 10,000 students, 2) not encompassed by a Standard Metropolitan Area according to the US Census, 3) population density less than 150 per square mile, 4) at least 40% of the population lives in communities with less than 5,000 people, 5) no four-year degree granting institution within the geographic boundaries. Virtually every one of the 60 school districts in BC, save those in Victoria, Prince George, Kamloops, Kelowna, Nanaimo and the Lower Mainland would be considered rural according to the criteria established by Hite et al. And, since most districts are spread out over large geographic areas, a district could be considered urban or suburban, but include rural schools. This poses problems in attempting to define what is meant by *rural.*

A Ministry of Education report in BC (BC Ministry of Education, 2003b), entitled *Enhancing Learning: Report of the Task Force on Rural Education,* identifies 32 out of 60 BC school districts, representing 15% of the student population in BC, as rural (BC Ministry of Education, 2003a). This conveys the impression of small student populations. But, smallness was not directly addressed. However, it is a fact that the Task Force adopted the Statistics Canada

(2002) definition of rural to include small urban communities with populations between 1,000 and 9,999, and communities where less than 50% of the population commutes to work in an urban center with more than 10,000 people. By this definition, smaller communities lying near urban centers would still be considered rural. However, many of these communities (near urban centers) support a substantial population base that allows for large high schools. Just as there are many criteria on which to judge the ruralness of communities, school districts or schools, different criteria can be applied to defining smallness.

Small Schools

Small comprehensive high schools have variously been defined as having between 300 and 900 students (Cotton, 1996; Fowler, 1992; Howley, 1994; Irmsher, 1997; Klonsky, 1995). Each of these researchers based their conclusions on different types of analyses, and so their points of comparison are different, but this does suggest three divisions to consider when discussing the size of schools: those housing fewer than 300 students, those with 300 to 900 students and schools with more than 900 students.

The division of sizes can be seen as arbitrary. According to Van Ark (2002), a school with 100 students per grade level is small. Many rural schools in BC serve grades 8 to 12, so 100 students per grade would mean these schools house about 500 students. Many of BC's rural schools are smaller than this. Opinion is varied as to what makes a school too small. Irmsher (1997) reports that 750 students make a school large enough to be comprehensive, consistent with Conant's (1959) description. In BC, a school with 900 students would likely be located in a service center (Montgomery, 1999) or urban area, and within the context of BC schools, would be considered large. Small is a relative term.

How Does Size Matter?

Lee and Smith (1997) reported that in schools with fewer than 300 students, less learning occurred. The suggestion was made that the very small size proved too limiting in the range of choices for students, and as such, resulted in lower achievement. They concluded that schools with 600 to 900 students were of optimal size. However, which factors are used to determine optimal size seems to vary among researchers. Howley (1994) sees 400 students as an adequate size for a school to meet the curricular needs of its students. Adequate and optimum are different concepts, and depend upon how each is measured, but Meier (1996) showed that an optimal size, in terms of student achievement, is 300 to 600 students.

The size of a school can be seen to influence outcomes for students, both in cognitive and affective domains. In terms of students from disadvantaged socioeconomic backgrounds, a school size of 600 to 900 students appears to be optimal (Lee & Smith, 1997). Apparently, the positive effects are due to the communal nature of the school organization, whereby a more multidimensional and interdisciplinary approach leads to students, teachers and administrators taking more of a shared responsibility for the conditions within the building, as compared to the more bureaucratic structure of larger schools. This suggests a possible alternate model for governance within small schools, in order that the benefits of the small setting are maximized, instead of bureaucratized.

Depending on how one defines "disadvantaged," the small rural communities of BC could also be seen as disadvantaged, and hence, Lee and Smith's conclusion may apply in BC. But, in BC, few rural schools have 600 to 900 students (BC Ministry of Education, 2002a). Determining the optimal size of BC's small rural schools is not the purpose of this study. However, looking at how ruralness and smallness are variously defined enables identification and placement of schools in the category of *rural*.

Generally, schools of 300 to 600 students are large enough to offer the range of options to suit a high school graduation program. For this study, a high school is considered *small* if the population in grades K to 12 is less than 600 students and *rural* if it lies in a community outside of commuting distance to an urban area and not in a service center. This definition serves several purposes. It includes the smallest of schools in BC that still offer programs for senior high school students. It also includes those relatively larger schools found in small communities around the province that offer grades 8 to 12, or some other configuration of junior and senior high programs. This becomes important when considering the impacts to course offerings for students in small rural schools. Additionally, this definition serves to minimize the influence that a local urban or service center may have on the population of the community and the school.

To this point, the discussion of educational equity has led to perhaps two different notions of what constitutes equal opportunity for students: 1) the same courses and programs offered at each school in the province (equality), or 2) different courses and programs offered at each school (fairness). When issues of curriculum are raised, value judgments come into play over what is considered important for students to learn. Additional concerns over the means to achieve the curricular goals are part of the equation too. The importance of science and mathematics education has been considered in terms of how these subjects have been accorded status by curriculum theorists, society and teachers. This has led to talk of teacher expertise and the role it plays in representations of subjects and subject areas for students. The chapter concluded with an examination of the context of schooling for rural and small communities and what makes a school rural or small. Consideration has also been given to what might be an optimal size for a small school, and the arbitrariness of such a distinction. Additionally, what might make a school "big enough" to offer the range of programs for a high school has been

examined. As discussed earlier, small schools play an important role in their communities, and from a perspective of the need for equitable access to educational opportunities, student access to science and mathematics courses in small rural schools needs to be examined.

As already demonstrated by the Rural Schools Task Force (BC Ministry of Education, 2003b) and Montgomery (1999), small rural schools face unique problems due to their size and geography. The market-driven economic policy applied to these schools has created problems for students, leading to the inequities among BC schools. Although all subjects are important in their own right, contemporary society currently appears to accord higher status to some subjects over others. This is perhaps due to the economy of the time. The 20th century saw tremendous growth in technology. Technology advancement relies heavily on science and mathematics. As such, certain courses have become requisite subjects for entry into post-secondary programs that have scientific and mathematical orientations. For every child to have an opportunity to decide on whether to pursue these programs or not, access to high school science and mathematics courses is required.

The theoretical underpinnings and literature review in this chapter form the framework in which the current study was framed, through which data was collected, analyzed and the outcomes interpreted. Based on the qualitative nature of the questions being asked in this study, which follow immediately in Section 2.10, Chapter Three presents the methodology for the study and describes the locations of the participating schools. Additional details are provided of the data gathering and data analysis processes in Chapter Four, along with the presentation of results and discussion. The implications and recommendations made in Chapter Five are also consistent with the framework developed in the current chapter.

2.9 Problem Statement

Small schools in the rural areas of BC seek to offer equality of educational opportunity for their students. Access to science and mathematics programs, then, becomes a challenge in small rural BC schools. The study was undertaken in order to explore factors impacting high school students' access to senior science and mathematics courses. The study was guided by the following questions:

1. What are the conditions under which senior science and mathematics courses are offered in the small rural schools of BC?
2. How is senior science and mathematics course delivery organized in small rural schools of BC?
2. How does the organizational structure of the small rural school setting impact the delivery of these courses to students? How does this impact students' access?
4. How does the mode of delivery impact student decisions about senior science and mathematics courses?

CHAPTER 3

Methodology

3.1 Introduction

In order to examine the factors that impact student access to senior science and mathematics courses in the small rural schools of BC, a qualitative, a mixed-methods approach was employed. These mixed-methods (Creswell, 2003) involved examination of a variety of official documents and reports to situate and establish the sense of the problem whose better understanding was gained from the use of questionnaires and interviews to elicit perspectives from principals, teachers and students who work and go to school in small rural BC schools. Based on the objectives of the study, which are to identify the conditions under which senior science and mathematics courses are offered in the small rural high schools of BC, how course delivery is organized and how these organizational structures impact students' access and decisions about senior science and mathematics, the mixed-method approach was deemed appropriate.

The preliminary phase (Palys, 1997) examined documents from the BC Ministry of Education, school districts and schools to provide a basis for the qualitative phase of the inquiry (Denzin & Lincoln, 1998, 2000; Lincoln & Denzin, 1998; Lincoln & Guba, 1985; Stake, 1995, 1998, 2000). Case study (Merriam, 1988, 1998; Stake, 1995, 1998, 2000; Yin, 2003) and interpretive case study (Merriam, 1988, 1998) methods were used in data gathering, whereby the perspectives of selected principals, teachers and students were sought in order to explore the

factors impacting students' access to senior science and mathematics course offerings in the small rural schools of British Columbia.

The preliminary phase of the study provided a basis for the development of questionnaires (G. Anderson, 1990), for use in the qualitative phase of the study. Follow-up face-to-face interviews further explored themes that emerged from the questionnaire data corpus (Fontana & Frey, 2000; Miles & Huberman, 1984, 1994).

In-depth analysis of data began once questionnaires were returned. Emergent themes served as the basis for categorizing and coding (Erickson, 1986). Interpretation (Gallagher & Tobin, 1991) was dependent upon how themes emerged. These themes informed the development of follow-up interview questions, which were conducted with volunteering participants. The evolving data were then subjected to further analysis, since analysis is an ongoing process. Understanding of the emergent themes and unique characteristics of the small rural school setting was sought as the entire data corpus was built.

Context and Participants

As explained in Chapter Two, small rural high schools have been defined as those having 600 or fewer students (Cotton, 1996; Howley, 1994; Irmsher, 1997; Meier, 1996) and located outside of commuting distance (about 60km) to a service or urban center (Montgomery, 1999; Statistics Canada, 2002). In practical terms, a commuting distance of 60km may be an impossible distance to cover for a day's work, since the connections between small rural communities may be highway, floatplane or ferry, and travel through wilderness and mountainous regions is often required. In some cases, these modes of transportation are

operational only seasonally. This amalgamated definition allowed the small schools in rural areas to be identified and then invited to participate in the study. The potential participating schools, which offer programs for grade 11 and 12 students, then, are located in every region of the province.

A map of the province is included as Appendix A, which indicates the regions of the province where service and urban centers are located, and their surrounding areas. The larger communities of BC, which do not include the small rural high schools, are also located all over the province. The high schools in these larger communities are usually quite populous, ranging from 800 to 1500 students. Brief descriptions of these regions are included in order that the reader can gain a sense of the territory being described, and envision the surrounding countryside, where the small rural schools of the province can be found.

All of the northern British Columbia service centers are located along Highway 16 between Prince George and Prince Rupert. Scattered between them and farther north are several smaller communities, which have high schools. These communities are largely logging towns, some having lumber or pulp mills. Out on the coast is Prince Rupert, a busy rail and ferry terminus for the North Coast. Surrounding Prince Rupert for hundreds of kilometers north and south along the Inside Passage are tiny fishing and logging villages accessed by boat or floatplane only. The schools along the Inside Passage are sometimes part of the public school system, but are often operated by the local aboriginal education authority and are usually K to 12 community schools.

The Cariboo Chilcotin Coastal region includes the belt of the province from Jasper National Park on the east to Bella Bella on the west. There are but three service centers in this region, Quesnel, Williams Lake and 100 Mile House, which are located along the same 300km stretch of Highway 97. Small rural schools are scattered all over the rest of this vast stretch of

terrain, which is largely rangeland or lodgepole pine forest.

The southeast corner of the province includes the Columbia Trench, the Southern Rockies and several smaller mountain ranges that slice the region in a general north/south direction. Deep snowfalls and warm dry summers characterize this region that has two service centers, Creston and Cranbrook. Logging, ranching, mining and outdoor recreation are the main industries.

The Thompson Okanagan region includes the wine making and fruit growing areas of BC. There has been a population boom in the region over the last 10 years, and so, towns like Kelowna, Salmon Arm and Kamloops are not small towns anymore, and it is no wonder, with mild (relatively speaking!) winters, and hot, dry summers, the area is very appealing.

The southeastern shoreline of Vancouver Island is also densely populated. With the exception of the Malahat Pass, it seems that the area has become one big city stretching from Victoria to Nanaimo.

The most densely populated region of the province, and growing fast, is the Lower Mainland. Agriculture is still an important part of the local economy, but the more than 15 municipalities rely less and less on agriculture as time goes on. The region is divided by the various arms of the Fraser River, which serves as a major shipping and receiving portal for Western Canada and the Prairie provinces.

This brief characterization of the service centers and urban areas of the province serves to identify the rest of the schools in the province as potentially participating in the study. The process for carrying out the study is described in this chapter.

3.2 Preliminary Phase

Various websites and documents were used to search for background information about the issue of student access to senior science and mathematics course offerings being investigated in the study. Documents from the BC Ministry of Education, school districts in British Columbia and individual schools were searched for information on science and mathematics course offerings at the senior level, the number of specialist teachers for science and mathematics, provincial exam participation and percentages of students scoring A and B marks on the examinations in science and mathematics. This search helped to identify issues that may be of import for the context of the study. The searching also provided evidence that, in fact, there are differences in terms of course offerings among and between schools in BC (BC Ministry of Education, 2002e). The subsequent phases of the study then utilized this data to inform question development for the questionnaires and interviews.

A search of BC Ministry of Education documents and school and district demographic data provided information to allow selection of schools fitting the criteria of "small and rural." A total of 55 schools located in 32 different school districts that met these criteria were identified (See Appendix B). Searching other documents, such as school web sites, Ministry of Education (2002a, 2002c, 2002e, 2003e), Council of Ministers of Education, Canada (2002) documents and Fraser Institute reports (2002, 2003), provided additional background information, such as aims and purposes of education in BC and Canada, perceived importance of science and mathematics and discussion of various school and student success indicators. Additionally, this searching identified several schools whose configuration had recently changed to junior high, and so grades 11 and 12 courses were no longer offered in these schools.

Provincial examination data (for Biology, Chemistry, Physics and Mathematics) over the past five years (1997/98 to 2001/02) allowed for some comparison between small rural schools and province-wide averages (BC Ministry of Education, 2002e). (See Appendix C). For example, calculations of Average Participation Rates and %A or B Provincial Examination Marks were made for the 55 schools identified as small and rural. As the chart in Appendix C shows, these averages are substantially lower than the provincial averages, with one exception of Biology 12 participation, which is essentially the same as the provincial average.

These data were then compared with Fraser Institute rankings for all of the secondary schools in BC. Charts were generated, which showed that small rural schools, on the average, occupy the low positions in the rankings than other public schools in the province. Additional comparisons of Fraser Institute rankings with 5-year Provincial Exam average failure rates and rurality index (Montgomery, 1999) and Fraser Institute ranking and rurality index. While the Fraser Institute has an objective for "the redirection of public attention to the role of competitive markets in providing for the well-being of Canadians" (Fraser Institute, 2003, p. 1), the basis of which lies in a market-driven economy, the fact is that public attention is directed to the publications of the Fraser Institute, through such releases as its annual *Report Card on British Columbia's Secondary Schools*.

Montgomery's (1999) rurality index was also used to conduct some comparisons, including 5-year average Provincial exams per student and 5-year Provincial Exam average failure rates. In terms of the current study, data such as these were used to consider what types of factors might influence the small rural schools of BC to fall low on examinations per student and high on examination failure rates relative to provincial averages.

School and district websites, among other documents, were searched for the number of senior science and mathematics course offerings at the schools, as well as the number of subject

specialist teachers at the schools. Statistics Canada websites and community websites were also accessed for school and community demographic data. These background data searches were used to inform development of the questionnaires (G. Anderson, 1990) for the next phase of the study.

3.3 Description of the Case

The study aimed at examining the issue of student access to senior science and mathematics in the small rural schools of BC. The definition of what constitutes small and rural serves three purposes: 1) it bounds the study to identify the pool of potential participants, and 2) it provides a view into schools which are in fact small, and which face challenges in the offering of senior science and mathematics courses due to their size, and not some larger factors of school governance, for example, and 3) it renders specific to the study any assertions about the data gained from the selected participating schools.

Case study methods (Merriam, 1988, 1998; Stake, 1995, 1998, 2000; Yin, 2003) were deemed appropriate based on what Merriam has identified as the four characteristics of a case study: 1) it is particularistic, where looking at the case itself is important for what it can reveal about the phenomenon under study, 2) it is descriptive, where many variables and their interactions are considered, 3) it provides a heuristic to help the reader understand the phenomenon, and 4) is inductive, where concepts, hypotheses or theories emerge from the data. Yin (1984) suggests that case study methods are appropriate when the variables that comprise the phenomenon cannot be separated from the context of the situation. But, like Stake (1998, p. 236)

has said, "Case study is not a methodological choice, but a choice of object to be studied," so that the case is defined by interest in the individual cases, and not by the choice of methods used.

According to Merriam (1988), an interpretive case study produces 'rich, thick description' with descriptive data that "are used to develop conceptual categories or to illustrate, support or challenge theoretical assumptions held prior to the data gathering" (p. 28). This study questions the notion of equality of educational opportunity in terms of student access to senior science and mathematics course offerings in the small rural schools of BC. Potential recruits for participation in the study were principals of schools identified as small and rural, teachers of grade 11 and 12 science and mathematics courses and grade 11 and 12 students who were taking, intended to take or had taken senior science or mathematics courses.

3.4 Permissions

Permission was sought from the UBC Behavioural Ethics Research Board during the preliminary phase of the study (See Appendix D). Further permission to do research was sought from the superintendents of the school districts in which the identified small rural schools were located (see Appendix E). Letters were mailed to the superintendent in each of the 32 identified school districts (Appendix B). It should be noted that in some districts the superintendent is vested with the power to grant permission, while in others, approval is granted by the Board of Trustees. In total, 14 superintendents or their designates responded to this letter, and 13 granted permission for me to recruit participants from their schools. These 13 school districts include 22 of the 55 schools originally identified as small and rural in the preliminary phase of the study. In

three school districts, the superintendent's office called or wrote back seeking clarification about the details of the study and the involvement being requested of the participants. Two of these subsequently agreed to allow the schools of their district to participate. One Assistant Superintendent's office, after receiving the requested information about the study, opted not to participate. In one additional case, the superintendent declined to participate. In total, there were 18 districts that did not respond to the introduction letter sent to the superintendent's office.

Once permission was granted to access the schools of the district, an introduction letter to the Principal of each of the schools in the district fitting the small and rural criteria was sent (see Appendix F). Voluntary participation was sought from the Principal. The Principals were also requested to assist in the conduct of the study by seeking willing volunteers among the teachers in the school.

Through another introduction letter (See Appendix G), teachers were asked to participate in the study and to assist in the random distribution of questionnaires to volunteering students. An introduction letter to students requested them to participate in the study provided parental or guardian permission was granted (see Appendix H). An additional Assent Form sought students' assent to participate. This form was attached to a Parent/Guardian Consent Form (see Appendix I), which requested each parent or guardian to grant permission for his or her child to participate in the study. Those who participated in the questionnaire phase were additionally asked to indicate if they were willing to be interviewed as a follow-up to the questionnaire (Appendix J). Permission to audiotape the interview was requested at the time of the interview.

3.5 Questionnaire Administration

Copies of the questionnaires for principals, teachers and students accompanied the letters seeking permission, and participation was voluntary (see Appendix K). A total of 20 packages were sent to schools whose principals had indicated willingness to participate in the study. From this group of schools, 12 agreed to participate in the study and returned completed questionnaires. A map showing the general location of each of these 12 schools can be found in Appendix L.

From the 12 schools that volunteered, 11 principals, 28 teachers and 46 students from these schools completed the relevant questionnaire. Three different types of questionnaires, one for each participant group (Principals, Teachers, Students) comprised the package that was mailed out to the schools. A different number of volunteers were sought from each school, depending on the size of the school, and hence the size of questionnaire packages sent out was relative to the size of the school. Each school received one questionnaire for the principal.

Participating schools are located in all of the regions of the province, save for the Lower Mainland, which as discussed earlier is a fast-growing region and largely urban, and the Cariboo Chilcotin Coast region, where one of the district superintendents offered permission, but no school in the district volunteered to participate. Nonetheless, participating schools are spread out over the rural regions of BC.

Since this is an interpretive study, the spread provided a wide view of the participants' perspectives. Individual viewpoints are reflective of the situation of the individual, as well as the local environment, and through the reporting of participants' perspectives every effort is made to accurately represent their voices. Of course, whenever interpretation is involved, the researcher

must take extreme care to ethically and sensitively offer the stories of the participants.

Questionnaires (G. Anderson, 1990) developed to explore factors impacting access to students' senior science and mathematics courses in small rural schools of BC were mailed to participating schools. Some overlap in the nature of the questions for each type of questionnaire was a deliberate attempt to triangulate the outcomes, questionnaires and emergent themes.

The questionnaires sought perspectives from the three participant groups on the factors that impact senior science and mathematics students' access to their courses. The *Principal* -- the questionnaire inquired into the organizational structure of the school, including departmentalization, the scheduling of courses, teacher qualifications and workload, staffing, teachers' experience levels, and the teaching and learning environment; *Teachers* -- the questionnaire for teachers sought their perspectives on professional development, mentoring of student teachers, workload, instructional strategies and support from parents; and, *Students* -- the questionnaire sought their perspectives from grade 11 and 12 students on how they made decisions around taking senior science and mathematics courses, and the role of counselors regarding senior science and mathematics course selections. Copies of the questionnaires are included as Appendix G.

3.6 Data Analysis

In-depth data analysis began once the first returned questionnaires were received. Each questionnaire received was assigned a unique identifier, with a letter for the school, a P (for Principal), a T (for Teacher) or an S (for student), and a number designating which teacher or

student from that school. These designations aided in organizing the data and facilitated later retrieval. For example, the code F-S-3 refers to the third student from School F. All questionnaire responses were transcribed, and stored in a database. A surface analysis of questionnaire responses was made, which included grouping and sorting responses according to the question asked. Individual responses were then chunked into thematically constructed categories, which was facilitated through the cutting and pasting of individual responses onto note cards. It was then possible to look through the responses in a search for similar elements and underlying messages conveyed in the comments. The process involved categorizing, coding and summarizing key points (Erickson, 1986), as well as looking for things that stood out. This occurred repeatedly as new packages of questionnaires arrived. Several different coding schemes were developed and refined, in order to explore further emergent themes (Miles & Huberman, 1994), which also indicated the progressive sophistication of the analysis process. From this analysis, themes were constructed, which then enabled comparison of responses in a search for commonalities. Working hypotheses were also developed in this phase of the study, as patterns emerged around the themes. A matrix of data sources, organized by the themes (see Table 4.1, p. 71) informed development of further questions for consideration during the follow-up face-to-face interviews.

3.7 Interviews

Selected participants who had indicated a willingness to be interviewed and whose questionnaire responses were deemed to be enlightening and relevant to the objective of the

study were interviewed in follow-up in-depth face-to-face interviews (See Appendix M). These questions were developed following insights gained from the analysis of the questionnaire responses and often resulted in free-flowing interview responses. The interviews sought clarification and elucidation of participant perspectives on the factors that impact access to senior science and mathematics courses. A total of 3 principals, 6 teachers and 5 students from four different schools participated in face-to-face interviews. Three of these teachers, in addition to teaching a grade 11 or 12 science also taught a grade 11 or 12 mathematics course. The in-depth interviews lasted up to 1.5 hours with principals and teachers, and 45 minutes with students. The interviews were audiotaped and later transcribed verbatim in order to aid in subsequent data analysis and also became part of the data corpus.

3.8 Data Analysis

The process of data analysis while the interviews were underway was in many ways iterative. Guidelines for the interviews with principals and teachers were used initially, but then as the interviews progressed, additional open-ended questions emerged. This is a benefit of a semi-structured interview, where interesting and relevant issues can be explored further. A similar process was used for the interviews with students, although being mindful of the time being taken did limit a deeper exploration of the issues that arose during the session.

All of the interviews were audiotaped and transcribed verbatim. The responses from the transcribed interviews were then categorized and coded according to the previously developed coding system, and further searching and comparison of responses for common elements and

messages. The revelations from one interview also informed the question asking in subsequent interviews, as efforts were made to better understand the issue and triangulate information (Mathison, 1988).

An additional strategy that aided data gathering was the use of such tools as memoing, where at the conclusion of the interview and during transcribing, I recorded my own reflections on a Contact Summary Form (Miles & Huberman, 1994). This form allowed consideration of additional concerns and issues that were to be interrogated further in later interviews.

Together, the audiotapes, transcriptions, memos and categorization and coding methods became part of the data corpus. Further examination of the data corpus allowed for additional data analysis and interpretation, seeking more broad-based and deeper themes, attempting to 'make sense' of the case (Lincoln & Guba, 1985).

3.9 Results Reporting

In subsequent chapters of this thesis, responses from individuals are identified in one of two ways: 1) if the response came from a questionnaire, the respondent is identified with a designation, such as (Student, School F), indicating that the participant is a student at school F, and, 2) if the response came from an interview, the quote is identified with the pseudonym of the participant and the date of the interview. A summary of the demographic information for those who participated in interviews can be found in Table 4.3 (p. 73).

3.10 Credibility and Trustworthiness

Qualitative research must address concerns over credibility and trustworthiness in different ways than quantitative studies must. Catherine Marshall's (1985, 1990) criteria for assessing value and trustworthiness have been built into this study. The design and methods are detailed so that the reader can judge their adequacy and whether they make sense. The research questions informed the gathering of data, and in turn, the data informed the interpretations made there from. This linkage is explicit, and is presented in a readable form for the reader to consider. The study fits in a larger context of scholarly work on rural education, yet goes beyond what was previously considered. During the whole process, copious records are preserved and stored in retrievable form. Procedures have also been recorded in a sort of audit trail.

Some of Guba and Lincoln's (1989) *Fourth Generation Evaluation* also served as reference for the study. In particular, the criteria for credibility, transferability, confirmability and dependability will be addressed here.

Credibility

Lincoln and Guba (1985) outline credibility as a goal for the conduct of the inquiry, whereby the subject is identified and described accurately. Then, the inquiry is "credible to the constructors of the original multiple realities." (cited in Marshall & Rossman, 1999, p. 192). This study has aimed to understand the issue of student access to senior science and mathematics in small rural schools. There are a complex of factors constituting this issue, and the story being told in Chapter Four is my attempt to offer and explain the findings. Credibility is thus judged on how dependable and believable the findings are. In particular, three of Guba and Lincoln's

(1989) postulates pertain: progressive subjectivity, member checking and peer debriefing.

Progressive Subjectivity

When conducting social science research, it is important to acknowledge the dynamic nature of the social situation. The situation itself is not static, nor is the viewpoint of the researcher. From two perspectives, then, this issue has been addressed. Firstly, it was expected that later phases of the study would be informed by the earlier phases and information learned there, so a better understanding of the case being researched was gained as the study progressed. In this case, the developing constructions were continually revisited. Secondly, I am a novice researcher, whose viewpoint is evolving and techniques at interviewing improving with each subsequent interview. My own lens was developing and shifting as the study progressed.

Member Checks

Confirming and disconfirming evidence for teachers' perceptions were sought through questionnaires and interviews with all three participant groups in an effort to prevent the teacher perspective (my own and that of the participating teachers) from dominating the original perceptions and subsequent constructed interpretations.

Later discussions with interviewees provided opportunity for the researcher's interpretations to be shared, and allowed participants to monitor subjectivity and check for possible errors. This helped to lend clarity as well as ensure credibility.

Peer Debriefing

Throughout the study, discussions were held with "disinterested peers" in order that the findings could be tested out. This involved sharing preliminary coding schemes, interview

protocols, concept maps and assorted diagrams that began the interpretive process. Peers and other teaching colleagues assisted the process by posing questions that helped to bring the working hypotheses and emerging themes to the surface.

Transferability

Another criterion for addressing quality issues in research is the issue of transferability, or generalizability. Throughout this study, it is the participants' perspectives that were sought, in order that the situation of the participants could be better understood. It is improper to attempt to transfer any conclusions from this group to a larger group, as there is no intention or indication that the selected participants are representative of any larger group of small rural schools. If someone sought to draw inferences to a larger group, there would be a necessity to demonstrate that the larger set is somehow represented by the smaller set from which this study was drawn. However, triangulation was used to gather data from multiple sources in this study, and so, corroboration or elaboration of a particular piece of data became possible.

Confirmability

We could ask how confirmable these particular findings would be if the study were conducted again with the same group of participants. Given the same set of data, would two different interpreters conclude the same thing? In some ways, they would, because the data does speak, but in others no, since each researcher brings his or her own subjectivity to the analysis. And, there are multiple theoretical lenses through which a data corpus could be viewed. I have attempted to use the theoretical framework as explicated in Chapter Two as the lens for gathering and interpreting the data. From these findings, then, inferences are drawn. In this way, the data confirm the general findings, which lead then to the implications.

Dependability

According to Guba and Lincoln (1989), dependability is an "established, trackable and documentable process" (p. 242). As the research and analysis progresses, increasingly sophisticated shifts in design and processing occur. For the current study, a series of "coding schemes" were used to subject the growing data corpus to deepening layers of analysis. The most recent of these, and hence the most mature, has been compared to the data and interpretations as reported in Chapter Four. It is through these sorts of "audits" that both confirmability and dependability can be assured.

3.11 Summary

This chapter presents a summary of the research methods and data gathering and analysis processes that have been used to explore the issues that impact student access to senior science and mathematics courses in the small rural schools of BC. As an interpretive case study, it sought the perspectives of the principals of schools that participated, as well as senior science and mathematics teachers and students regarding the factors that impact student access to senior science and mathematics courses in the small rural schools of British Columbia. It utilized a mixed-methods approach where information from government, school district and school documents helped to define "small and rural" and inform the development of questionnaires for principals, teachers and students.

Voluntary participation was sought from the school districts in which each of the identified schools is located. Participants in 12 schools completed questionnaires. Data analysis

occurred in several stages as the data corpus grew. Interviews sought to further elucidate the perspectives of participants on the themes that emerged.

CHAPTER 4

Results and Discussion

4.1 Introduction

According to Dewey (1897/1978), education is a process of living, and as such, it is the schools' and teachers' responsibility to facilitate students' participation in the process. This happens through the students' experience of the learning environment, which includes an array of elements in the school, including the school's culture, its students and its teachers, as well as material resources available for learning. The condition of the physical plant of the school could also be considered a factor of the learning environment. The community in which the school is located also influences what goes on in the school (Fullan, Watson & Leithwood, 2003; Howley & Eckman, 1997). The interactions among these factors are complex, yet, in important ways, the nature of these interactions impact the offering of senior science and mathematics courses in the small rural schools of BC, which this case study has considered.

Science and mathematics subjects are examinable at the Provincial level at the end of grade 12[1]. Student success in these subjects is perceived by schools and the public to translate into achievement. But, according to Goodlad (1984), "preoccupation with student achievement takes away from the current state of curriculum offerings, pedagogy, student-teacher relations, school and class climate, principal-teacher relations, parental satisfactions and dissatisfactions,

[1]Modifications to the Graduation Program for the graduating class of 2006 will require new provincial exams in grade 10 for science and mathematics, as well as language arts (BC Ministry of Education, 2003d)

and a host of other highly important matters" (p. xvii). Each of these issues in one way or the other influences the people in the school and represents conditions under which courses such as senior science and mathematics get offered.

Perspectives from principals, teachers and students who work in these schools were sought through questionnaires and interviews. Since this is an interpretive study (Gallagher & Tobin, 1991), the aim has been to let the data speak, attending carefully while it did, and then conversing with it in a hermeneutical process to further interpret the information offered. The questionnaire responses provided an early view, while follow-up interviews provided an opportunity to further interrogate the emergent themes. Preliminary matrix displays (Miles & Huberman, 1994) were used to categorize and seek patterns among questionnaire responses. Table 4.1 details the themes and categories emergent from the questionnaire data corpus.

Table 4.1 Categories Emergent from the Questionnaire Data Corpus by Major Themes

	Student Access to Specialist Teachers	**Teacher Qualifications and Attitudes**	**Student Aspirations and Attitudes**	**Organizational Support and Course Delivery**
Principals	-science &mathematics teacher distribution -declining enrolments	-teacher qualifications -uneven workload -teaching outside areas of specialization	-participation and attendance rates at post-secondary -desire to access quality courses	-funding -staffing decisions -program maintenance
Teachers	-workload -not enough qualified teachers	-specialty training -professional development	-student motivation -student desire for good jobs or career -parents' input	-changes to course load -resource availability
Students	-availability of courses -availability of specialist teachers	-perceptions of teacher expertise	-guidance -student involvement -decision making for course taking and future	-classroom resources -counselor availability -input to changes

After preliminary examination of the questionnaire data corpus, the development of interview questions became an important part of the interpretive process, which continued during

and after the interviews with selected participants (see Appendix J). The interviews were semi-structured and Table 4.2 presents a matrix of selected interview questions, which were posed as follow-up to the questionnaire and the emergent themes derived there from.

Table 4.2 Selected Interview Questions

	Student Access to Specialist Teachers	**Teacher Qualifications and Attitudes**	**Student Aspirations and Attitudes**	**Organizational Support and Course Delivery**
Principals	How available are subject specialists? To what extent are they utilized in junior and senior science and mathematics courses?	What can you say about teachers' workloads in small rural schools? Who teaches which courses?	What is it about some students that allows them to be successful in distance learning?	How important is staff stability? To what extent does staff turnover influence school programs?
Teachers	Do you think that the junior science courses provide an adequate background for students?	What options/choices are available for your professional development?	What motivates students to do well in senior science and mathematics courses?	What can you say about resources available to support senior science and mathematics?
Students	What would you do if the course you wanted was not available at your school? Why?	How much does a teacher's qualification in teaching senior science or mathematics courses matter to you? Why?	What can you say about why some students choose not to take senior science and mathematics courses?	What types of support services do you have available for senior science and mathematics courses?

Not every question was asked at each interview and these were not the only questions, but the ones presented very much shaped the direction and depth of the inquiry.

Further, interview question matrices (Mills, 2003) were developed for each of the themes. Data sources were outlined, organized and categorized using the matrices. These questions were further probed through interviews with selected principals, teachers and students whose responses were considered most enlightening in terms of relevance to the research questions. Using the guiding questions, as developed from the questionnaire data, face-to-face interviews were conducted with three principals, six teachers and five students. Interviews varied in length from 45 to 90 minutes. Table 4.3 summarizes demographic data for these 14 participants.

Table 4.3 Participants who were Interviewed

Participant Code	Pseudonym	Participant Group	Years in the Current Position	Years in District
C-P	Martin	Principal	2	23
F-P	Steve	Principal	2	2
J-P	Nora	Principal	2	8
B-T	Erin	Teacher	1	1
C-T	Doug	Teacher	1	1
C-T	Marge	Teacher	9	9
F-T	Norm	Teacher	21	21
F-T	Harold	Teacher	18	18
J-T	Lisa	Teacher	1	1
B-S	Donna	Student	4	12
C-S	Betsy	Student	4	11
C-S	Oscar	Student	5	12
F-S	Bart	Student	5	12
F-S	Bonnie	Student	5	12

The information presented in Table 4.3 includes the participants' school code, pseudonym, status as a principal, teacher or student and the number of years spent in that school and the district. The last two columns are included, most particularly for principals and teachers, to demonstrate the amount of time spent in that setting. The numbers reflect, in some cases, people who have worked in that setting for many years, while in other schools, very few people remain on staff for such a period. The significance of this information will be addressed later in the thesis.

Throughout the reporting of this study, responses from interviews are identified with pseudonyms assigned to the participants, while responses from questionnaires are identified by the type of participant (Principal, Teacher or Student) and the school code (A to J) of the respondent.

In-depth discussion of the emergent themes is the focus of the next section of this

chapter. Reference to research literature is woven through the discussion as applicable. In turn, each of the themes will be addressed, offering responses from selected participants and interpretation in the context of the theme. Individual responses have been chosen because they express views directly similar or implied in those of many other participants. In other cases, views unique to particular participants are quoted because of the learning and enlightenment they provide. And in some instances, multiple perspectives are presented, serving to illustrate the diversity of participants' views, as well as the variety among the schools of the study. This is an important feature of the data, as each school in the study has unique challenges of geography, local culture and demographics. In many ways, these particular challenges frame the current study in their impacts upon the learning environment. However, this chapter discusses the key factors that impact the delivery of senior science and mathematics courses in small rural BC high schools.

4.2 Emergent Themes

Several major themes emerged from the study. First, *student access to specialist teachers* is problematic in small rural schools, as teachers may not be available, or they may teach most of their courses outside their specialty areas. This leads some students to consider distance learning as an option for taking the courses they need, but the difficulty of the content and need for high levels of independence and motivation remain troublesome.

Teacher qualifications and attitudes impact the delivery of senior science and mathematics courses. It was emphasized that content knowledge and pedagogical expertise were

complementary, but in many cases, meaningful professional development for teachers was difficult to access, yet seen as necessary for improving practical skill. Where the teacher was new to the profession, the tremendous workload created by the variety of courses in the timetable had significant impacts on the programs being offered.

A third theme, *student aspirations and attitudes*, to some extent, influence the offering of senior science and mathematics courses in the small rural schools of BC. Student goals and aspirations dictate how the students approach the courses. Their post-secondary and career aspirations provide the focus and motivation to work through the challenges of accessing specialized courses. Relationships with teachers, counselors and parents appear to be a major influence in student decision-making.

Lastly, *organizational support for course delivery* depends on budgetary factors, stable teacher and student populations and resources for laboratory experiences. These factors may be unevenly available to the small rural schools of BC. Emergent from the data corpus of questionnaire responses and interview transcripts were a number of key factors which impact student access to senior science and mathematics course offerings in the small rural schools of BC. Student access to specialist teachers is in many ways limited by the teacher distribution in the district, heavy workloads for the teachers in small schools and the impacts of declining enrolments. Qualified teachers are seen as prerequisite for the delivery of quality programs for students, yet many teachers are employed to teach courses outside of their areas of specialization.

Student aspirations and expectations dictate their selection of particular courses, especially senior sciences and mathematics. Student attitudes toward the teacher and the subject influence decision making and course taking behavior. The organizational structure of the small rural school may support the delivery of senior science and mathematics programs, or it may interfere. Arguably, effective delivery of senior science and mathematics courses must be

supported through the organizational structures at the school, including staffing stability, resource and funding allocations, as well as the taught curriculum. These factors impact and are impacted by the organizational structure of the school. This section of the chapter discusses each of the four themes emergent from the study.

4.2.1 Student Access to Specialist Teachers

Every principal reported having specialist teachers in the science and mathematics departments. In the larger schools of the study, science and mathematics specialists teach in their disciplines, for example, geology, chemistry or mathematics. Every school in the study had at least one science specialist on staff, but these teachers generally taught additional subjects outside their discipline areas too. In the smallest of the schools, the following comment would be typical of a teacher's workload: "I taught 6 different classes last term because then I had the two senior classes" (Lisa, Interview, August 21, 2003). However, it was revealed that quite often a non-mathematics specialist teaches some mathematics courses, especially junior mathematics, and in one case, the principal of a large high school (with 600 students) reported "we do not have a senior math specialist; they're all science guys who have had to teach math over the years and pick up a course here and there" (Steve, Interview, May 13, 2003). The teaching of mathematics courses from Grade 8 through to Grade 12 was handled by an assortment of teachers, having varied expertise in chemistry, biology, home economics, technology education and English.

Teachers were asked on the questionnaire to specify the senior courses they taught and indicate which were outside of their specialty areas. Many of the participating teachers indicated that they teach outside their subject specialty areas. This is largely due to the small population size of the schools, and the inability of the schools to fill a teacher's timetable with courses within his or her area of specialization. This information has been combined with data supplied

from the principals to compose Table 4.4.

Principals and teachers considered student access to courses in terms of specialist teachers, as illustrated by this teacher, who was commenting on his belief in the importance of having teachers to lead classes, "The interpretations that the teacher can give are key for many students to learn effectively." (Teacher, School K)

Participating students considered access in terms of basic courses: Math 11 and 12, Biology 11 and 12, Chemistry 11 and 12, Physics 11 and 12 and Calculus. Students were asked on the questionnaire if all of the courses they might like to take are offered in their schools. The students from the smallest schools reported having access to these courses: Math 11 and 12, Chemistry 11 and 12 and Biology 11 and 12. Those reported as missing were Physics 11 and 12 and Calculus. Students from the largest school of the study reported having courses available through grade 12 in math, physics, chemistry, biology and calculus (plus English Literature). Students in the larger schools expect to take classes with teachers, while students in the smallest of the schools reported that these courses were available to them only through distance learning: "I had to take Physics 11 and 12 (and English 11) by Distance Learning. If I wanted to take these courses, this was the only option" (Student, School A). Students in some of the larger schools didn't need to consider Distance Learning as an option, as typified by this comment, because, "I'm able to take everything that I need during my timetable" (Student, School I).

Table 4.4 Senior Science and Mathematics Teachers' Course loads.[2,3]

School & Size	*Teacher's Degree*	*Senior Courses taught in area of specialization*	*Courses taught over last 3 years outside area of specialization*
A<	Biology	Bio 11/12	PM 11/12; EM 11; Chem 11/12
B*	Biology	Bio 11/12	Chem 11/12; PM 11/12; Phys 11
C*	General Science		Phys 11/12; Chem 11/12
C*	Biology	Bio 11/12	
C*	Mathematics	PM 11/12; Calculus; AM 11	
D>	Biology		PM11/12
D>	Mech. Eng.	Phys 11/12	
D>	Biology	Bio 11	PM 11/12
D>	Biology	Bio 11/12	Earth Sci 11
D>	Anatomy		Chem 11/12
E*	Physics	Phys 11/12	PM 11/12; Calculus
E*	Biology	Bio 11/12	
E*	Chemistry	Chem 11/12	AM 12; PM 11
F>	Geology	Earth Sci 11; Geol 12	AM 11
F>	Chemistry	Chem 11/12	
F>	Biology	Bio 11/12	PM 11
G>	Geology	Earth Sci 11	Bio 11; Phys 11; PM 11/12
G>	Biology	Bio 11/12	
G>	Physics	Phys 11/12	PM 11
G>	Mathematics	PM 12; Calculus	

[2] Individual schools are identified with a letter and are here assigned a population size code. This enables some comparison of teacher workload and size of the school: <=less than 100 students; *=100 to 350 students; >=more than 350 students, and up to 600

[3] Abbreviations for courses include: PM=Principles of Mathematics; AM=Applied Mathematics; EM=Essentials of Mathematics. These are the three levels of mathematics courses mandated by the Provincial Ministry of Education, however, it is unusual to see all three courses offered at any grade level in the small rural schools of the Province.

H>	Mathematics	PM 11/12; Calculus	Phys 11/12
I*	Agriculture		PM 11; Chem 11/12
I*	Biology	Bio 11	EarthSci 11; Phys 11; Com11/12; PM 11/12
I*	General Studies		Bio 11/12
J>	Biology	Bio 11	PM 11/12
J>	General Science		Bio 11/12; Chem 11/12
K>	Physics	Phys 11/12	Chem 11/12; Info. Tech. 11/12
L*	Biology/Chemistry	Bio 11/12; Chem 11/12	Phys 11/12
L*	Mathematics	PM 11/12; Calculus	

Many students resist considering distance learning courses, particularly for senior sciences and mathematics, especially if the local school offers the courses. But, for those students who have taken distance-learning courses, many asserted that the need for high levels of personal motivation and independence were factors that deterred them from taking additional courses. Difficulty with the content was also a factor. One student offered, " I wouldn't even consider taking a major science or math course this way" (Student, School F). Teachers also expressed the view that Distance Learning courses are more difficult, requiring motivational skills and learner behaviors not possessed by many high school students. "Very few students have the maturity and direction to complete self-paced programs. We see this on a regular basis with correspondence courses not completed" (Teacher, School K).

Principals reported that students are motivated to take senior sciences and mathematics for a number of reasons. Primary among these is the intrinsic interest of things scientific, based on the nature of the material. According to Donna, a student who was interviewed, the teachers of these courses had demonstrated enthusiasm through the way they presented themselves and the material, serving to engage students along the way. She attributed much of her success to the

interest these teachers had inspired.

Students reported having several influences on their decision-making in taking senior science and mathematics courses. Questionnaire items asked about the influence of Grades 8 through 10 teachers, counselors and parents. Many students felt that their teachers of grades 8 through 10 science and mathematics courses had had a significant influence on their decision-making. This student's comment was representative: "I have pursued more sciences because the teachers I had helped me enjoy my studies and were full of knowledge" (Student, School D).

It was clear that, quite often, the junior teachers later taught the senior subjects, having met the students in the junior program. The students went on to say that these teachers provided foundational knowledge, made the courses interesting, helped to identify personal interests and encouraged career exploration. This student summed up the views of many others: "My grade 10 science teacher was very influential. He encouraged our class to keep our options open" (Student, School F). One student felt pressured by her teachers, and perhaps got the wrong message:

> They practically jam it down your throat that you can't make it big in life without math skills or some form of knowledge in science. University is like a battle zone; everyone is fighting to get the right course and the right grades. (Student, School G)

Her comments may also suggest the need for a good relationship between students and teachers. Another student reflected, "if you have a conflict with one teacher you may not take that course because in a small school you only have one teacher teaching that class…" (Student, School C). With limited course options, some students considered the personal characteristics of the teacher when making decisions to take a particular course.

Many students saw having small sized schools, in turn leading to small sized classes, as being beneficial in terms of accessing their teachers. They would agree that benefits derive,

"because it is such a small school, there is a lot more teacher-to-student time. This is a great strength because it allows the students to have questions answered immediately and help when it's needed" (Student, School L). Furthermore, they considered their teachers as experienced, capable and caring people, who held high academic expectations for students: "Our school may be small but the classes are great. Teachers are able to help students one-on-one and put in that extra effort to make sure students are on the right track. Academically, this is beneficial" (Student, School L).

In addition to demonstrating enthusiasm and interest in the subject, principals believe that teachers should have specialized expertise in order to teach senior science or mathematics. This is in line with what Palmer (1999) suggested as an identifying characteristic possessed by high quality teachers. Their ability to communicate enthusiasm, use a wide variety of hands-on activities, and skills at explaining concepts are clearly attractive to students. Availability of teachers has been cited by participants in the current study as critical. However, as this study revealed, schools are facing increased pressure towards cost efficiencies and many schools have fewer teachers on staff each year. This means a greater variety in any one teacher's course schedule, and tremendous pressure in terms of workload.

Each of the small rural schools of BC that participated in the study had at least one science specialist on staff. In addition to teaching courses in their subject specialty, many teachers also teach outside of these areas, especially when new to the school. The initial lack of experience with material in other subject areas is mitigated through gaining experience in teaching the new courses and through accessing relevant professional development tailored to improve and expand competencies. Teachers' access to this sort of professional development, as will be discussed later, especially for those who work in the small rural schools of the province, is limited.

Availability of teachers in terms of specialization is a different issue than having them on staff and underutilizing them. For example, a physics specialist may teach one block each of Physics 11 and 12, and then have 5 more assorted courses in science and mathematics. This teacher is underutilized since his other specialized expertise is of limited relevance to a portion of his or her course load. It is certainly arguable, though, that specific discipline-based knowledge is beneficial for the teaching of junior science courses (Nashon, 2003) and subject specific knowledge is presented in the junior courses.

Another school may have a biology specialist teaching chemistry, physics and mathematics. A teacher in such a position is also underutilized, but in a different way, since his or her area of specialization is not one of the subjects taught. In this case, the teacher will need to gain familiarity with the other disciplines. This usually happens, at first, when the timetable is scheduled. A teacher may spend the summer getting prepared for the new courses. He or she may attend university courses, or conduct independent study. It is likely that the individual courses taught in small rural schools, will be offered only once each year, for example, Chemistry 11 and Chemistry 12, so that it takes several years of experience before a teacher can be said to have gained competence in these additional subject disciplines. Stress on the teacher in terms of heavy workload is significant (BCTF, 1993a). Teachers must cope, or leave. This aspect of life in small, rural schools has not been given much attention, although perhaps it should be.

To this point, discussion has centered on science specialization. As noted, specialist teachers predominate in the science and mathematics departments of small rural BC schools. However, it is often the case that a non-mathematics specialist teaches some mathematics courses, especially junior mathematics, even though the National Council of Teachers of Mathematics (NCTM) as well as other technical reports in British Columbia have recommended that junior mathematics teachers should be subject specialists (Marshall, Taylor, Bateson &

Brigden, 1995; NCTM, 2000; Robitaille, 1992). Every school in the study had at least one science specialist on staff, and as a result, there were mostly science people teaching junior science courses. However, being a "science" specialist means the specialty could be geology, physics, forestry or a host of other disciplines. Having training in any one of these areas apparently "qualifies" one to teach any other science, or mathematics. Here is where the local needs of the small rural school may outweigh subject expertise in emphasis, despite the research literature on the importance of teacher expertise. It may be that specialized training is less important than merely having a teacher in the classroom. Perhaps the attitude is that any science (or math) teacher is better than none. Here may lie the greatest inequity for students in small rural schools as far as course offerings are concerned: subject specialist teachers do not populate all of the senior science and mathematics courses in their schools.

Many teachers teach outside their subject specialty areas. This is in large part due to the small student population at the school, and the inability of the school to fill a teacher's timetable with courses in his or her area of specialization. In smaller schools, it is not uncommon for one teacher to be responsible for two or more provincially examinable courses, for example, chemistry and physics, as was revealed in the current study. Few teachers have degrees in more than one subject, and being the science teacher on staff may mean that the workload doesn't include the specialty area at all. This was found to be the case in a number of schools. This lack of formal preparation for subjects in the teaching workload may be more of a problem at the beginning of a teacher's career when the heavy workload and variety of courses is most keenly felt by teachers in small rural schools. As experience is gained, along with skills in student management, teachers may be better able to prepare for and handle the addition of unfamiliar new material. The heavy workload and time demands on the teacher are significant.

About half of the teachers in the study reported working within their areas of

specialization. This seems to contradict what many principals said about their difficulties in attracting and retaining specialist teachers. Apparently, principals consider "science" a specialty. Virtually every school that participated in the study had specialist teachers for biology and mathematics. Some of the small rural BC schools also had specialist chemistry and physics teachers.

Table 4.4 detailed areas of teacher specialization and information about the courses taught. In some cases, the course listed was taught only once in the three-year period. In addition to the senior courses, each teacher will then have between two and five additional blocks of junior courses each term. These could be general science courses, such as Science 8, 9 or 10, or mathematics, but in some cases, other courses such as music, physical education or English were also in the teacher's timetable. The variety of courses for such teachers means the workload is substantial.

Science and mathematics specialist teachers populate small rural schools. But, it may be interesting to consider why, for example, in School I, a teacher with a General Studies background teaches senior biology courses, while the biology specialist on staff teaches outside his area of expertise. Unfortunately, this could not be probed through follow-up interviews. But, it might be that the teacher with the greater amount of seniority has more decision-making choice about workload than someone new to the district. It could also be a case where the young teacher was brought in for "future considerations" (e.g. the future retirement or promotion of a teacher on staff may create an opening for this teacher's expertise). Herein lies another area of a teacher's life in a small rural school that remains unexamined.

Workload Issues

Variety in the teachers' workload largely depends on the size of the school. In the smaller schools of the study, with student populations less than 300, the percentages of teachers working outside of their subject specialty areas are higher, and not only are the majority of courses taught outside the area of specialization, but there are also a great many different subjects in the teacher's schedule. Principals stated that this was a reality of small schools, due to the numbers of students and a variety of low-enrolling courses. A remote school presents an extreme case, and Nora, the only principal of such a school to be interviewed, had much to say on this issue: "unfortunately, those good teachers, we're hard on them" (Interview, August 28, 2003). A stronger teacher gets a heavier and more diverse workload, because, in the principal's view, she can handle it. Nora's school is in an isolated community and often faces large staff turnover each year. Nora's school hired five new teachers in the 2002/03 school year (out of a staff of 14). Several of these teachers were new to the profession. The Mathematics 12 teacher at this school was in such a position. Newly certified in Biology, she was offered a job that included junior science and mathematics, as well as music and Mathematics 12, but not biology. While she worked hard to develop her Mathematics 12 program for the students, this was not her area of specialization, and hence the students' access to Mathematics 12 was limited.

When teachers work outside of their areas of specialization, legitimate questions about teacher qualifications are raised. The challenge of working outside of one's specialty area may be frustrating, and also may be a factor in the high turnover rates at some schools. Another reason for the high turnover rate was, according to Nora, the isolation: "I don't think people realize. They think, what an adventure! But [they] don't realize where they are, how much work it is and…how expensive it is to come and go." Perhaps it is the combination of heavy workload, inexperience and isolation that makes work in schools such as Nora's, more of a challenge. Even

Nora, a seasoned veteran after eight years at the school, acknowledged,

> the community and the school is pretty tough on a person. You really need to have lots of energy and be willing to want to change how things are going in the school, and I think that's hard to do if you've been here a long time. You get kind of tired... (Interview, August 28, 2003).

This stress on teachers in small rural schools is a reality. When a teacher is in the early years of his or her career, the large variety of courses in the workload represents a significant personal time commitment, far beyond the hours of the school day. Doug called his preparation load, "Incredible. It's every night doing something, weekends—both days, full time." (Interview, May 15, 2003). And even then, there is a feeling that the day's work has not been completed (BCTF, 1993a). Another BCTF study found that teacher well-being was related to attitudes over "the unmet needs of students" (BCTF, 1993b).

An experienced teacher calls upon the knowledge gained through years of experience to mitigate the workload issues, while attending to student needs. Marge offered, "I think our workloads are pretty good. It's not overly heavy, depending on the number of students you have. The difference is we usually teach a variety of courses rather than focus on one." (Interview, May 16, 2003). There is apparently quite a gap in how these two teachers experience their workloads: Doug was nearing the end of his first year of full-time teaching, while Marge had been in the same school for 9 years. Gaining experience in the small school context requires many years of work at a high level of intensity, as well as specific professional development to gain the knowledge and skills needed for the variety of different courses.

Teachers who spoke of the heavy workload demands also cited time constraints as factors limiting the variety of activities offered in their grade 12 science and mathematics courses. Specifically they mentioned the need to cover large quantities of content material. A relatively inexperienced teacher observed, "the demands of the course and what is to be covered seems to

limit [labs and projects in Biology 12]...As I gain more experience perhaps this will not be such a limiting factor" (Teacher, School D). This teacher seemingly feels that his inexperience has something to do with the time pressure he has felt and that, over time, his management skills will develop more fully and serve to mitigate the other pressures. Similar sentiments were echoed in a study by the BC Teachers Federation (BCTF, 2001) suggesting that teachers, in general, are facing intensifying workloads. In the perspectives of this study's participants, the small rural school environment is even more intense.

While teachers who make the choice to teach in a small rural community do so for a variety of reasons (to gain experience, to see new territory, to gain easier access to preferred recreational activities, etc), they also must choose to relocate to the community in which the school is located. The distance to the next town may make it impractical or impossible to commute, and so, transitioning to the new community is part of the move to a new job. Making a transition to a new environment is always difficult, but for teachers new to a community, it represents one additional facet of the challenge of the new work setting. Being new on staff also means that the assortment of courses to teach is quite varied.

Another facet of working in a remote community is the nature of the community into which the teacher has arrived. It is likely that it is not the teacher's home community, and so family and friends are distant. As well, there may be only one teacher of Mathematics 12 for hundreds of miles. There is no one to go to for help, possibly increasing the sense of isolation.

Many small school districts have reported difficulty in attracting and retaining subject specialist teachers (Clark, 1992; Sher, 1983; Storey, 1992). Darling-Hammond (1997) cited working conditions as a significant reason why teachers leave the profession and believes that this is the place to direct attention in order to improve schools and education. The heavy workload faced by teachers in small rural schools may be the important factor for these districts

in order to retain staff. Small schools have few staff members, so the range of course options falls to these few people. In real terms, this could mean a different subject or grade level each hour of the school day, particularly if a teacher has low seniority and must teach the range of courses no one else wants, or if there is only one science or mathematics teacher on staff.

The demands on a teacher in a small rural school are heavy, but teachers' roles in the school system are changing too (Hargreaves, 1992, 1994). The job is becoming more complicated, even intensifying (Easthope & Easthope, 2000; Lieberman, 1988). As teachers face the challenges of an intensifying workload, changes to the delivery of educational services and structural changes within the schools themselves, teachers and students in small rural schools face an added dimension as the viability of their schools is questioned. Growing teacher stress is inevitable. Contributing to this teacher stress are additional factors in small rural schools, including heavy workload and the instructional demands of teaching many courses. These factors interact so as to limit students' access to senior science and mathematics courses.

4.2.2 Teacher Qualifications and Attitudes

When principals were asked their perspectives on the importance of teachers having degrees in the subjects being taught, all of the participating principals affirmed the importance by responding with such phrases as "absolutely essential" and "very important." This is because, "the courses cover a lot of material and the teachers need to have a lot of knowledge" (Principal, School J). However, two principals indicated that despite their preference for this level of qualification among teachers, they expressed concern over declining enrolments or "with current union and hiring practices—<u>not possible</u>" (Principal, School I).

One principal, who agreed that while subject expertise is very important, added " but this doesn't necessarily mean that he/she is a good teacher" (Principal, School C). This was a unique

comment, but one from which much can be learned. In other words, possession of requisite knowledge is not necessarily an indication of a good teacher. The depth of knowledge that a subject specialist brings to a course, and his or her skill in practice are fundamental for student understanding and achievement. Expert content knowledge and pedagogical skill can therefore be seen as complementary. Ideally, all courses are taught by expert teachers (with both pedagogical and content expertise), but this becomes a programming challenge when declining enrolments force teachers out of their specialty areas, and limits student access to teachers with specialized subject knowledge.

In a small school, the science teacher may have been trained in Biology, but is called upon to teach Physics or Geology. While principals felt strongly about the need for teachers to be certified in their teaching areas, the reality is that in small rural schools, teachers work outside their specialty areas for a significant portion of their workloads. Teacher qualification in the science specialty areas has been shown to impact student learning outcomes (Druva & Anderson, 1983), and this relationship grows stronger as students move towards the senior course levels. According to Łaczko and Berliner (2001), teachers' subject area knowledge is important because the content in the senior courses is more complex. This is an important aspect of teacher quality that has such significant impact on the teaching and learning of senior science and mathematics in small rural schools.

Teachers, also, felt that subject expertise was important for the teaching of senior science and mathematics courses. Those who lacked formal preparation in the courses they taught felt additional pressures in their working lives. Doug, as a first year teacher, taught two provincially examinable subjects. He commented that his workload was "incredible," requiring him to spend many evenings and weekend hours learning the material and then preparing lessons:

> I'm not up to date on the Physics 12 this year....The first term with Physics 11 and Chemistry 12 being the first time...it was continually day and night. I would honestly be afraid to calculate what my hourly wage was. (Doug, Interview, May 15, 2003)

He went on to express the hope that as he gained more teaching experience, his heavy workload would become more manageable. Other, experienced teachers also spoke of the challenge of taking on new courses, but pointed out that this is much less of a challenge for experienced teachers. Marge, during the interview (May 16, 2003), admitted, "What I like about it, I don't get stuck in a rut teaching just one course, or two courses. I get to teach the whole gamut...and I like that variety."

With many teachers in small rural schools working outside of their specialty areas, the question then becomes, how can teachers gain the subject area knowledge in order to ensure student access to these subjects? Professional development is widely seen as the mechanism whereby teachers gain content and pedagogical expertise.

Professional Development

Darling-Hammond (1997) reported that the way to improve education is to improve the qualifications and competencies of teachers. For in-service teachers, this means professional development (ProD) through attendance at conferences, workshops or university courses.

School districts often provide workshops to address goals for the district. One teacher commented that Professional Development Days "deal with current and relative issues within our own school. We need to travel far in order to develop skills within our teachable areas" (Teacher, School J). For many teachers in small rural schools, the district-hosted professional development workshops are seen as inadequate or irrelevant for their specialized needs as senior science or mathematics teachers. "Most ProD activities do not help me become a better teacher. We live in

the north and most of the ProD activities which could be helpful occur in the south" (Teacher, School G).

For newer teachers, who may lack specific knowledge and skills in the courses they teach in a small rural school, access to relevant professional development is vital, yet difficult to access. Distances to travel are great, and hence, expensive. Travel out of the community is key too, for dealing with feelings of isolation when working in a small rural community.

The questionnaire for teachers asked about support for their professional development needs. The majority of teachers (19 of 29 respondents) felt that the support available to them was unsatisfactory, due to limited funding available, the time involved in travel, the difficulty in accessing subject-specific workshops or lack of relevance of the workshops provided by the district. Apparently, limited funding made teachers' access to workshops difficult. Others saw the professional development provided by the school district as inadequate for the specialized needs of senior science or mathematics teachers:

> I teach primarily math—I have only been able to attend one math related Pro-D event and had to go to Vancouver for it. Pro-D funds only allow one trip every three years, and then nothing until the next trip. (Teacher, School D)

As a result, teachers felt forced to seek their own ways and means of attending conferences or workshops, but the cost of travel is often prohibitive. A teacher in a remote community stated that a trip to Vancouver for a science teachers' conference used all of his ProD funding for 3 years. One teacher reported having it worse than this: in his school district, only once every three years does funding cover 50% of the cost of attending a conference. At such conferences, teachers learn about current teaching strategies, get new ideas, convene with other subject specialists and interact with science educators. As such, conferences are valuable learning opportunities for teachers working in small schools.

Many teachers expressed the hope that professional development opportunities could help them to become better teachers, but many lamented their inability to access relevant activities which would help them at the particular stage of their careers where this access could be helpful, as typified by this comment: "I find it difficult to find and access ProD that would help me at this point in my teaching career" (Teacher, School C).

Teachers at the largest (and least rural) school in the study felt that their ProD needs were adequately supported. There were four teachers who commented favorably about the support they received. They were able to save their district-supplied funds, which enabled travel to one conference in Vancouver every two years. In combination with district-hosted ProD workshops, which were held locally, it was felt that this adequately met their needs for ProD. This teacher felt that his professional development needs were met "quite adequately. ProD is a [union local] responsibility with funding from the board. I have usually been able to get or go to whatever I have needed" (Teacher, School G).

Teachers in the larger schools of the study reported being able to work together during district ProD days, but some commented that more and more, this time is being taken up with administrative activities, and is becoming less focused on professional growth. Enabling teachers to meet together around pedagogical and content issues for their subject specialty teaching areas could be a major contribution to improving the quality and competence of instruction in small rural schools.

The size and rurality of the school seems to dictate the feelings teachers have about their access to professional development. Teachers in remote schools were most vehement about their lack of access, and hence held strong views on the inadequate support for ProD. The distances involved make their travel the most difficult, in terms of time and expense, either for district-sponsored workshops or attendance at conferences in urban centers. Several teachers saw the

inadequacy of professional development funding as a major drawback to working in a small rural school.

Even teachers who feel their needs for ProD are not adequately met believe in the benefits of working in a small rural school setting. One of the issues cited repeatedly was that the workload was diverse and as a result, interesting. Many of the teachers enjoyed this diversity and variety to their working lives, even though they most often felt overworked. It is precisely because of this interest they have taken in working in the small school setting that they should be supported in their own professional development and personal well-being.

An additional activity viewed as extremely useful professional development by those teachers who had had opportunity to do so, is the supervision of student teachers. Of the 30 respondents to this question, ten indicated that they had supervised student teachers. Only four of these 10 teachers had been supervisors on more than one occasion, and two of these teachers had been supervisors in their previous (urban) schools, and not in the small rural ones. These ten teachers worked in six of the participating schools. There were 19 responding teachers who reported never having supervised a student teacher. Many of them expressed a desire to, with comments such as this:

> Never in 14 years of teaching. I think that I have missed out as a result. Teaching something makes you understand it better. Having a student teacher would make me a better teacher. (Teacher, School K)

Those teachers who had worked with pre-service teachers reflected on the value of such an opportunity, in terms of their own professional growth. One teacher stated that supervising a student teacher had been an "Excellent experience. I feel I learned as much as they have especially in areas of new technologies; web sites, Internet resources, etc" (Teacher, School F).

Another teacher, who had previously lived and worked in Vancouver, reported never

having had a student teacher since moving north, but, "We have had frequent staff turnover and I have had the opportunity to mentor new teachers. It's exciting. They have energy, enthusiasm and are willing to try anything" (Teacher, School L). This mentoring was obviously a positive experience for the teacher, which he found stimulating and interesting. He went on to lament that more of these young teachers didn't choose to stay on staff. Small rural schools could perhaps better utilize the opportunity to host student teachers or offer mentoring for young teachers as a means whereby experienced teachers can be engaged in stimulating personal professional development.

The current study found many young and inexperienced teachers populating the small rural schools of the province, and teaching senior science and mathematics courses (see Table 4.3, p. 73). These teachers take jobs in remote communities for a variety of reasons, one of which is the job opportunity. Since they are early in their careers, their teaching experience is limited, even in their subject specialty areas. Workloads likely include a wide variety of different courses, with unfamiliar (or only vaguely familiar) content, so, much time and effort must be devoted to learning the material, planning for working with students and then implementing the plans in the classrooms. Students notice when their teachers have limited content knowledge, as reflected in such comments as, "Some of our teachers are not up to par for the courses they are teaching" (Student, School C). Other students are a bit more sympathetic, "there is only so much that 4 or 5 teachers can teach" (Student, School A). Students in these schools, then, face limitations in their ability to access the subject specialty content knowledge of senior science and mathematics, as the teachers' pedagogical content knowledge and skills are just developing.

Many of these teachers have had no specialized training for working in a remote community, although one had: Lisa had taken her teacher training program at a small college in BC which had connections to the Teacher Education program at a major university, and as such,

was placed in a small rural school for her Practicum. She commented that this experience was valuable in that it gave her exposure to life in a small school and reinforced her interest in teaching in such a community. Through this program, along with her earlier experience in going to school at a smaller college (instead of at University, where most teachers take their training), she felt well prepared to move to an isolated community to begin her teaching career.

An early study by Massey and Crosby (1983) recommended that teacher-training programs need to do a better job of preparing teachers for work in remote communities, through expanding teachers' preparation in more content areas and for a wider age range of students. They also suggested that training programs should provide experience with education in the rural community setting, giving prospective teachers the opportunity to better understand the nature of the community and school relationship in small rural areas. Ostensibly, teachers who have developed an understanding and appreciation for the virtues and strengths of a particular small community are better suited to working there. Lisa's experience in her own teacher education program seems to support Massey and Crosby's claims.

While the current study found several new, inexperienced teachers at work in BC's small rural schools, the specific impacts of their inexperience on senior science and mathematics course offerings can only be surmised since teaching strategies and behaviors for experienced and inexperienced teachers were not compared. But, education research supports the importance of specialized training for teachers in subject areas (Hawk, Coble & Swanson, 1985; Monk & King, 1994; Wilson, Floden & Ferrini-Mundy, 2002), teacher behaviors and pedagogical decision-making (Mitchell, Robinson, Plake & Knowles, 2001; Wenglinsky, 2002) and preparation in a teacher education program (Laczko & Berliner, 2001) for effectiveness in teaching. Models for rural education emphasize the role of the teacher, suggesting that teachers need to be well-trained generalists to work in outlying communities (Van Balkom, Mooney &

Gandell, 1994). It would appear that in many cases, small rural schools are where young teachers go to gain experience.

Teacher Attitudes

Teachers reflected that their own roles in the classroom were "extremely important." They see themselves as important mediators of student access to content knowledge. Consequently, they believe that distance learning courses limit students' access to many important aspects of the educational experience. For example, "Teachers can bring real life stories/situations to the class to help students see the relevance of what they are learning" (Teacher, School D). Another teacher suggested that, "classroom discussion leads to higher order thinking and increases learning" (Teacher, School E). Many of the teachers seemed to indicate that for students to have "access" to a meaningful learning situation, a number of factors are involved, many of which are mediated by the teacher. These same factors are missing in a distance learning setting, which is an alternate mode by which students can take courses. These factors include teachers' knowledge, both in terms of content and pedagogical skill, the benefits of positive teacher/student interactions, the value of the social environment of the classroom and the possibility for remediation when a student has difficulty.

Students seemed to concur with the attitudes of the teachers, but spoke more in terms of access to teachers: "With such small classes, the teachers are really good about working one-on-one with students and helping them understand anything they need" (Student, School F). Ready access to teachers was a significant advantage of the small school environment, as indicated by this student: "There are many strengths such as more time with a teacher, smaller class sizes and we can work in classrooms with teachers for added direction" (Student, School L). One-on-one access is beneficial because, "Teachers know you and take the time to help you," and, "Most

teachers know a lot about the subject they teach" (Student, School H).

Teachers and students both articulated the importance of trust in their relations with one another. One teacher, whose views were particularly insightful, observed that very little learning had occurred during her first year of tenure at the school, because insufficient time had passed to enable a trusting relationship to develop between her and the students in the school. I was reminded of my own experience of teaching at a school in a remote village, where the question most frequently asked in May and June of my first year teaching there, was "Are you coming back next year, Miss?" Several students in the current study echoed the importance of a trusting relationship. Teachers seem to view the development of this relationship to be one of their key responsibilities as they work in the school. Also, teachers' abilities and attitudes are important.

Teachers reported that their abilities and confidence set the tone for the students in the school. Students reported that these teachers had impacts in a number of ways: offering encouragement and guidance, exposing students to out-of-the-ordinary careers, making the courses enjoyable and interesting through their enthusiasm and subject expertise and providing foundational skills for later study, much like Palmer (1999) reported on student perceptions of what makes science teachers "high quality." Ihejieto and Nwokedi (1993) demonstrated these teacher effectiveness skills to be particularly important for students of physics. Teachers' pedagogical decisions and activities were demonstrated by Wenglinsky (2002) to be of significance for student success. A student in the current study offered, "They told me how important each was and let me know I could handle the more difficult courses" (Student, School C). The teacher demonstrated confidence in the student, who in turn, felt encouraged and empowered by having such confidence shown. This personal relationship is an important factor, but so is the academic preparation of the teacher. And, in small schools, teachers seem to take on the additional role of guidance counselors, especially for senior science and mathematics.

The attitudes of all participants suggest that they value teachers' roles in the school setting. This allows students to have access to courses and information. Teachers' resistance to distance learning initiatives will be discussed later, but their concerns seem to be for student access. Resistance to change for the participants in this study means keeping schools open and teachers in place to lead classes.

Adams and Salvatera (1998), in their study about what makes for successful block scheduling in high schools, revealed that many times the structural and programmatic changes in scheduling were unaccompanied by changes in the individuals (teachers). They concluded that static teacher behavior limited the effectiveness of the broader organizational changes being instituted. If teachers see an organizational change, such as increased use of distance learning, as a threat to themselves or their students, this type of resistance can be expected, even a normal reaction (Janas, 1998; National School Board Association, n.d.). Like the teachers in the current study, this may be how people in smaller schools cope with large-scale organizational changes and yet continue to operate. It may be that facing limitations to what a school can do is better than having no school at all. And increasingly, school closure is seen as the choice when pressures mount for greater efficiency of operations, as reported by the BCTF (2003) as many small rural schools have closed in the last two years. Limited access may be better than no access!

4.2.3 Student Aspirations and Attitudes

The principals who participated in the study underscored the importance of good relationships among teachers and students. When asked during an interview to comment on what he views as benefits of the small school for students in science and mathematics, Steve, a principal, said, "the benefits are, the potential relationships between the teacher and the student

become more personal" (Interview, May 13, 2003). He went on to say that many of his teachers were involved in coaching or other extra-curricular activities, which enabled personal connections to be built between teachers and students.

All participants acknowledged that as students set goals for their futures, choices are made to move along educational or occupational pathways. Among the influences on student decision-making are early interest in the subject, which is inspired by engaging and enthusiastic teachers, recognized success, which inspires further interest, and a utilitarian notion of the value of education, and science and mathematics in particular. Students are influenced by their teachers, parents and counselors as they set goals and move through their school years.

Early Interest in Science and Mathematics

Along with developing strong personal relationships with the teachers in the school, the current study found that subsequent course taking behavior on the part of the students was indicated by the students' attitudes towards the teacher. Like the views of many other students, this student believed the junior teachers had been a positive influence: "My teachers of grades 8, 9, 10 have influenced me to take senior science and math courses by providing a wide range of activities and/or lab experiments to make the learning a lot more fun and enjoyable" (Student, School L). This personal connection was an important aspect of this student moving on to the senior sciences and mathematics courses.

When the same people are the teachers of junior science and mathematics and subsequently the senior specialty areas, the students and teachers have opportunity to know each other well. This was repeatedly cited in the current study as an advantage of the small school environment, and fundamental for students' later choices to take advanced courses.

One of the interviewed principals offered, "I think a lot of the time, the success the kids

get, the positive self image that they get is reinforced especially at the junior level" (Steve, Interview, May 13, 2003). Bart, a student who served as a major informant on this issue, reflected on how recognition was an important factor: "I've been successful [since early years in school], so I think that having success early helps to motivate…I'm thankful that my successes were recognized giving me that motivation" (Interview, September 8, 2003). His early interest was kindled, and then, having achieved success that was publicly recognized, served to motivate him to seek that experience of success again, further stimulating his interest in these subjects. Early exposure to and success with these subjects then leads to demand for these courses later. Teachers in the earlier grades stimulate and encourage young students' interests in science and mathematics, and then, as students get older, they take more advanced courses. Another factor for student motivation is the presence of other students who are striving for high personal goals.

Having a number of students each of whom is working hard to achieve personal goals serves the purpose of maintaining a culture of excellence in the school. A critical mass is necessary: there must be enough students in the group to have influence over one another and courses offered that they take together. One student commented that until the arrival of a new highly academic student at his school, he had always been the top student. Upon feeling pressure from the new student, he had a choice to make: let the new student take over the top spot, or reconsider his efforts at maintaining his superior position. This student, in the spirit of competition, developed a more collegial work pattern with a third student, and through the process, realized that the output of the pair was greater, in terms of learning and success, than either of them could have achieved separately. Clearly, this student's attitude toward the nature of his learning and schoolwork had changed by facing some competition for the top spot in the academic standings. It is unclear how this student would have completed his high school career without this additional motivating factor driving him, as he stated, "I [had] started slacking off a

bit" (Bart, Interview, September 8, 2003). With a small peer group, this boy had spent many years establishing and then maintaining his position at the top of the class, leading perhaps to a sort of complacency on his part. Peer relations are obviously an influence on student motivations. When a group of students is pushing each other, the challenge becomes then to strive harder, seeking greater academic challenges. These are the students who then want to take courses like Physics 12 and Calculus.

Student interest in science and mathematics usually develops early. One student offered, "I have always felt strongly about going into the sciences" (Student, School L). Students weren't asked specifically about when their interests began, but according to Jacobs, Finken, Griffin & Wright (1998), a strong indicator of future interest and aspiration in science for high school girls is participation in science-related activities, such as summer camps, earlier in their lives. Early interest in science and mathematics may also be stimulated through extra-curricular visits to science centers, museums or aquaria (Joyce & Farenga, 1999).

Students from small and rural communities may have limited or no early exposure to extra-curricular science or mathematics activities, for example, field trips to museums, science centers or aquaria. Schools in urban centers are much more likely to take advantage of these types of opportunities than rural schools due to the proximity and ease of access to such places. It may be that limited access to extra-curricular science and mathematics activities prevents students from considering a wider range of possible educational or occupational choices at the early age when exposure to them seems significant. Science and mathematics courses in small rural schools may need to include opportunities for students to consider future goals and aspirations that are science-related. The role of having a range of course offerings available in the small rural schools may in some way mitigate the limited opportunities for other types of career exploration. Teachers' abilities to make these connections and enable career exploration

through meaningful learning experiences are vital. The role of a well-prepared and experienced teacher to offer this type of access for students cannot be overstated.

Other studies have examined student interest in science and mathematics. Lewko, Hein, Garg and Tesson (1993) found that by Grade 9, students had solidified their interest in science. This was most often the result of strongly positive experiences in junior high. Again, this suggests the importance of gaining early exposure to science activities where interest starts to grow and subsequently the development of positive relationships between students and teachers, which takes time.

How these types of experiences contribute to students' development of conceptual understandings and metacognitive awareness is currently under investigation (Nashon & Anderson, in press). A complex linkage is suggested among student exposure to motivating activities, development of student interest in science and mathematics and later conceptual understandings built upon the earlier experiences. While early interest in science and mathematics influences student motivations for senior course taking, so too the relationships students have with teachers, parents and counselors.

Teachers' Influence

Students reported that teachers had made their courses enjoyable and interesting through a combination of stimulating activities, personal enthusiasm and subject knowledge. Teachers were credited with having a positive influence on students. Students offered, "The most obvious influence they've had on my decisions is whether or not they made the previous science and mathematics course enjoyable" (Student, School F), and "my teachers of grades 8, 9 and 10 have influenced me to take senior level science and math courses by providing a range of activities and/or lab experiences to make the learning a lot more fun and enjoyable." (Student, School L).

Through comments of this nature, it is clear that students view the relationship with the teacher as very important. The personal characteristics and exhibited enthusiasm, as well as subject knowledge the teacher has, enable the building of this relationship. For many students, this was built over the years of attendance at the school, and due to the nature of the small school environment, they had had courses with the same teachers throughout their years at the school. In the perspectives of participating students, the small school has a decided advantage over larger, more bureaucratic facilities in terms of teachers and students knowing each other well.

Several students were obviously influenced in a negative way by their junior science or mathematics teachers. At one school, the Science 10 teacher "circled around biology far more than anything else, and [now] I hate it, but I need to take Biology 12, even though I dread it" (Student, School I). At another school, a grade 10 Math teacher, who also taught History 12 and Geography 12, "tried to convince students to take social studies instead of or alongside senior sciences" (Student, School L). Apparently, the teacher sought to dissuade students from the sciences in order that his senior social studies courses enrolled more students. The active discouragement of the two cited teachers was certainly not the norm in the schools of this study, but it suggests that teachers have an important influence on student decision-making, whether positive or negative.

If the relationship between teachers and students is a negative one, student consideration of those courses may be precluded because of a poor relationship between the teacher and the student. In a large school, there will likely be a choice of teachers. In a small school, there is no such choice, and unfortunately, some students decide on courses based on the perceived personality of the teacher, and not necessarily on the virtue of the course. Personal characteristics of the teacher have also been cited as influencing some students' choices to not take senior sciences. One student reported that the "biology teacher speaks in a monotone voice and the

chemistry teacher is energetic and organized, so I chose chemistry over the two" (Student, School B). Another student reported, "if a teacher made a part of my class difficult or unenjoyable…I find that I do not want to take it any further" (Student, School H). Because in these small schools students rarely have a choice of teachers, particularly for senior science and mathematics courses, the teacher has a potentially significant impact on students' decisions about these courses.

The influence of the teacher could be either positive or negative, but one student reported teacher conflict as being responsible for avoiding a particular senior science or mathematics course:

> But if you have a conflict with one teacher you may not take that course because in a small school you only have that teacher teaching the class, whereas in a large school there would be different teachers teaching the same course (Student, School C).

This seems to be an important factor, at least for some, but one student stated, "Sometimes [the] course is taken because it is needed in spite of the teacher" (Student, School F). When queried about this during the interview, he cited the influence of his parents in making decisions not on personal likes and dislikes, but rather on the necessity of taking the course and remaining focused on what is to be learned. This level of maturity was, in my view, missing from those students who refused to take courses with particular teachers out of a personal dislike. It also seems to reinforce the importance of teachers in developing and maintaining positive relationships with the students in the school. Nonetheless, the vast majority of students cited their science and mathematics teachers as positive influences.

Parental Influence

The questionnaire for teachers asked for comment on the support provided by the parent group. Their responses reflected the presence (or absence) of a PAC group, and to some extent, the personal interactions they had with the parents of their students.

The role of parents in the schools varied considerably. It may be that the level of parental involvement is a function of the culture of the community in which the school is located, where some "old-time" families place differential value on formal education. Teachers at one school commented that because the community (and consequently, the school) had been around for many years, there was a history of parents attending the same school. Apparently, parents brought their own school experiences into their relations with the teachers. It was a blue-collar town, with working-class values, which according to one teacher in particular, made them view the school with some suspicion and mistrust. Teachers make efforts to communicate with parents, but "Parents are uninvolved as a general rule. They want to be included and kept informed, but do not follow-up on discussed ideas" (Teacher, School J). For teachers who want to keep communication lines open and involve the parents in the children's school life, this type of attitude is frustrating, and may in some ways hinder the work of the teacher. In responding to the questionnaire item "How supportive is your parent group?" a number of teachers felt that parents had little or no involvement with the school. Another teacher commented that he wished "we had the support bingo gets" (Teacher, School J).

Parent Advisory Committees (PAC) are a fixture at every school. Some PAC groups are very active, most often in fund-raising. Several teachers commented that the monies raised by PAC allow the purchase of support materials, while parents volunteer at school dances, sporting events and in the cafeteria. Money was not often targeted to subject areas, but rather to programs of benefit to the whole school or the school's extra-curricular programs.

While teachers in many schools reported an active PAC group, far more cited limited or non-involvement of the parents. In a school of approximately 300 students in grades 8 to 12, there were only 3 parents who regularly attended PAC meetings. At this school, a teacher sardonically commented, "What parent group?" (Teacher, School E). A teacher at another school expressed concern that the diversity of the community was not reflected on the PAC at her school, which is located in a First Nations community. Parents likely have a host of reasons for refraining from active participation in school organizations. However, recent research literature supports the notion that students, whose parents are actively involved in their child's life and the life of the school, are more likely to be successful at school (Bird, 2003). It is likely that a series of highly complex interactions are responsible for this success. It may be that, in general, parents active in the school pay more attention to their children at home too and offer other kinds of support, such as follow-up after discussions with teachers. In any case, good relationships between home and school are important for students as they move through the school.

Positive parental influence may happen on another level. In a small community, the teachers may be better acquainted with parents. Kozol (1981) noted that teacher-parent alliances were built through friendships. It may be that parents and teachers, by virtue of the small community, have occasion to interact socially, and hence, are better able to positively influence students. This again could be a consequence of the small community, where people know each other well. Conversely, it may be the lack of a positive relationship between parents and teachers that negatively influences students' course taking behavior.

Counselor Influence

The majority (60%) of students reported that counselors' influence was negligible or non-existent. Pillay (in press) concurs with this figure. From the responses provided on the questionnaires in the current study, it is unclear if there are no counselors in some schools, counseling services are inaccessible or that the students have no personal relationship with the counselors. In any case, students believe their access is limited. For schools with counselors, students reported two complicating factors challenging students' access to guidance services. Firstly, it is difficult to get to know the person in the counselor's office because he or she may only be there for a short while, and secondly, access to the counselor is problematic, due to the minimal amount of time the counselor is available to see students. This student's comment includes the implicit suggestion that building a relationship with the counselor is difficult if not impossible:

> There has been no counselor influence! Our counselors change yearly, and our counselors, due to budget cuts are only one regular teacher with counseling duties tacked on the side...this leaves little time to meet with them. Out of the 4 years of high school I have never been sat down and asked what I wanted to do, the opportunities that are open to me, and what courses I need to take. (Betsy, Interview, May 16, 2003)

This student seems to believe that the counselor should be available to help with decision-making for high school and post-secondary, and to ensure that appropriate prerequisites have been met. Yet, building a relationship is viewed as necessary by students in order for information to be accessed. This is a different type of access for students, but one that is relevant for course planning in science and mathematics.

Other students (40%) credited counselors with various roles: help in planning timetables and balancing course loads; help in planning for post-secondary education, advising for prerequisites and expectations; offer career exploratory activities; encouraging students to take

courses that interest them. This guidance may be critical. Asked during the interview about what she thinks motivates students to do well in senior science and mathematics, Marge, a teacher, said, "Most of them want to do well because they have a plan" (Interview, May 16, 2003). But, how do the students make their plans? This may be the vital role for counselors and teachers in small rural schools: help students to devise their own plans for the future. Those students with clearly articulated goals choose their high school courses accordingly, are focused on their studies and are motivated to do well.

Interest in science develops along with students' attitudes, ideals and expectations. From these develop educational and occupational goals. Grade 11 and 12 students then choose courses based on their chosen career pathways and the function these courses serve as entry to post-secondary education (Lockwood, 1998). Lockwood's study was based in urban schools that had counselors available to the students, and as shown in the current study, this may not be the case for small rural schools. But, apparently even in schools that have counselors, their work was to provide course-taking guidance and not career guidance. Perhaps the teachers and counselors of small rural schools attempt to fill both these roles, with varying degrees of success. This may be reflected by the lack of connection many students reported with the school counselor. However, as stated earlier, student access to counselors is problematic, hence students may lack access to vital information about coursework, which in turn can lead to inaccessibility of senior science and mathematics. Pillay (in press) has suggested in his analysis of longitudinal data from the *Paths on Life's Way* project (Andres, 1993, 2001), which has followed the graduating class of 1988 in British Columbia, that in terms of information, counselors and counseling programs did not provide enough accurate information or guidance for students while they were still in high school.

It would appear that more schools are relying on teachers, parents and students to

perform the counselor function, in the absence of a formal position at small rural schools. However, one student did comment on a personal level: counselors "gave me that small nudge that I needed" (Student, School H). When asked about the influence of grades 8 to 10 science and mathematics teachers, one student offered "It was more the counselors and my parents that encouraged me so that I could keep my doors open" (Student, School K). It appears that the counselors in these two schools, at least, serve an important function for student decision-making. Through the offering of options and encouragement, students consider plans for their futures. This seems dependent on having a particular person in the school who has been the counselor for many years. Or perhaps, as was the case with Donna and Bart who were children of counselors, students at the school would know the counselors because they are parents of their friends. Again, this suggests the importance of the personal relationships between students and the adults in the school, and the resultant positive influence that this has on student decision-making. The relationship with a teacher or counselor is so important, yet remains a challenge for students in many small rural schools.

Knowing students on a personal level was suggested by participating principals as a primary reason for the academic successes at his small school. Perhaps this is better enabled through a combination of staff stability and the small size of the school, and reflects the importance of people knowing each other well in small schools. Clearly, for individuals, a variety of personal influences are possible and likely.

Student Goal Setting and Post-Secondary Aspirations

Principals in the small rural schools of this study variously reported that 15-40% of their students went on to university or college within two years of leaving high school. Andres (2001) reported that about 75% of the British Columbia graduating class of 1988 had attended some

form of post-secondary schooling within one year after high school graduation, while 5 years after graduation, the percentage had climbed to 90%. This result seems to contradict what the principals of the current study have reported. However, it should be noted that the principals were asked for an estimate, and none of the principals admitted to actually keeping such records, so it is possible that their estimates are low. It could also be that the provincial average reported by Andres, which includes students from all over the province, is skewed toward urban students, who attend post-secondary programs at a higher rate than their rural counterparts (Andres & Looker, 2001; Looker & Dwyer, 1998). The important point is that a large number of students do in fact go on to additional schooling after high school, and their high school preparation is foundational for these later studies.

The need to prepare for post-secondary programs is a strong motivator for students to take the prerequisite courses in high school. While a proportion of students go on to university, senior science and mathematics courses are prerequisite for many different programs. Students have other considerations as they make their choices, and a number of influences are present.

The current study has shown that student interest in the school subjects of science and mathematics is a complex interaction of early exposure to the subject, recognized success at an earlier age, the personality and competence of those people the student contacts in the school and encouragement from parents and others. Students choose a career path, partly as a consequence of these interactions.

Educators believe that student goal setting is an important step along the personal development pathway. Students in the current study reported taking senior science and mathematics courses because they are prerequisites for post-secondary attendance, enabling them to move along the path toward their career goals. Goal setting has been shown to be a strong indicator for later course-taking behavior and career choice (Lockwood, 1998). Indeed, Hoogstra

(2002) found that taking advanced mathematics courses in high school was predictive for later mathematics and science careers.

In small schools, it is likely that the populations of students vary considerably from one year to the next. Marge, a teacher, commented "It varies from year to year, so one year you'll have some really gung ho kids that really want to learn...and other years, it doesn't matter what you do, they're going to do minimum, they don't care" (Interview, May 16, 2003). She went on to talk about how much fun it was to have a classroom full of the former, and how frustrating it was to have a bunch of the latter. Students' attitudes towards schooling and their relationships with the adults in the school emerged repeatedly as important factors in the small rural school environment.

Students, whose goals do not include post-secondary education, rarely take advanced science or mathematics courses in high school, as reported by teachers in the current study. These students may then be precluded from participation in any meaningful way in social conversations that have a basis in science. These students often have their own commonsense versions of what kind of learning is useful and how it is relevant to them (Aikenhead, 1996; Chinn & Brewer, 1993; Claxton, 1996; Cobern, 1996; DeBoer, 2000; Driver, Asoko, Leach, Mortimer & Scott, 1994; Duschl, 1988; Hills, 1989). Some would argue that these students can go back to school later, perhaps as adults, and gain the technical background for subsequent career choices, but Lewco et al. (1993) found that students who had not taken adequate preparatory courses while in high school never did take advantage of this opportunity to return to school, and were, in reality, foreclosed from scientific or technical occupations by virtue of their high school course-taking behavior. Adamuti-Trache (2003) found that even ten years after high school graduation, it was still the case that people didn't return to school to take these upgrading courses. It remains important, then, for a variety of course options to be available for students

while they are still in high school and for students to take them.

The Business Council of BC (2003a, 2003b), through its so-called "Third Option" is promoting many technical occupations and careers, which are believed necessary for the economic development and progress of the Province. Many students in the small rural schools of BC are in the position of finishing high school without the effective prerequisites or interest in further study and face limited future occupational prospects as a result. While choices over future pathways many times dictate students' course taking behavior, other influences on student decisions are also present. Teachers are most influential in this regard. Parents' expectations for their children are also factors. Having the courses available is the first level of access.

For students from rural areas, post-secondary aspirations are linked to their developing self-concept (Van Hook, 1993). These students, then, must leave their home communities in order to pursue their educational or occupational goals, and the decision-making patterns for these students are different than for students who have grown up in an urban area (Corbett, 2001; Looker, 1993). And, when students have less direct access to post-secondary institutions by virtue of having grown up in a rural area, their aspirations are correspondingly lower (Looker & Dwyer, 1998).

Rural students have consistently demonstrated their lower occupational expectations and aspirations, when compared to their urban counterparts (Andres, Anisef, Krahn, Looker & Thiessen, 1999; Haller & Virkler, 1993). Andres and Looker (2001) suggested that this was a result of rural students' limited exposure to the range of educational and occupational opportunities, and may in part be due to the limited course choices they have while in high school (Looker, 1993, 2001). This suggests an important role for schools in small rural communities, as interfaces between the local setting and the larger world of educational and career opportunity. Andres et al. consider the academic program available to students in high

school as a most important factor influencing student expectations. The current study supports these findings from the perspective of course offerings presently available in the small rural schools of BC. Of course, the school is only one place with influence over career and educational goal setting. Others include the family, and parental educational attainments, the local community culture, and the expectations it holds for its young people, the socio-economic status of the family and the local community, as well as other social and political influences.

Student Decision-Making

Students were asked how they are consulted when course offerings at their school are changed. Of 45 responses to this question, 26 expressed sentiments similar to this one: "We are told of the new changes, not asked, and students are not consulted if this inconveniences them, or their education" (Student, School I). In this way, students were forced to simply react to the imposed changes and adjust their aspirations accordingly. Many students expressed frustration over changes that happen in this manner.

There were two students who offered that there hadn't been any course changes during their time at the school, while three others replied that they didn't know how this process worked. The remainder of the replies (14) described how the process of course selections was carried out at that student's school. In some cases, the counselor met with the students to discuss their programming options, while in others, students are asked to express interest in particular courses through a course selection process. Most schools then compile these lists late in the spring semester and decide which courses can be offered, based on the number of students interested in a course and to some extent, the availability of a teacher. It seems to be a Catch-22, as students may be presented with a list of all of the provincially approved courses, but in reality, only a handful of these will actually be offered. An unusually small number of students (which is

often the case for the specialized senior science and mathematics courses at small schools in any given year) for a particular course means it likely won't be offered: "It is sometimes frustrating when you cannot take a course you need and want, and end up taking a course that is a waste of time" (Student, School F). Students are asked what they are interested in, but this doesn't mean that the course will be offered. Indeed, asking students what they might like to take may give them a false sense of having a choice and the feeling of participating in a popularity contest, as in all likelihood, only those courses with high enrolment will be offered. This can result in different courses being offered each year, and make it very difficult to plan a graduation program. Students will come to realize that the listing of a course in the school's Course Selection Guide doesn't necessarily mean it will be on the timetable. Student frustration is a likely result when their "choice" wasn't really a choice at all.

One school goes through a two-stage course selection process, whereby the first round is an 'expression of interest.' This information is then compiled into a list of what will actually be offered, and then the second round ensues for students to sign up for their choices. The principal at this school spoke of the difficulty of timetabling using such a process. Some courses are offered in multiple blocks at this school, for example, junior science courses. Those that are only offered once, such as senior sciences and mathematics become the source for scheduling conflicts.

This same principal spoke of the forced choices students had to make, based on the offering of only one block of a particular course. It may be that the offering of 'choice' to students is actually just a management tool, since the range of available choices is limited, and enforced by the administrative decisions about which courses get offered and which don't. The 'choice' may really be in the principal's hands, and not the students'.

Having limited resources available will impact the types of choices students can make.

For choices to be meaningful, they must be seen as choices. As schools get smaller, "choice" diminishes and students may even have less input into decision-making at the school. Earlier it was reported that students felt that their small schools were supportive of relationship building with the adults in the school. Along the same lines, students are very involved with school activities. One principal reported that upwards of 80% of the students in the school were involved with the school's extra-curricular programs: sports teams, student government and peer tutoring, to name just a few. These students expect to be involved in decision-making at the school level, but the majority of students reported having no input into how course changes to the school's timetable were considered.

4.2.4 Organizational Support and Course Delivery

The principals were asked about the extent of departmentalization in their schools. Of the 11 principals who participated in the study and responded to this question, nine indicated that teachers were organized into subject area departments. The remaining two schools had only one teacher in the science and mathematics areas. Departments may decide how certain course offerings are handled or how resources are allocated. In large comprehensive high schools, aspects of the departmental organization are significant influences on the professional working environment for teachers (Donnelly, 2000). In the small rural schools of this study, Department Heads handle ordering of supplies, chair department meetings and attend to other administrative duties. The Department Head is likely one of the senior people on staff and, as such, may serve to provide continuity in the school's science and mathematics departments over time. In this section, issues pertaining to senior science and mathematics course delivery, which indicate organizational support for or are consequences thereof, are discussed.

Importance of Stability

Many of the small rural schools in BC experience staffing changes each year. This is due to teacher attrition, fluctuating numbers of students or changes to district or Ministry of Education policy resulting from budgetary factors. Nora, as reported previously, had 5 new teachers join her staff of 14 Full Time Equivalents (FTE), because the previous spring, the teachers in those positions decided not to return. These teachers were reported to have left due to a combination of factors, which according to Nora included teacher burnout, isolation from friends and family and the expense of living in the remote community.

Students expect to have stability for their programming options in high school. Although, for some schools this is a problem:

> When we make our selections in June for the fall, we are then notified that one course has been dropped and a different one is put in place of it. This makes is very difficult to plan ahead when you don't know if the course you need will be offered in the years to come. (Student, School C)

Stability in the courses offered from year to year allows students to plan their high school programs. A student at one school described the process of timetabling at his school, where the "Principal walks in and asks for a show of hands for who wishes to take a class. [He] counts and walks out. Usually [we] find out course offering changes when the timetable comes out September of school year" (Student, School F). This type of uncertainty has significant impacts for students who wish to take low-enrolling courses, such as senior science and mathematics.

Counselors in some schools assist with rescheduling timetables, or in finding a different course, when the desired one is no longer offered. "When course offerings are changed, students are consulted immediately and are given a list of alternative courses being offered. The students are usually consulted by a teacher or a counselor" (Student, School L). For many students in small rural schools, counseling time is difficult to access, and courses are offered infrequently,

and never in multiple time slots, so planning ahead becomes a big issue for students.

The questionnaire asked principals to comment on the status of staffing and course offerings. Most felt that continuity of staffing was a significant factor in the quality of program delivery for these schools, as illustrated by these comments: "Our math and science programs have had consistent staffing for many years. This has definitely had a role in our academic success of students in the past" (Principal, School B), and, "Results are usually lower when there is a change of teacher" (Principal, School G).

Several principals considered it their good fortune to have had a particular science or mathematics teacher teaching in their schools for a number of years. Other schools reported having relatively stable staffing at their schools for a number of years. The least rural and largest schools in the study tended to have more of their teachers in positions long-term. Additionally, those schools with stable staffing and/or teachers remaining in the position for many years tended to have higher student participation and percentages of A and B marks on provincial exams.

Many principals reported budgetary constraints as a significant factor in their abilities to maintain staffing levels. Over time, their schools and districts have fewer and fewer teachers on staff, yet struggle to maintain course offerings. Norm reported that his school had had as many as 48 FTE during the mid-1980s, while in 2002/03, only 29 remained. The student population was only slightly lower in 2002/03. This systemic shift to having fewer teachers on staff compounds the impacts of attrition and smaller student populations, and over time, has had significant impacts on the stability of the school environment.

Stability in course offerings is important, and so is staffing stability. This represents another level of challenge for those who work in small rural schools, as students pursue their goals and ambitions. Teachers working in the same teaching roles over years enable continuity of

the school's programs. And, as stated earlier, this is how teacher competence and proficiencies develop. Students who build relationships with teachers while in their junior courses are more likely to take advanced courses at the grade 11 or 12 level with those same teachers, the current study has revealed. Hence, continuity of course offerings and staffing serves to support delivery of senior science and mathematics programs at small rural schools.

Staff Turnover

Many of the small schools in the study reported high staff turnover rates in general, which had a detrimental effect on the continuity of the programs being offered. Staffing stability enables continuity. Students who experience success as junior students are more likely to take further courses. Those who take senior courses have probably been positively influenced by the teachers in the junior program. Experienced teachers with content knowledge in a specialty subject are likely to have been at the school for a long time, and are in a position to be a positive influence on students. This complex of stabilizing factors over time is fundamental in terms of enabling student success.

The principals articulated the strong relationship between the stability of the staff at a particular school and the participation and success rates for students in senior science and mathematics courses at that school. One of the senior science specialist teachers at a school, as reported by the principal, "has been here for many years, 25 years at least…and what did we get? The highest mark in the province last time we had a ___ class" (Steve, Interview, May 13, 2003).

Arguably, schools with high staff turnover rates are the ones where teacher workload is heaviest. This was attested during interviews with principals and teachers at remote schools. Specific attention to workload issues at these schools could enable a stabilization of staffing and hence, operate to build a more positive and supportive culture in the school, one that promotes

excellence. Overworked teachers who are only recently acquainted with the students are not in an immediate position to have a positive influence. This is a staff development process, which takes time.

Fluctuations in the teacher population can also occur as a result of changing numbers of students. Some communities seem to experience more population transience than others, and as a result, student numbers change from year to year. Fewer students equates to fewer teachers in the school. In either case, teacher attrition or fewer students in the school, different (or fewer) teachers start the next school year and this has a potentially negative impact on the teaching of senior science and mathematics courses in the small rural schools of the province.

Resources

Resources for delivering senior science courses, including laboratory equipment and supplies, were widely cited as important factors in the delivery of senior science courses. For mathematics, especially at the senior levels, the major concern is over time constraints, and not material resources. In general, teachers feel that senior science courses ought to include a variety of laboratory work and projects, and so, a well-stocked laboratory is an important facet of delivering a science program. This is more the case in grade 11 courses, and less so in the grade 12 courses, as fewer teachers acknowledged doing labs or projects in grade 12 courses. Teachers' reasons for this included the curricular and instructional demands of the grade 12 courses (including heavy content), a lack of experience with the material, time constraints and an emphasis on Provincial Exam results.

Out of 26 teacher responses to the question "To what extent are labs and projects used in your senior science and mathematics courses?" There were 23 teachers who indicated that labs were a major part of the courses they taught. Only two of these teachers expressed any difficulty

in terms of access to equipment or resources: One indicated that expensive equipment for physics labs was not available and the other stated that there were insufficient resources for students to work independently on projects. It is possible that the nature of the question didn't offer sufficient invitation for teachers to comment on specific resources. However, the large number of teachers who indicated that they felt labs were an important part of the courses they taught suggests that small rural schools are adequately supplied with materials to run laboratory-based courses. Apparently, students see this differently.

When asked to describe their school's academic strengths and limitations, eight students spoke of resources or available money. Most of these students viewed resource availability as a limitation to what they could do in their science courses: "Lab equipment is in poor repair and there's often not enough" (Student, School H), and "The limited resources restrict independent and class experimentation" (Student, School C).

Only one student commented that resource availability was a strength of the programs at his small school, and ironically, this student was from the same school as the above student: "We have lots of resources and good textbooks and some teachers are really good" (Student, School C). This seeming inconsistency, in my view, reflects the different experiences that individual students have, and indicates that a one-size-fits-all approach to education is inappropriate.

It is also likely that students will have different concerns over resource issues in their schools than either teachers or principals, but by commenting on resources, students' perceptions are made visible. Teachers did comment on other types of limitations faced in doing lab work in their courses, and these revolve around time constraints and preparation for Provincial Examinations.

The need to spend time preparing students for the Provincial Examination was seen as a limiting factor to the number and variety of laboratory activities conducted in grade 12 science

and mathematics courses. Mathematics teachers, in particular, felt constraints due the topical nature of the Mathematics 12 curriculum. This curricular emphasis was evident, particularly amongst those teachers who did not do lab activities or projects: "In Math 12, we stick to the curriculum, rush through it at a pace which is already difficult for most kids to maintain. [There is] no time for projects" (Teacher, School D). Several teachers mentioned that material in some of the Physics 12 lab activities is also included in the Provincial Exam, and so justified the inclusion of lab activities in the course on this basis. Other teachers believe in the integral benefits of lab work, but feel the need to be selective in choosing which labs will be done. One teacher felt that due to the need to attend to test preparation, lab work could not be justified.

Teachers believe they are assessed as teachers on the basis of their students' results on the Provincial Exam: "we don't stray too far from the basics of the curriculum since Provincial Exam results are so closely monitored" (Teacher, School C). The additional pressure of the Provincial Examination affects the diversity of the activities in the learning environment, including accommodation for different learning styles and may serve to narrow the curriculum by overemphasizing the tested material and diminishing time spent on other exploratory activities. Timetabling restrictions may also serve to limit classroom hours available.

In addition to material resources, principals seem to consider teachers as resources too. Several principals spoke of having facilities and staffing to offer specialized senior science courses, but don't do it because "the direction in education in the last few years seems to encourage cost efficiency and a factory model of education resulting in larger class sizes and more limited opportunities for variability in programming" (Principal, School B). The provincial Ministry of Education has recently enacted changes to class size policy, which might be having some unintended consequences for small, rural schools.

A provincial mandate for a district-wide class size average of 30 students includes

funding formulas designed to reflect this (BC Ministry of Education, 2003e) has been enacted. Small schools must therefore make choices about which courses can enroll this many students. The consequence of this policy in BC's small schools seems to be that low-enrolling courses don't get offered. Or, if they do, other courses must over-enroll to maintain the 30-student, district-wide average. For some schools, this has meant 40 or more students in Physical Education or other elective courses. Where low-enrolling courses are still offered, students who opt to take Physics 12, for example, may have to choose not to take other elective courses, due to a scheduling conflict. And, if the grade 12 class only has 30 to 35 students, it is likely that there are only two course offerings in a given slot of the timetable. This has meant an overlap with some of the grade 11 courses, and several schools in the study have instituted a no-specific-grade-level-policy for elective courses. The challenge for the teacher in these courses is significant.

In some schools, other types of impacts to the timetable have been felt. School F demonstrates a case in point: last year, 36 students expressed interest in taking Physics 11. The physics lab was designed to hold 24 students, but instead of offering two sections of the course, the decision was made to offer only one, with 30 students. Several students, then, were turned away from taking this course, even though they had expressed an interest in taking it. This is a highly unusual situation, in that it was the only school where students were turned away from taking a course that was actually being offered at the school. Most of the schools reported having too few students to even offer the course (perhaps 10 or 12 is seen as a minimum), or so few students that significant pressure was placed on other courses scheduled in the same block. This is surely an unintended consequence of the 30-students-per-class average.

Principals reflected that the 30-students-per-class policy instituted by the BC Ministry of Education resulted in timetabling inflexibility, instead of allowing the offering of courses to

accommodate students. In schools where there are fewer teachers on staff each year, fewer students in the school and less money to address concerns in the building, meeting the needs of students becomes more challenging.

In an effort to offer courses with small numbers of enrolling students, several schools reported that senior science courses are being offered every other year. Although trying to make the courses available is commendable, students now must plan farther ahead for their senior courses. In most schools, counselors are not readily available to assist in this process, so students may end up not getting into the courses they want. And, courses may be dropped from the school's timetable without any student consultation.

The small number of students is seen as the reason why a wider range of courses is not offered in small rural schools. Pressures from external sources, such as the Ministry of Education policy of 30-students-per-classroom, may unintentionally exacerbate the small and shrinking number of course offerings available to students in small rural schools. When faced with decisions about how to cut costs in schools, administrators have very few options. The 30-student-per-class policy allows them to justify eliminating low-enrolling courses, or offering courses infrequently so that a larger number of students can in a way be stored up. The result is clear from this study: students must accept fewer options and choices.

When asked, "What are the factors which influence the delivery of senior science and mathematics courses in your school?" six principals spoke directly of staffing issues. Most of these linked staffing levels to the larger issue of school funding. More specifically, a push towards cost efficiency, resulting in larger class sizes in general, has the effect of decreasing the availability of any low-enrolling courses, such as senior chemistry or physics. With fewer teachers on staff, principals have decreased flexibility for programming options as a consequence of the cost efficiency moves. One of the principals during the interview compared his high

school to another, much larger high school in the same district that offers "three blocks of physics which gives you lots of flexibility, whereas here, what am I going to do with 12 kids? Do I offer it? Or do I not offer it?" (Steve, Interview, May 13, 2003). This kind of decision-making by the principal is a major influence on which courses get offered at small rural schools in BC.

Curricular Issues

Principals and teachers expressed worries over curricular narrowing as a result of constraints on their small rural schools. From an administrative standpoint, fewer teachers with subject specific expertise teaching in their areas of specialization contribute to this narrowing. Teachers, in particular, expressed concern that Provincial Examinations force them to be more test-specific in their teaching than they would like to be. From either perspective, student access to science and mathematics is limited.

As indicated at the beginning of this thesis, the senior science and mathematics courses considered in this study are Biology, Chemistry, Physics and Principles of Mathematics. These courses are seen as prerequisite for university or post-secondary entrance, and as such, need to be available to students who intend to embark upon post-secondary studies. Each of these courses, at the grade 12 level, has a provincial examination, which comprises 40% of the students' mark in the course. The other 60% is the "School Mark," which is calculated together with the "Exam Mark" for a Final Mark on the student's transcript (BC Ministry of Education, 2003d). The exam is seen by many teachers and students to dictate how the courses are taught and what is to be learned. Grade 12 students from across the province write the tests on the same day. The tests reflect the curricular emphases as published in the Integrated Resource Packages [IRP] (BC Ministry of Education, 2001).

The IRPs are the curriculum documents in BC. These are grade- and subject-specific in

terms of content. Curricular concerns are raised in the Rural Task Force Report (BC Ministry of Education, 2003b). The suggestion has been made that the current curricular documents, which could be viewed as content standards, are unsuitable for guiding practice in the small rural schools of the province. It is argued that since many rural schools have multi-graded classrooms, the grade level structure of the IRPs is inappropriate. A different curriculum model would, then, need to be developed, which takes into account the mixed composition of the classrooms in small rural schools. According to the BC Rural and Small School Teachers' Association such a model and will be working with the BC Ministry of Education to develop it (Sherri Peppin, Personal Communication, June 17, 2004).

Distance Learning as a Choice

Many students expressed reluctance to take courses through distance learning because these courses are not seen as legitimate alternatives to similar teacher-led courses. This was due in large part to the perceived difficulty of the course materials and the lack of interaction with teachers and other students. In a way most teachers seemed to concur with the students' sentiments by saying that the courses required a level of maturity and study skills, which most high school students lack. Some teachers considered the course materials too difficult, while others felt that the materials were "watered down." Either of these views could be seen as reinforcing the importance of the teacher's role for student success in courses. Likely, teachers would be reluctant to view distance learning as a suitable replacement for their own involvement with students in the classroom. These divided views could also suggest an unwillingness, on the part of some teachers to adapt to change (Adams & Salvaterra, 1998; Behar-Horenstein, Pajares & George, 1996). Resistance to the increased use of distance learning could also reflect concerns over job security, which are very real as 81 small rural schools have been closed in BC in the last

two years (the other 9 were small schools in urban areas), and more than 2500 full-time teaching positions eliminated across the province during this time period (BC Teachers' Federation, 2003).

Teachers oppose the expanded use of distance learning for students in small rural schools as a substitute for a teacher-led environment. They expressed concerns over the challenging content of senior science and mathematics courses, which make it difficult for students to be self-directed: "Students [are] not used to encountering 'hard' material and need support through the process. They are ready to give up too easily" (Teacher, School D), and "Math is a very difficult subject to self-teach oneself because of the many possible concepts that are used in each step to solve a mathematical problem" (Teacher, School C). Teachers further elaborated that distance learning courses generally require motivation levels and study techniques that most students do not possess. There is likewise no opportunity for conceptual feedback to students or adaptation for different learning styles, according to the participating teachers, many of whom seemed to agree with this perspective, "The depth of learning or discipline to finish or guidance is increased with a teacher. Many students drop the correspondence course and do not continue. Top students need conceptual feedback for complete understanding" (Teacher, School D). One teacher revealed during an interview that, although he had advised many students while they undertook distance learning courses, it was very rare for a student to complete Mathematics 12 through this mode of course delivery.

As students work in the distance learning environment, there is limited possibility for interaction with a teacher, and so students have little opportunity for conceptual feedback on their developing understandings, as well as enculturation (Hodson & Hodson, 1998), which teachers agreed was vitally important especially for the top students. With programmed learning materials, such as those used by the Distance Education schools in BC, there is no possibility for

adaptation for different learning styles, And, completion rates for distance learning courses are notoriously low (Bosetti & Gee, 1993; Moore & Kearsly, 1996).

Many teachers in small rural schools have training and experience in offering a range of course options for students. Additional training and time to gain experience, for young teachers, could mean that a highly specialized, yet diversely capable workforce was in place in these schools. In some schools, distance learning is offered and available to complement the local course offering schedule. In some cases, students have a choice of mode of course delivery. However, for many of the small rural schools participating in this study, "choice" means something different: if the course is not offered in the school's timetable, the "choice" is not choice of mode of delivery, but rather a choice to take the course at all. This is a very different sort of decision, with much more significant consequences in terms of the student's future.

When a huge variety of courses must be taught by only a few people, workload concerns are very real. It is arguable that there is a limit to which the intensification of teacher workload can continue. The question of whether this limit has been reached is confounded by the rhetoric from educational authorities on the inability to offer a range of program options in small schools. Distance learning is seen and offered as a solution to this "problem." I would argue that it is the efficiency agenda and not student needs or teacher availability, which is driving this sort of rhetoric.

The direct result of the efficiency agenda is reduced services for students. As schools become smaller, the variety of programs diminishes. For rural BC, this means fewer options for students in the senior courses, particularly in the sciences and mathematics. The Ministry of Education Graduation Program lists 53 Grade 11 and 12 science courses (including International Baccalaureate and Advanced Placement) and 32 mathematics courses (Ministry of Education, 2003d), not including those taught in French. While no school in the Province offers every one of

these courses, small and rural schools in BC offer a small fraction of these. For students who want to take courses not offered at their school, due to low enrolment or lack of available teacher expertise, the courses can be taken through distance learning. Many students offered that they had considered taking distance-learning courses at various points of their high school careers, most often because the desired course wasn't available at the local school.

The province's technological infrastructure is being improved so that more courses can be delivered using the capabilities of the Internet (BC Ministry of Education, 2003b). This use of technology is being supported in order that more courses are available to students around the Province, purportedly in a more cost-effective manner. However, according to Woo & Kimmick (2000), there is no evidence that course delivery over the Internet saves money.

In the smallest school participating in the study (fewer than five students per grade level), senior science and mathematics students access their courses through distance learning. There is one specialist science teacher on staff, a biologist, who is called upon to teach a variety of junior science and mathematics courses, as well as support students who are taking other senior courses, in chemistry, physics and mathematics through distance education. With a small teaching staff of perhaps four teachers, neither students nor teachers at this school expect that every course could be delivered in a classroom setting. These students and teachers, then, view distance learning as a viable alternative to not taking the course at all. This is in direct contrast to the attitudes of students and teachers in the larger schools of the study.

Students who have a choice to take courses via the distance learning mode of course delivery or through a teacher-led course reported that they would prefer to choose a teacher-led course because "I believe teachers can teach me the course better…" (Student, School F). Students acknowledged that they struggle with the content demands and study skills required for success in a distance learning environment, preferring instead the interaction with the teacher and

other students offered in the face-to-face setting. Students who do not have the choice of delivery mode face a different question: Do I really want to take this course? For students who are accustomed to taking courses with teachers, when left with distance learning as the only choice, the answer is often "No. It is not the way I prefer to learn new topics" (Student, School I).

Funding Allocations

Principals cited funding issues as influencing the types of programs that are offered in their schools. Some spoke of staffing limitations, such as no specialist mathematics teacher on staff, while others spoke directly of funding issues. Several principals mentioned both staffing and funding issues as factors in the delivery of senior science and mathematics courses. These principals expressed concern over the adequacy of funding to allow the offering of low enrolling courses. Specialized, advanced courses are by nature low enrolling in small rural schools. Supports, therefore, are necessary to enable these courses to be offered.

Funding issues take on additional significance in small, rural schools. Field trips are used for curricular enhancement by teachers who plan these trips (Anderson & Lucas, 1997). Informal settings and their value in promoting students' scientific conceptual understandings is being investigated (Anderson, Thomas & Ellenbogen, 2003; Anderson & Zhang, 2004; Falk & Dierking, 1992; Rennie & McClafferty, 1996). Teachers in several schools of the current study spoke of the expense involved in taking students on field trips. Long bus rides, ferries or planes are involved for students in rural areas for virtually any type of field trip experience, things that are easily accessible to students in urban centers. While none of the study participants felt that equivalent field trips should be made available for all students across the Province, many teachers would like to take their students on field trips to such places as Science World or a planetarium. They cited the great expense and distance involved as limiting factors. This is the

case for curricular as well as extra-curricular trips. If the school is within driving distance from an urban center, a day-trip may take the physics class to a roller coaster park for a day of "Amusement Park Physics." If the distance is too great, students may never get the chance to partake in such activities, and as mentioned earlier, these may enable students to engage in career exploration and deepen conceptual understanding (Nashon & Anderson, in press). Some may wonder why parents don't, then, take their children out of the community on vacations and attend at some of these types of places. It is likely that the family faces the same sorts of constraints in traveling: expense and distance.

Lisa, whose school was one of the most remote schools in the study, had traveled with her students on a field trip to visit colleges and universities around the province. Two of the students on the trip had never been out of the immediate area of their home community. Many would view school as an ideal place for students to gain access and exposure to a range of experiences out in the world. While this may be realistic and accessible in an urban center, the challenge for schools in rural areas to do this is substantial. The challenges mostly center on funding availability. This may be a justifiable place to offer differential funding, specifically for programs in remote communities, according to the actualist view of equality of educational opportunity.

It should be noted that students in outlying communities have access to experiences that urban students do not. These may include ranching or fishing as the family business, or hiking, kayaking or hunting as recreational activities. In many ways, these types of experiences underpin the lives of those students who live in the rural areas of the Province. However, in terms of what is not available to them, school-based factors are consequential. The next part of the discussion examines the nature of funding and impacts in the schools.

Education funding formulas in British Columbia are based on the number of students in

the school (BC Ministry of Education, 2003e). A per-student amount is allocated to the school district based on the number of students enrolled on September 30. Additional amounts are allocated based on size of the district, geographical isolation factors and assorted other calculations designed to mitigate the higher per-student costs associated with operating smaller schools in smaller districts. Principals repeatedly cited funding as a significant factor that impacts the delivery of senior science and mathematics programs at their schools. Small communities in British Columbia are experiencing significant population shifts and emigrations are resulting in declining student populations (Hayter, 2000; Shearer, 1971; Ward, 2002). These population changes have a large impact on the stability of the school setting and as a result, the course offerings at the local high school.

In a way, many of the issues discussed in this chapter have their basis in school funding. Teaching and support staffing levels, professional development for teachers, supports for low-enrolling programs and resource availability all depend on funding. How many teachers work at the school? What are their specialty teaching areas? What resources are available? All of these questions pertain to course offerings. If the school is to offer a range of course options for its students, staffing and resource levels must be in place. These cost money. At what point is school funding inadequate for its business to be conducted, and how is this decision made? From the results of this study, it is arguable that this threshold has already been crossed, as students perceive their access to senior science and mathematics as limited.

4.3 Summary

The participants in the current study have demonstrated that senior science and mathematics course offerings in their small rural schools are limited in number and type of delivery mode, subject expertise of the teachers, and hence, student access. The implications for students and their futures cannot be overstated, as high school programming and course taking has predicted university degree completion status (Andres & Krahn, 1999) and access to a wider range of career choice. While university attendance is but one of many pathways to adulthood, many post-secondary opportunities and career pathways require science and mathematics as prerequisites. When public education is the gateway to science and scientific literacy, including participation in a technological society and for responsible citizenship (BC Ministry of Education, 2003a; BC Progress Board, 2002; Hodson, 1998; Rutherford, 2001), student goal setting and post-secondary aspirations and attendance become paramount. This decision-making happens over years, but early interest in science and mathematics is key for young students, as are influences from significant others in the students' lives, for example, teachers, parents and counselors. Students who set goals for their futures then opt for the prerequisite courses in high school. The organizational structures in the school support the delivery of the courses, or in some way interfere. It appears that a number of structures that have in the past been supportive of a variety of course options have been eroded to the point of ineffectiveness. As a result, students' access to senior science and mathematics courses is becoming available only through the further limitations of the distance-learning mode of access.

CHAPTER 5

Conclusions, Implications and Recommendations

This chapter is organized into main three sections: the *Thesis Conclusions,* which are constructed around the key findings from the study, the *Implications* of the findings for students, teachers, small rural schools and curriculum, finally, *Recommendations*, which include questions for further research.

5.1 Conclusions

This study has examined the issue of student access to senior science and mathematics courses in small rural schools in BC. The study sought the perspectives of principals, teachers and students from small rural schools in BC on the factors impacting student access to the courses. Analysis of the data collected revealed key factors impacting student access to Grades 11 and 12 biology, chemistry, physics and mathematics courses. These include: 1. Student access to subject specialist teachers, 2. The qualifications of the teachers and their attitudes, 3. The aspirations of the students and their attitudes, and 4. Staff stability and organizational structures within the schools.

5.1.1 Student access to subject specialist teachers

Subject specialist teachers are unevenly distributed among the small rural schools that participated in this study. Approximately half of senior science and mathematics courses offered in the participating schools are taught by non-specialist teachers, that is, if the courses are taught at all. Non-specialist teachers may possess incomplete or inadequate conceptual understandings of the complex content in these areas, which are then taught to the students. And, teachers in the small rural schools that participated in the study have very heavy workloads. These have potentially significant consequences for student access to the subject specific information of the science and mathematics disciplines.

5.1.2 The qualifications of teachers and their attitudes

Many times, teachers in the small rural schools who participated in the study teach outside their subject specialty areas. Science and mathematics as subject areas contain complex content, and so teachers need to have complementary expert subject knowledge and pedagogical content knowledge. This depth of knowledge is important in order for students to gain access to the content of the subject discipline areas. When the teacher is not a subject expert, this can be a significant impact on student access to the subject area. Teachers can, however, develop expertise through accessing relevant professional development opportunities and gaining experience in teaching the subjects. But, professional development was found to be difficult for teachers in the participating small rural schools to access.

Teachers in the study believe that they serve an important role as mediators for students to the specialty subject areas of science and mathematics, and a positive relationship between the teacher and the student seems to be an important criterion of access for students in the small rural schools of the study. When teachers and students know each other well, students have better

access to the conditions enabling success in learning, and small schools provide much opportunity for one-to-one interaction between teachers and students. These relationships are facilitated by a variety of conditions, but mostly are presupposed on the teacher's ability and personality, as well as student goal-orientation and interest in success.

5.1.3 Student aspirations and their attitudes

The study revealed that students' attitudes toward their teachers and the subject are important influences on student decision-making. Student interest in science and mathematics develops when the teachers are seen to be credible and make the courses interesting and enjoyable. Probably most important is the role teachers play in offering encouragement and motivation as students make decisions for the future. Teachers also serve as resource people for information about careers and post-secondary opportunities.

Teachers and students from the study expressed the belief that personal goal setting is key as students consider options for their futures. This means that they need the opportunity to explore a variety of educational and occupational pathways. Students cited teachers, parents and the local community as important factors in this consideration.

Courses in high school are prerequisites for post-secondary pathways, but course choices, as found by the study, are few in small rural schools. Students want to take courses with teachers and would like to have guidance from counselors, but as reported in the study, counselors are largely unavailable.

5.1.4 Staff stability and structural changes impact students' access

The study has shown that schools with stable student population numbers, teaching staff, and consistent program availability are resilient in the face of structural changes, which are on-going in the participating small rural schools. A stable teaching staff is key to the continuity of program options for students. But, the small rural schools that participated in the study often face high turnover rates and operate with fewer teachers each year. The uncertainty and instability that this causes has significant impacts on the school environment, and hence student access to educational services and course offerings.

Even though changes to the school or its programs have a significant impact on students, participating students reported that, as a rule, they were not consulted about these changes. This leads to further instability in the school setting, as these changes make it difficult for students to access the courses or programs they would like to take, and may have more serious consequences for later decision-making. Distance learning courses are offered as alternatives to in-school course offerings, but many students in this study suggested that they would not want to take senior science and mathematics courses or other higher-level courses through distance learning. Distance learning is not a viable alternative to having teachers in classrooms.

Many of the participating small rural schools that are most affected by student population declines are undergoing reconfiguration, consolidation or closure. The teaching of important courses such as senior science and mathematics is significantly affected. Impacts on the setting from budget pressures, declining enrolments, fluctuating staffing levels and others all have significant effects too. Access to science and mathematics was examined in this study, but the impacts are likely to be felt just as significantly in other subject areas.

5.2 *Implications*

This study has shown that a number of factors influence the conditions under which senior science and mathematics courses are offered in BC's small rural schools. Student access to expert teachers is one of the important aspects of student access to science and mathematics. Likewise, how the teachers are supported in their work, through such things as material resources and timetabling arrangements, are organizational structures of the school, which in turn impact the delivery of senior science and mathematics. From the inferences and conclusions presented in the previous section, implications for students, teachers, schools and the curriculum are drawn.

For Students

If teachers of complex content areas, such as science and mathematics, lack strong foundational knowledge, student access to the content of the discipline may be limited. This is a serious consequence as deep conceptual understanding is a stated curricular goal for science education and scientific literacy.

The small school size enables small class sizes and the benefits that derive there from. However, people in small rural schools believe that certain things should be expected as a result of a small population. Students, in particular, expect that they will not have a wide selection of course choices available to them, although they would like to have such a choice. They do expect to have a variety of courses offered and that teachers will lead them. It will remain the responsibility of the students to take these offered opportunities, but subsequent populations of students may grow accustomed to the lack of choice and set their aspirations accordingly.

A lack of opportunity to take pre-requisite courses may preclude consideration of a range

of career choices, and hence limit a student's potential for his or her future (Adamuti-Trache, 2003; Looker, 2001), at a time when business groups and society attach high value to scientific and mathematical knowledge. Rural students may have limited exposure to the range of different types of professions or occupations, both because there is a smaller likelihood that their parents are occupied in a professional or technical capacity and their exposure to the range of scientific disciplines through their high school courses may be limited.

Students' access to courses in their small rural schools may be the deciding factor of which careers they are able to choose, since it is through their high school course taking behavior that the necessary prerequisites for post-secondary study are gained. Students must have access to a course in order to take it, no matter what their later aspirations may include, and this has been shown to be a problem. Students undertake career exploration during their school years, and schools must provide opportunities for such exploration. Teachers and counselors are key as facilitators for this exploration by students.

The traditional resource-extractive industries of the rural regions of BC are undergoing restructuring (Hayter, 2000, 2003; Shearer, 1971), which is requiring adjustment to the nature of job opportunities. It may be that rural students will be relegated (sacrificed?) to the service economy, since their options for participation in a technological future are effectively cut off before they, perhaps, can understand the implications of such decisions. While the service economy sector is growing in BC (Business Council of BC, 2003a), students who have no option but to work in these low status, seasonal and low paying jobs will see their futures as very dim indeed. Relegating rural children to the service economy will effectively remove them from participation in the larger society, and the shrinking of programs at the small rural schools will facilitate this. This is a very serious potential consequence of moves toward efficiency of operations in small rural schools, as being promoted through staffing cutbacks and increased use

of distance education modes of delivery for the small rural schools of the province.

For Teachers

In small rural schools, perhaps the problem is not so much in attracting teachers to the small rural schools, but rather in keeping them. Heavy workload makes the job challenging. Instability in the setting leads to very real concerns for job security. This suggests that better support systems in the schools may serve the function of developing and maintaining subject expertise in the small rural schools of BC. Teachers likewise feel the importance of positive student-teacher relations. The personality of the teacher is a key factor.

In some cases, the small size of the school has dictated a multi-grade arrangement for secondary students. However, this requires a different type of training for teachers, as it is rare for high school teachers to have been trained to work with multiple grade levels or with such wide variation as is typically found in an elementary, multi-graded classroom. In small rural high schools, teachers are accustomed to working outside of their specialty areas, but the addition, in some cases, of two or more grade levels in the same room is new, and represents an increase to the workload where pressures are already great. A wider selection of course offerings is enabled, but teachers already have a diverse workload in which a different course is likely taught each hour of the day and work intensification for teachers becomes an even larger issue.

For Small Rural Schools

When teacher expertise is unevenly distributed and student populations are transient, as is the case with many small rural schools, the delivery of courses may well be uneven from year to year, if in fact the courses are even offered. It is this type of instability that may be reflected in the measures suggesting that rural schools are performing at a substandard level relative to their urban counterparts (BC Ministry of Education, 2003b). Schools with lower participation rates on provincial examinations and low percentages of students scoring A or B marks, on the average, may reflect the underlying economic instability in the community in which the school is located. There are, however, small rural schools with relatively high participation rates and percent of students scoring A or B on the provincial examinations. It may be the opposite side of the same coin. These schools typically have more stable student numbers, staffing and course offerings. As school populations all over rural BC continue to shrink, increased pressure will likely be felt in these schools too.

The BC Ministry of Education (2003a) is promoting distance learning as a means whereby students in small rural schools can have access to a range of course offerings that their schools are unable to provide. The Ministry documents cite efficiency concerns as the reason why small schools cannot provide for the range of student interests and abilities that may be present in the school. As small rural schools continue to decline in population, student distributions for certain courses will make distance learning seem more viable as an option for course delivery.

There is a significant danger present, given the current political climate, that moves toward cost-efficiency will overshadow the importance of small rural schools. With accountability measures, such as Provincial Examination and other standardized testing scores, focusing on educational outputs, the uniqueness of the small school situation is lost, as are the

contributing factors to the measures. The mechanism of accountability needs to be questioned.

In the current configuration of distance education, completion (not the same as 'success') rates are very low. Requiring more small rural school students to take their advanced coursework through distance learning, without significant changes in how these courses are delivered (Moore, 1986), could have more serious consequences as students ultimately choose not to take the courses at all.

British Columbia is a geographically diverse province. Communities have grown up around the local extractive industries. Recent economic downturns have reshaped the global marketplace, so too BC's resource communities. This has meant new challenges for the schools around BC. Most significant in this regard is the trend to declining populations in rural communities. And, in Canada, families are having fewer children (Statistics Canada, 2002). This has serious implications for future provision of educational opportunities for students. When funding for schools is on a per-capita basis, declining enrolments mean that school districts must seek ways to economize. The direct result is reduced services and fewer options for students, including senior science and mathematics courses.

For Curriculum

When teachers must teach much of their workload outside their areas of expertise, there is a significant danger that the official curriculum will be incongruous with the taught curriculum (Cuban, 1993). It has been suggested in this study that curricular narrowing is already occurring as increased emphasis is given to provincial examination results, and hence, material covered by the exam is given more attention during class. This may be exacerbated when an inexperienced teacher has few personal resources from which to offer a rich and deep educational experience for the students.

There is a distinct paucity of literature examining provincial exam scores in BC and their correlation to desired curricular outcomes, despite publication of test data for a number of years and asserted relevance of scores by Ministry officials (Ministry of Education, 2002a) and others (Fraser Institute, 2002, 2003). Studies in the US have shown that increasing emphasis on standardized testing results in curricular narrowing (Amrein & Berliner, 2002; Darehshori, 1977; Haney, Madaus & Lyons, 1993; Hewson, Kahle, Scantlebury & Davies, 2001; Kohn, 2000; Westerlund & West, 1996), and some teachers believe themselves to be evaluated on the basis of their students' scores on provincial examinations. This also has the potential to change the taught curriculum into a test-specific and narrow one.

Whether derived from test specificity, a narrow view of curriculum may be responsible for why small numbers of students choose to take senior science and mathematics courses (Adamuti-Trache, 2003). Science educators have also raised this issue, and suggest that a different approach to curriculum and to teaching is warranted (Aikenhead, 1994; 1996; Hodson, 1998; Matthews, 1994). Subject specialist knowledge as well as pedagogical content knowledge, and the development thereof, may be key to engineering this shift in the perception of science, and while adjustments to teacher competencies and capabilities are required whenever curricular changes are made, these take time to implement.

5.3 Recommendations

This study has examined impacts on student access to senior science and mathematics course offerings, impacts that are the consequence of larger forces operating on and in the small rural schools of the province. It is acknowledged that competing forces will be present whenever recommendations for change are considered, and the issues are complex, so change will be difficult. With this in mind, the following summary of recommendations is made, which have come about as a result of the responses provided on the questionnaires and through interviews with principals, teachers and students in small rural schools around BC.

Recommendation #1. Students need access to a range of course offerings.

It is recommended that a range of course offerings for students be maintained.

Students need to see choices as visible manifestations of what is possible for them. A range of course options helps to assure that students are exposed to a wide variety of subject areas and disciplines, across the curriculum. This will require keeping schools open and subject specialists on staff. Organizational structures at the school may also support the offering of a range of courses, such as alternative school timetables, flexible staffing arrangements or the sharing of resources with the local community college or between neighboring communities or schools. The potential of the Internet has yet to be fully developed.

If a school cannot offer a specialty course, for example, Physics 12, perhaps the students who want to take this course should be funded to attend an intensive summer school course or other such learning opportunity whereby students from small schools could earn the course credit, while actually participating in a program. These would be preferable to the current mode

of delivery for distance learning courses, which are still (in most cases) modular, print-based materials. Utilizing the full potential of the Internet to conduct courses via two-way videoconferencing and on-line interfacing remains a futuristic image for rural BC schools, and until the highly interactive technologies are widely available, distance learning in its current form does not represent equitable opportunity for students in senior sciences and mathematics.

Recommendation #2. Teacher expertise is vital.

It is recommended that teacher expertise be maintained in small rural schools.

In the specialty areas of senior sciences and mathematics, the knowledge base of the teacher, including pedagogical content knowledge, is essential for students to succeed. Likewise, experienced teachers who have developed their programs over time and have had opportunity to develop positive relationships with students are more effective in their roles.

Maintaining a range of subject expert teachers in small rural schools will be increasingly difficult as the schools continue to shrink. Contact with well-trained and experienced teachers is seen as vital for student learning and meeting student needs. The funding allocation system needs to be reconsidered, as, in small schools where populations are shrinking, the budgeting procedures still depend on a per capita formulation. This has resulted in instability in the staffing levels, course offerings and material resources for the schools, through the necessity to make decisions to cut programs and services each year. Funding which is adequate to maintain a range of teacher expertise in classrooms is necessary.

A more radical approach might be to assemble a roving core of widely experienced subject specialist teachers who move to different schools for a semester, or shorter time, offering the low-enrolling courses on a rotating basis in schools that are unable to fund the variety of teachers on staff who are expert in chemistry, physics or mathematics, for example. It is

acknowledged that current constraints make this possibility untenable, but it might be interesting to consider different arrangements of how teachers are staffed at high schools. This would also require a different view of school-based administration, as a larger number of people would operate within the building, but not on a full-time basis.

It is recommended that teachers be supported to expand their areas of subject expertise.

Support for teachers includes access to personally relevant professional development with appropriate financial support, additional training options to expand the knowledge base to other subject areas through such means as attendance at university for continuing study, certificate programs or a second degree and access to current teaching resources and methods such as using internet databases and on-line tools for instruction.

Encouraging and enabling teachers to become part of collaborative communities may be an additional means whereby the isolation of remote communities could be lessened. Building relationships with university teacher education programs and research projects could also positively impact teachers' access to current pedagogical knowledge and skills. Rearrangements of how educational expertise is distributed, including allowing university staff to work in other settings, and teachers to more fluidly move around the province could facilitate more direct connections between the theoretical and practical divide that now separates universities from high schools as places where educators work.

Recommendation #3. Technology should support the teacher-led environment.

It is recommended that before any wholesale movement to distance education as the mode of course delivery for small rural schools be undertaken, careful consideration is given to the implications.

Using technology to deliver courses for students in small rural areas is an increasing reality. Utilizing the advantage that can be provided through high technology connections between schools, districts and the Internet may offer students access to specialized content that may not be present in their schools. But, distance learning, even with technology, is not for everyone (Wilson & Litle, 1998). It is isolating (Thorpe, 1995), difficult (Fung & Carr, 2000), course completion rates are low (Bosetti & Gee, 1983; Moore & Kearsly, 1996) and students should self-select into distance learning courses (Roblyer, 1999). Students need the option to consider distance learning, but not as the only alternative to a course led by a teacher in a classroom.

Many schools around the province still lack high-speed access to the Internet. While upgrades are promised and pilot projects underway, many high quality advanced technologies remain unavailable, such as synchronous course delivery. Their use in other settings is being questioned both in BC (Vancouver School Board, 2004) and elsewhere (Webster, 2004). Teachers need the option to use technology to provide supplemental information and programming, while being mindful of the individual needs of their students. It is inappropriate to view technology as a replacement for teachers.

Recommendation #4. Re-examine conceptions of curriculum.

It is recommended that the trend toward curricular narrowing be reversed.

This will be challenging in the current test-specific environment of education. Perhaps, in

BC, it is time for us to examine the role that standardized tests really play, and what importance we should rightly ascribe to them, since, as teachers reported, their presence dictates what is done in senior science and mathematics classrooms. This is a concern for all schools, not just small rural ones. However, small rural schools are likely to have inexperienced teachers working outside of their subject specialty areas, so their ability to work within this test-specific environment may further compromise the delivery of senior science and mathematics courses in small rural schools and students' access to educational opportunity.

Questions for Further Research

While this study has gained important insight into the issue of student access to senior science and mathematics in the small rural schools of BC, a number of other important questions have arisen. These include questions about school organization, new teachers, the gendered nature of science knowledge and the science curriculum.

There are a number of models for school organization in rural areas. Of the ones that are successful elsewhere, how might these be adapted to the British Columbia school system? And, could the goals of the educational system in BC be better supported with a different organization?

Beginning teachers were not specifically sought out in this study, but many were found. An interesting study would involve following young teachers as they begin their working lives in small rural schools. Conceptions of why some choose to stay (and why many more leave all too quickly) could inform the development of training programs and hiring policies. I suspect that rural districts that customarily hire a number of new teachers each year have developed their own policies. Are there specific strategies used by some districts so that more of the young teachers stay in the employ of the district? Are there different kinds of supports for these teachers in

different districts?

The gendered nature of scientific knowledge has been raised, but not thoroughly investigated in this study. Is science knowledge gendered in small rural schools? Are there fewer females from rural areas of BC taking science and mathematics courses? Are there, then, fewer young women entering science and mathematics-related fields? What role does the gender of the teacher play in science and mathematics courses in small rural schools?

The issue of curriculum narrowing has been raised, and yet, our understanding of the nature of scientific and mathematical knowledge changes. Scientific understandings and curricular emphases often parallel the political and economic dynamics of the day. Do teachers and students need to learn to be more adaptable and receptive to these changes? Or would a questioning habit of mind be more appropriate, so that people have the intellectual tools to assess validity claims, conduct inquiry and construct reasoned arguments? Would greater clarity of the notion of *scientific literacy* help in this regard?

Thesis Summary

Seeking perspectives from the three different participant groups, who work in many different schools around the province, has allowed a view into the issue of access to senior science and mathematics courses that would not otherwise have been available. Important policy considerations derive therein as our values are put to the test: Since schools cost more per pupil in rural areas of the province, should we continue to support the inequitable distribution of resources so that a shrinking number of people can live in small rural areas? I say yes—This is a necessary expense for the society as a whole to bear. We seek equity in programs offered in schools. Unequal distribution so that the criteria of access can be met requires a differential application of the principle of equity.

We should also be asking ourselves why all Canadians should live in urban centers. If the current trend toward depopulation continues, very few people will live in the outlying areas of BC. This may seem like an economic argument as consolidated civic services are seen to be cheaper to deliver. As cities grow (and, arguably, too fast: ask Surrey, BC), a different range of problems is created, most of which are very expensive, from additional civic services like police, water and sewers to housing, transit and road building. In my view it is a false economy to allow or promote the rural regions to be emptied of people. The economy of the Province, and indeed of Canada, will remain tied to the resource extractive industries for the foreseeable future. These industries do not operate in the cities. Why should work camps occupy mine sites, fish-processing centers or logging areas? A society that promotes family as a value should also promote rural life as a choice.

So, did this study need to be conducted? Absolutely! If we say that we value something, then we need to follow up the rhetoric to see if it is actually put in place. Availability of services,

including schools, becomes key. Small rural schools in BC are each unique. They operate under tremendous pressure and constraint, struggling to offer a variety of programs and options for their students. Bringing to light the issue of student access to science and mathematics provides a small glimpse into the life of these schools and communities, and from this glimpse, a better understanding of the situation in small rural BC high schools has emerged.

Perhaps this study has confirmed what was already suspected about the small rural schools of BC. Student choices are limited, teachers are unevenly distributed and the viability of small schools is threatened. The larger impacts from political agendas and corporate decision-making are significant, if indirect, on the schools in small, resource-based communities. These impacts are most often outside the purview of the school environment and its decision-making authority, leaving those who work within the small rural schools to cope with the decisions made elsewhere. It may be that, as suggested by principals and teachers of this study, a stable school environment is in the best position to weather the larger forces operating and impacting the school. However, as reported in this study, schools in different parts of the province have variable capacities in their ability to manage the impacts of these forces, and as a consequence, students are differentially able to access specialized senior science and mathematics courses, qualified and experienced teachers and the conditions which enable success in school.

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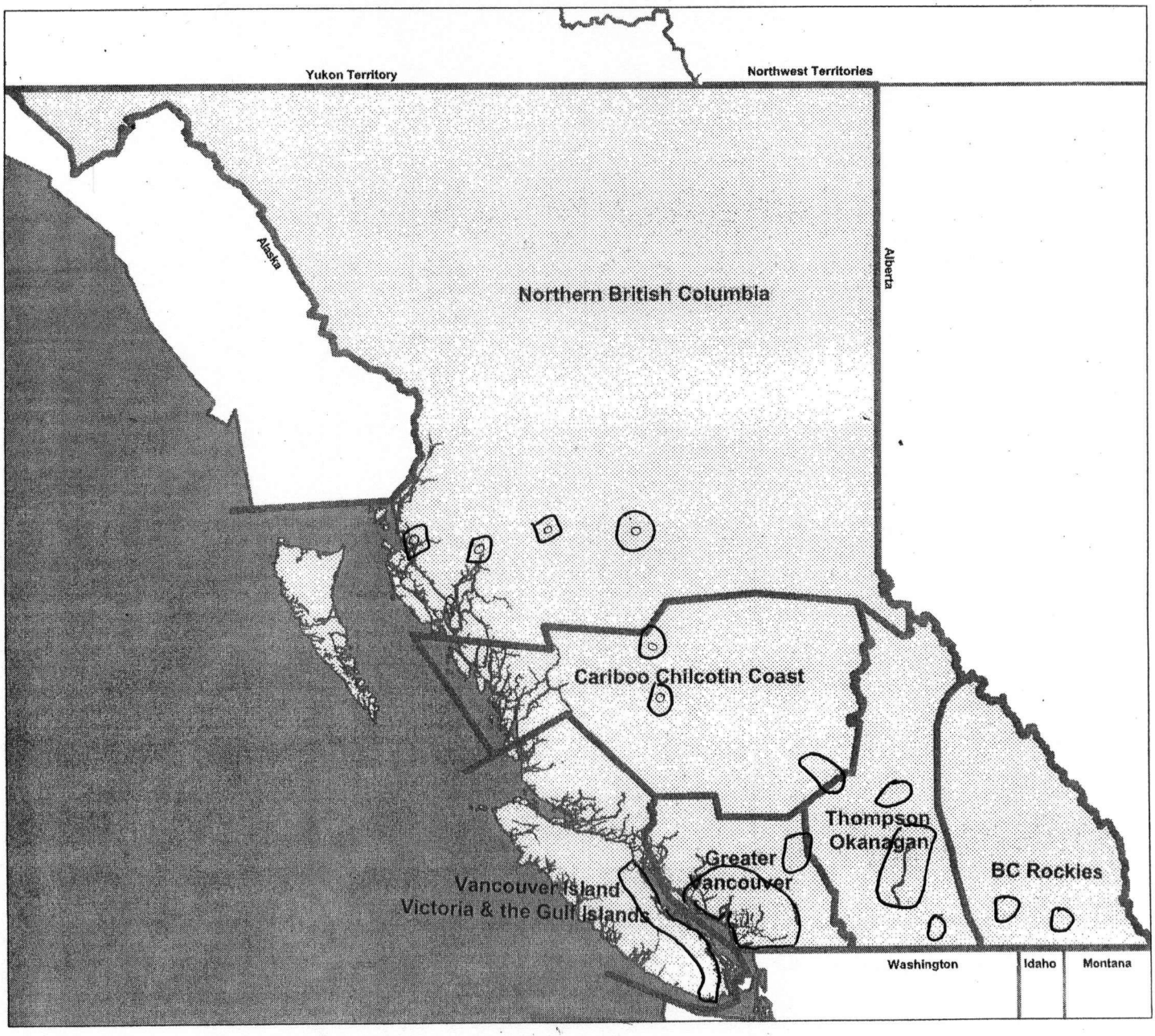
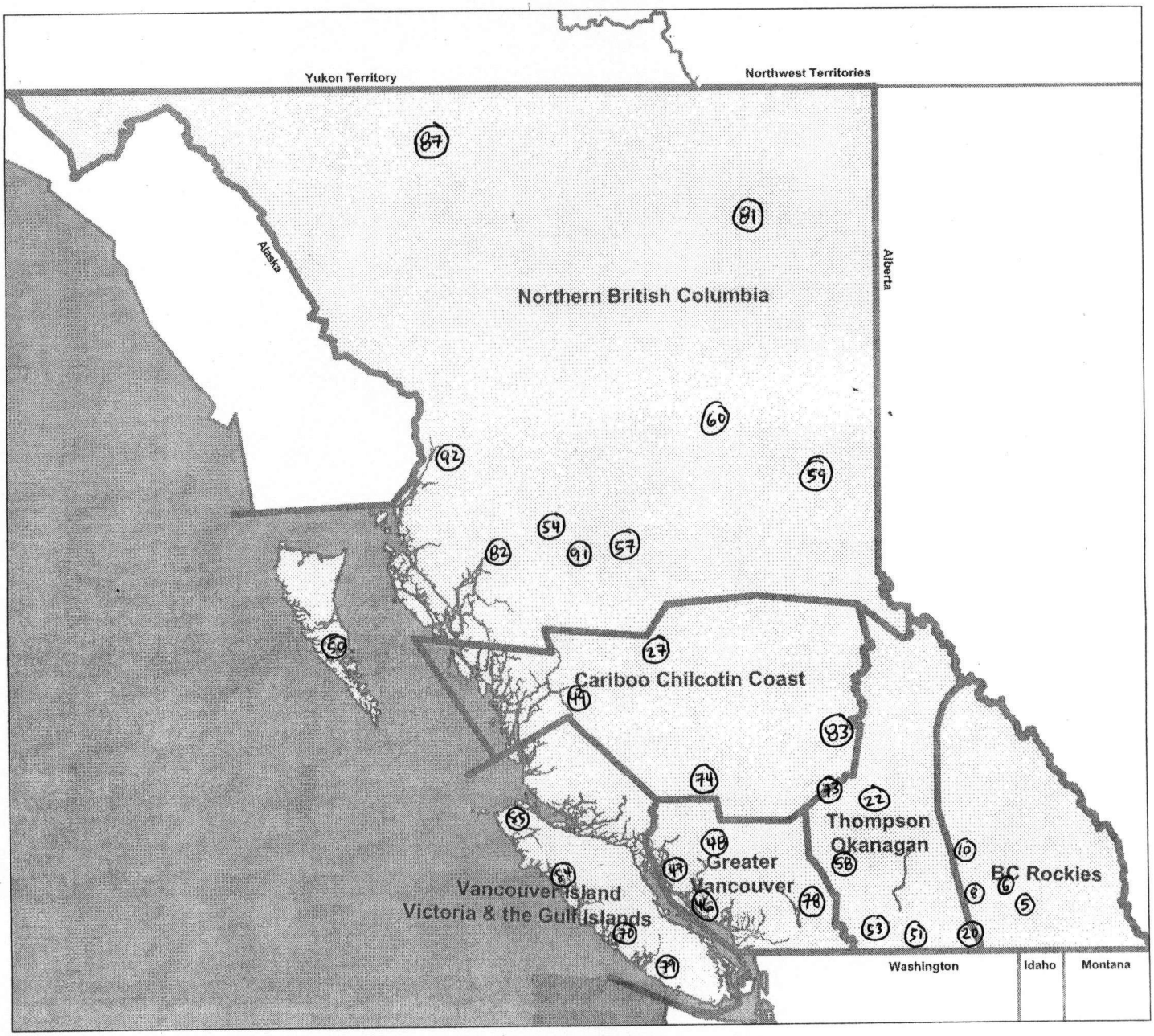
Appendix A

Map of Service Centers and Urban Areas of British Columbia



Appendix B

Map of 32 BC School Districts from whom Permission was Sought



Appendix C

5-year Comparison of Averages for Participation and %A or B Marks on Provincial Examinations[4]

	Biology	*Biology*	*Chemistry*	*Chemistry*	*Physics*	*Physics*	*Mathematics*	*Mathematics*
	Participation Rate	*%A or B*	*Participation Rate*	*%A or B*	*Participation Rate*	*%A or B*	*Participation Rate*	*%A or B*
Provincial Average	*29.1*	*38.4*	*22.9*	*49.5*	*18.1*	*51.0*	*33.2*	*43.8*
Small Rural School Ave. (n=55)	*30.8*	*32.2*	*16.8*	*34.7*	*7.6*	*32.1*	*25.7*	*25.2*
Study Group Ave. (n=12)	*22.8*	*31.7*	*17.1*	*36.5*	*5.7*	*46.7*	*21.5*	*26.1*

[4] Data retrieved from BC Ministry of Education (2002e)

Appendix E

Introduction Letter to Superintendent

Dear Sir/Madam:

Accessing Science and Mathematics Course Offerings: The Case of Rural BC High Schools

My name is Dr. Samson Nashon, Assistant Professor in the Department of Curriculum Studies, Faculty of Education at the University of British Columbia. With my research assistant, Wendy Nielsen, we are conducting a study into the issues of access faced by BC students in rural and small school settings, particularly in the subjects of senior sciences and mathematics.

We request you permit us to involve principals, teachers and students from your schools in this study. Their participation will involve completing a mail-in questionnaire and possibly a follow-up face-to-face interview. We are seeking their perspectives on the issues of access for Grades 11 and 12 science and mathematics students. Voluntary consent will be sought from all participants, and parental consent will be sought for students to participate. An Ethical Clearance has been sought and obtained from the UBC Behavioural Research Ethics Board. A copy of the Certificate of Approval is attached.

All participation is voluntary.

This study comprises a significant portion of the research for Wendy Nielsen's Master of Arts thesis. The findings of this study will enable us to better understand the complexities of small school life, particularly for students who want or need to take senior science and mathematics courses. We are also examining the linkages between issues of access and student success in these programs, highlighting the need for equitable distribution of rural specialist science and mathematics teachers.

Thank you most sincerely, in advance, for taking your most valuable time to consider this request. If you would like to receive a copy of the completed study, or have any questions, please contact Dr. Nashon at (604) 822-5315.

If you have any concerns regarding the study, you may contact the Office of Research Services at the University of British Columbia, at (604) 822-8598.

Sincerely,

Dr. Samson Nashon
Assistant Professor
Department of Curriculum Studies
Telephone: (604) 822-5315
Email: samson.nashon@ubc.ca

enclosure

Appendix F

Introduction Letter to Principal

Dear Sir/Madam:

Accessing Science and Mathematics Course Offerings: The Case of Rural BC High Schools

My name is Dr. Samson Nashon, an Assistant Professor in the Department of Curriculum Studies, Faculty of Education, at the University of British Columbia. With my research assistant, Wendy Nielsen, we are conducting a study into the issues of access faced by BC students in rural and small school settings, particularly in the subjects of senior sciences and mathematics.

We request that you voluntarily participate in the study. Your participation will involve completing a questionnaire, which seeks your perspectives on the issue, and a possible follow-up interview, should there be a need for clarification. Additionally, your permission is requested for us to access your senior science and mathematics teachers and students, through questionnaires and potential follow-up interviews.

This study comprises a portion of the research for the Master of Arts thesis for Wendy Nielsen. The findings of this study will enable us to better understand the complexities of small school life, particularly for students who want or need to take senior science and mathematics courses, and the linkages between issues of access for students and their success in their high school programs.

I look forward to hearing from you. If permission is granted, we would like to commence our study by 15 March 2003. If you would like a copy of the completed report, please advise Dr. Nashon and we will be happy to make one available for you.

Please feel free to contact Dr. Nashon at (604) 822-5315 with any questions you may have about this study.

If you have any concerns regarding the study, please contact the Office of Research Services at the University of British Columbia, at (604) 822-8598.

Sincerely,

Dr. Samson Nashon
Assistant Professor, Department of Curriculum Studies
Telephone; (604) 822-5315
Email: samson.nashon@ubc.ca

Appendix G

Introduction Letter to Teachers

Dear Sir/Madam:

Accessing Science and Mathematics Course Offerings: The Case of Rural BC High Schools

My name is Dr. Samson Nashon, an Assistant Professor in the Department of Curriculum Studies, Faculty of Education, at the University of British Columbia. With my research assistant, Wendy Nielsen, we are conducting a study into the issues of access faced by BC students in rural and small school settings, particularly in the subjects of senior sciences and mathematics.

We request that you voluntarily participate in the study by completing a questionnaire, which seeks your perspectives on issues of student access. If you agree to complete the questionnaire and would like to clarify your questionnaire responses in a follow-up interview, should there be a need, please complete the Interview Consent form at the end of the questionnaire.

Your participation is voluntary.

Please hand out the Student Packages (consisting of Parent Consent, Student Assent, Student Questionnaire and return envelopes) and assist in their collection and return to UBC in the large return envelope.

This study is being undertaken as part of the thesis research for Wendy Nielsen's Master of Arts program. The findings of this study will enable us to better understand the complexities of small school life, particularly the effects they might have for students who want or need to take senior science and mathematics courses and the linkages between issues of access and student success in these programs.

Thank you most sincerely, in advance, for your willingness to participate in this study. If you would like a copy of the completed report, please advise Dr. Nashon and we will be happy to make one available for you.

Please feel free to contact Dr. Nashon at (604) 822-5315 with any questions you may have about this study.

If you have any concerns regarding the study, please contact the Office of Research Services at the University of British Columbia, at (604) 822-8598.

Sincerely,

Dr. Samson Nashon
Assistant Professor, Department of Curriculum Studies

Appendix H

Introduction Letter to Parent

Dear Sir/Madam:

Research: Accessing Science and Mathematics Course Offerings: The Case of Rural BC High Schools

My name is Dr. Samson Nashon, Assistant Professor in the Department of Curriculum Studies, Faculty of Education at the University of British Columbia. With my research assistant, Wendy Nielsen, we are conducting a study into the issues of access faced by BC students in rural and small school settings, particularly in the subjects of senior sciences and mathematics.

We request that you permit your son or daughter to participate in this study. His or her participation will involve completing a mail-in questionnaire and possibly a follow-up face-to-face interview. We are seeking student perspectives on the issues of access for senior science and mathematics students. Your son or daughter will also be asked to consent to participate before filling out the questionnaire.

Your participation is voluntary.

This study comprises a significant portion of the research component for Wendy Nielsen's Master of Arts thesis. The findings of this study will enable us to better understand the complexities of small school life, particularly for students who want or need to take senior science and mathematics courses.

Thank you most sincerely, in advance, for your support in the conduct of this study.
If you would like to receive a copy of the completed study, or if you have any questions, please contact Dr. Nashon at 604-822-5315.

If you have any concerns regarding this study, you may contact the Office of Research Services at the University of British Columbia, at (604) 822-8598.

Sincerely,

Dr. Samson Nashon
Assistant Professor
Department of Curriculum Studies

Appendix I

PARENT CONSENT FORM

Accessing Science and Mathematics Course Offerings:
The Case of Rural British Columbia High Schools

Principal Investigator Dr. Samson Nashon, Assistant Professor
UBC Department of Curriculum Studies
(604) 822-5315

Co-investigator Wendy Nielsen, Research Assistant
UBC Department of Curriculum Studies
(604) 822-9526

This study constitutes a portion of the research for the Master of Arts thesis, and is being supported by a Research Assistantship through the Faculty of Education and the Office for Graduate Programs and Research.

Purpose

This study proposes to investigate teacher distribution and its effects on rural BC high school students' level of access to senior science and mathematics courses and participation rates on BC provincial examinations in science and mathematics.

This study will lead to a better understanding of the linkages between student access to senior science and mathematics courses and students' achievement on provincial examinations.

Study Procedures

Your son or daughter will be presented with a questionnaire that asks for responses to a series of questions. It is estimated that this will take 30 minutes to complete. Your son or daughterís teacher will arrange a suitable time for this to happen.

If you are willing to allow your son or daughter to participate in a follow-up, face-to-face interview subsequent to the questionnaire, please so indicate by completing the form at the end of the questionnaire. Participation is completely voluntary and your son or daughter may elect to withdraw from participating at any time. The follow-up interview may take up to 1 hour, and will be scheduled at your son or daughterís convenience in May 2003.

Your son or daughter will be asked to sign an ìAssent Formî, after you have given permission for him or her to participate. Your son or daughter can still decide not to participate even if you give your permission.

Confidentiality

Responses to the questionnaire will be kept in strictest confidence. Only the Principal Investigator, Dr. Nashon, and the Co-investigator, Wendy Nielsen, will have access to these documents. All documents and tape recordings will be identified by code number and kept in a locked cabinet. Transcribed interviews will also be coded so as to maintain privacy. Your son or daughter will not be identified by name in any reports of the completed study.

The Freedom of Information and Protection of Privacy Act of British Columbia protect rights to privacy. This Act lays down rules for the collection, protection, and retention of personal information by public bodies, such as the University of British Columbia. Further details about this Act are available upon request.

Contact for information about the study

If you have any questions or desire further information with respect to this study, you may contact Samson Nashon, at (604) 822-5315. You many also request a copy of the completed study.

Contact for information about the rights of research subjects:

If you have any concerns about your treatment or rights as a research participant, you may call the Office of Research Services at the University of British Columbia, at (604) 822-8598.

Consent

Your son or daughter's participation in this study is entirely voluntary and you may refuse to have him or her participate, or withdraw from the study at any time without any consequence.

Your signature below indicates that you have received a copy of this consent form for your own records, and agree to allow him or her to participate.

I consent/do not consent (circle one) to my child's participation in this study.

Signature	date	Please print your name here

Student Assent

Your participation in this study is entirely voluntary and you may refuse to participate, or withdraw from the study at any time without any consequence to your class standing.

Your signature below indicates that you have received a copy of this assent form for your own records, and that you are willing to participate in this part of the study.

Signature date Please print your name here

Appendix J

Interview Request Form

Detach this section and seal it in the small envelope labeled INTERVIEW.

.....

Fill in this section if you are willing to discuss and clarify your responses to the questionnaire during a follow-up interview. It is voluntary to complete this section and there will be no consequence for not completing this section or withdrawing from the interview process.

Please print your name _____

Signature _____ **Date** _____

Email: _____ **Telephone:** _____

Administrator Questionnaire, Page 6 of 6
Teacher Questionnaire, Page 5 of 5
Student Questionnaire, Page 5 of5

Answer the questions below by writing your responses in the spaces provided.

IT SHOULD TAKE YOU ABOUT 30 MINUTES TO COMPLETE THIS QUESTIONNAIRE. No identifying mark(s) should be placed on this questionnaire, so that your privacy can be assured.

IF YOU ARE WILLING TO DISCUSS YOUR QUESTIONNAIRE RESPONSES IN A 1 HOUR FOLLOW-UP INTERVIEW for any clarification of the information you have provided, should there be any need, please complete the section at the end of the questionnaire items. Detach the completed section and seal it in the small envelope labeled INTERVIEW. Put the completed questionnaire and the sealed small envelope in the large envelope provided for mail-in return.

The contact information you provide at the end of the questionnaire will be kept strictly confidential since only Dr. Nashon and his research assistant will open the envelope containing your completed questionnaire. This information will be used to arrange the follow-up interview. Once the interview arrangement is in place, the section regarding your identity will be shredded.

Place the completed questionnaire in the envelope provided, seal and return to UBC.

You may take not more than two weeks to return the completed questionnaire.

You are free to withdraw from this part of the study at any time.

Once again, thank you for your participation in this study.

Questions for Administrators

Is your school departmentalized? To what extent?

About what percent of your students go to university or college directly from high school?

Does your school have certificated subject specialists teaching senior science and mathematics courses?

To what extent is consistency in staffing a factor for student success in senior sciences and mathematics courses?

For student success, how important is the teacher's attitude toward the subject?

How important do you feel it is for the teacher in a senior level science or mathematics course to have a degree in the subject being taught?

What factors affect the activities of your science and mathematics programs?

For each subject listed, state the university major of the teacher(s) who currently teach(es) the course(s).

Science 8 _____
Science 9 _____
Science 10 _____
Mathematics 8 _____
Mathematics 9 _____
Mathematics 10 _____

How many sections of these courses are taught in a given school year at your school?

Earth Science 11 __	Biology 11 __	Chemistry 11 __	Physics 11 __	Math 11 __
Geology 12 __	Biology 12 __	Chemistry 12 __	Physics 12 __	Math 12 __
	Applications of Math 11 ___		Calculus 12 ___	
	Applications of Math 12 ___			

Thank you for completing the questionnaire. We appreciate your valuable time.

IT SHOULD TAKE YOU ABOUT 30 MINUTES TO COMPLETE THIS QUESTIONNAIRE. No identifying mark(s) should be placed on this questionnaire, so that your privacy can be assured.

IF YOU ARE WILLING TO DISCUSS YOUR QUESTIONNAIRE RESPONSES IN A 1 HOUR FOLLOW-UP INTERVIEW for any clarification of the information you have provided should there be any need, please complete the section at the end of the questionnaire. Detach the completed section and seal it in the small envelope labelled INTERVIEW. Put the completed questionnaire and the sealed small envelope in the large envelope provided for mail-in return. When your school's responses are completed, please seal the large envelope and return it to UBC.

The contact information you provide will be kept strictly confidential since only Dr. Nashon and his research assistant, Wendy Nielsen, will open the envelope containing your completed questionnaire. This information will be used to arrange the follow-up interview. Once the interview arrangement is in place, the section regarding your identity will be shredded.

Place the completed questionnaire in the envelope provided, seal, and together with other sealed envelopes from your school, put them in the common (large) one for mail return to UBC.

Questionnaire for Teachers

Please list the senior science and mathematics courses you have taught over the last 3 years and put a tick beside the courses that are outside of your degree/area of specialization.

How important do you think it is for students to take courses in a teacher-led environment, as opposed to distance learning, OSCAR or other models? Please give reasons for your answer.

How often have you supervised student teachers? How has this experience affected your practice?

How are your professional development needs supported?

How supportive is your parent group?

How are labs or projects used in your senior courses? To what extent do the students get to decide the purposes and aims of what they will study?

IT SHOULD TAKE YOU ABOUT 30 MINUTES TO COMPLETE THIS QUESTIONNAIRE. No identifying mark(s) should be placed on this questionnaire, so that your privacy can be assured.

IF YOU ARE WILLING TO DISCUSS YOUR QUESTIONNAIRE RESPONSES IN A 1 HOUR FOLLOW-UP INTERVIEW, should there be any need for any clarification of the information you have provided, please complete the section at the end of the questionnaire. Detach the completed section and seal it in the small envelope labeled INTERVIEW. Give the sealed small envelope with your questionnaire to your teacher, so that they can be sent back to UBC.

The contact information you provide at the end of the questionnaire will be kept strictly confidential since only Dr. Nashon and the research assistant will open the envelope containing your completed questionnaire. This information will be used to arrange the follow-up interview. Once the interview arrangement is in place, the section regarding your identity will be shredded.

Place the completed questionnaire in the envelope provided, seal, and return it to your teacher, who will then see to it that the student questionnaires returned to UBC.

Questions for Students

Does your school offer all of the courses you might like to take? If not, which ones are missing?

Being offered	Missing

How are students consulted when course offerings are changed?

Have you considered taking courses through Distance Learning? Why or why not?

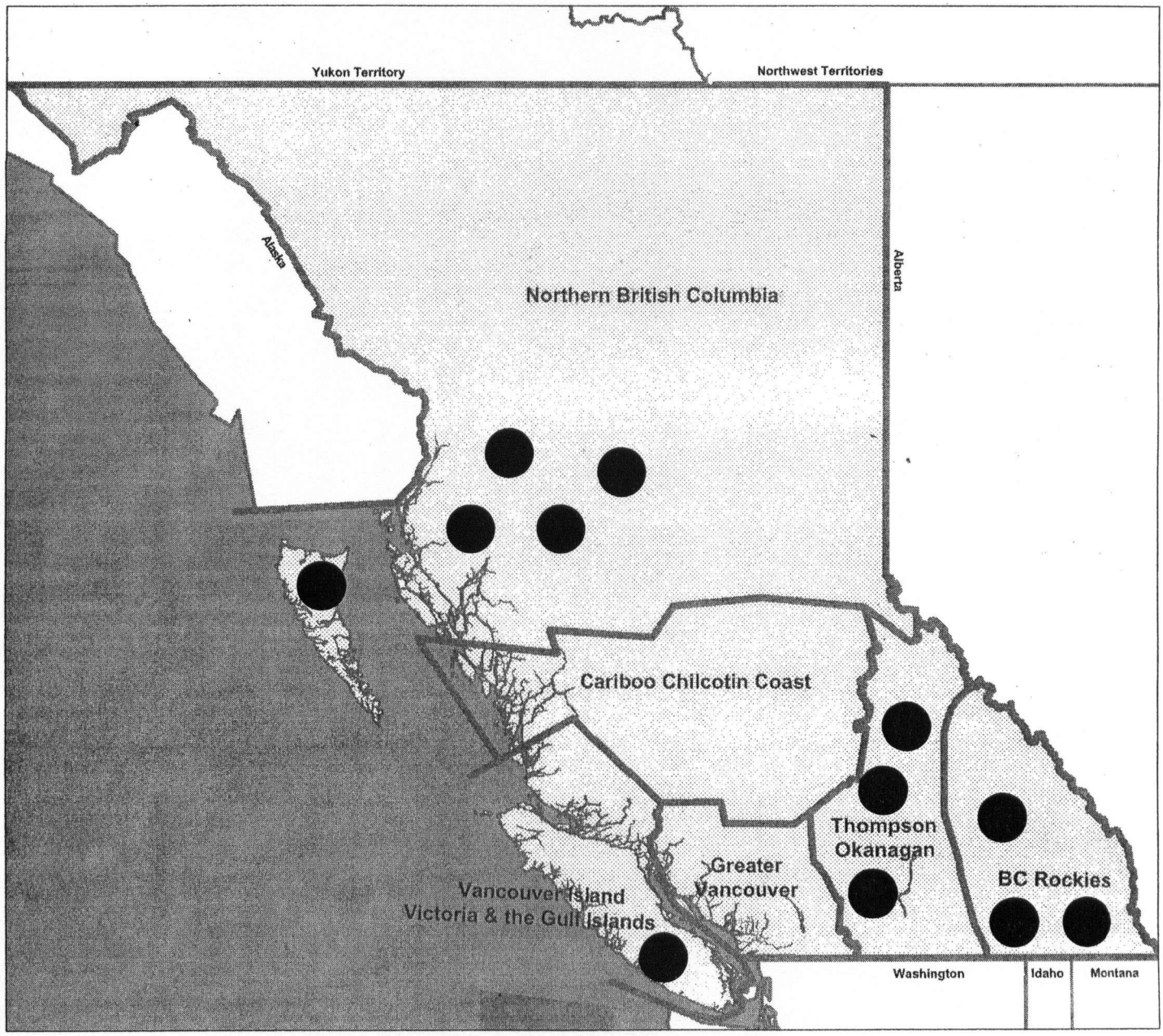
What influence have your teachers of grade 8, 9 or 10 subjects had on your decisions to take senior level science and mathematics courses?

What influence have counselors had on your decisions to take senior science and mathematics courses?

What do you consider to be some of the academic strengths and limitations of your small high school?

Appendix L

Map of 12 Participating Schools' Locations



Appendix M

Questions to guide face-to-face interviews with Principals and Teachers

A. What would you consider to be the conditions under which senior science and mathematics courses are offered in your small rural high school?

1. What do you see as the benefits of the small school for the learning environment?
2. What motivates students to take and/or do well in senior science and math courses?
3. What do you see as some factors which motivate teachers?
4. How available is outside help for students in senior science and math courses?
5. To what extent has the environment become "test-specific" in the schools?
6. Which pedagogical approaches are utilized in science and math programs?

B.What can you say about your working life as a senior science and math teacher in a rural BC high school?

1. What can you say about teachers' workloads in small and large high schools?
2. How often does your courseload change? under which circumstances?
3. What are some of the benefits of the small school size for teachers' work lives?
4. What options/choices are available for professional development?
5. How available are university and/or graduate level programs? What influences attendance at these types of programs?
6. How do student needs and expectations influence teachers' working lives?
7. What pressures are there around teacher evaluation? Do you see student performance on provincial exams as related to teacher evaluation?
8. How important a factor is shrinking enrolment? What stresses or challenges are felt? How is workload affected (directly or indirectly) by school closures?
9. What influence does staff stability have on the working lives of teachers?
10. What can you tell me about any additional pressures, besides teaching, in your small rural school setting?

C. How does the organizational structure of your rural setting impact the delivery of senior science and mathematics programs?

1. How does your departmentalized structure support the science and math programs?
2. What can you say about staff stability? How is it maintained?
3. What aspects of courses/programs/timetabling are flexible year-to-year while stability is maintained?
4. What can you say about other available resources to support senior science and math programs?
5. Who decides how course offerings are changed? How does this impact the learning environment?

6. What creative administrative arrangements are out there? Would you characterize the administrative structure as traditional?
7. How have moves toward cost efficiency affected administrative staff? district staff?
8. What can you say about the principal's role in staffing decisions?

D. How do students in schools such as yours make decisions about senior science and mathematics courses?

Courses

1. What can you say about the limitations faced by students with regards to course options?
2. What can you say about the limitations faced by students with regards to choice of teachers?
3. Are there choices of delivery mode? How does this affect decision-making?
4. Who assists students in their decision-making?
5. What do you see as the advantage afforded by the small school afford for student decision-making?

Post-secondary/Career decisions

1. What limitations are felt by students as they plan for post-secondary or career opportunities?
2. Who assists students in their decision-making about post-secondary?
3. How are student transitions supported? facilitated?
4. What can you say about how students consider their options for the future?
5. What can you say about post-secondary participation rates compared to post-secondary completion rates for rural kids? What factors influence these rates?

E. What would you consider to be unique about the way your school offers senior science and mathematics programs?

Questions to guide interviews with students

A. How do you view distance learning?

1. What is it about science and mathematics courses that students find unappealing or difficult to take in a distance learning environment?
2. Do you think this affects a student's career aspirations or goals? How?
3. Many students have said that they wouldn't consider distance ed (because they can take all the courses they want). How would this change if the courses weren't available at school?

B. What sorts of influences have you had in your choices to take senior science and mathematics courses?

1. What kinds of support or advice did your teachers of Grades 8-10 maths and sciences offer?
2. Have you taken senior courses with the teachers you had in junior science and math?
3. What role have your parents played in your choices to take senior sciences and maths?
4. In which other ways are your parents involved with your schoolwork?
5. What role does your community have in your school life?

C. What can you say about the availability of courses in the specialized subjects of senior science and mathematics?

1. Does the fact that a teacher is a subject specialist, or not, matter to you? How? Why?
2. How much does it matter that a teacher is experienced at teaching that subject?
3. What would you do if the course you wanted wasn't available at your school?
4. What other decisions do you make when deciding on a course of study?
5. Some have said that there is a teacher shortage coming. What do you think should be done to address this problem?

D. What are some of the factors of the learning environment of your senior science and mathematics courses?

1. What motivates you do to well in your courses?
2. Which types of support services do you have available both inside and outside of school for senior sciences and mathematics courses?
3. What can you say about why some students choose not to take senior sciences and maths?
4. Do you feel you should have more choice about what you study in your courses?
5. What is the nature of the relationship between your teachers and your parents?